

**LIGO VACUUM EQUIPMENT  
FINAL DESIGN REPORT**

**VOLUME II** *Part #*

**ATTACHMENT 5 SPECIFICATIONS/MISC.**

*LIGO-C960965-01-V*

<b>CONTRACT NO:</b>	<b>PC 175730</b>
<b>PSI DOCUMENT NO:</b>	<b>V049-1-097</b>
<b>PROGRAM I.D.</b>	<b>LIGO VACUUM EQUIPMENT</b>
<b>CDRL NO:</b>	<b>03</b>
<b>APPROVAL STATUS:</b>	<b>A</b>

**Process Systems International, Inc.  
20 Walkup Drive  
Westborough, MA 01581**

CALIFORNIA INSTITUTE OF TECHNOLOGY  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



**LIGO PROJECT**

Title:

**SPECIFICATION FOR LIGO CRYOGENIC CONTROL VALVES**

**6.0 SHOP TESTING**

6.1 The equipment shall be tested in accordance with the manufacturer's standard shop test.

**7.0 INSPECTION**

7.1 All testing and inspections called for in Attachment C (Specification V049-2-033, General Equipment Requirements) shall be performed by the vendor. Additional quality assurance requirements are listed in Attachment A, Quality Assurance Requirements Summary.

**8.0 WARRANTY**

8.1 Refer to Specification V049-2-034, Purchased Equipment Commercial Requirements (attached to the Request for Quotation), for warranty requirements.

**8.2 Performance Guarantee**

The valves must be sized to allow the specific flow rates while operating with the designated pressure drops.

SPECIFICATION		
Number		Rev.
A	V049-2-062	2

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

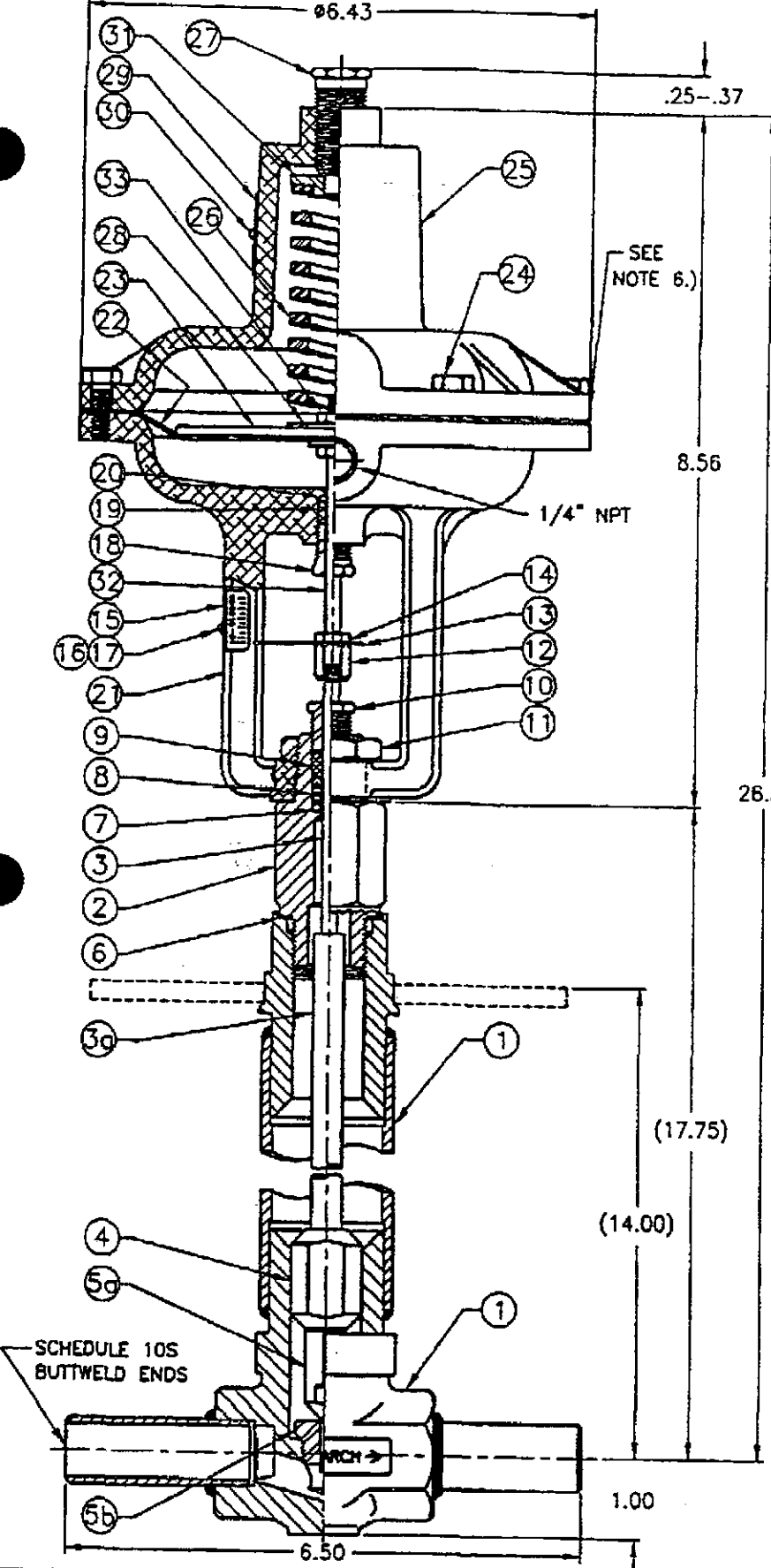
LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: CRYOGENIC CONTROL VALVES	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-062
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:  Inspector:  Date:
MILESTONE SCHEDULE	N/A		X		X	
VENDOR Q.A. PLAN	2		X	2	X	
CLEANING PROCEDURE	2		X	2	X	
PREP FOR SHIPMENT PROCEDURE	N/A		X		X	
ASSEMBLY DRAWINGS	4		X	2	X	
VALVE SIZING CALCULATION	*	X			X	PRIOR TO SHIPMENT.
IN-PROCESS INSPECTIONS	*			2	X	
OPERATION & MAINTENANCE MANUALS	8			5	X	
SHOP TEST PLAN	N/A		X	2	X	PRIOR TO RELEASE FOR FABRICATION.
SHOP TEST (WITH REPORT)	*			2	X	PRIOR TO RELEASE FOR SHIPMENT.
SHOP DIMENSIONAL INSPECTION	*			2	X	
WELDING PROCEDURES	4 WK		X	2	X	
* PER APPROVED VENDOR SCHEDULE						

**Title:**

**SPECIFICATION FOR LIGO CRYOGENIC CONTROL VALVES**

**Attachment B  
PSI Valve Data Sheets**

<b>SPECIFICATION</b>		
Number		Rev.
<b>A</b>	<b>V049-2-062</b>	<b>2</b>



PARTS & MATERIAL LIST				
QUANTITIES ARE FOR ONE (1) UNIT ONLY				
QTY	PART NO.	DESCRIPTION	MATERIAL	
1	527467-0001	BODY	316L SST	
2	527338-0001	BONNET	316 SST	
3	525614-0001	STEM	316 SST	
3a	522759-0001	STEM	316 SST	
4	525613-0001	CONNECTOR	316 SST	
5a	SEE NOTE 1	INNERVALVE	316 SST	
5b	SEE NOTE 1	SEAT	316 SST	
6	500240-0001	GASKET	316 SST	
7	520755-0017	ADAPTOR	PFA	
8	541548	PACKING SET	TFE	
9	520754-0001	FOLLOWER	PFA	
10	520794-0001	GLAND	316 SST	
11	520749	LOCKNUT	303 SST	
12	520391	CONNECTOR	303 SST	
13	510157	TRAVEL POINTER	300 SER SST	
14	410011	STEM NUT	316 SST	
15	520985-0002	TRAVEL SCALE	300 SER SST	
16	400001-0072	SCREW	300 SER SST	
17	430002-0022	FLAT WASHER	300 SER SST	
18	525026-0001	O-RING GLAND	316 SST	
19	522768	O-RING FOLLOWER	TFE	
20	490002-0001	O-RING	SLIDING RUBBER	
21	520987-0002	PRESS CASE & YOKE	ALUMINUM	
22	510154-0003	DIAPHRAGM	BUNA/ NYLON	
23	520388-0002	DIAPHRAGM PLATE	STEEL/ ZINC PL	
24	400029-0001	HEX HELIXM SCREW	300 SER SST	
25	520988-0002	SPRING CASE	ALUMINUM	
26	510031-0107	SPRING	STEEL	
27	522785-0001	SPRING ADJUSTOR	300 SER SST	
28	430002-0020	WASHER	300 SER SST	
29	512416-0002	NAMEPLATE	300 SER SST	
30	400018-0012	DRIVE SCREW	300 SER SST	
31	520388-0001	SPRING SEAT	ALUMINUM	
32	520993	TOPWORKS STEM	316 SST	
33	410030-0002	LOCKNUT	300 SER SST	

- NOTES:
- 1.) TRIM ASS'Y P/N: 540366-0001  
INNERVALVE TO SIZE AND CHARACTERISTIC SPECIFIED.  
(SIZE J Cv 0.05 CHAR. LINEAR)  
ITEM 5a & 5b SOLD AS A SINGLE TRIM SET.  
TRIM SET & GASKET ITEM#6 ARE OPTIONAL SPARE PARTS.
  - 2.) NOMINAL STROKE - .562
  - 3.) INSTRUMENT SIGNAL RANGE 3-15 PSI
  - 4.) RECOMMENDED SPARE PARTS ARE ITEMS 20, 22 & 26. ADDITIONAL RECOMMENDED SPARE PART IS PACKING KIT PART NO. 543801-0001 (INCLUDES ITEMS 7, 8 & 9)
  - 5.) WHEN ORDERING SPARE OR REPLACEMENT PARTS, PROVIDE FACTORY THE VALVE ASSEMBLY SERIAL NUMBER AND ALL OTHER NAMEPLATE DATA.
  - 6.) FURNISHED WITH ECKARDT 4-20 mA POSITIONER & GO SWITCH (MODEL# 7G-23523-A1) TO INDICATE CLOSED PER DWG CD-952107.

PRINT CERTIFIED FOR: **PROCESS SYSTEMS INTERNATIONAL**  
 P.O. #: 555781-00  
 LOCATION: WESTBOROUGH, MA  
 SERIAL NUMBER: 223915 THRU 223926 TAG NO: NONE  
 BADGER BY: *Doolittle* DATE: 2-20-96

1.1 926908		DPC 10-9-96		DRAWN DESIGNED DATE 2-20-96 SCALE NONE SHT 1 OF 1 ISSUE MATERIAL AS SPECIFIED	
BADGER METER RESEARCH CONTROL VALVES				DWG. NAME: 1/2" BODY/ BONNET CBX STYLE ASSEMBLY 14" EXTENSION WITH SCHEDULE 10S BUTT WELD NIPPLES & ATO TOPWORKS	
				DWG. NO: CD-952106	

V049-L-062, Rev 2 Attachment B Pg 3 of 3

**INSTRUMENTS, PRIMARY ELEMENTS AND CONTROL VALVES**

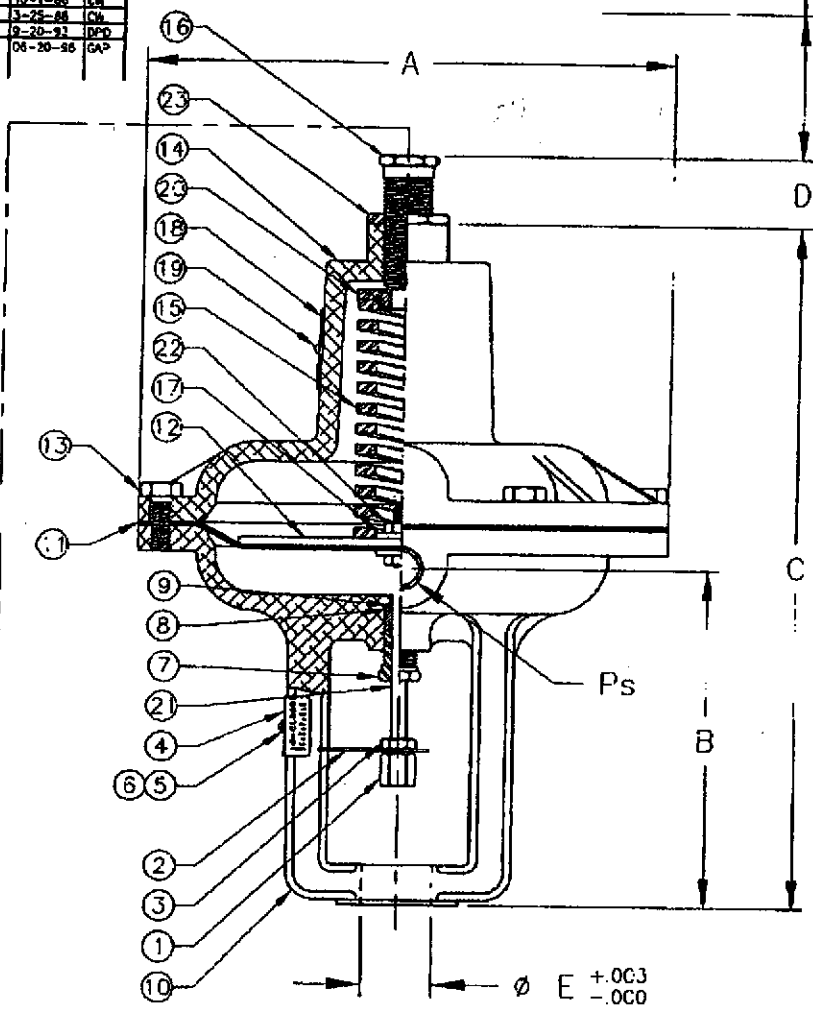
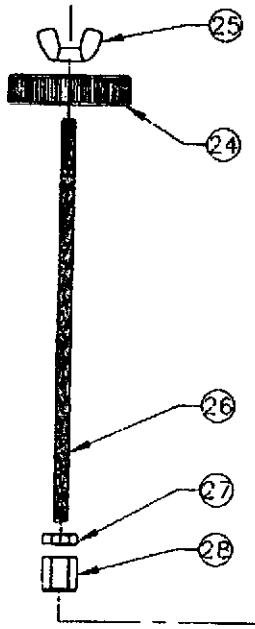
PSI S20	PROJECT <u>LIGO</u> UNIT <u>80K Pump</u> P.O. _____ ITEM _____ CONTRACT _____ MFR SERIAL* _____	Data Sheet <u>1</u> of <u>1</u> SPEC <u>V049-2-062</u> TAG _____ DWG <u>V049-0-006</u> SERVICE _____					
1	Fluid <u>Liquid Nitrogen</u>	Crit Pres PC <u>492.28 psia</u>					
	Units	Max. Flow	Norm Flow	Min. Flow			
	SERVICE CONDITIONS	LIQUID	VAPOR	LIQUID	VAPOR		
2	Flow Rate	(lbm/hr.) <u>31.41</u>		<u>9.00</u>			
3	Inlet Pressure	<u>5-13 psig</u>					
4	Outlet Pressure	<u>0.5 psig</u>					
5	Inlet Temperature	<u>-312°F</u>					
6	Spec Wt/Spec Grav/Mol Wt						
7	Viscosity/Spec Heats Ratio	cP <u>.128</u>	<u>.0056</u>	<u>.128</u>	<u>.0056</u>		
8	Vapor Pressure Pv	<u>24.7 psia</u>					
9	*Required Cv		<u>.031</u>		<u>.009</u>		
10	*Travel	%					
11	Allowable SPL	dBA					
11	*Predicted SPL	dBA					
12	LINE: <u>LN2 SUPPLY</u>	ACTUATOR:					
13	Pipe Line Size / In <u>1/2"</u> <u>Sch 10S</u>	53	*Type <u>Cylinder</u>				
14	& Schedule / Out <u>1/2"</u> <u>Sch 10S</u>	54	*Mfr & Model _____				
15	Pipe Line Insulation <u>fiberglass liner with foam outer covering</u>	55	*Size _____ Eff Area _____				
	VALVE BODY/BONNET:	56	On/Off _____ Modulating <u>YES</u>				
16	*Type <u>Globe</u>	57	Spring Action Open/Close <u>F.C.</u>				
17	*Size _____ ANSI Class <u>150</u>	58	*Max Allowable Pressure _____				
18	Max Press/Temp <u>50</u> psig / <u>302</u> F	59	*Min Required Pressure _____				
19	*Mfr & Model _____	60	Available Air Supply Pressure:				
20	*Body/Bonnet Matl <u>SS</u> / <u>SS</u>	61	Max <u>80</u> psig Min _____				
21	*Liner Material/ID _____ / _____	62	*Bench Range _____ / _____				
22	End / In <u>B.W.</u>	63	Act Orientation _____				
23	Connection / Out <u>B.W.</u>	64	Handwheel Type _____				
24	Flg Face Finish _____	65	Air Failure Valve _____ Set at _____				
25	End Ext/Matl _____ / _____	66					
26	*Flow Direction _____	67	*Input Signal (psig) <u>4 to 20 mA</u>				
27	*Type of Bonnet <u>extended stem</u>		POSITIONER:				
28	Lub & Iso Valve _____ Lube _____	68	*Type <u>Electro - pneumatic</u>				
29	*Packing Material _____	69	*Mfr & Model _____				
30	*Packing Type _____	70	*On Incr Signal Output Incr/Decr _____				
31		71	Gauges _____ By-pass _____				
	TRIM: <u>see attached for further info.</u>	72	*Cam Characteristics _____				
32	*Type _____	73	*Input signal _____ (psig) _____				
33	*Size <u>J</u> Rated Travel _____		SWITCHES:				
34	*Characteristics <u>linear</u>	74	Type <u>limit</u> Quantity <u>1</u>				
35	*Balanced/Unbalanced _____	75	*Mfr & Model _____				
36	*Rated Cv <u>.05</u> FI _____ Xt _____	76	Contacts/Rating _____				
37	*Plug/Ball Material <u>316 S.S.</u> / _____	77	Actuation Points <u>valve closed</u>				
38	*Disk Material _____	78					
39	*Seat Material <u>316 S.S.</u>		AIR SET:				
40	*Cage/Guide Material _____	79	*Mfr & Model <u>Conoflow GFH85</u>				
41	*Stem Material <u>316 S.S.</u>	80	*Set Pressure _____				
42		81	Filter _____ Gauge _____				
	SPECIALS/ACCESSORIES:	82					
43	NEC Class _____ Group _____ Div _____		TESTS:				
44	NOTES:	83	*HydroPressure _____				
45	<u>1. Flashing service</u>	84	ANSI/FCI Leakage Class _____				
46		85	Max. Shutoff Diff. Press. _____ (psi) _____				
47		86					
48			Rev.	Date	Revision	Orig	App.
49			0	2/28/96		DM	
50			1	9/19/96		DM	
51							
52							

V049-2-062, Attachment B  
Rev 2 Page 2 of 8

\* Information supplied by manufacturer unless already specified.

REV	DESCRIPTION	DATE	BY
1	NEW	11-8-85	GAP
2	ECN 6641	10-1-86	CK
3	ECN 7192	3-25-88	CK
4	ECN 8212 CAD REDRAW	9-20-91	DPD
5	CAD REDRAW	06-20-98	GAP

F (ADD FOR HANDWHEEL)



	DIMENSIONS	
	1/4" ACTUATOR	1/2" ACTUATOR
P.S.	1/8" NPT	1/2" NPT
A	5.12	6.43
B	3.34	4.29
C	6.59	8.5E
D	.18-.31	.25-.37
E	.625	.875
F	1.00	1.18

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES AND DECIMALS THEREOF.  
 Dwg No. **CD-950754** DATE **01.05**

PARTS & MATERIAL LIST					
QUANTITIES ARE FOR ONE (1) UNIT ONLY					
ITEM NO.	1/4" PART NO.	1/2" PART NO.	QTY	DESCRIPTION	MATERIAL
1	520997	520391	1	CONNECTOR	300 SER SST
2	510252	510157	1	TRAVEL POINTER	300 SER SST
3	410099	410011	1	STEM NUT	300 SER SST
4	520636-0002	520985-0002	1	TRAVEL SCALE	300 SER SST
5	400C01-0072	400001-0072	1	SCREW	300 SER SST
6	430C02-0022	430002-0022	1	WASHER	300 SER SST
7	525C25-0031	525026-0001	1	SLAND	300 SER SST
8	522761	522768	1	FOLLOWER	TFE
9	511826	490002-0001	1	O-RING	SILICONE RUBBER
10	520995-0002	520987-0002	1	PRESS CASE & YONG	ALUMINUM
11	510261-0001	51054-0003	1	DIAPHRAGM	BLANK NYLON
12	520994-0001	520386-0002	1	DIAPHRAGM PLATE	STEEL ZNC P.
13	430029-0003	400029-0001	6	RIM SCREWS	300 SER SST
14	520996-0002	520988-0002	1	SPRING CASE	ALUMINUM
15	510051-0040	510051-0107	1	SPRING	STEEL
16	520990-0002	520390-0003	1	SPRING ADJUSTOR	300 SER SST
17	430C32-0037	430002-0020	2	WASHER	300 SER SST
18	512416-0002	512416-0002	1	NAMEPLATE	300 SER SST
19	400018-0002	400C18-0012	2	DRIVE SCREW	300 SER SST
20	520991-0001	520366-0001	1	SPRING SEAT	ALUMINUM
21	520992	520993	1	STEM	316 SST
22	410030-0001	410030-0002	2	LOCKNUT	300 SER SST
23	410061-0052	522615	1	LOCKNUT, ADJUSTOR	300 SERIES SST
24	522762-0002	522762-0001	1	HANDWHEEL	BRASS
25	410064-0004	410064-0005	1	WINGNUT	300 SERIES SST
26	521271	520389-0001	1	STEM, HANDWHEEL	300 SERIES SST
27	410069	410011	1	NUT	300 SERIES SST
28	520997	520391	1	CONNECTOR	300 SERIES SST

- NOTES:
1. RECOMMENDED SPARE PARTS ARE ITEMS 9, 11 & 15.
  2. WHEN ORDERING REPLACEMENT PARTS, PROVIDE FACTORY THE VALVE SERIAL NUMBER FROM THE NAMEPLATE ON THE ACTUATOR.
  3. ITEMS 23 THRU 28 ARE OPTIONAL EQUIPMENT AVAILABLE AT EXTRA COST - SPECIFY MANUAL HAND-WHEEL WHEN DESIRED.

THIS PRINT CERTIFIED FOR: \_\_\_\_\_

P.O.: \_\_\_\_\_

LOCATION: \_\_\_\_\_

SERIAL NUMBER: \_\_\_\_\_ TAG NO: \_\_\_\_\_

BADGER BY: \_\_\_\_\_ DATE: \_\_\_\_\_

VALVE SPECIFICATIONS

**BADGER METER**

RESEARCH CONTROL VALVES

1/4" & 1/2" STANDARD ATO TOPWORKS

DATE: 5-9-83

PROJECT NO: 29

REV: CD-950754

DATE: 6-21-96

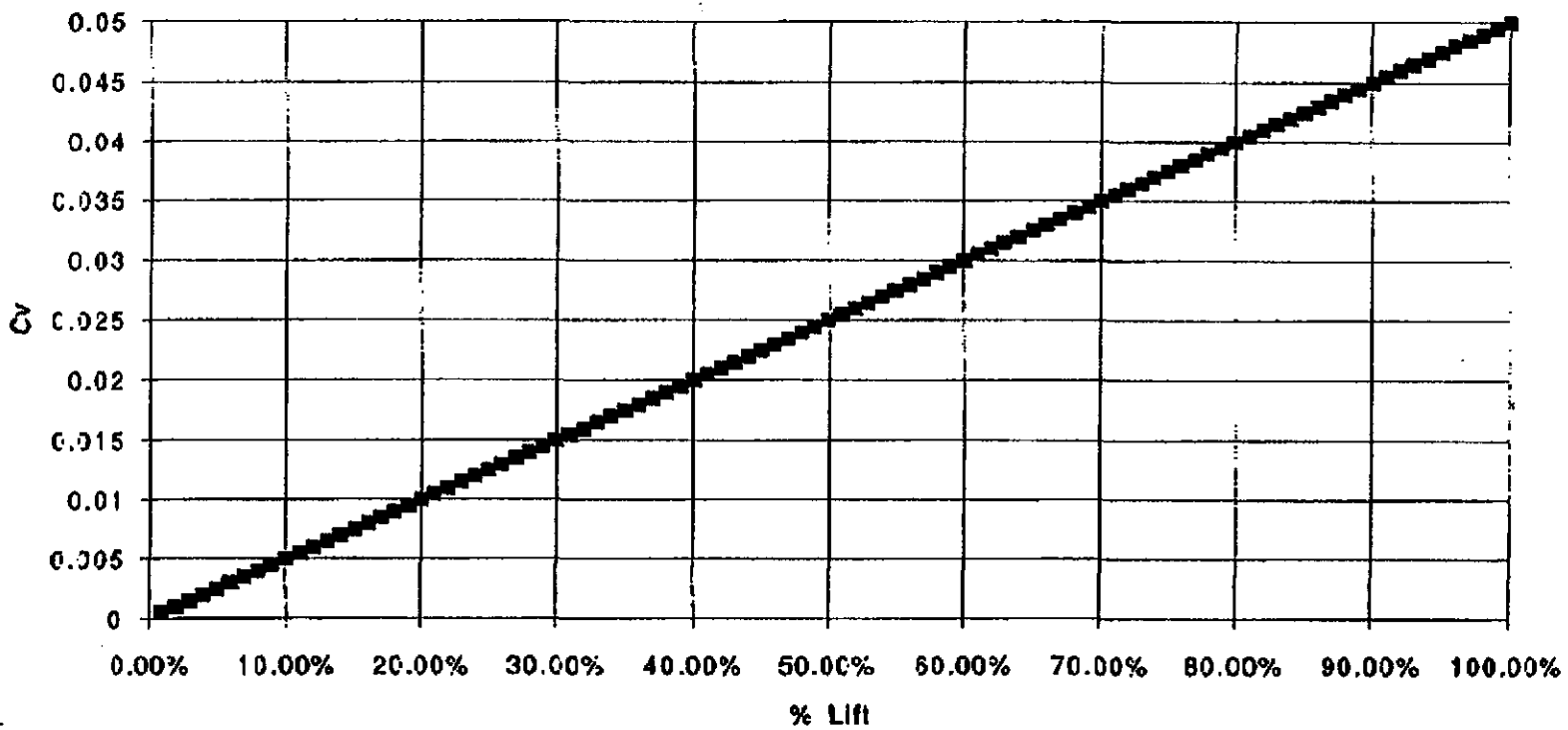
SCALE: 1/1

PER 941312

1 OF 1

VO44-2-062, Rev 2  
 Attachment B  
 Page A of 3

### "J" LINEAR



V049-2-062, Rev 2  
Attachment B  
Pg 5 of 20



"J" LINEAR

.05 CV MAX.

CV%	TRAVEL %	CV
1.00%	1.00%	0.0005
2.00%	2.00%	0.001
3.00%	3.00%	0.0015
4.00%	4.00%	0.002
5.00%	5.00%	0.0025
6.00%	6.00%	0.003
7.00%	7.00%	0.0035
8.00%	8.00%	0.004
9.00%	9.00%	0.0045
10.00%	10.00%	0.005
11.00%	11.00%	0.0055
12.00%	12.00%	0.006
13.00%	13.00%	0.0065
14.00%	14.00%	0.007
15.00%	15.00%	0.0075
16.00%	16.00%	0.008
17.00%	17.00%	0.0085
18.00%	18.00%	0.009
19.00%	19.00%	0.0095
20.00%	20.00%	0.01
21.00%	21.00%	0.0105
22.00%	22.00%	0.011
23.00%	23.00%	0.0115
24.00%	24.00%	0.012
25.00%	25.00%	0.0125
26.00%	26.00%	0.013
27.00%	27.00%	0.0135
28.00%	28.00%	0.014
29.00%	29.00%	0.0145
30.00%	30.00%	0.015
31.00%	31.00%	0.0155
32.00%	32.00%	0.016
33.00%	33.00%	0.0165
34.00%	34.00%	0.017
35.00%	35.00%	0.0175
36.00%	36.00%	0.018
37.00%	37.00%	0.0185
38.00%	38.00%	0.019
39.00%	39.00%	0.0195
40.00%	40.00%	0.02
41.00%	41.00%	0.0205

VOA9-2-062, Rev 2  
Attachment B  
Pg 6 of 3

42.00%	42.00%	0.021
43.00%	43.00%	0.0215
44.00%	44.00%	0.022
45.00%	45.00%	0.0225
46.00%	46.00%	0.023
47.00%	47.00%	0.0235
48.00%	48.00%	0.024
49.00%	49.00%	0.0245
50.00%	50.00%	0.025
51.00%	51.00%	0.0255
52.00%	52.00%	0.026
53.00%	53.00%	0.0265
54.00%	54.00%	0.027
55.00%	55.00%	0.0275
56.00%	56.00%	0.028
57.00%	57.00%	0.0285
58.00%	58.00%	0.029
59.00%	59.00%	0.0295
60.00%	60.00%	0.03
61.00%	61.00%	0.0305
62.00%	62.00%	0.031
63.00%	63.00%	0.0315
64.00%	64.00%	0.032
65.00%	65.00%	0.0325
66.00%	66.00%	0.033
67.00%	67.00%	0.0335
68.00%	68.00%	0.034
69.00%	69.00%	0.0345
70.00%	70.00%	0.035
71.00%	71.00%	0.0355
72.00%	72.00%	0.036
73.00%	73.00%	0.0365
74.00%	74.00%	0.037
75.00%	75.00%	0.0375
76.00%	76.00%	0.038
77.00%	77.00%	0.0385
78.00%	78.00%	0.039
79.00%	79.00%	0.0395
80.00%	80.00%	0.04
81.00%	81.00%	0.0405
82.00%	82.00%	0.041
83.00%	83.00%	0.0415
84.00%	84.00%	0.042
85.00%	85.00%	0.0425
86.00%	86.00%	0.043
87.00%	87.00%	0.0435

V099-2-062, Rev. 2  
Attachment B  
Pg 7 of 5

88.00%	88.00%	0.044
89.00%	89.00%	0.0445
90.00%	90.00%	0.045
91.00%	91.00%	0.0455
92.00%	92.00%	0.046
93.00%	93.00%	0.0465
94.00%	94.00%	0.047
95.00%	95.00%	0.0475
96.00%	96.00%	0.048
97.00%	97.00%	0.0485
98.00%	98.00%	0.049
99.00%	99.00%	0.0495
100.00%	100.00%	0.05

V049-2-062  
 Rev. 2  
 Attachment B  
 Pg 8 of 8

Title: SPECIFICATION FOR FABRICATION of BAKEOUT CONTROL SYSTEM CABINET

**SPECIFICATION FOR  
FABRICATION of BAKEOUT CONTROL SYSTEM CABINET  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** *DAF / Daniel J. Parente*

**ELECTRICAL :** *Fred Bork*

**QUALITY ASSURANCE:** *Alan L. Brudlock*

**TECHNICAL DIRECTOR:** *D. A. Miller*

**PROJECT MANAGER:** *Bob Berg*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

5	BAR 10/14/96	A 27 10/31/96	CHANGED DWG. REVISION NUMBERS. DEC 0304
4	BAR	D.W. 7-27-96	Added 2040's TO DWG 97 PER DEC 0291
3	BAR 7/30/96	MB 8-1-96	ISSUED FOR "AS-BUILT" CHANGES DEC #0231
2	BAR 5/1/96	FAB 5-13-96	ISSUED FOR DESIGN/REV. CHANGES DEC #0181
1	PPS	FAB 3-26-96	ISSUED FOR PURCHASE, DEC #095
0			ISSUED PER BID DEC #089
REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>			<b>SPECIFICATION</b>
INITIAL APPROVALS	PREPARED	DATE	APPROVED
	PPS	3/12/96	D Miller 3.12
			Number
			V049-2-068
			Rev.
			5

TABLE OF CONTENTS

1 SCOPE OF WORK . . . . . 3

2 DRAWING AND SPECIFICATION INTENT . . . . . 3

3 DEFINITIONS . . . . . 3

4 EXCEPTIONS . . . . . 4

5 CODES AND STANDARDS . . . . . 4

6 LABELED EQUIPMENT . . . . . 4

7 INSTALLATION RESTRICTIONS . . . . . 4

8 SPECIFIED EQUIPMENT AND SUBSTITUTIONS . . . . . 4

9 WIRING SYSTEMS . . . . . 5

10 TESTING . . . . . 7

11 INSPECTION . . . . . 7

12 RELEASE FOR SHIPMENT . . . . . 7

13 WARRANTY . . . . . 8

14 RECORD DRAWINGS . . . . . 8

15 EQUIPMENT DELIVERY SCHEDULE . . . . . 8

— APPENDIX I—DRAWING LIST / CART . . . . . 9

— APPENDIX II—ITEMS FURNISHED BY BUYER / CART 10

— APPENDIX III—BILL OF MATERIALS / CART . . . . . 11

— ATTACHMENT A: PAINTING REQUIREMENTS

<b>SPECIFICATION</b>	
Number	Rev
<b>A V049-2-068</b>	<b>5</b>

**1 SCOPE OF WORK**

This specification establishes minimum requirements for material, fabrication, documentation, packing, and shipping to Process Systems International, Westborough, MA. of the control system cabinet(s) in accordance with drawings and attachments.

**2 DRAWING AND SPECIFICATION INTENT**

- 2.1 Intent of the Drawings and Specifications is to assist and guide the Vendor and to establish minimum requirements.
- 2.2 Drawings indicate arrangement and approximate location of components.
- 2.3 Comply with specific, detailed requirements indicated in lieu of generally stated requirements.
- 2.4 Portions of these Drawings and Specifications are abbreviated and may include incomplete statements. Infer the omitted words or phrases such as "the Vendor shall", "shall be", "as indicated on the drawings", "in accordance with details", "a", "the", and "all".
- 2.5 Drawings and Specifications do not undertake to indicate every item necessary to produce a complete installation of the Work indicated or specified.

**3 DEFINITIONS (ALSO SEE THE GENERAL CONDITIONS)**

- By Others Work not under this Contract.
- Indicated Shown or noted.
- Install Place, secure, and connect.
- Labeled Approved by nationally recognized testing company.
- Permitted As by code, Contract Documents, or Buyer.
- Provide Furnish and install.
- Buyer Process Systems International (PSI).
- Required As by code or Contract Documents.
- Submittal Information required to show that the proposed equipment meets project requirements.
- Use Provide material or equipment referenced.
- Vendor Successful bidder accepting responsibility for equipment fabrication.
- Work Material, equipment and fabrication and other requirements as established in the Contract Documents.

<b>SPECIFICATION</b>	
Number	Rev
<b>A V049-2-068</b>	<b>5</b>

Wire (Verb) Connect to equipment indicated and provide wiring required for connection.

Wiring Conductors, raceways, and accessories as required for a complete installation.

**4 EXCEPTIONS**

Exceptions to the specification shall be specifically brought out under a schedule titled, "Schedule of Deviations". In the absence of the "Schedule of Deviations," it shall be deemed that the Vendor's offer is fully in compliance with this specification.

**5 CODES AND STANDARDS**

5.1 Comply with requirements of NFPA 70 (NEC) and NFPA 79 (Electrical Standard for Industrial Machinery).

5.2 The Drawings and Specifications do not undertake to repeat requirements written in the above code and standard.

**6 LABELED EQUIPMENT**

Provide labeled equipment where recognized national testing company standards, such as UL, exist.

**7 INSTALLATION RESTRICTIONS**

7.1 Arrange and install equipment in accordance with the manufacturer's specifications and as indicated on Drawings.

7.2 Permanently install a cabinet designation nameplate in a conspicuous location as indicated on Drawings.

7.3 Label equipment with designation as indicated. Use adhesive backed labels with 1/8" high lettering as applicable.

7.4 Label terminal strips as indicated using manufacturer's printed terminal strips labels.

**8 SPECIFIED EQUIPMENT AND SUBSTITUTIONS**

8.1 The manufacturer of the equipment specified is used as the basis of the design and to establish quality required for this project.

8.2 The description following a catalog number is basically to identify the product, but it may also call for accessories, options, and modifications which are beyond the cataloged product.

8.3 Submit proposed substitutions to Buyer for acceptance. With submittal, provide details of necessary changes to accommodate substitutions. Submit samples if requested.

<b>SPECIFICATION</b>	
Number	Rev
<b>A V049-2-068</b>	<b>5</b>

9 WIRING SYSTEMS

9.1 POWER WIRE, 480 & 277 VAC

9.1.1 Provide #14 AWG or larger single, stranded copper, type MTW, conductors rated 90°C, 600 volts unless otherwise specified.

9.1.2 Use colored coded insulation in sizes up to #8 AWG, except up to #6 AWG for grounding conductors, and black insulated conductors in larger sizes (see WIRING IDENTIFICATION).

9.1.3 See TESTING.

9.2 CONTROL WIRING, 120 VAC

9.2.1 Provide #16 AWG or larger single, stranded copper conductors with Type MTW insulation rated for 90°C and 600 volts unless otherwise indicated. Install conductors in wireway marked "AC WIREWAY" as indicated.

9.2.2 Use colored coded insulation (see WIRING IDENTIFICATION).

9.2.3 See TESTING..

9.3 CONTROL WIRING, 24 VDC (discrete signals)

9.3.1 Provide #18 AWG or larger single, stranded copper conductors with Type MTW insulation rated for 90°C and 600 volts unless otherwise indicated. Install conductors in wireway marked "DC WIREWAY" as indicated.

9.3.2 See TESTING..

9.4 INSTRUMENT WIRING

9.4.1 4-20mA analog signals: Provide #18 AWG stranded copper, shielded twisted pair, single or multi-pair cables as indicated, rated 90°C and 300 volts. Install in wireway marked "DC WIREWAY" as indicated.

9.4.2 Thermocouple: Provide #20 AWG ANSI type JX, solid thermocouple extension cable shielded, rated 105°C and 300 volts.

9.4.3 See TESTING.

9.5 WIRING IDENTIFICATION

9.5.1 Power Wiring

9.5.1.1 Color code 480/277 volt conductors as follows:

- line A . . . . . brown
- line B . . . . . orange
- line C . . . . . yellow
- neutral . . . . . gray
- ground . . . . . green

<b>SPECIFICATION</b>	
Number	Rev
<b>A V049-2-068</b>	<b>5</b>



9.5.2 Control Wiring

9.5.2.1 Color code 208/120-volt conductors as follows:

- 120 VAC—line . . . . . red
- 120 VAC—neutral . . . . . white
- 24 VDC . . . . . blue
- ground . . . . . green

9.5.2.2 Identify each single conductor at each end with indicated wire number or designation. Use self laminating, printed, Brady type wire marker.

9.5.3 Instrument Wiring

9.5.3.1 Shielded twisted pair cables shall have one black and one white conductor.

9.5.3.2 Identify each cable end with indicated cable number or designation. Use self laminating, printed, Brady type wire marker.

9.6 WIRING INSTALLATION

9.6.1 Provide sufficient wire length to permit grouping and training the wires and cables. Where applicable, use self-locking nylon wire ties; cut off loose ends. Take care not to exceed manufacturer's wire bending radii. Do not allow wiring to bear against edges of enclosures. Replace wiring cut too short to meet installation requirements.

9.7 WIRING TERMINATIONS AND CONNECTORS

9.7.1 Power Wiring

9.7.1.1 Where more than one conductor requires termination and terminals are not provided as part of the equipment, provide screw or pressure type insulated terminal blocks.

9.7.1.2 Tighten screw type hardware in accordance with manufacturer's published torque values. If not available, comply with UL 486A standards.

9.7.2 Control Wiring

9.7.2.1 Where more than one conductor requires termination and terminals are not provided as part of the equipment, provide screw or pressure type insulated terminal blocks.

9.7.2.2 Install stripped wire ends into terminal and tighten to manufacturers specifications. Do not install more than two wires in any one terminal point.

9.7.2.3 Remove insulation from ends of conductors using mechanical or electric heat type stripper.

9.7.3 Instrument Wiring

9.7.3.1 Where shielding is noted as "CUT AND TAPE", shielding shall be cut back and shall not be visible, or protrude from insulating sleeve.

9.7.3.2 Coil, insulate, and label ends of spare conductors.

9.7.3.3 Remove insulation from ends of conductors using mechanical or electric heat type stripper.

<b>SPECIFICATION</b>	
Number	Rev
<b>A V049-2-068</b>	<b>5</b>

9.8 EQUIPMENT GROUNDING CONDUCTORS

- 9.8.1 Where a ground lug is attached to a painted panel, remove paint under lug prior to the installation of ground lug.
- 9.8.2 If a grounding stud or existing panel mounting bolt is used, secure grounding conductor with ring type compression terminal, star type washer between the panel and grounding terminal, and hex nut.

10 TESTING

- 10.1 No equipment shall be energized without consent of the Buyer.
- 10.2 It is the Vendor's responsibility to conduct tests without damage to equipment.

10.3 CONTROL AND INSTRUMENT WIRE TESTING

- 10.3.1 Check point-to-point continuity of each conductor to ensure that wiring is intact and terminated at the proper place at both ends.
- 10.3.2 Verify wire connections are made in accordance with terminal wiring diagrams and schedules.
- 10.3.3 Using highlighter (transparent marker), indicate on terminal wiring diagram sheets that each wire and connection has been verified. Make these sheets available to Buyer.
- 10.3.4 Replace defective wiring and retest.

10.4 RECEPTACLES TESTING

Test polarity and grounding of each receptacle device.

10.5 SCHEDULING, NOTIFYING, AND WITNESSING TESTING

Provide the Buyer with at least seven days notification of scheduled testing. With the notification, include a list of proposed tests and the expected time to perform these tests.

11 INSPECTION

The responsibility for inspection rests with the manufacturer; however, Buyer reserves the right to review equipment at any time during fabrication to assure that the materials and workmanship are in accordance with this specification and the code.

12 RELEASE FOR SHIPMENT

The Vendor shall have a signed "Release for Shipment" form provided by the Buyer's Quality Assurance representative prior to full or partial shipment of product.

**SPECIFICATION**

Number

**A V049-2-068**

Rev

**5**

**13 WARRANTY**

The construction of equipment shall be performed in the highest manner of workmanship using only new and unused top quality materials. The equipment shall be guaranteed against defects in materials and workmanship for a period of one year from the date of placement in service.

**14 RECORD DRAWINGS**

Maintain a set of prints marking them to accurately reflect the actual fabrication. Deliver the set of marked prints to Buyer prior to shipment.

**15 EQUIPMENT DELIVERY SCHEDULE**

One cart is required May 17, 1996 :

**SPECIFICATION**

Number	Rev
<b>A V049-2-068</b>	<b>5</b>

**APPENDIX I**

DRAWING LIST / CART

**GENERAL INFORMATION DRAWINGS**

V049-3-014 Rev 2 PLC/PC/Data Acquisition Layout

**CABINET LAYOUT DRAWINGS**

V049-3-013 Rev 5 Assembly, Heater Control Cart (7 sheets)

**CABINET SCHEMATIC DRAWINGS**

V049-3-011 Rev 2 Elect Schematic, Control System (9 sheets)

V049-3-012 Rev 3 Elect Schematic, Heater Power (2 sheets)

**SPECIFICATION**

Number	Rev
<b>A V049-2-068</b>	<b>5</b>

**APPENDIX II**

ITEMS FURNISHED BY BUYER / CART

**Allen-Bradley PLC Equipment**

- (1) 1771-A3B1 12 Slot Chassis
- (1) 1785-L30B PLC 5/30
- (1) 1771-DMC Co-Processor Module
- (1) 1771-DRS1 1 MEG memory expansion for 1771-DMC
- (1) 1784-KTX DH+ PC Interface Module
- (1) 1771-CP1 Power Supply Cable
- (1) 1771-P7 16 Amp Power Supply
- (8) 1771-OAD 120 VDC 16 Point Output Module
- (1) 1771-IAD 120 VDC 16 Point Input Module

**Personnel Computer**

- (1) P5-120 Gateway-2000 120 Pentium PC with 16 MB Ram, 1.2 GB HD, 6X CD-ROM, 3.5" 1.44 MB V036-3-17" SVGA Monitor, Desktop Case, 104+ Keyboard, Microsoft Mouse, running on Windows NT

**Tempscan-1000A Thermocouple Acquisition System**

- (1) TEMPSCAN-1000A Main Chassis, includes rack mounting hardware
- (1) EXP/11A 10 Slot expansion chassis, cable and rack mounting hardware
- (7) TEMPTC-32A 32 Channel T/C scanning Module for Non-Grounded T/C's
- (1) RS-232 Cable PC/AT serial port RS-232/422 Cable (9/25 pin sub-D) to TEMPSCAN-1000A 6 feet long

**Miscellaneous**

- (1) Bakeout cart nametag

**SPECIFICATION**

Number	Rev
<b>A V049-2-068</b>	<b>5</b>

APPENDIX III

BILL OF MATERIALS / CART

BILL OF MATERIALS (DWG V049-3-013)

PAINT SPEC	ITEM	QTY	P/N	VENDOR	DESCRIPTION
	1	2 EA	800MR-A2AS	ALLEN BRADLEY	PUSH BUTTON, BLACK FLUSH, 1 NO, 1 NC
	2	1 EA	800MR-H32BLAS	ALLEN BRADLEY	KEY-LOCK SWITCH, 2 POS, 1 NO, 1 NC
	3	1 EA	800MR-FX6A4S	ALLEN BRADLEY	PUSH BUTTON, RED MSHRM, 1 NO, 1 NC
	4	4 EA	1492-PD31123	ALLEN BRADLEY	POWER DISTRIBUTION BLOCK
	5	12 EA	199-DR1	ALLEN BRADLEY	1 METER SYMMETRICAL DIN RAIL
	6	114 EA	1492-UF8	ALLEN BRADLEY	FUSE BLOCK, 30A, 600VAC
	7	448 EA			RHMS, #4-40 X 3/8" LG.
	8	2 EA	97 3100 A 14S-7 S	AMPHENOL	CONNECTOR, 3 POLE
	9	35 LF	4A-0405	ANIXTER	CABLE, 5/C 4 AWG, TYPE SO
	10	35 LF	4A-1203	ANIXTER	CABLE, 3/C 12 AWG., TYPE SO
	11	1 EA	4SSL 1/2	APPLETON	4" X 2 1/8" HANDY BOX
	12	1 EA	2510	APPLETON	DUPLEX RECEPTACLE COVER
PTHALO BLUE	13	1 EA	ER-16823	BUD INDUSTRIES	24" RACK ENCLOSURE
PTHALO BLUE	14	1 EA	ER-16873	BUD INDUSTRIES	24" ADD-A-RACK ENCLOSURE
PTHALO BLUE	15	2 EA	ER-16833	BUD INDUSTRIES	24" RACK STEEL DOOR
CARBIDE BLACK	16	2 PR	PMR-9451	BUD INDUSTRIES	RACK PANEL MOUNTING RAILS
CARBIDE BLACK	17	1 PR	AB-1854	BUD INDUSTRIES	19" TO 24" X 7" ADAPTER
CARBIDE BLACK	18	1 PR	AB-1855	BUD INDUSTRIES	19" TO 24" X 8 3/4" ADAPTER
CARBIDE BLACK	19	1 PR	AB-1856	BUD INDUSTRIES	19" TO 24" X 10 1/2" ADAPTER
	20	2 PR	RC-7761	BUD INDUSTRIES	4" X 1 1/4" CASTER W/BRAKE
CARBIDE BLACK	21	1 EA	SH-2488	BUD INDUSTRIES	24" SLIDING SHELF
CARBIDE BLACK	22	1 EA	PA-2405 MG	BUD INDUSTRIES	24" X 8 3/4" BLANK RACK PANEL
	23	112 EA	KTK-10	BUSS	FUSE, 10A, 500VAC
	24	1 EA	MDA-20	BUSS	FUSE, 20A, 250V, 1/4 X 1 1/4
	25	2 EA	MDA-8	BUSS	FUSE, 8A, 250V, 1/4 X 1 1/4
	26	1 EA	MDA-5	BUSS	FUSE, 5A, 250V, 1/4 X 1 1/4
	27	1 EA	MDA-1	BUSS	FUSE, 1A, 250V, 1/4 X 1 1/4
	28	8 EA	MDA-1/2	BUSS	FUSE, 1/2A, 250V, 1/4 X 1 1/4
PTHALO BLUE	29	1 EA	874-N5	EDWARDS	ALARM HORN, SURFACE MOUNT, 120VAC
	30	1 EA	52R-N5	EDWARDS	ALARM BEACON, RED, 120VAC
	31	16 EA	199 095.13	ENTRELEC	FUSE HOLDER, 25A, 600VAC
	32	1 EA	199 635.24	ENTRELEC	FUSE HOLDER END SECTION
	33	20 EA	115 486.03	ENTRELEC	TERMINAL BLOCK, 20A, 600VAC
	34	1 EA	118 368.16	ENTRELEC	TERMINAL BLOCK END SECTION
	35	2 EA	103 002.26	ENTRELEC	END STOP
	36	2 EA	231 030.24	ENTRELEC	MARKING TAGS, 5MM, 1-100
	37	2 EA	234 030.27	ENTRELEC	MARKING TAGS, 8MM, 1-100
	38	16 EA	167 075.25	ENTRELEC	FUSE BLOWN INDICATOR

SPECIFICATION

Number

A V049-2-068

Rev

5

Title: SPECIFICATION FOR FABRICATION OF BAKEOUT CONTROL SYSTEM CABINET

PAINT SPEC	ITEM	QTY	P/N	VENDOR	DESCRIPTION
	39	1 EA	TED134060WL	GE	CIRCUIT BREAKER, 480VAC/60A/3PH.
	40	1 EA	TEDUV1	GE	UNDERVOLTAGE RELEASE, 120VAC
	41	1 EA	TEDAS2AB1R	GE	AUXILIARY SWITCH
	42	2 EA	A-LF16M18	HOFFMAN	FLUORESCENT LIGHT, 120VAC
	43	1 EA	5262	HUBBELL	15A DUPLEX RECEPTACLE
	44	1 EA	074-01-032	HUBBELL	CORD GRIP, 1.35 CORD DIA
	45	1 EA	074-01-010	HUBBELL	CORD GRIP, .616 CORD DIA.
	46	1 EA	2311	HUBBELL	MALE PLUG, 20A, 125V
	47	1 EA	560F7W	HUBBELL	MALE PLUG, 60A, 3 PH. Y 277/480
CARBIDE BLACK	48	1 EA	6531-JLM	INDUSTRIAL COMPUTER	19" RACK MOUNT FOR 17" MONITOR
	49	1 EA	I-115	ISLATROL	POWER FILTER, 115VAC, 1PH. 15A
	50	2 EA	1897A41	McMASTER-CARR	OVAL HANDLE, 9" X 1 3/4"
PTHALO BLUE	51	4 EA	8890T14	McMASTER-CARR	LIFTING EYE, 3/8"-16
	52	112 EA	206430-1	AMP	RECPT., SQ. FLNG., REVERSE SEX, 10A
	53	224	66360-2	AMP	SOCKET, #14 AWG., 600VAC, 10A
	54	4 EA	TJP-4-48-J	OMEGA	TYPE "J" CONNECTOR PANEL, 12 X 4
	55	2 EA	LAM2A2/0-14-6	PANDUIT	POWER LUG
	56	24 LF	E1.5X3LG6	PANDUIT	WIREWAY, 1 1/2" X 3"
	57	24 LF	C1.5LG6	PANDUIT	WIREWAY COVER, 1 1/2" X 3"
	58	12 LF	E2X3LG6	PANDUIT	WIREWAY, 2" X 3"
	59	12 LF	C2LG6	PANDUIT	WIREWAY COVER, 2" X 3"
	60	6 LF	E3X3LG6	PANDUIT	WIREWAY, 3" X 3"
	61	6 LF	C3LG6	PANDUIT	WIREWAY COVER, 3"
	62	34 EA	ABM25-AT-CO	PANDUIT	TY-RAP BASE, BLACK
	63	113 EA	K10P-11A15-120	POTTER & BRUMFIELD	RELAY, 120VAC, 277VAC 10A CONTACT
	64	113 EA	27E895	POTTER & BRUMFIELD	RELAY SOCKET
	65	113 EA	20C297	POTTER & BRUMFIELD	HOLD DOWN SPRING
CARBIDE BLACK	66	1 EA	SH2484	BUD INDUSTRIES	24" FIXED SHELF
	67	2 EA	TJP-2-24-J	OMEGA	TYPE "J" CONNECTOR PANEL, 12 X 2
	68	2 EA	A-EK460NDH	HOFFMAN	ELECTRICAL DOOR INTERLOCK
	69	2 EA	FNQ-1/10	BUSS	FUSE, 1/10A, 500V, TIME DELAY
	70	2 EA	35301	THOMAS & BETTS	COPPER GROUND LUG, #10 SCREW
PTHALO BLUE	71	1 EA	A-VK44	HOFFMAN	LOUVER PLATE KIT
	72	1 EA	VY20/D/011/ST	ENTRELEC	CAM SWITCH, 20A, 90 DEG. ACTUATOR
	73	18 EA	93N1004	NEWARK	1/4" X #6 CPVC SPACER
	74	1 EA	800MR-P16AS	ALLEN BRADLEY	PILOT LIGHT, AMBER, 120VAC
	75	1 EA	97-3106-A-14S-7 P	AMPHENOL	PLUG, 3 POLE
	76	1 EA			RESISTOR, 1/4 WATT, 150 OHM, 5%
	77	1 LF	3610T13	McMASTER CARR	#8 STAINLESS STEEL SASH CHAIN
CARBIDE BLACK	78	1 PR	SA-1349	BUD INDUSTRIES	CHASSIS SUPPORT ANGLE

**SPECIFICATION**

Number

**A V049-2-068**

Rev

**5**

ATTACHMENT "A"  
PAINTING REQUIREMENTS

**1 SCOPE**

This attachment establishes minimum requirements for paint material, application, and durability of smooth and textured finishes to equipment as indicated on the Drawings and as follows .

**2 SURFACE PREPARATION**

- 2.1 Remove dirt, oil products, water vapor, oxidation, slag, scale, flux, and other foreign materials from surfaces to be painted in accordance with good commercial practice and industry accepted methods. Clean surfaces with solvent prior to painting.
- 2.2 Use industry-accepted fillers to cover minor surface imperfections such as press-in stud heads, flat head screws, rivets, indentations, and welds.

**3 PRIME COAT**

Apply Sherwin-Williams Polane spray fill D61-A23. Sand smooth after application.

**4 FINISH COAT**

- 4.1 Phathalo Blue, Textured Coating:  
Apply Sherwin-Williams Polane "T", #F63TX-L-1465 (PSI stores # 300614).
- 4.2 Carbide Black:  
Apply Sherwin-Williams Polane "T", #F63-B12. (PSI stores #300608)
- 4.3 Submit proposed substitutions to Buyer for acceptance.

**ATTACHMENT "A"**

Number	Rev
<b>A V049-2-068</b>	<b>3</b>



**Title: SPECIFICATION FOR FABRICATION OF BAKEOUT CONTROL SYSTEM CABINET**

PAINT SPEC	ITEM	QTY	P/N	VENDOR	DESCRIPTION
CARBIDE BLACK	79	1 EA	PA-2402 MG	BUD INDUSTRIES	24" x 3 1/2" BLANK RACK PANEL
	80	1 EA	QS3294	EMED CO.	CAUTION LABEL: MULTIPLE ELECTRICAL SOURCES
	81	1 EA	Q53204	EMED CO.	CAUTION LABEL: LOCK OUT POWER
	82	5 FT			ANGLE, 1 1/2" EQUAL LEG X 3/16" THK.
	83	2.5 FT			ANGLE 1" EQUAL LEG X 3/16" THK.
	84	1.5 FT			COPPER BAR, 1" WIDE X 1/4" THK.
	85	4.25 FT			SHEET STEEL, #16 GA. X 5" WIDE CRS

**SPECIFICATION**

Number

**A V049-2-068**

Rev

**5**

Title: SPECIFICATION FOR 80K PUMP BURST DISC

**SPECIFICATION FOR  
80K PUMP BURST DISC  
FOR**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

David Moore

QUALITY ASSURANCE:

A. B. Burdbook

TECHNICAL DIRECTOR:

D. A. Williams

PROJECT MANAGER:

REB

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1	DM 12/9/96	REB 12/9/96	Released for purchase with revisions per DEO # 384
0	DM 9/11/96		Released for quote & purchase on DEO # 0260
PROCESS SYSTEMS INTERNATIONAL, INC.			SPECIFICATION
INITIAL APPROVALS	PREPARED	DATE	APPROVED
	DM	9/11/96	REB
			DATE
			9/16/96
Number A V049-2-138			Rev. 1

**TABLE OF CONTENTS**

- 1.0 Scope
- 2.0 Schedule
- 3.0 Equipment Requirements
- 4.0 Design Requirements
- 5.0 Required Documentation
- 6.0 Shop Testing
- 7.0 Inspection
- 8.0 Warranty

- Attachment A LIGO QA Requirements Summary
- Attachment B General Equipment Requirements  
PSI Specification V049-2-033, Rev. 2
- Attachment C Hydrodyne drawing no. 48-6759, Burst Disc  
Assembly, LIGO 80K Cryopump

**SPECIFICATION**

Number <b>A</b>	<b>V049-2-138</b>	Rev <b>1</b>
--------------------	-------------------	-----------------

**Title: SPECIFICATION FOR 80K PUMP BURST DISC**

**1.0 SCOPE**

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of the 80K pump burst disc for the LIGO vacuum system.

All attachments are incorporated herein by reference and made a part of this specification.

The specified equipment is for use as part of the Vacuum Equipment supplied for the Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO, which is operated by Caltech and MIT under an NSF grant, includes two sites (Hanford Reservation, near Richland, WA, and Livingston, LA). Each site contains laser interferometers components and optical beams, and other support facilities.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

**2.0 SCHEDULE**

2.1 Equipment delivery shall be as follows:

PSI Part No.	Quantity	Delivery
V049-2-138-P1	14	

**3.0 EQUIPMENT REQUIREMENTS**

3.1 The burst discs will be used to protect the LIGO 80K cryopump vacuum chamber shell from overpressure in the event of a break in the liquid nitrogen circuitry within the chamber. The burst discs shall be purchased from the following supplier:

Hydrodyne Division of F.P.I. Incorporated  
3125 Damon Way  
Burbank, California 91505

**4.0 DESIGN REQUIREMENTS**

4.1 Mechanical Requirements

SPECIFICATION		
Number	V049-2-138	Rev.
A		1

Title:

**SPECIFICATION FOR 80K PUMP BURST DISC**

4.1.1 The helium leak rate, burst pressure, temperature range, and materials of construction of the burst disc shall conform to Attachment C, Hydrodyne drawing no. 48-6759. The inlet and outlet flanges, however, shall be a 4-1/2" rotatable Conflat flange, and a 4" ASA 150 lb. pipe flange, respectively. The burst disc is required to relieve a 70 deg. F gaseous nitrogen flow rate of 6524 lb<sub>m</sub> /hr. at its set pressure (set pressure = 11psig +/-10 %). This requires a minimum relieving area of 3.36 in.<sup>2</sup> to assure adequate protection of the 80K pump chamber.

4.2 Electrical Requirements  
Not applicable.

4.2.1 Instrumentation Requirements  
None required.

4.2.2 Power requirements  
Not applicable.

**SPECIFICATION**

Number  
**A**

**V049-2-138**

Rev.

**1**

**Title: SPECIFICATION FOR 80K PUMP BURST DISC**

4.2.3 The following paragraphs of Attachment B are not applicable:

5.1.5	5.1.4	5.2
6.4	8.1	8.2
8.4	8.6	9.3
9.4		

**5.0 REQUIRED DOCUMENTATION**

In addition to the documentation listed in Attachment B, the following documentation shall be provided prior to shipment:

- Manufacturer's standard QA reports (including final functional test reports).
- A Certificate of Compliance must be furnished for materials used in the construction of the device.

**6.0 SHOP TESTING**

The equipment shall be tested in accordance with the manufacturer's standard shop test.

**7.0 INSPECTION**

7.1 All testing and inspections called for in Attachment B (Specification V049-2-033, General Equipment Requirements) shall be performed by the Vendor. Additional quality assurance requirements are listed in Attachment A, Quality Assurance Requirements Summary.

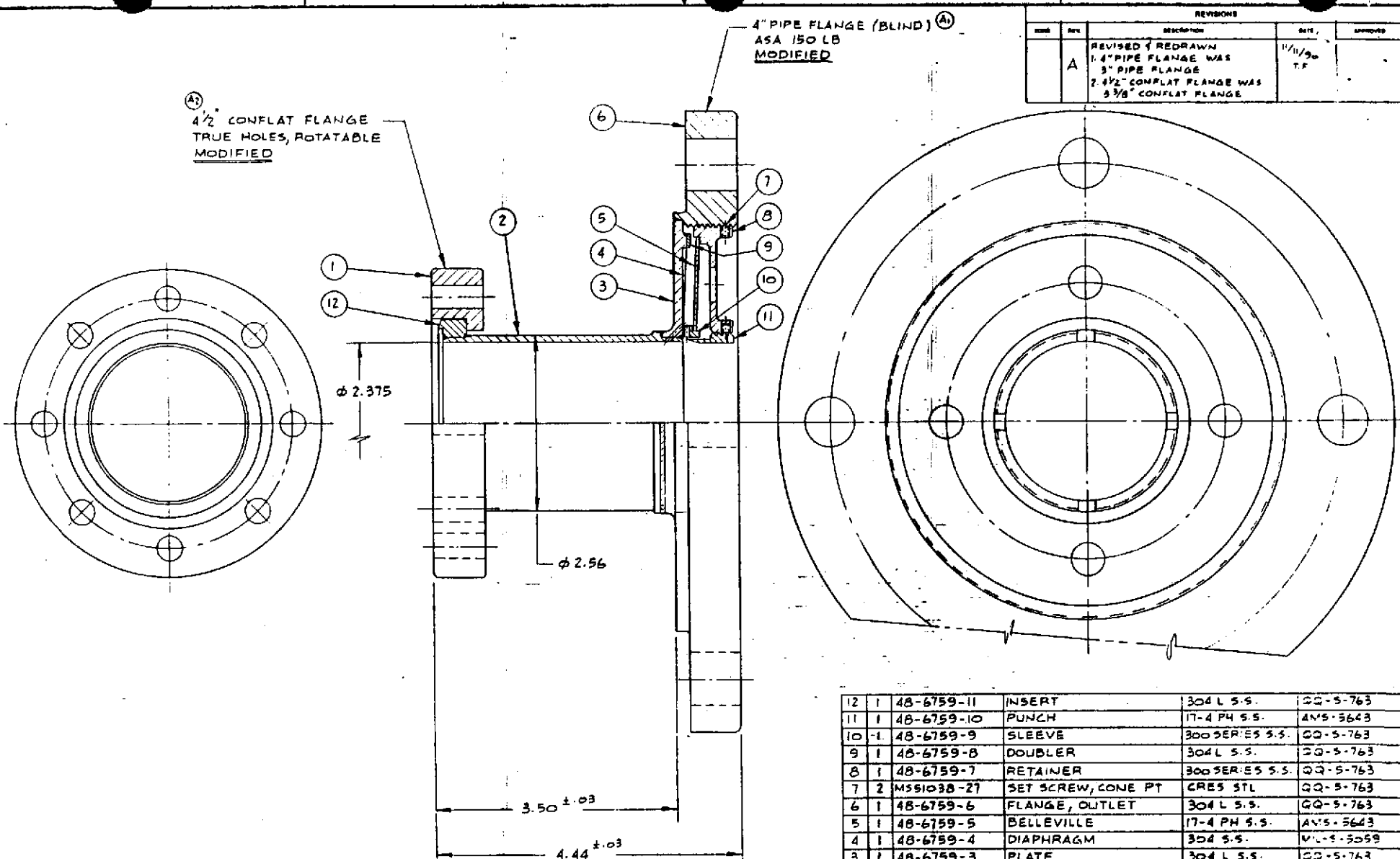
**8.0 WARRANTY**

Refer to Specification V049-2-034, Purchased Equipment Commercial Requirements (attached to the Request for Quotation), for warranty requirements.

<b>SPECIFICATION</b>		
Number	V049-2-138	Rev.
<b>A</b>		<b>1</b>

**ATTACHMENT "A"**  
**LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY**

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: 80K PUMP BURST DISCS	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPEC NO: V049-2-138
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:
						Date:
MILESTONE SCHEDULE	2 Wk		X	2	X	
VENDOR Q.A. PLAN	2 Wk		X	2	X	
CLEANING PROCEDURE	4 Wk		X	2	X	
PREP FOR SHIPMENT PROCEDURE	6 Wk		X	2	X	
ASSEMBLY DRAWINGS	4 Wk		X	2	X	
DESIGN REVIEW			X			PRIOR TO RELEASE FOR FABRICATION.
IN-PROCESS INSPECTIONS						PRIOR TO RELEASE FOR FABRICATION.
SHOP TEST PLAN	8 Wk		X	2	X	PRIOR TO RELEASE FOR FABRICATION.
SHOP TEST (WITH REPORT)				2		PRIOR TO RELEASE FOR SHIPMENT.
WELDING PROCEDURES	4 Wk		X	2	X	
* PER APPROVED VENDOR SCHEDULE						



REVISIONS				
REV	BY	DESCRIPTION	DATE	APPROVED
A		REVISED & REDRAWN 1. 4" PIPE FLANGE WAS 3" PIPE FLANGE 2. 4 1/2" CONFLAT FLANGE WAS 3 3/8" CONFLAT FLANGE	11/1/96 T.F.	

QTY	PART NO.	DESCRIPTION	MATERIAL	GENERAL SPECIFICATION
12	48-6759-11	INSERT	304 L S.S.	QQ-5-763
11	48-6759-10	PUNCH	17-4 PH S.S.	AMS-5643
10	48-6759-9	SLEEVE	300 SER:ES S.S.	QQ-5-763
9	48-6759-8	DOUBLER	304 L S.S.	QQ-5-763
8	48-6759-7	RETAINER	300 SER:ES S.S.	QQ-5-763
7	M591038-27	SET SCREW, CONE PT	CRS STL	QQ-5-763
6	48-6759-6	FLANGE, OUTLET	304 L S.S.	QQ-5-763
5	48-6759-5	BELLEVILLE	17-4 PH S.S.	AMS-5643
4	48-6759-4	DIAPHRAGM	304 S.S.	ML-5-5059
3	48-6759-3	PLATE	304 L S.S.	QQ-5-763
2	48-6759-2	TUBE	304 L S.S.	QQ-5-763
1	48-6759-1	FLANGE, INLET	304 L S.S.	QQ-5-763
BSC		48-6759	ASSEMBLY	

- 4. LEAKAGE: THRU & EXTERNAL  $1 \times 10^{-9}$  SCCS MAX/GHE
- 3. BURST PRESSURE: 11.0 PSID +0, -10%
- 2. TEMPERATURE RANGE: -320°F TO 302°F
- 1. FLUID MEDIUM: GN<sub>2</sub>

NOTES:

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .015 .005 .01 ±0.5°		CONTRACT NO.		hydrodyne Burland, CA 91505	
MATERIAL		APPROVED	DATE	BURST DISK ASSEMBLY - LIGO, 80K PUMP	
DRAWN		A. VISKET	2/30/96	SIZE	FSCM NO.
CHECKED				C	07107
PARTS LIST		DWG. NO.		DWG. NO.	
		48-6759		48-6759	
APPLICATION		DO NOT SCALE DRAWING		SCALE	1:1
				SHEET	1

Attachment C 1 to VO49-2-138





**SPECIFICATION TABLE OF CONTENTS**

- 1.0 Definitions
- 2.0 Deleted
- 3.0 General Requirements
- 4.0 Codes and Standards
- 5.0 Design Requirements
- 6.0 Materials
- 7.0 Utilities
- 8.0 Welding
- 9.0 Required Documentation
- 10.0 Nameplates
- 11.0 Cleaning and Painting
- 12.0 Quality Assurance Requirements
- 13.0 Preparation for Shipment
- 14.0 Startup Assistance
- 15.0 Deleted

Attachment A Other Electrical Requirements

Number  
Rev.

<b>SPECIFICATION</b>	
Number <b>A</b>	Rev. <b>2</b>

**1.0 DEFINITIONS**

- 1.1** The "Vendor" is defined as the successful bidder accepting responsibility for meeting all requirements of this specification.
- 1.2** The "Owner" is defined as the California Institute of Technology (Caltech) in partnership with the Massachusetts Institute of Technology (MIT), under a grant from the National Science Foundation.
- 1.3** The "Buyer" is defined as Process Systems International, Inc. (PSI).
- 1.4** The "sites" are located on the Hanford reservation near Richland, Washington and in Livingston, Louisiana.

**2.0 DELETED****3.0 GENERAL REQUIREMENTS**

- 3.1** The Vendor shall be responsible for coordination of all sub-suppliers and for overall warranty and guarantees of all equipment, including their compatibility. The Vendor shall comply with all applicable referenced specifications and standards and invoke them on each sub-supplier purchase order.
- 3.2** Equipment will be installed at Hanford (near Richland), Washington and in Livingston, Louisiana. Unless otherwise indicated, equipment shall be capable of continuous service in an indoor location with a controlled temperature of  $23 \pm 1.5$  C and a relative humidity controlled at  $40 \pm 5\%$ . The equipment will, however, be exposed to diurnal and seasonal ranges during shipment, construction and power loss. It shall, therefore, not be damaged by exposure to temperature in the range of -20 to +40 C, or a humidity of 100%.
- 3.3** The Buyer shall be notified at least 10 working days prior to the start of major fabrication, assembly or testing.
- 3.4** Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to fabrication, assembly, cleaning and test areas for the purpose of monitoring activities.

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-033

Rev.

**2**

Title

# SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

## 4.0 CODES AND STANDARDS

### 4.1 Priority of Codes and Standards

1. Codes
2. Standards
3. Data Sheets
4. This Specification

4.2 All conflicts shall be brought to the attention of PSI for a written resolution prior to award of a purchase order. If more than one document applies to a technical requirement, the more stringent requirement shall have precedence.

### 4.3 Applicable Codes and Standards:

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code  
Pressure Vessels: Section VIII, Division I  
Welding and Brazing Qualifications: Section IX

American National Standards Institute (ANSI)  
ANSI A58.1: ASCE Minimum Design loads for Buildings and Other Structures

International Standards Organization  
ISO Standard 2861: Flange Standards

Expansion Joint Manufacturers' Association (EJMA)  
EJMA Standards

Government Standards  
Building and safety codes: local, state and federal, including OSHA  
Federal Standard 209 for Cleanrooms

Number

Rev.

## SPECIFICATION

Number

**A**

V049-2-033

Rev.

**2**

Page **4** of **14**

Title

# SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

## 5.0 DESIGN REQUIREMENTS

The construction of equipment shall be performed in the highest manner of workmanship using only new and unused top quality materials. The equipment shall be guaranteed against defects in design, materials and workmanship as required elsewhere in the Contract.

### 5.1 Mechanical Requirements

5.1.1 Equipment feet or mounting plates shall have machined surfaces. Shim stock used shall be stainless steel.

5.1.2 Each vacuum element greater than 12" in diameter shall be designed, fabricated and tested in accordance with the latest edition of the ASME B&PV Code, Section VIII, Division 1, and subsequent addenda (except as noted under section 8.0, Welding), even though vacuum chambers lie outside of the scope of that document.

5.1.3 Bolt holes in flanges shall straddle natural centerlines.

5.1.4 Reasonable measures shall be taken to minimize noise. The goal is for acoustic noise to not exceed NC-15 when measured at any point within 1' of the equipment.

5.1.5 Reasonable measures shall be taken to minimize vibration. The goal is for the vibration of any item of equipment not to induce motion of the walls of any vacuum chamber or of the facility floor within 1 meter of any chamber which exceeds the following spectral density limits:

<u>Frequency Band, Hz</u>	<u>Vibration Limit, m/√Hz</u>
0.1 - 10	$3 \times 10^{-11}$
10 - 1000	$3 \times 10^{-9} \times (1/f)^2$
1000 - 10000	$3 \times 10^{-15}$

The above limits apply when all simultaneously operating equipment is running, and in the absence of vibration from other sources. Limited narrow band exceptions may be permitted, subject to Buyer's acceptance. Compliance with this requirement may be demonstrated by any combination of measurements and analysis, subject to Buyer's acceptance.

Number  
Rev.

<b>SPECIFICATION</b>	
Number <b>A</b>	Rev. <b>2</b>
V049-3-033	
Page <u>5</u> of <u>11</u>	

Title

**SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS**

- 5.1.6 ANSI Standard A58.1 shall be applied to determine the probability of earthquakes and seismic coefficients at the two sites.
- 5.1.7 No equipment shall emit or harbor particulates at a level inconsistent with maintenance of a clean environment conforming to Federal Standard 209 Class 50,000.
- 5.1.8 The equipment shall be designed for a minimum serviceable life of 20 years.
- 5.1.9 Exposure of the equipment to ambient conditions during construction, power failure or control failure shall not result in damage.
- 5.1.10 Separable parts shall be fully interchangeable between assemblies.
- 5.1.11 Adequate clearance shall be provided for assembly of mating flanges and for handles. External access shall be provided to all vacuum seams for leak checking.
- 5.1.12 Elements heavier than 50 pounds shall have lifting lugs installed.
- 5.1.13 Vendor shall specify all bolt torque requirements in the equipment operating and maintenance manual.

5.2 Electrical Requirements

5.2.1 General Electrical Requirements

- 5.2.1.1 Electrical equipment and wiring shall conform to the National Electric Code.
- 5.2.1.2 All electrical equipment shall meet commercial standards for EMI (see Attachment A).
- 5.2.1.3 Electrical equipment shall meet the acoustic noise and vibration requirements of Sections 5.1.4 and 5.1.5, above.
- 5.2.1.4 See Attachment A for other electrical requirements.

5.2.2 Instrumentation Requirements

- 5.2.2.1 Instrumentation shall be of industrial quality and shall be subject to the acceptance of the Buyer.

Number  
Rev.

<b>SPECIFICATION</b>	
Number <b>A</b>	Rev. <b>2</b>
V049-2-033	
Page <u>6</u> of <u>14</u>	

## SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

5.2.2.2 Vibration monitoring is not a requirement of this specification.

5.2.2.3 Unless otherwise indicated, analog instrument signals shall be 4-20 ma or 0-10 VDC.

### 5.2.3 Controls Requirements

Control signals shall be 24 VDC.

### 5.2.4 Power Requirements

5.2.4.1 Motors shall comply with the Vendor's standard specifications, unless otherwise required by this specification. The minimum service factor of motors shall be 1.15. Motors shall be sized so that they can start and accelerate their loads to design speed at 90% voltage, and shall be energy efficient, if required by local or state codes.

5.2.4.2 Motors less than 3/4 HP shall be 120 VAC, 1 phase, 60 Hz. Those 3/4 HP to 200 HP shall be 460 VAC, 3 phase, 60 Hz.

## 6.0 MATERIALS

6.1 Materials used for pressure or vacuum retaining parts, nuts, bolts and studs shall be new. Where practicable, materials shall be of US origin; where not, materials from Canada, the European Community or Japan may be used. The Vendor's quotation shall identify the country of origin and how he intends to establish material traceability and conformance of composition and properties to applicable codes.

6.2 Copies of mill test reports of chamber and flange materials shall be furnished. Other nozzles, small parts, small flange nozzles, and bolting materials shall be furnished with a Certificate of Compliance.

6.3 Fabricated components exposed to vacuum shall be made from type 304L or 316L stainless steel using low carbon weld filler wire, where required. Standard catalog items of 304 or 316 stainless steel are acceptable if not available in 304L or 316L. Copper, aluminum and prebaked Viton (Dupont Type E-60C, manufactured by Parker or Buyer-accepted equal) must be used for seals. Vacuum feedthroughs must utilize UHV compatible glass or ceramic. All other materials are subject to Buyer's acceptance.

## SPECIFICATION

Number

A

V049-2-033

Rev.

2

Page 7 of 19

Number

Rev.

Title

**SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS**

- 6.4 Vacuum surfaces shall not be allowed to come into contact with carbon steel or oil, including during forming, handling or manufacture. Machining fluids shall be water soluble and free of oil and sulfur.
- 6.5 When manufacturing materials are marked for material identification or traceability, marking shall be done on the outside, and not on surfaces that will be exposed to vacuum.

**7.0 UTILITIES**

The following utilities are available. The vendor shall state in his proposal the usage of each utility.

**7.1 Electric Power**

120 VAC, 1 phase, 60 Hz  
480 VAC, 3 phase, 60 Hz or 208/120 VAC, 3 phase, 60 Hz

7.2 Instrument Air: 80 psig, -60 C Dew Point

7.3 Deleted.

**8.0 WELDING**

- 8.1 Welding exposed to vacuum shall be done by the gas tungsten arc inert gas (GTAW) process, with a 100% Argon shield and purged back gas.
- 8.2 Welding techniques shall deviate from the ASME Code in accordance with the best ultra high vacuum practice to eliminate any "virtual leaks" in the welds. Wherever practicable, welds shall be internal and continuous. External welds for structural purposes shall be intermittent to eliminate trapped volumes.
- 8.3 Defective welds shall be repaired by removal to sound metal and rewelding.
- 8.4 Vacuum weld procedures shall include steps to avoid contamination of the heat affected zone with air, hydrogen, hydrocarbons or water. This requires that inert purge gas, such as argon, be used to flood the vacuum side of heated portions. All vacuum surfaces and weld wire shall be cleaned prior to welding

Number  
Rev.

<b>SPECIFICATION</b>	
Number <b>A</b>	Rev. <b>2</b>
V049-2-033	
Page <b>5</b> of <b>14</b>	



Title

## SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

- 8.5 The finished product shall be free of weld spatter, cutoff spatter, free iron, weld oxidation and defects. There shall be no grinding or abrasion of completed welds or internal vacuum surfaces. Completed welds shall only be cleaned with SS wire brushes that have not previously come in contact with carbon steel.
- 8.6 All welding procedures, procedure qualifications and welders employed on this job shall be qualified in accordance with ASME Section IX, latest edition.

### 9.0 REQUIRED DOCUMENTATION

#### 9.1 Drawings

- 9.1.1 Assembly drawings shall be submitted for the Buyer's review prior to fabrication. They shall include all pertinent design data and calculations, including design pressures and temperatures.
- 9.1.2 Drawing acceptance must be obtained from the Buyer prior to the start of fabrication. Drawing acceptance does not constitute acceptance of any errors or of any deviation from these specifications or any instructions relating to the work. The Vendor shall call attention to any such deviations by separate written notice. Unless specific written acceptance is obtained from the Buyer, deviations are not acceptable.
- 9.1.3 If changes are made to any drawing subsequent to acceptance, drawings shall be resubmitted with all changes clearly identified. "As-Built" drawings shall be submitted.
- 9.1.4 Drawings in AutoCad, Release 12.0 are preferred. All documents stored electronically (procedures and CAD drawings) shall be backed up daily and the back-up tape shall be stored in a fire-proof safe.

#### 9.2 Mechanical Data

- 9.2.1 Dimensioned outline drawings (indicating weights and center of gravity). These shall be submitted with the Vendor's proposal.
- 9.2.2 Connection sizes and ratings, design and test pressures and temperatures.
- 9.2.3 Cross-section drawings of all seals identifying all seal parts and materials.

## SPECIFICATION

Number

A

Rev.

2

V049-2-033

Page 1 of 14

Number

Rev.

9.2.4 Allowable nozzle loads, if applicable.

9.2.5 All procedures to be utilized shall be submitted for acceptance prior to use. This includes welding, QA, cleaning, testing, welding, Heat Treating, leak testing, etc.

9.3 Electrical Data

9.3.1 Electrical schematics and wiring diagrams

9.3.2 Control logic documentation

9.3.3 Instrument data sheets

9.3.4 Motor data sheets

9.4 Acoustic Noise and Vibration (See Sections 5.1.4 and 5.1.5)

9.4.1 A plan describing how the Vendor will address the design issues associated with acoustic noise and vibration is to be submitted.

9.4.2 An analysis of the equipment's design dynamic characteristics (mass, center of gravity, isolator stiffness, transmissibility). The analysis shall support the Vendor's claim of meeting or not meeting the specification requirements. In the case that the requirements are not met, the Vendor shall show that all reasonable engineering attempts have been made to meet them, and the design will be subject to the Buyer's written acceptance prior to the start of manufacturing.

9.5 Test and QA Data

The following shall be submitted where applicable:

9.5.1 Manufacturer's Code Data Report

9.5.2 Nameplate facsimile

9.5.3 Hydrotest results (Deleted)

Number

Rev.

## SPECIFICATION

Number

A

V049-2-033

Rev.

2

Page 10 of 14

Title

## SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

9.5.4 Performance and leak test procedures and results

9.5.5 Mill test reports and certificates of conformance per Section 6.2

9.6 Other Documentation

9.6.1 Schedule, including design, material procurement and fabrication activities

9.6.2 Priced spare parts list with recommended spares

9.6.3 Installation, Operation and Maintenance Manual, including drawings

9.6.4 A status report with updated schedule shall be submitted monthly

### 10.0 NAMEPLATES

10.1 Each separable part (except fasteners, seals and interchangeable, standard blank flanges) shall be permanently marked with a unique identification number in a location readily viewable.

10.2 Each item shall have a stainless steel nameplate (permanently attached if practical). Nameplates shall include the Vendor's standard data. Where provided, each motor shall also have a nameplate.

### 11.0 CLEANING AND PAINTING

11.1 Equipment internals shall be cleaned and free of all foreign materials.

11.2 External carbon steel surfaces shall be cleaned and painted. The Vendor's standard is acceptable if it meets specification requirements and is compatible with federal standard 209 class 50,000.

Number

Rev.

## SPECIFICATION

Number

**A**

V049-2-033

Rev.

**2**

Page 11 of 14

Title

# SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

- 11.3 Surfaces exposed to vacuum shall be cleaned in accordance with procedures accepted by the Buyer prior to fabrication and installation. Surface recontamination during subsequent processes shall be prevented. Cleaning procedures for ultra high vacuum service shall be required.
- 11.4 Items shall be wrapped or sealed after cleaning to maintain cleanliness through handling, transportation and storage. Care shall be taken to minimize exposure to corrosive environments, such as those containing chloride compounds.

## 12.0 QUALITY ASSURANCE REQUIREMENTS

The responsibility for inspection and testing rests with the Vendor. However, the Buyer reserves the right to review equipment at any time during the fabrication to assure that the work performed is in accordance with this contract. The Vendor shall give the Buyer 10 working days notice prior to the start of major fabrication, assembly or testing so that his representative may witness these tests.

The vendor shall have implemented inspection system in effect at all times during this contract. The inspection system shall comply with the following:

### Design Control And Change Control

Provide a system to control the issuance of documents and drawings including changes to the locations where the work is being performed. The system shall address both electronic files and hard copies.

### Material Control

Provides system that controls materials from receipt through the finished product. This system shall assure that only accepted items are used and installed. Physical identification shall be used to the maximum extent possible.

### Quality Planning (Traveler)

A system of shop travelers shall be established for all work in process. The traveler shall contain Hold/Witness points of the Vendor, the Buyer and the Owner. All planning documents shall be submitted to the buyer for acceptance prior to fabrication.

Number

Rev.

## SPECIFICATION

Number

A

Rev.

2

V049-2-033

Page 12 of 19

Title

## SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS

### Receiving Inspection

Measures shall be established to inspect incoming materials to the applicable procurement documents. Status of materials shall be visible, by tagging or marking.

### In-Process And Final Inspection

A system of inspection and test status shall be maintained using tags, markings, shop travelers, stamps or inspection records.

### Control Of Special Process' And Testing

A system shall be established to assure that welding, heat treatment, cleaning and NDE are accomplished under controlled conditions, in accordance with written procedures, using qualified personnel, to the applicable codes and standards.

### Calibration Of Measuring And Test Equipment

A system shall be established and documented to assure that tools, gages, instruments and other inspection, measuring, and testing equipment are of the proper range, type and accuracy. The above shall be controlled, calibrated, and certified against nationally known standards (NIST).

### Control Of Non-Conformances

A system shall be established and documented to control items or services which do not conform to requirements. The system shall include appropriate procedures for identification, documentation, segregation, disposition and notification.

### Documentation And Records

Sufficient records shall be prepared as work is performed to furnish documentary evidence of the quality of items and activities affecting quality.

Number

Rev.

## SPECIFICATION

Number

A

V049.2-033

Rev.

2

Page 13 of 14

Title

**SPECIFICATION FOR GENERAL EQUIPMENT REQUIREMENTS**

**13.0 PREPARATION FOR SHIPMENT**

- 13.1 Items shall be completely drained and dried.
- 13.2 Bolted connections shall be made up before shipment.
- 13.3 Aluminum plate shipping covers shall be attached with bolts to flanged connections, and with suitable attachments to other connections.
- 13.4 Units shall be completely covered for protection against the ambient and weather conditions expected during transportation. Units shall be adequately protected for unsheltered storage at the sites.
- 13.5 The Vendor shall have a signed "Release for Shipment" form provided by the Buyer's Quality Assurance representative prior to full or partial shipment of product.
- 13.6 Shipping crates shall have the Buyer's purchase order number, Vendor's name and list of tag numbers or part numbers on the outside of each crate.
- 13.7 Surfaces that will see vacuum shall be further protected by, after final cleaning, sealing openings with oil-free heavy duty aluminum foil, attaching the nozzle cover and applying shrink wrapped plastic.

**14.0 STARTUP ASSISTANCE**

The services of a qualified startup assistant shall be provided on request of the Buyer or the Owner to provide operator training and startup assistance at the sites.

**15.0 DELETED**

Number  
Rev.

**SPECIFICATION**

Number

**A**

V049.2-033

Rev.

**2**

Page 14 of 14

Title

**ATTACHMENT A**

**OTHER ELECTRICAL REQUIREMENTS**

- 1.0 Definitions
- 2.0 Exceptions
- 3.0 Codes and Standards
- 4.0 Labeled and Listed Equipment
- 5.0 General Assembly Requirements
- 6.0 Wiring
- 7.0 Field Connection Boxes
- 8.0 Testing
- 9.0 Deleted
- 10.0 Motor Data Sheets

Number

Rev.

**SPECIFICATION**

Number

**A**

**V049-2-033**  
**Attach. A**

Rev.

**2**

Title

## 1.0 DEFINITIONS

Indicated	Shown or noted.
Labeled	Approved by nationally recognized testing company.
Permitted	As by code, Contract Documents, or Buyer.
Provide	Furnish and assemble.
Buyer	Process Systems International (PSI)
Required	As by Contract Documents and/or applicable codes and standards.
Submittal	Information required to show that the proposed equipment meets project requirements.
Use	Provide material or equipment referenced.
Vendor	Successful bidder accepting responsibility for equipment fabrication.
Work	Material, equipment and fabrication and other requirements as established in the Contract Documents.
Wire (Verb)	Connect to equipment indicated and provide wiring required for connection.
Wiring	Conductors, raceways, and accessories as required for a complete installation.

## 2.0 EXCEPTIONS

If the Vendor cannot meet requirements established under this specification and its attachments, provide a list of deviations with your proposal. In the absence of a list of deviations, it shall be deemed that the Vendor's product is fully in compliance with this specification.

Number

Rev.

## SPECIFICATION

Number

**A**

Y049-2-033

Rev.

**2**

Page **2** of **9**



**3.0 CODES AND STANDARDS**

The assembly shall comply with applicable parts of latest editions of publications by the following organizations:

- American National Standards Institute, Inc. (ANSI)
- Code of Federal Regulations (CFR) Title 47, Part 15
- Electrical Standards for Industrial Machinery (NFPA 79) unless otherwise indicated
- Factory Mutual (FM)
- Federal Communications Commission (FCC) Part 15
- Institute of Electrical and Electronics Engineers (IEEE)
- Insulated Cable Engineers Association (ICEA)
- National Electric Code (NFPA 70)
- National Electrical Manufacturers Association (NEMA)
- Underwriter's Laboratories (UL) or equipment and installation standards by other nationally recognized testing companies

**4.0 LABELED AND LISTED EQUIPMENT**

Provide UL label (or that of other nationally recognized testing company) or listed components where such standards exist.

**5.0 GENERAL ASSEMBLY REQUIREMENTS**

- 5.1 Arrange and assemble components in accordance with their manufacturers' specifications.
- 5.2 Label components with the equipment designation as indicated using adhesive backed labels with 1/8" high lettering.
- 5.3 Label terminal strips as indicated using printed manufacturer's labels.
- 5.4 Where air-actuated valves require pilot solenoids, mount the solenoid valves on the air operated valves.

Number  
Rev.

<b>SPECIFICATION</b>		
Number	A	Y049-2-033
		Rev. 2
	Attach. A	Page 3 of 9

Title

## 6.0 WIRING

Install wiring in raceways, wireways, or neatly tirewrapped wire bundles. Provide product data for all cables.

### 6.1 Power Wire

6.1.1 Provide #12 AWG or larger single, stranded copper conductors with Type THHN-THWN or MTW insulation rated 90 C, 600 volts.

6.1.2 Use black colored insulation, except green for equipment grounding conductors.

### 6.2 Control Wire (Discrete Signals)

6.2.1 120 VAC: Provide #14 AWG, stranded copper, multiconductor cable with Type THHN-THWN or MTW insulation rated 90 C, 600 volts.

6.2.2 24 VDC: provide #16 AWG stranded copper, twisted pairs, single or multipair cables rated 90 C and 300 volts.

6.2.3 Color code conductors as follows:

120 VAC—Line	Red
120 VAC—Neutral	White
24 VDC	Blue
External Source	Yellow
Ground	Green

6.2.4 Identify each single conductor at each end with wire number or designation. Use printed, sleeve type wire marker.

### 6.3 Instrument Wire (Analog Signals)

6.3.1 4-20 mA: Provide #16 AWG or larger, stranded copper, individually shielded twisted pairs, single or multipair cables rated 90 C, 300 volts unless otherwise indicated. Where practicable, install cables spaced at least 12 inches away from power and control wiring.

## SPECIFICATION

Number

**A**

Y049-2-033

Attach. A

Rev.

**2**

Page **4** of **9**

Number

Rev.

**Title**

6.3.2 Provide shielded twisted pair cables with one black and one white conductor.

6.4 Thermocouple Wire

6.4.1 Provide #16 AWG solid thermocouple extension cable shielded, rated 105 C, 300 volts of type required.

6.4.2 Provide thermocouple extension wire in accordance ISA color coding standards.

6.5 Wire and Cable Installations

6.5.1 Identify each cable end with cable number or designation. Use printed sleeve wire marker.

6.5.2 Provide sufficient wire length to permit grouping and training the wires and cables. Where applicable, use self-locking nylon wire ties; cut off loose ends. Do not exceed manufacturer's wire bending radii. Do not allow wiring to bear against edges of enclosures. Replace wiring cut too short to meet installation requirements.

6.6 Wiring Terminations and Connectors

6.6.1 Control Wiring

6.6.1.1 To terminate #10 AWG and smaller conductors to buses, enclosures, and similar applications, provide compression (crimp) terminals.

6.6.1.2 To terminate #8 AWG and larger conductors, provide either compression (crimp) connectors using matching installing tool or mechanical screw type connectors.

6.6.1.3 Where more than one conductor requires termination, provide screw or pressure type insulated terminal blocks.

6.6.2 Instrument Wire

6.6.2.1 Use insulating sleeve to secure shielding at instrument end of cable. Clip shields to avoid protruding from insulating sleeve.

6.6.2.2 Coil, insulate, and label ends of spare conductors.

Number  
Rev.

**SPECIFICATION**

Number	A	V049-2-033	Rev.	2
--------	---	------------	------	---

Attach. A 3 of 9  
Page

**Title**

**6.6.2.3 Remove insulation from ends of conductors using mechanical or electric heat type stripper.**

**6.7 Equipment Grounding**

**6.7.1 Bond motors, heaters, and other electrical equipment to skid base. Weld to diagonal corners of skid base a 4 by 6 by 1/2 inch steel plate with two 3/8"-16 tapped holes spaced two inches apart, or if steel base is at least 1/2 inch thick, tap holes directly into steel base.**

**6.7.2 Do not ground instrument shielding. Use insulating tape or heat shrink to secure shielding at instrument end of cable. Connect shielding at other end of cable to junction box terminal. (Shielding connects to a single ground reference point at Owner's controller or I/O rack.)**

**6.7.3 Completely remove paint, dirt, and corrosion down to bare metal where connectors, lugs, and other metal components are attached to mounting panels and enclosures to assure grounding continuity.**

**6.7.4 Where a grounding stud or existing panel mounting bolt is used, the Vendor may provide the grounding conductor with a ring-tongue terminal and a "star" type washer installed between the panel and terminal. Use hexagon nut to secure tightly.**

**7.0 FIELD CONNECTION BOXES**

**7.1 To facilitate field wiring, provide separate power, control, and instrument NEMA 4 or 12 type enclosures, unless otherwise required, with terminals and a minimum of 20 percent spare terminals.**

**7.2 Arrange surrounding work and location of boxes to permit box accessibility and to permit (bottom, sides, top, and rear) entrance of field conduits.**

**7.3 In power box, segregate voltage systems using barriers or separate boxes. Use box to terminate motors, heaters, and other branch circuits with #8 AWG and small wiring. PSI will field wire larger circuits directly to equipment junction boxes.**

Number  
Rev.

<b>SPECIFICATION</b>		
Number	Y049-2-033	Rev.
<b>A</b>	Attach. A	<b>2</b>
Page <u>6</u> of <u>9</u>		

**Title**

7.4 In instrument box, segregate temperature element wiring using barriers or separate boxes.

**8.0 TESTING**

It is the Vendor's responsibility to conduct the following tests without damage to equipment.

**8.1 Wire Testing**

8.1.1 Check point-to-point continuity of each conductor to ensure that wiring is intact and terminated at the proper place at both ends.

8.1.2 Verify wire connections are made in accordance with terminal wiring diagrams and schedules.

8.1.3 Deleted

8.1.4 All defective wiring shall be replaced and the unit retested.

**8.2 Motors**

8.2.1 Before connecting motor, measure motor winding resistance in accordance with manufacturer's recommendations.

8.3 Test each three-phase motor for proper rotary direction.

8.4 Submit a signed test report for each electrical test conductor.

9.0 Deleted

**10.0 MOTOR DATA SHEETS**

The attached motor data sheets shall be completed by the Vendor and submitted to the Buyer with the Vendor's proposal.

Number

Rev.

**SPECIFICATION**

Number

**A**

**V049-2-033**

Attach. **4**

Rev.

**2**

Page **7** of **9**

Title

### MOTOR DATA SHEET - DESIGN PARAMETERS

ITEM	DESIGN PARAMETERS	MOTOR DATA	MOTOR DATA	MOTOR DATA	MOTOR DATA
1	Motor Identification (tag)				
2a	Volts				
2b	Phases				
2c	Hertz				
3	Synchronous RPMs				
4	Efficiency (premium/energy/norm)				
5	Service Factor				
6	Load Brake Horse Power				
7	Starting Torque				
8	Type Load (fan/pump/comp)				
9	Drive (belt/direct couple)				
10	Rotation (CW/CCW)				
11	Enclosure				
12	Mounting (horz/vert)				
12a	NEMA Type Flange				
12b	Vertical Trust (up/down)				
13	Indoor/Outdoor Use				
14	Space Heater, 120V (no/watts)				
15	Winding Temp Sensor (yes/no)				
16	Bearing Temp Sensor (yes/no)				

Number

Rev.

### SPECIFICATION

Number

**A**

V049-2-033

Attach. A

Rev.

**2**

Page **8** of **9**

Title

## MOTOR DATA SHEET - MANUFACTURER'S NAMEPLATE

ITEM	MANUFACTURER'S NAMEPLATE	MOTOR DATA	MOTOR DATA	MOTOR DATA	MOTOR DATA
1	Motor Identification (tag)				
2a	Mfr:				
2b	Type				
2c	Frame Size				
3	Horsepower Output				
4	Time Rating (NEMA MG1-10.35)				
5	Max Ambient Temperature				
6	Insulation System				
7	RPM @ Rated Load				
8	Frequency				
9	Phases				
10	Rated Load Amps				
11	Voltage				
12	Locked Rotor Amps or NEMA Code Ltr				
13	NEMA Design Letter				
14	Efficiency				
15	Service Factor				
16	Thermal Protectors				

ITEM	MANUFACTURER'S DATA	MOTOR DATA	MOTOR DATA	MOTOR DATA	MOTOR DATA
1	Motor Identification (tag)				
2	Bearing Type				
3	Bearing Lub				
4	Efficiency @ Full Load				
5	Efficiency @ 3/4 Load				
6	Efficiency @ 1/2 Load				
7	Power Factor @ Full Load				
8	Power Factor @ 3/4 Load				
9	Power Factor @ 1/2 Load				
10	Space Heater Voltage				
11	Space Heater Watts				

Number

Rev.

### SPECIFICATION

Number

**A**

Y049-2-033

Attach. A

Rev.

**2**

Page 9 of 9





**SPECIFICATION FOR  
80K PUMP MANUAL REGENERATION VALVE  
FOR**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** David Moore

**QUALITY ASSURANCE:** N/A

**TECHNICAL DIRECTOR:** D.C. W. W. Clean

**PROJECT MANAGER:** Bill Bayly

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1	DM 10/7/96	D.W.W. 10-7-96	Changed out weld ends to socket weld DEO # 295
0	DM 9/14/96	D.W.W. 9-17-96	Released for purchase on DEO # 263

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-140
	DM	9/12/96	AB	9/17/96	Rev. 1

**Title: SPECIFICATION FOR 80K PUMP MANUAL REGENERATION VALVE**

**Manufacturer:** The William Powell Company  
**Type:** 2400 series globe valve  
**Size:** 1-1/2"  
**Quantity:** 12  
**Rating:** 150 lb. class  
**Model Number:** 2475SWE  
**Body/Bonnet Material:** Stainless steel, A-351, A-276  
**Handwheel Material:** Carbon steel  
**End Connections:** socket weld ends to mate to sch. 10S pipe  
**Packing:** teflon  
**Disc Material:** Stainless steel, A-276  
**Identification:** V049HV-190, HV-192, HV-290, HV-292, HV-390, HV-392,  
V049HV-490, HV-590, HV-690, HV-692, HV-790, HV-890

<b>SPECIFICATION</b>	
Number <b>A</b> V049-2-140	Rev. <b>1</b>

Title: SPECIFICATION FOR 80K PUMP VENT HEATER

SPECIFICATION FOR  
80K PUMP VENT HEATER  
FOR  
LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

David Moore

ELECTRICAL ENGINEER:

James J. Tarenta

TECHNICAL DIRECTOR:

T. M. Williams

PROJECT MANAGER:

RICHARD BAGLEY

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV	LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE		
0		<u>DMoore</u>	<u>9/16/96</u>	<u>11/9/96</u>	<u>14/14/96</u>	<u>Issued for purchase, DEO # 0264</u>
PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	NumberA	Rev.
	<u>DMoore</u>	<u>9/16/96</u>	<u>11/9/96</u>	<u>14/14/96</u>	<u>V049-2-141</u>	<u>0</u>

**Title:** SPECIFICATION FOR 80K PUMP VENT HEATER

**Supplier:** McMaster-Carr Supply Co.

**Description:** Constant-Output Heat Cable,  
with power connection kit and temperature switch

**Size:** PSI P/N V049-2-141-P1: 92' long cable  
PSI P/N V049-2-141-P2: 50' long cable

**Rating:** 12 watts/ft, 400° F max. exposure temperature

**Model Number:** 35535K76 (cable)  
35535K52 (power conn. kit)  
3599K34 (temp. switch)

SPECIFICATION		
Number	V049-2-141	Rev.
A		φ

**Title: SPECIFICATION FOR CLEAN ROOM FAN/FILTER MODULES AND FLOURESCENT LIGHTING FIXTURES**

**SPECIFICATION FOR  
CLEAN ROOM FAN/FILTER MODULES  
AND  
FLOURESCENT LIGHTING FIXTURES**

FOR

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** BAR

**ELECTRICAL:** FAOZ BANK

**QUALITY ASSURANCE:** GENE SRENGAL

**TECHNICAL DIRECTOR:** D. C. M. W. J. J. J.

**PROJECT MANAGER:** [Signature]

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
2	6002 refer to		REVISED FOR PURCHASE. DEO #0305
1	D. M. W.	REB 9/30/56	REVISED PER DEO 0279
0	D. M. W.	REB 9/14/56	ISSUED FOR QUOTE PER DEO 0265

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number
	BAR	9/19/56	REB	9/19/56	V049-2-142
					Rev. 2

**Title: SPECIFICATION FOR CLEAN ROOM FAN/FILTER MODULES AND  
FLOURESCENT LIGHTING FIXTURES**

**TABLE OF CONTENTS**

1.0	Scope	3
2.0	Testing	3
3.0	Drawings	3
4.0	Delivery	3
5.0	Equipment	3

**ATTACHMENTS**

- A. LIGO Quality Assurance Requirements Summary

**SPECIFICATION**

NUMBER  
AV049-2-142

REV  
2

**Title: SPECIFICATION FOR CLEAN ROOM FAN/FILTER MODULES AND FLOURESCENT LIGHTING FIXTURES**

**1.0 SCOPE**

This equipment will be used to fabricate cleanroom for use with ultra high vacuum equipment.

**2.0 TESTING**

HEPA filter units (or of each type) shall be tested to verify particulate removal. A test report shall be provided to the Buyer.

The HEPA filter assemblies shall be protected from hydrocarbon contamination throughout manufacture and testing. No hydrocarbon vapors shall be used for testing.

**3.0 DRAWINGS**

Bidder shall submit outline drawing for HEPA filter units and lighting units with their proposal.

**4.0 DELIVERY**

Delivery is required as soon as possible. Bidders to state their delivery schedule with the proposal.

**5.0 EQUIPMENT DATA**

1. 2 ft. x 4 ft. Fan/Filter Module for class 100 cleanroom system. 16 Units Required.  
PSI part number V0492142P1.
  - A. Fan/Filter Module to have prefilter section. Ductwork collars are not permitted.
  - B. Filter to be HEPA type, with 99.99% efficiency on 0.3µm particle size.
  - C. Fan motor to be wired for 277 VAC.
  - D. Fan motor to have local speed control mounted on Fan/Filter Module. Speed control to have adjustment range of 50% of fan speed to 100% of fan speed or better.
  - E. Fan/Filter Module to have 10' extension cord with NEMA L7-15P twist-lock male plug.
  - F. Fan/Filter Module to be constructed of either aluminum or stainless steel, or both.
  - G. Fan/Filter Module shall work in conjunction with Gordon Inc. CG-15 clean room grid-system.
  - H. Fan/Filter Module shall have a capacity of 415 to 730 CFM.
  - I. Tag or permanantly mark the PSI part number on the fan/filter module.
  
2. 2 ft. x 3 ft. Fan/Filter Module for class 100 cleanroom system. 208 Units Required.  
PSI part number V0492142P2.
  - A. Fan/Filter Module to have prefilter section. Ductwork collars are not permitted.
  - B. Filter to be HEPA type, with 99.99% efficiency on 0.3µm particle size.
  - C. Fan motor to be wired for 277 VAC.
  - D. Fan motor to have local speed control mounted on Fan/Filter Module. Speed control to have adjustment range of 50% of fan speed to 100% of fan speed or better.
  - E. Fan/Filter Module to have 10' extension cord with NEMA L7-15P twist-lock male plug.
  - F. Fan/Filter Module to be constructed of either aluminum or stainless steel, or both.
  - G. Fan/Filter Module shall work in conjunction with Gordon In. CG-15 clean room grid systems.
  - H. Fan/Filter Module shall have a capacity of 415 to 730 CFM.
  - I. Tag or permanantly mark the PSI part number on the fan/filter module..

<b>SPECIFICATION</b>	
NUMBER <b>AV049-2-142</b>	REV <b>2</b>

**Title: SPECIFICATION FOR CLEAN ROOM FAN/FILTER MODULES AND  
FLOURESCENT LIGHTING FIXTURES**

3. 2 ft. x 3 ft. Fluorescent Lighting Fixture for class 100 cleanroom system. 68 Units Required.  
PSI part number V0492142P3.

- A. Lighting Fixture to be wired for 277 VAC.
- B. Fixture to have Energy saving lights.
- C. Lighting Fixture shall work in conjunction with Gordon Inc. CG-15 clean room grid systems.
- D. Lighting fixture to have 10' extension cord with NEMA L7-15P twist-lock male plug.
- E. Tag or permanantly mark the PSI part number on the lighting fixture.

<b>SPECIFICATION</b>	
NUMBER	REV
AV049-2-142	2





**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR HORIZONTAL ACCESS MODULE**

**TABLE OF CONTENTS**

<b>1.0 SCOPE</b>	<b>3</b>
<b>2.0 SCHEDULE</b>	<b>3</b>
<b>3.0 GENERAL REQUIREMENTS</b>	<b>3</b>
<b>4.0 REQUIRED DOCUMENTATION</b>	<b>4</b>
<b>5.0 SHOP TESTING</b>	<b>4</b>
<b>6.0 INSPECTION</b>	<b>4</b>
<b>7.0 WARRANTY</b>	<b>4</b>
<b>8.0 Q.A. REQUIREMENTS</b>	<b>4</b>
<b>9.0 APPENDIX: DWG. V049-2-144 HAM CLEAN ROOM SYSTEM SOFTWALL PANEL DETAILS</b>	<b>5</b>
<b>ATTACHMENT A: LIGO QA REQUIREMENT SUMMARY</b>	
<b>ATTACHMENT B: GENERAL EQUIPMENT REQUIREMENTS PSI SPECIFICATION V049-2-033, REV 2</b>	

<b>SPECIFICATION</b>	
<b>NUMBER</b>	<b>REV</b>
<b>A V049-2-144</b>	<b>0</b>

**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR HORIZONTAL ACCESS MODULE**

**1.0 SCOPE**

1.1 This specification covers the minimum requirements for the design, materials, fabrication, inspection, testing, preparation for shipping, and shipment of softwall panels for portable softwalled cleanrooms for the LIGO vacuum system.

All attachments are part of this specification.

The specified equipment is intended for use as part of the Vacuum Equipment supplied for the Laser Interferometer Gravity wave Observatory (LIGO). LIGO, which is operated by Caltech & MIT under a NSF contract, includes two installations at widely seperated sites: near Hanford, WA. and Livingston, LA. Each installation contains laser interferometers in an L shape with 4 KM arms, a vacuum system for the sensitive interferometer components and optical beams, and other support facilities.

1.2 This specification covers the requirements for one Horizontal Access Module (hereinafter called HAM) clean room softwall panel set. Refer to section 2.0 delivery schedule for quantities.

1.3 These panels shall be used in a portable class 100 clean room system.

**2.0 SCHEDULE**

The deliverary schedule shall be as follows:

Washington Site: qty of 1 12/1/96

Lousiana Site: qty of 1 12/1/96

Total required: 2

**3.0 GENERAL REQUIREMENTS**

2.1 Panels shall be constructed of transparent 40mil fire-retardant PVC with weighted bottoms.

2.2 Panels shall be attached to structural framework (by PSI) via non-particulating "Dual Lock" or equivalent attachment strips along the top edge of the panel, or such attachment as suggested by manufacturer. The mating piece of "Dual Lock", or other attachment method, shall be supplied with the appropriate panel.

Attachment method shall be suitable for supporting the weight of the panels during normal operation without sagging or pulling free.

2.3 Panels intersecting beam tubes shall have a closable "Dual Lock" seam to enable setting panel in place around beam tube. Refer to appendix A, dwg. #v049-2-144 for arrangement of beam tubes.

2.4 Panels intersecting beam tubes shall have a method of cinching panel tube around circumference of the beam tube. Beam tube diameters vary from 68.25" to 30". Panel must accomodate varying diameters. Refer to appendix A, dwg. #v049-2-144 for arrangement of beam tubes.

2.5 Panels intersecting beam tubes shall have a method of closing beam tube opening for use when beam tube is not installed.

2.6 Adjacent panels shall overlap by 3" min. each side, or as suggested by manufacturer.

**SPECIFICATION**

NUMBER

A V049-2-144

REV

0

**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR HORIZONTAL ACCESS MODULE**

**4.0 REQUIRED DOCUMENTATION**

The documentation called for in Attachment A shall be supplied by the vendor.

**5.0 SHOP TESTING**

The Vendor shall perform his standard testing.

**6.0 INSPECTION**

The inspections called for in Attachment A shall be performed by the vendor.

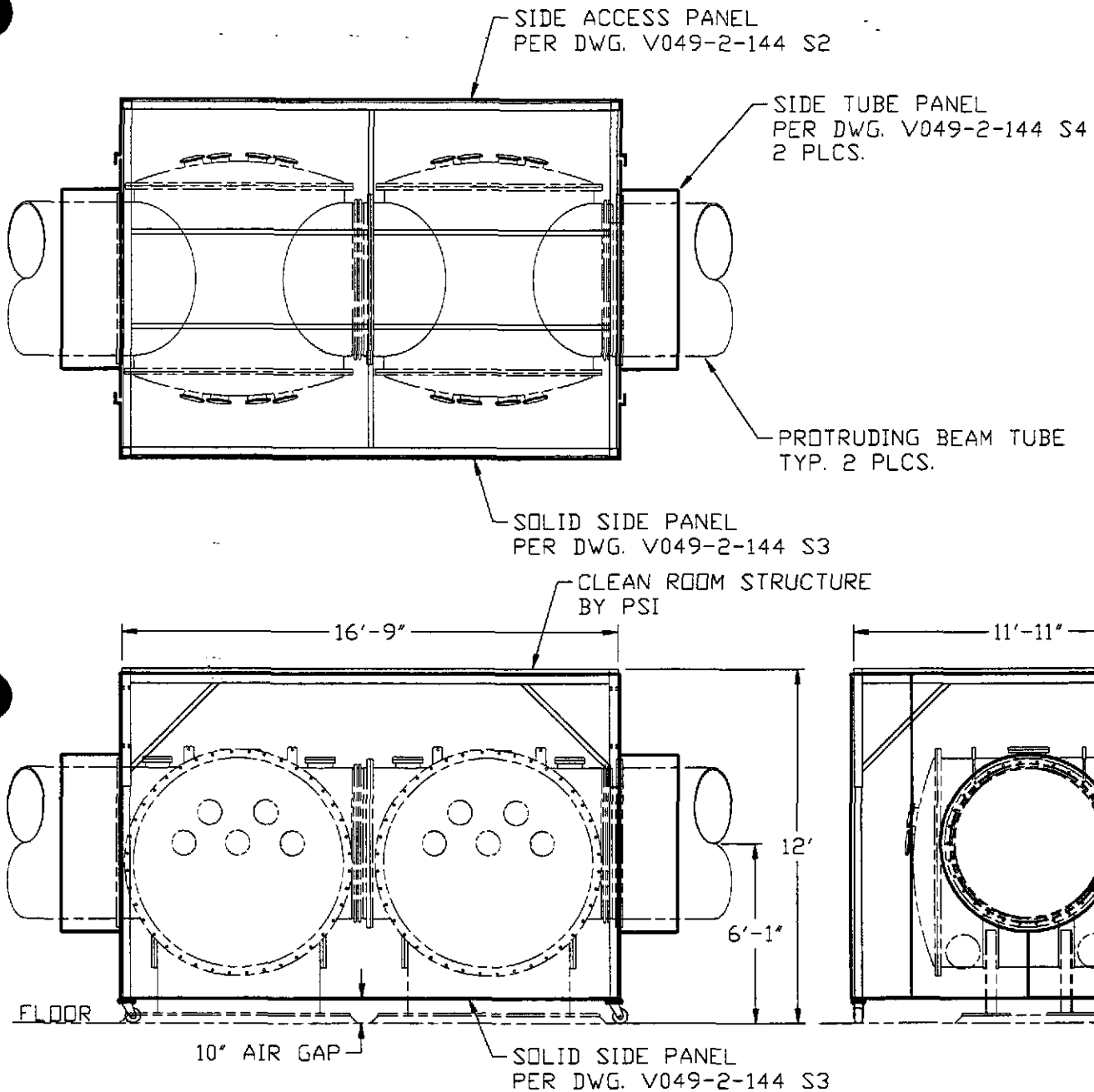
**7.0 WARRANTY**

Refer to Specification V049-2-034, Purchased Equipment Commercial Requirements (attached to Requests for Quotation), for warranty requirements.

**8.0 Q.A. REQUIREMENTS**

Q.A. requirements shall be provided as specified on Attachment A.

SPECIFICATION	
NUMBER	REV
A V049-2-144	0



**NOTE:**  
 SIDE PANELS WILL OVERLAP ADJACENT  
 SIDE TUBE PANELS BY 3".



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

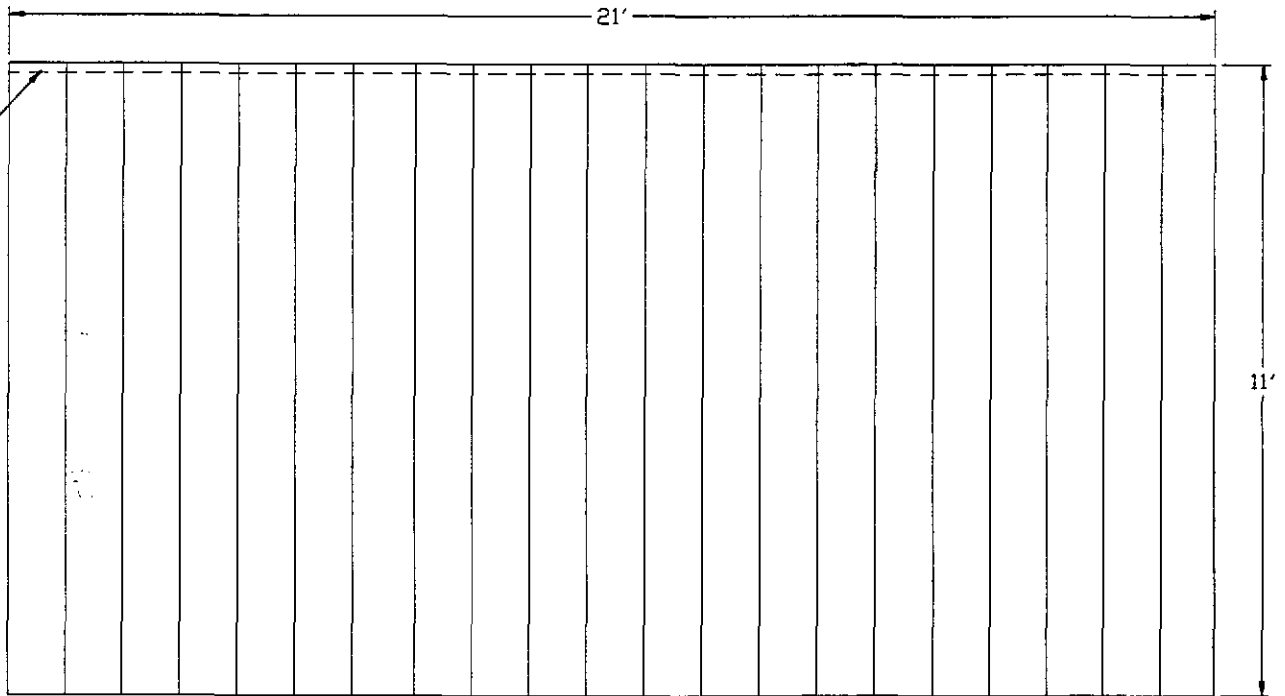
H.A.M. CLEAN ROOM SYSTEM  
 CLEAN ROOM SOFTWALL PANELS

CAD FILE NO.	SIZE	DWG. NO.	REV.
2144S1	A	V049-2-144	0

REV.	DESCRIPTION	DATE	BY	CHK.	APP.	SCALE: NONE	DRAWN: BAR	SHEET: 1 OF 4
------	-------------	------	----	------	------	-------------	------------	---------------

Sept 25, 1996 - 132709

DUAL LOCK  
ATTACHMENT



CORNER ACCESS PANEL  
40 MIL SOFTWALL PANEL STRIPS  
1 REQ'D



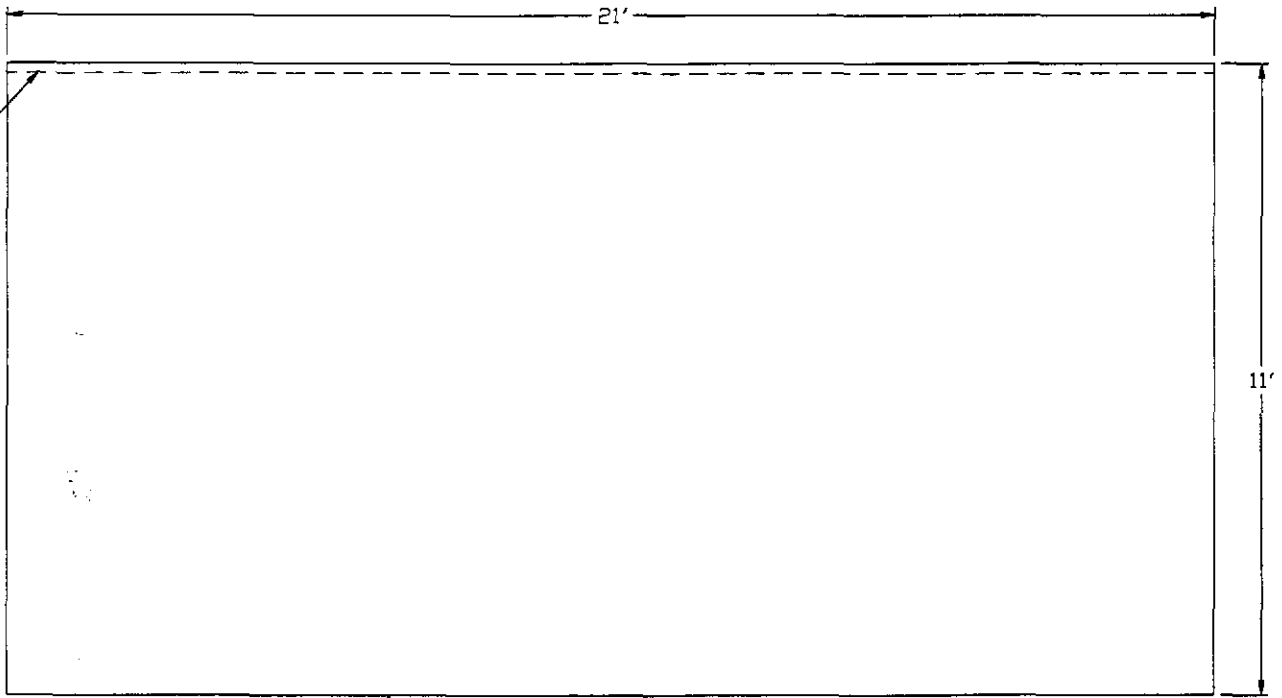
**PROCESS SYSTEMS INTERNATIONAL INC.**  
20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA

H.A.M. CLEAN ROOM SYSTEM  
SIDE ACCESS PANEL

CAD FILE NO.	SIZE	DWG. NO.	REV.
2144S2	A	V049-2-144	0
SCALE: NONE	DRAWN: BAR	SHEET: 2	OF 4


Sept 25, 1996 - 09:37:34

DUAL LOCK  
ATTACHMENT

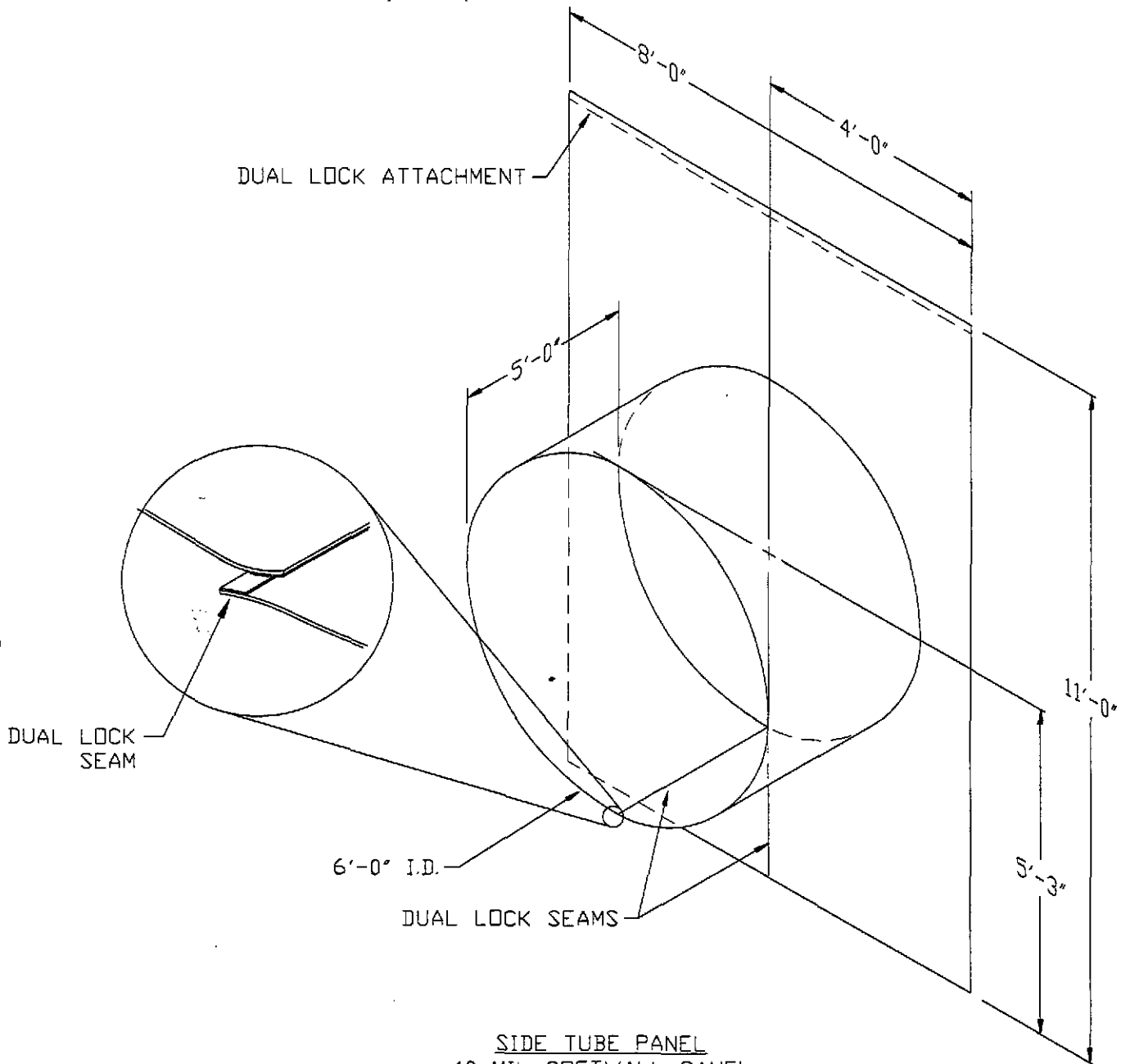


MAY BE CONSTRUCTED OF SEVERAL  
DIFFERENT OVERLAPPING PANEL  
LENGTHS.


CORNER ACCESS PANEL  
40 MIL SOFTWALL PANEL  
1 REQ'D

 <b>PROCESS SYSTEMS INTERNATIONAL INC.</b> 20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA			
H.A.M. CLEAN ROOM SYSTEM SOLID SIDE PANEL			
CAD FILE NO. 2144S3	SIZE A	DWG. NO. V049-2-144	REV. 0
SCALE: NONE	DRAWN: BAR	SHEET:	3 OF 4

Oct 04, 1996 - 15:22:22



SIDE TUBE PANEL  
 40 MIL SOFTWALL PANEL  
 2 REQ'D.

 <b>PROCESS SYSTEMS INTERNATIONAL INC.</b> 20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA			
<b>H.A.M. CLEAN ROOM SYSTEM</b> <b>SIDE TUBE PANEL</b>			
CAD FILE NO.	SIZE	DWG. NO.	REV.
2144S4	A	V049-2-144	0
SCALE: NONE	DRAWN: BAR	SHEET:	4 OF 4

Oct 04, 1996 - 15:38:12



ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: SOFTWALL CLEAN ROOM PANELS FOR HORIZONTAL ACCESS MODULE	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-144
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:  Inspector:  Date:
MILESTONE SCHEDULE	2 Wks.		X	2	X	
VENDOR Q.A. PLAN	2		X	2	X	
PREP FOR SHIPMENT PROCEDURE	2		X	2	X	
ASSEMBLY DRAWINGS	6		X	2	X	
DESIGN REVIEW	4	X			X	
OPERATION & MAINTENANCE MANUALS	TBD			5	X	

**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR BEAM SPLITTER CHAMBER**

**SPECIFICATION FOR  
SOFTWALL CLEAN ROOM PANELS  
BEAM SPLITTER CHAMBER**

**FOR**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

ASAC - 10/2/96

QUALITY ASSURANCE:

Alan R. Bullock

TECHNICAL DIRECTOR:

D. A. McWilliam

PROJECT MANAGER:

Paul Bayly

REV	BY - DATE	APPD. - DATE	DESCRIPTION OF CHANGE
0	ASAC 10/2/96	RES 10/4/96	ISSUED FOR THE FIRST TIME 0875

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	NUMBER	REV
	<u>ASAC</u>	<u>10/2/96</u>	<u>RES</u>	<u>10/4/96</u>	A	V049-2-145
						0

**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR BEAM SPLITTER CHAMBER**

**TABLE OF CONTENTS**

<b>1.0 SCOPE</b>	<b>3</b>
<b>2.0 SCHEDULE</b>	<b>3</b>
<b>3.0 GENERAL REQUIREMENTS</b>	<b>3</b>
<b>4.0 REQUIRED DOCUMENTATION</b>	<b>4</b>
<b>5.0 SHOP TESTING</b>	<b>4</b>
<b>6.0 INSPECTION</b>	<b>4</b>
<b>7.0 WARRANTY</b>	<b>4</b>
<b>8.0 Q.A. REQUIREMENTS</b>	<b>4</b>
<b>9.0 APPENDIX: DWG. V049-2-145 BSC CLEAN ROOM SYSTEM SOFTWALL PANEL DETAILS</b>	<b>5</b>

**ATTACHMENT A: LIGO QA REQUIREMENT SUMMARY**

**ATTACHMENT B: GENERAL EQUIPMENT REQUIREMENTS  
PSI SPECIFICATION V049-2-033, REV 2**

**SPECIFICATION**

<b>NUMBER</b> A V049-2-145	<b>REV</b> 0
-------------------------------	-----------------

**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR BEAM SPLITTER CHAMBER**

**1.0 SCOPE**

1.1 This specification covers the minimum requirements for the design, materials, fabrication, inspection, testing, preparation for shipping, and shipment of softwall panels for portable softwalled cleanrooms for the LIGO vacuum system.

All attachments are part of this specification.

The specified equipment is intended for use as part of the Vacuum Equipment supplied for the Laser Interferometer Gravity wave Observatory (LIGO). LIGO, which is operated by Caltech & MIT under a NSF contract, includes two installations at widely seperated sites: near Hanford, WA. and Livingston, LA. Each installation contains laser interferometers in an L shape with 4 KM arms, a vacuum system for the sensitive interferometer components and optical beams, and other support facilities.

1.2 This specification covers the requirements for one Horizontal Access Module (hereinafter called HAM) clean room softwall panel set. Refer to section 2.0 delivery schedule for quantities.

1.3 These panels shall be used in a portable class 100 clean room system.

**2.0 SCHEDULE**

The deliverary schedule shall be as follows:

PSI (Westborough Ma.)	qty of 1	12/1/96
Washington Site:	qty of 6	5/1/97
Lousiana Site:	qty of 3	12/1/97

Total required: 10

**3.0 GENERAL REQUIREMENTS**

2.1 Panels shall be constructed of transparent 40mil fire-retardant PVC with weighted bottoms.

2.2 Panels shall be attached to structural framework (by PSI) via non-particulating "Dual Lock" or equivalent attachment strips along the top edge of the panel, or such attachment as suggested by manufacturer. The mating piece of "Dual Lock", or other attachment method, shall be supplied with the appropriate panel.

Attachment method shall be suitable for supporting the weight of the panels during normal operation without sagging or pulling free.

2.3 Panels intersecting beam tubes shall have a closable "Dual Lock" seam to enable setting panel in place around beam tube. Refer to appendix A, dwg. #v049-2-145 for arrangement of beam tubes.

2.4 Panels intersecting beam tubes shall have a method of cinching panel tube around circumference of the beam tube. Beam tube diameters vary from 68.25" to 30". Panel must accomodate varying diameters. Refer to appendix A, dwg. #v049-2-145 for arrangement of beam tubes.

2.5 Panels intersecting beam tubes shall have a method of closing beam tube opening for use when beam tube is not installed.

2.6 Adjacent panels shall overlap by 3" min. each side, or as suggested by manufacturer.

SPECIFICATION	
NUMBER	REV
A V049-2-145	0

**Title: SPECIFICATION FOR SOFTWALL CLEAN ROOM PANELS  
FOR BEAM SPLITTER CHAMBER**

**4.0 REQUIRED DOCUMENTATION**

The documentation called for in Attachment A shall be supplied by the vendor.

**5.0 SHOP TESTING**

The Vendor shall perform his standard testing.

**6.0 INSPECTION**

The inspections called for in Attachment A shall be performed by the vendor.

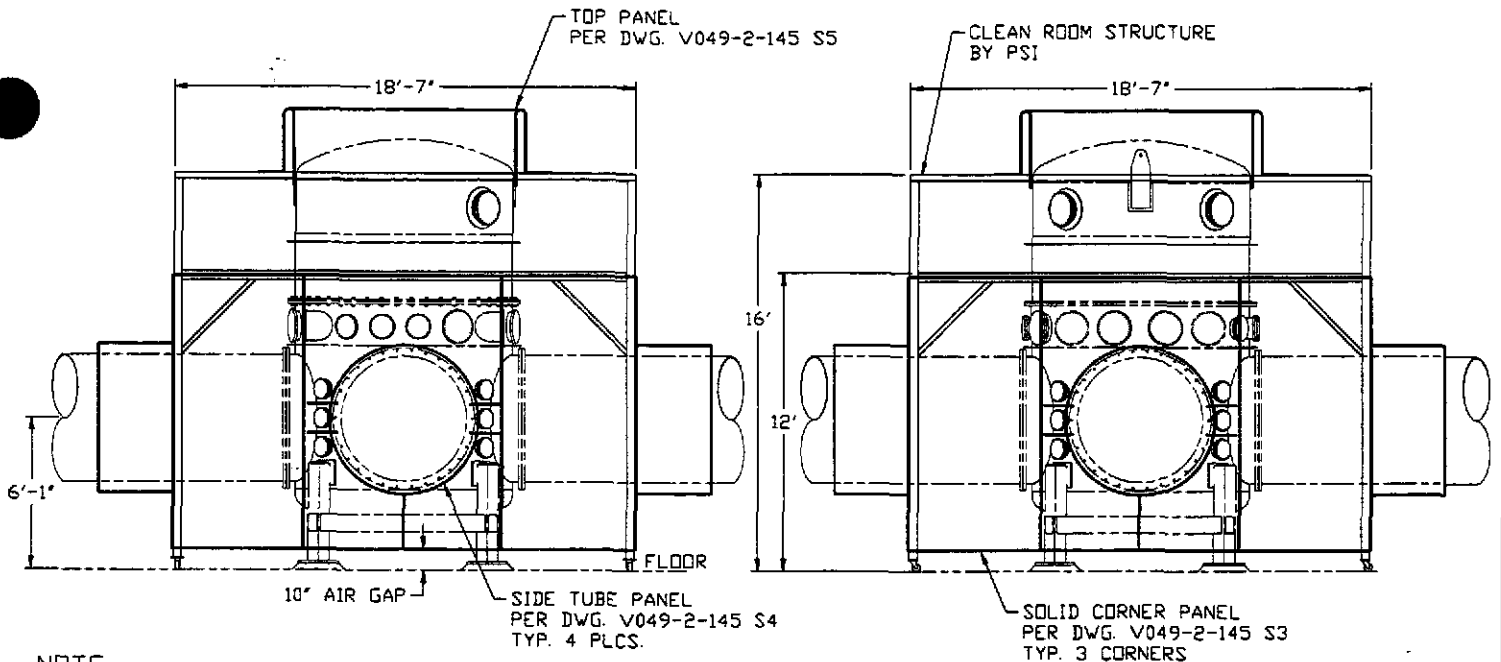
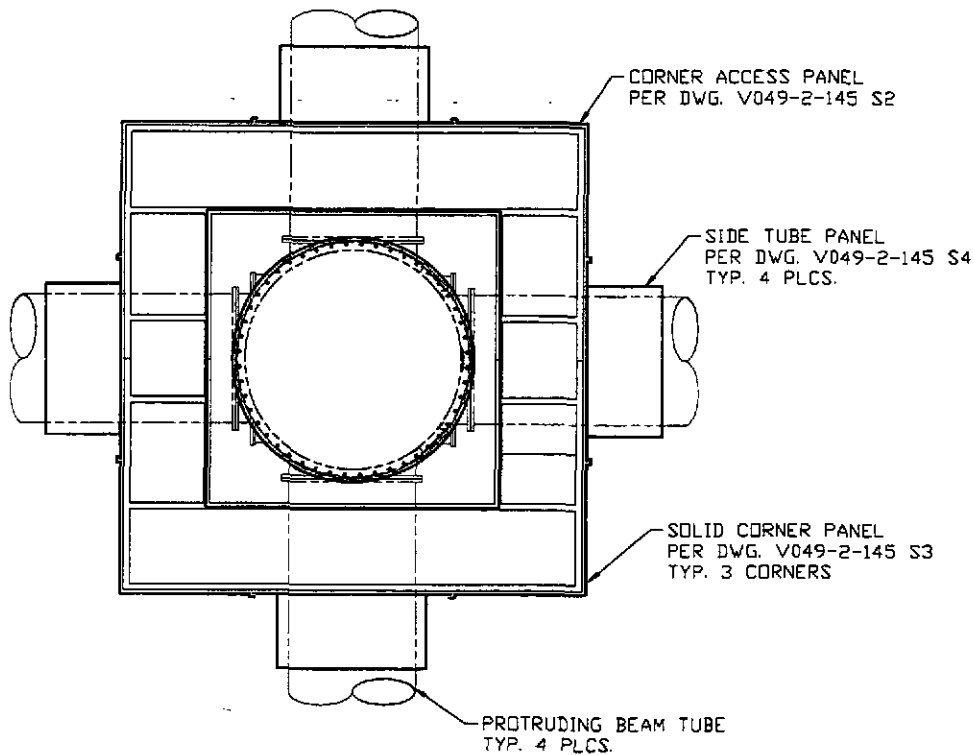
**7.0 WARRANTY**

Refer to Specification V049-2-034, Purchased Equipment Commercial Requirements (attached to Requests for Quotation), for warranty requirements.

**8.0 Q.A. REQUIREMENTS**

Q.A. requirements shall be provided as specified on Attachment A.

<b>SPECIFICATION</b>	
<b>NUMBER</b>	<b>REV</b>
<b>A V049-2-145</b>	<b>0</b>



**NOTE:**  
 CORNER PANELS WILL OVERLAP  
 ADJACENT SIDE TUBE PANELS BY 3".



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

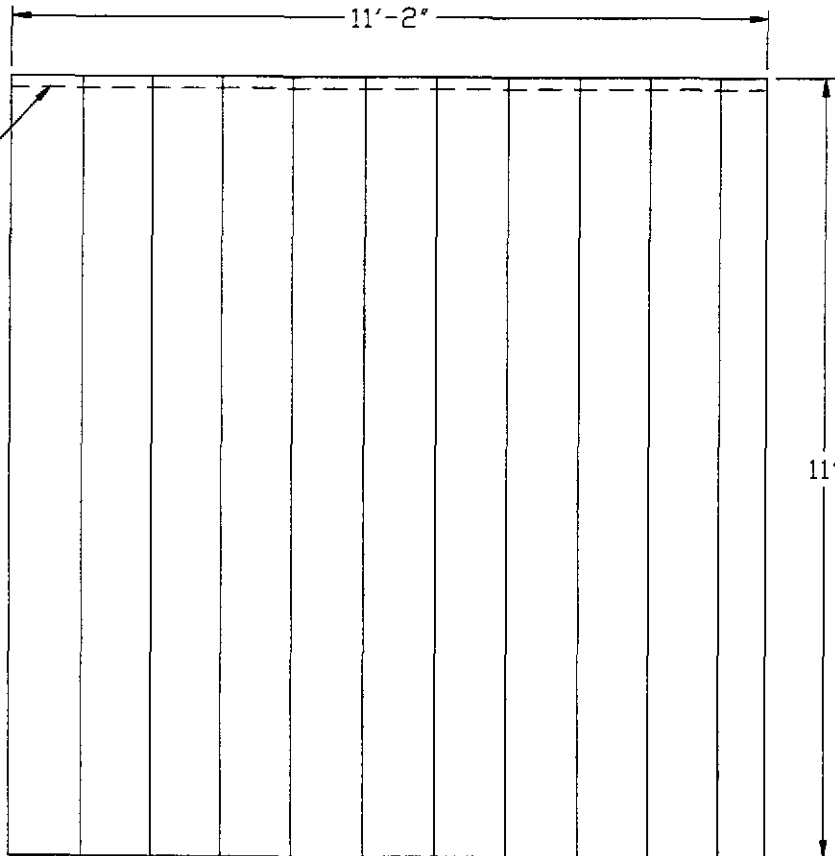
**B.S.C. CLEAN ROOM SYSTEM  
 CLEAN ROOM SOFTWALL PANELS**

CAD FILE NO.	SIZE	DWG. NO.	REV.
2145S1	A	V049-2-145	0

REV.	DESCRIPTION	DATE	BY	CHK.	APP.	SCALE: NONE	DRAWN: BAR	SHEET: 1 OF 5
------	-------------	------	----	------	------	-------------	------------	---------------

Oct 04, 1996 - 154928

DUAL LOCK  
ATTACHMENT



CORNER ACCESS PANEL  
40 MIL SOFTWALL PANEL STRIPS  
1 REQ'D



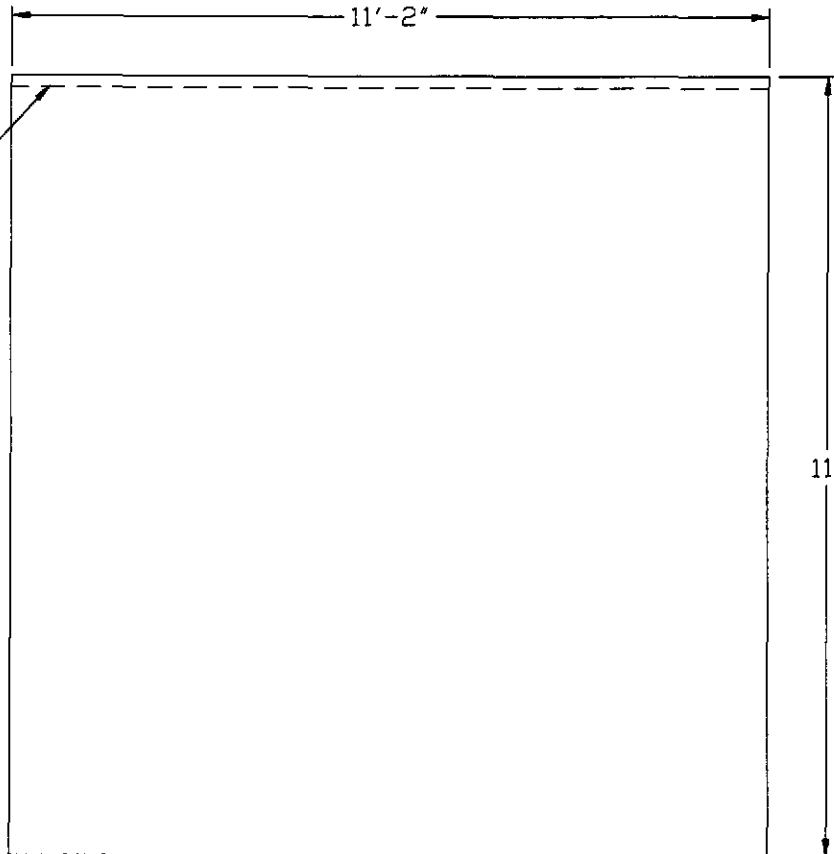
**PROCESS SYSTEMS INTERNATIONAL INC.**  
20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA

B.S.C. CLEAN ROOM SYSTEM  
CORNER ACCESS PANEL

CAD FILE NO.	SIZE	DWG. NO.	REV.
2145S2	A	V049-2-145	0
SCALE: NONE	DRAWN: BAR	SHEET:	2 OF 5

Oct 04, 1996 - 154951

DUAL LOCK  
ATTACHMENT



SOLID CORNER PANEL  
40 MIL SOFTWALL PANEL  
3 REQ'D

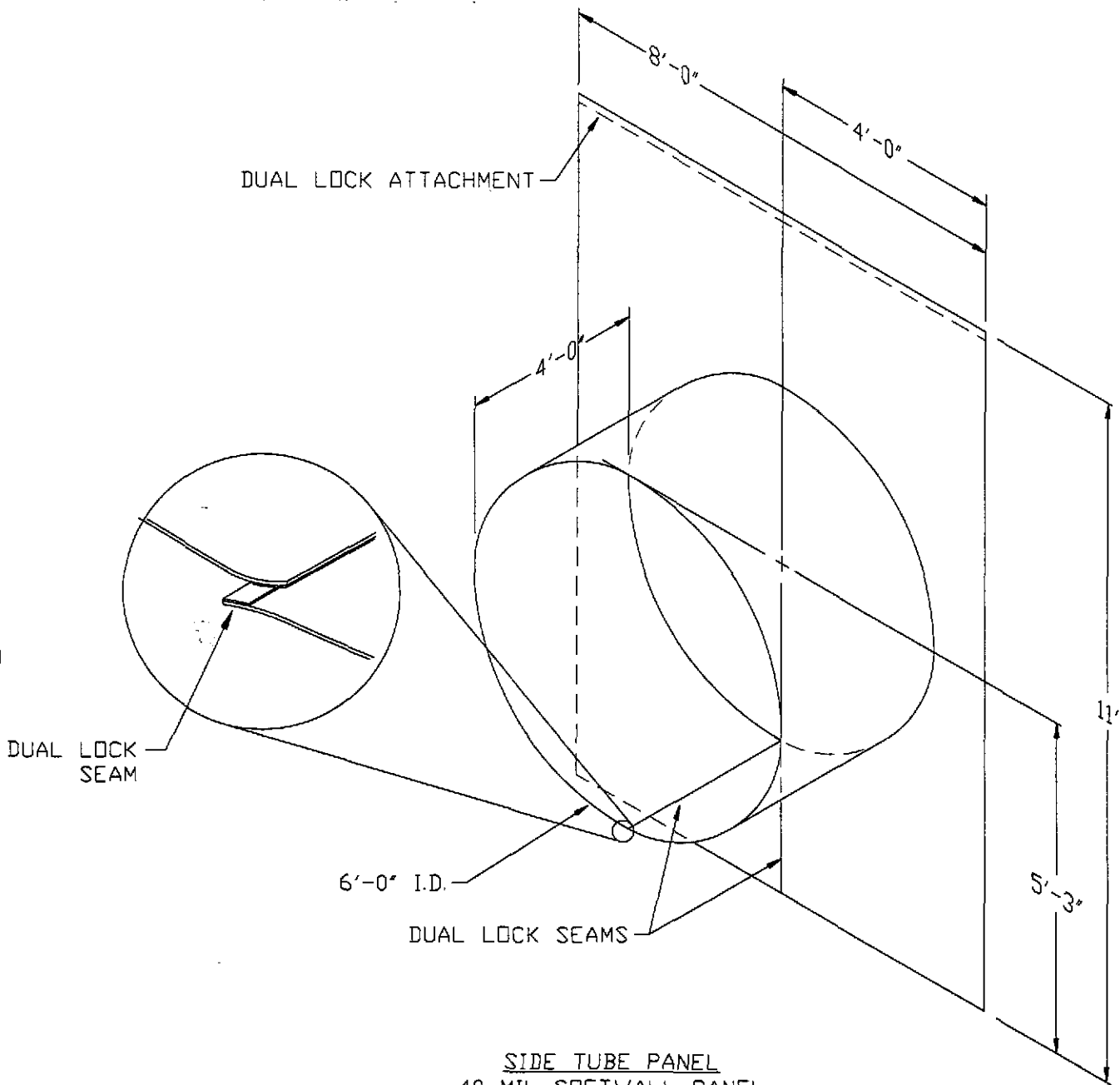


PROCESS SYSTEMS INTERNATIONAL INC.  
20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA

B.S.C. CLEAN ROOM SYSTEM  
SOLID CORNER PANEL

CAD FILE NO.	SIZE	DWG. NO.	REV.
2145S3	A	V049-2-145	0
SCALE: NONE	DRAWN: BAR	SHEET:	3 OF 5





SIDE TUBE PANEL  
 40 MIL SOFTWALL PANEL  
 4 REQ'D.

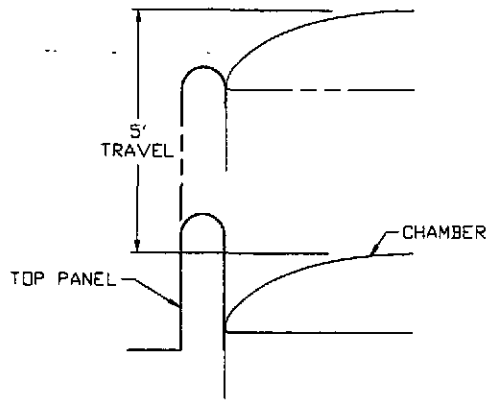


**PROCESS SYSTEMS INTERNATIONAL INC.**  
 20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA

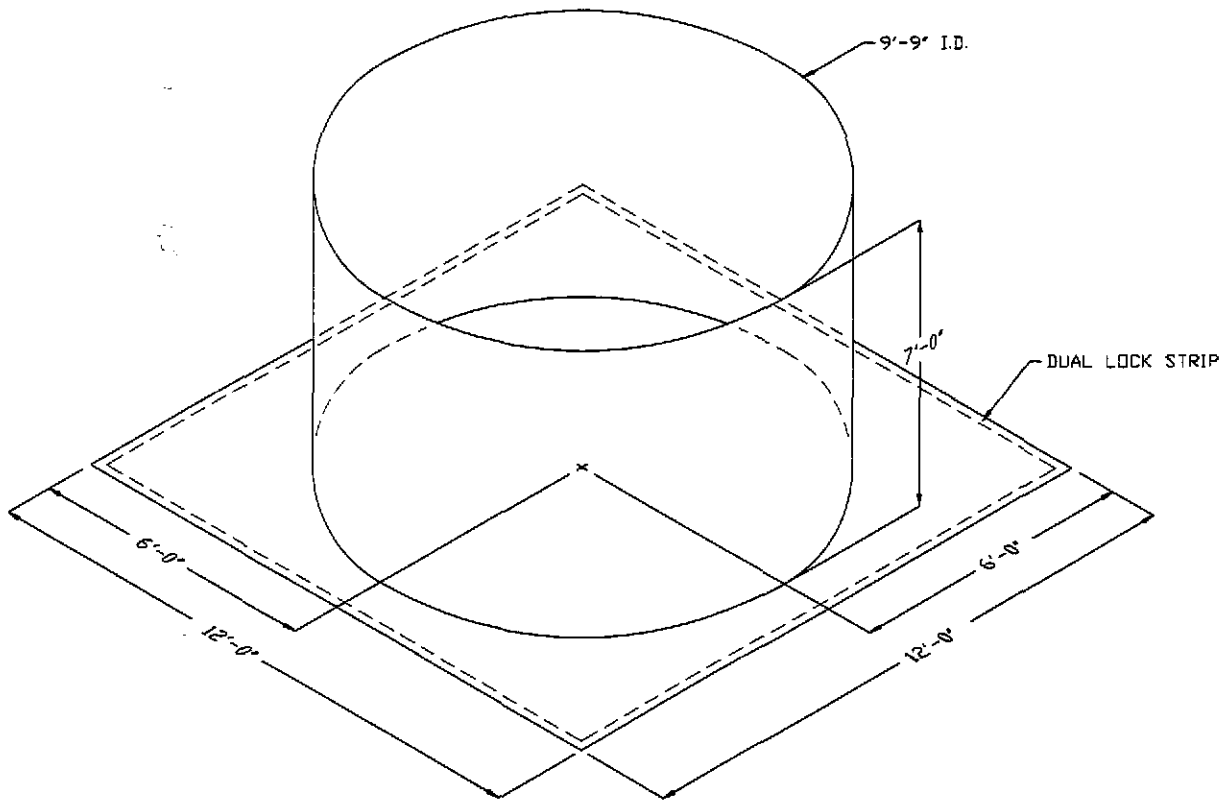
B.S.C. CLEAN ROOM SYSTEM  
 SIDE TUBE PANEL

CAD FILE NO.	SIZE	DWG. NO.	REV.
2145S4	A	V049-2-145	0
SCALE: NONE		DRAWN: BAR	SHEET: 4 OF 5

Oct 04, 1996 - 15:5028



DETAIL  
INSTALLATION OF TOP PANEL  
ON BSC CHAMBER & TRAVEL  
REQUIREMENTS.



TOP BSC PANEL  
40 MIL SOFTWALL PANEL  
1 REQ'D



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

B.S.C. CLEAN ROOM SYSTEM  
TOP PANEL

CAD FILE NO.	SIZE	DWG. NO.	REV.
2145S5	A	V049-2-145	0
SCALE: NONE		DRAWN: BAR	SHEET: 5 OF 5

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: SOFWALL CLEAN ROOM PANELS FOR BEAM SPLITTER CHAMBER	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-145
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:  Inspector:  Date:
MILESTONE SCHEDULE	2 Wks.		X	2	X	
VENDOR Q.A. PLAN	2		X	2	X	
PREP FOR SHIPMENT PROCEDURE	2		X	2	X	
ASSEMBLY DRAWINGS	6		X	2	X	
DESIGN REVIEW	4	X			X	
OPERATION & MAINTENANCE MANUALS	TBD			5	X	

Title:

**SPECIFICATION FOR CLASS 100 PORTABLE  
CLEAN GOWNING ROOMS**

**SPECIFICATION FOR  
PORTABLE CLASS 100  
CLEAN GOWNING ROOMS  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY: BANK

QUALITY ASSURANCE: G. SEMKAL

TECHNICAL DIRECTOR: D. McWilliams 10-1594

PROJECT MANAGER: Bob Beyer

Ø	BANK 10/15/96	RES 10/16/96	Released Per Dec 0306
REV	BY - DATE	APPD. - DATE	DESCRIPTION OF CHANGE

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	NUMBER	REV
	BANK	10/15/96	RES	10/16/96	A V049-2-157	0

**Title:**

**SPECIFICATION FOR PORTABLE CLASS 100  
CLEAN GOWNING ROOMS**

**TABLE OF CONTENTS**

<b>1.0 SCOPE</b>	<b>3</b>
<b>2.0 SCHEDULE</b>	<b>3</b>
<b>3.0 GENERAL REQUIREMENTS</b>	<b>3</b>
<b>4.0 REQUIRED DOCUMENTATION</b>	<b>4</b>
<b>5.0 SHOP TESTING</b>	<b>5</b>
<b>6.0 INSPECTION</b>	<b>5</b>
<b>7.0 WARRANTY</b>	<b>5</b>
<b>8.0 Q.A. REQUIREMENTS</b>	<b>5</b>

**ATTACHMENT A: LIGO QA REQUIREMENT SUMMARY**

**ATTACHMENT B: GENERAL EQUIPMENT REQUIREMENTS  
PSI SPECIFICATION V049-2-033, REV 2**

**SPECIFICATION**

**NUMBER**

**A V049-2-157**

**REV**

**0**

**Title: SPECIFICATION FOR PORTABLE CLASS 100  
CLEAN GOWNING ROOMS**

**1.0 SCOPE**

1.1 This specification covers the minimum requirements for the design, materials, fabrication, inspection, testing, preparation for shipping, and shipment of portable softwall gowning rooms for the LIGO vacuum system.

All attachments are part of this specification.

The specified equipment is intended for use as part of the Vacuum Equipment supplied for the Laser Interferometer Gravity wave Observatory (LIGO). LIGO, which is operated by Caltech & MIT under a NSF contract, includes two installations at widely separated sites: near Hanford, WA. and Livingston, LA. Each installation contains laser interferometers in an L shape with 4 KM arms, a vacuum system for the sensitive interferometer components and optical beams, and other support facilities.

1.2 This specification covers the requirements for 4'L x 4'W x 8'H gowning room and the 4'L x 8'W x 8'H gowning room. Refer to section 2.0 delivery schedule for quantities.

1.3 These gowning room will be used in conjunction with larger portable clean room systems.

**2.0 SCHEDULE**

The delivery schedule shall be as follows:

4'L x 4'W x 8'H gowning room:

Washington Site: qty of 4 8/1/97  
Louisiana Site: qty of 2 3/1/98

Total required: 6

4'L x 8'W x 8'H gowning room:

Washington Site: qty of 1 8/1/97  
Louisiana Site: qty of 1 3/1/98

Total required: 2

**3.0 GENERAL REQUIREMENTS**

**3.1 4'L x 4'W x 8'H Gowning Room**

3.1.1 Frame shall be constructed of 2" x 2" structural tube steel, or such material as deemed appropriate by the manufacturer to satisfy conditions of use. Frame shall further contain such supports and bracing as required to maintain structural integrity.

3.1.2 Frame shall be painted with a white epoxy finish.

3.1.3 Casters with a foot actuated locking mechanism shall be attached to the support legs to facilitate placement of gowning room.

3.1.4 Lifting lugs shall be attached to the top of the frame to enable lifting of gowning room via a single hook crane. Lugs shall be designed to support finished weight of gowning room.

<b>SPECIFICATION</b>	
NUMBER	REV
A V049-2-157	0

Title:

**SPECIFICATION FOR PORTABLE CLASS 100  
CLEAN GOWNING ROOMS**

3.1.5 Wall material shall be 16mil or 20mil clear vinyl, or such thickness as deemed appropriate by the manufacturer. Wall material shall be attached to frame as required by manufacturer.

3.1.6 A strip door shall be placed on one side of the gowning room. The side opposite the strip door shall not have a soft wall, but shall be left open. The other 2 sides shall have solid clear vinyl walls attached as described in 3.1.5. The open side of the gowning room shall be placed against an existing softwall strip door.

3.2.7 The gowning room shall be suitable for class 100, using air flow from adjacent class 100 clean room softwall strip door.

3.2.8 The ceiling or top panel of the gowning room shall be of transparent material suitable for use in a class 100 cleanroom environment.

**3.2 4'L x 8'W x 8'H Gowning Room**

3.2.1 Frame shall be constructed of 2" x 2" structural tube steel, or such material as deemed appropriate by the manufacturer to satisfy conditions of use. Frame shall further contain such supports and bracing as required to maintain structural integrity.

3.2.2 Frame shall be painted with a white epoxy finish.

3.2.3 Casters with a foot actuated locking mechanism shall be attached to the support legs to facilitate placement of gowning room.

3.2.4 Lifting lugs shall be attached to the top of the frame to enable lifting of gowning room via a single hook crane. Lugs shall be designed to support finished weight of gowning room.

3.2.5 Wall material shall be 16mil or 20mil clear vinyl, or such thickness as deemed appropriate by the manufacturer. Wall material shall be attached to frame as required by manufacturer.

3.2.6 A strip door shall be placed on one 8'W side of the gowning room. The side opposite the strip door shall not have a soft wall, but shall be left open. The other two 4'L sides shall have solid clear vinyl walls attached as described in 3.2.5. The open side of the gowning room shall be placed against an existing softwall strip door.

3.2.7 The gowning room shall have one HEPA blower/filter unit required to maintain a class 100 environment, with an attached flow-through fluorescent lighting fixture. The HEPA blower/filter and lighting fixture shall be wired for 120vac, with an extension cord. The extension cord shall be attached to one leg the gowning room at approximately 10" from the floor level, and shall measure 15 feet in length from that attachment point. The extension cord used shall be suitable for use with a NEMA 5-15R duplex receptacle.

3.2.8 An on/off switch for the lighting and the HEPA blower/filter shall be located on the exterior of the gowning room.

**4.0 REQUIRED DOCUMENTATION**

The documentation called for in Attachment A shall be supplied by the vendor.

**SPECIFICATION**

NUMBER	REV
A V049-2-157	0

Title:

**SPECIFICATION FOR PORTABLE CLASS 100  
CLEAN GOWNING ROOMS**

**5.0 SHOP TESTING**

The Vendor shall perform his standard testing.

**6.0 INSPECTION**

The inspections called for in Attachment A shall be performed by the vendor.

**7.0 WARRANTY**

Refer to Specification V049-2-034, Purchased Equipment Commercial Requirements (attached to Requests for Quotation), for warranty requirements.

**8.0 Q.A. REQUIREMENTS**

Q.A. requirements shall be provided as specified on Attachment A.

**SPECIFICATION**

NUMBER

**A V049-2-157**

REV

**0**



ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: CLASS 100 GOWNING ROOMS	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-157
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:  Inspector:  Date:
MILESTONE SCHEDULE	8 Wks.		X	2	X	
VENDOR Q.A. PLAN						
CLEANING PROCEDURE						
PREP FOR SHIPMENT PROCEDURE	8 Wks.		X	2	X	
ASSEMBLY DRAWINGS	8 Wks.			2	X	
DESIGN REVIEW						
IN-PROCESS INSPECTIONS						
OPERATION & MAINTENANCE MANUALS	12 Wks.			5	X	
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION						
WELDING PROCEDURES						

Title: SPECIFICATION FOR 80K PUMP VENT LINE CHECK VALVE

**SPECIFICATION FOR  
80K PUMP VENT LINE CHECK VALVE  
FOR**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:**

David Moore

**QUALITY ASSURANCE**

Chris Seal

**TECHNICAL DIRECTOR:**

D. A. in Willow

**PROJECT MANAGER:**

\_\_\_\_\_

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1	DM 11/15/96		Revised per DEC # 348
φ	DM 10/21/96		Initial release, quote, & purchase DEO # 315

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	NumberA V049-2-162	Rev. 4
	DM	10/21/96				

**Title: SPECIFICATION FOR 80K PUMP VENT LINE CHECK VALVE**

**Supplier:** Circle Seal Controls

**Description:** Brass check valve with female pipe thread ends, and teflon seal.  
Dimensions shown on Attachment 1 of this specification.

**Size:** 1/2 inch

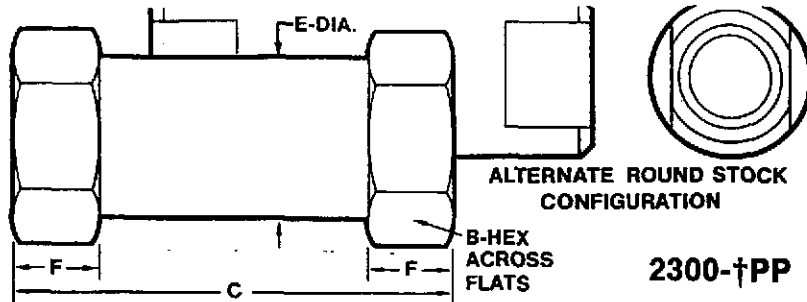
**Rating:** 0.5 psid cracking pressure

**Model Number:** 2320B4PP0.5

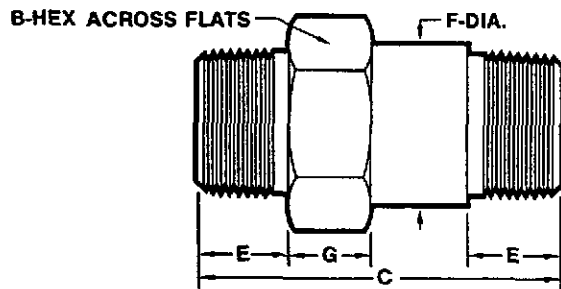
**Quantity:** One of each tag no:  
CV-107, CV-157, CV-207, CV-257, CV-307, CV-357  
CV-407, CV-507, CV-607, CV-657, CV-707, CV-807

**Documentation:** Five copies (total) of operating and maintenance instructions.

<b>SPECIFICATION</b>		
Number		Rev.
<b>A</b>	<b>V049-2-162</b>	<b>1</b>



DIMENSIONS				
SIZE	B-HEX	C	E	F
1/8	.625	1.50	.59	.31
1/4	.813	2.00	.77	.41
3/8	1.00	2.35	.95	.50
1/2	1.25	2.89	1.19	.56
3/4	1.50	3.30	1.43	.69



DIMENSIONS					
SIZE	B-HEX	C	E	F-DIA.	G
1/4	.625	1.82	.60	.59	.31
3/8	.813	2.21	.61	.77	.41
1/2	1.00	2.75	.79	.95	.50
3/4	1.25	3.03	.80	1.19	.56
1	1.50	3.67	.99	1.43	.69

### PART NUMBERS - (FEMALE CONNECTIONS)

MATERIAL	SIZE†	2349	2359	2333	2320
ALUMINUM	1/8	2349A-1PP	2359A-1PP	2333A-1PP	2320A-1PP
	1/4	2349A-2PP	2359A-2PP	2333A-2PP	2320A-2PP
	3/8*	2349A-3PP	2359A-3PP	2333A-3PP	2320A-3PP
	1/2*	2349A-4PP	2359A-4PP	2333A-4PP	2320A-4PP
	3/4*	2349A-6PP	2359A-6PP	2333A-6PP	2320A-6PP
BRASS	1/8	2349B-1PP	2359B-1PP	2333B-1PP	2320B-1PP
	1/4	2349B-2PP	2359B-2PP	2333B-2PP	2320B-2PP
	3/8	2349B-3PP	2359B-3PP	2333B-3PP	2320B-3PP
	1/2	2349B-4PP	2359B-4PP	2333B-4PP	2320B-4PP
	3/4	2349B-6PP	2359B-6PP	2333B-6PP	2320B-6PP
17-4PH STAINLESS STEEL	1/8	2349R-1PP	2359R-1PP	2333R-1PP	2320R-1PP
	1/4	2349R-2PP	2359R-2PP	2333R-2PP	2320R-2PP
	3/8	2349R-3PP	2359R-3PP	2333R-3PP	2320R-3PP
	1/2	2349R-4PP	2359R-4PP	2333R-4PP	2320R-4PP
	3/4	2349R-6PP	2359R-6PP	2333R-6PP	2320R-6PP

### PART NUMBERS - (MALE CONNECTIONS)

MATERIAL	SIZE†	2349	2359	2333	2320
ALUMINUM	1/4*	2349A-2MM	2359A-2MM	2333A-2MM	2320A-2MM
	3/8*	2349A-3MM	2359A-3MM	2333A-3MM	2320A-3MM
	1/2*	2349A-4MM	2359A-4MM	2333A-4MM	2320A-4MM
	3/4*	2349A-6MM	2359A-6MM	2333A-6MM	2320A-6MM
	1"*	2349A-8MM	2359A-8MM	2333A-8MM	2320A-8MM
BRASS	1/4*	2349B-2MM	2359B-2MM	2333B-2MM	2320B-2MM
	3/8*	2349B-3MM	2359B-3MM	2333B-3MM	2320B-3MM
	1/2*	2349B-4MM	2359B-4MM	2333B-4MM	2320B-4MM
	3/4*	2349B-6MM	2359B-6MM	2333B-6MM	2320B-6MM
	1"*	2349B-8MM	2359B-8MM	2333B-8MM	2320B-8MM
17-4PH STAINLESS STEEL	1/4*	2349R-2MM	2359R-2MM	2333R-2MM	2320R-2MM
	3/8*	2349R-3MM	2359R-3MM	2333R-3MM	2320R-3MM
	1/2*	2349R-4MM	2359R-4MM	2333R-4MM	2320R-4MM
	3/4*	2349R-6MM	2359R-6MM	2333R-6MM	2320R-6MM
	1"*	2349R-8MM	2359R-8MM	2333R-8MM	2320R-8MM

\*NOTE: Normally manufactured to order—minimum order quantity—40 pcs.

Attachment 1  
V049-2-162 Rev.1  
Pg 1 of 1



**CIRCLE SEAL CONTROLS, INC.**

POST OFFICE BOX 3666  
ANAHEIM, CALIFORNIA 92803  
PHONE (714) 774-6110 • FAX (714) 772-7332

Title: SPECIFICATION FOR 80K PUMP RESERVOIR RELIEF VALVE

SPECIFICATION FOR  
80K PUMP RESERVOIR RELIEF VALVE  
FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

David Moore

QUALITY ASSURANCE

Gene Senecal

TECHNICAL DIRECTOR:

D. W. Williams

PROJECT MANAGER:

Rick Boyz

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.


REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
----------	---------	------------	-----------------------

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-164	Rev.
	<u>DMoore</u>	<u>10/22/96</u>	<u>RES</u>	<u>10/23/96</u>		<u>0</u>

**Title: SPECIFICATION FOR 80K PUMP RESERVOIR RELIEF VALVE**

**Supplier:** Kunkle

**Description:** Bronze Safety Valve, Top Outlet

**Size:** 1/2". See Attachment 1 of this specification for dimensions.

**Set Pressure:** 15 psig

**Model Number:** 0001-C-KC0015

**Quantity:** One of each tag. no.  
RV-133, RV-183, RV-233, RV-283, RV-333, RV-383  
RV-483, RV-583, RV-633, RV-683, RV-783, RV-883

SPECIFICATION	
Number <b>A</b> V049-2-164	Rev. Ø



# BRONZE SAFETY VALVES FOR AIR, NON-HAZARDOUS GAS, STEAM SERVICE

## PRESSURE LIMITS

STEAM — 250 PSIG - 406°F.  
AIR/GAS — 250 PSIG - 300°F.

ASME Standard



N.B. Certified

## APPLICATIONS

- Air/Gas Compressors — portable or stationary.
- Pressure Vessels — including tanks, receivers, intercoolers, aftercoolers.
- Steam turbines, kettles, other steam-processing equipment.

## FEATURES

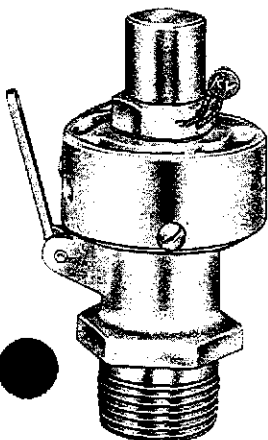
The "Original Kunkle" design. Very compact assembly. Cup-Type disc. Extra-long disc guides with precision lapped beveled seats. Fully enclosed spring. Warn ring offers easy adjustability for precise opening with minimum pre-open or simmer and exact blowdown control. Pivot between disc and spring corrects for mis-alignment and compensates for spring side thrust. Every valve is 100% tested/inspected for pressure setting, blowdown and leakage. All adjustments are factory sealed to prevent tampering or dis-assembly. Unique lift lever incorporated into valve body.

Overall Height — ½ & ¾" Model 1 — 3⅜"; Model 2 — 4"  
1" Model 1 — 4½"; Model 2 — 5½"  
Weight — ½ & ¾" Model 1 — 12 Oz.; Model 2 — 15 Oz.  
1" Model 1 — 1¾ Lbs.; Model 2 — 2¼ Lbs.

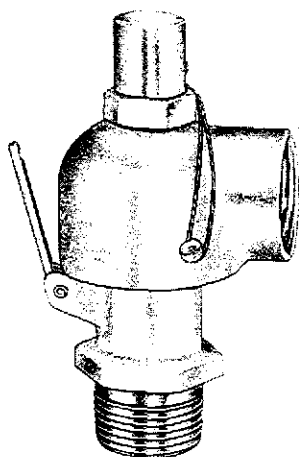
Nickel/Chrome plating for use on institutional equipment.  
Vibration dampener on lift lever.

## AIR/STEAM CAPACITIES

Set Pressure PSIG	½" x ¾"		1"		Set Pressure PSIG	½" x ¾"		1"		Set Pressure PSIG	½" x ¾"		1"	
	Lbs./Hr. Steam	SCFM Air	Lbs./Hr. Steam	SCFM Air		Lbs./Hr. Steam	SCFM Air	Lbs./Hr. Steam	SCFM Air		Lbs./Hr. Steam	SCFM Air	Lbs./Hr. Steam	SCFM Air
	10% Acc.	10% Acc.	10% Acc.	10% Acc.		10% Acc.	10% Acc.	10% Acc.	10% Acc.		10% Acc.	10% Acc.	10% Acc.	10% Acc.
5	82	29	142	50	50	258	92	445	158	150	517	183	895	318
10	104	37	179	63	60	293	104	504	179	175	553	196	959	340
15	125	44	215	76	70	325	115	560	199	200	577	205	1003	356
20	145	52	250	89	80	355	126	613	217	225	590	210	1028	365
25	165	59	284	101	90	384	136	662	235	250	592	210	1034	367
30	185	66	318	113	100	411	146	709	252					
40	223	79	383	136	125	469	167	811	288					

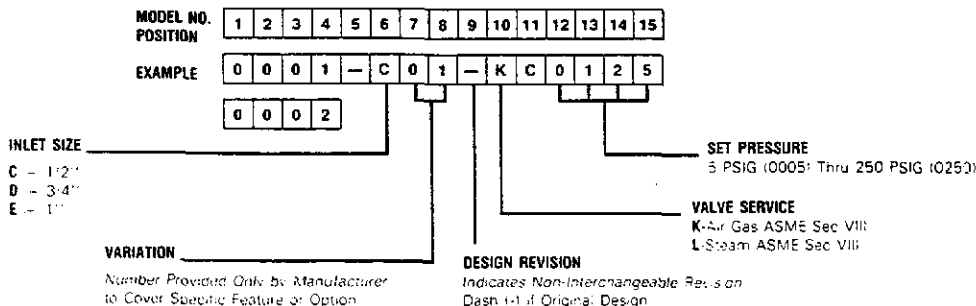


MODEL 1  
(TOP OUTLET)



MODEL 2  
(SIDE OUTLET)

## MODEL NUMBER/ORDER GUIDE



IMPORTANT: Kunkle Valve Division is not liable for any damage resulting from misuse or misapplication of its products (see warranty).



8222 Bluffton Road Box 1740 Fort Wayne, Indiana 46801-1740  
219-747-1533 FAX 219-747-7958

Attachment 1, 110V of Valve - 2-16-01, 110V of

Title: SPECIFICATION FOR 80K PUMP VENT MANUAL BYPASS VALVE

SPECIFICATION FOR  
80K PUMP VENT MANUAL BYPASS VALVE  
FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

David Moore

QUALITY ASSURANCE:

[Signature]

TECHNICAL DIRECTOR:

D. A. Williams

PROJECT MANAGER:

[Signature]

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV	LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
0		DM 10/23/96	ASS 10/27/96	Release for quote and purchase DEO #0327

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number	Rev.
	DM	10/23/96	ASS	10/28/96	A V049-2-165	0



**Title: SPECIFICATION FOR 80K PUMP VENT MANUAL BYPASS VALVE**

**Supplier:** TBV

**Description:** Cryogenic, extended stem manual ball valve

**Size:** 1-1/2". See Attachment 1 of this specification for dimensions.

**Operating Pressure:** 1 atmosphere, absolute

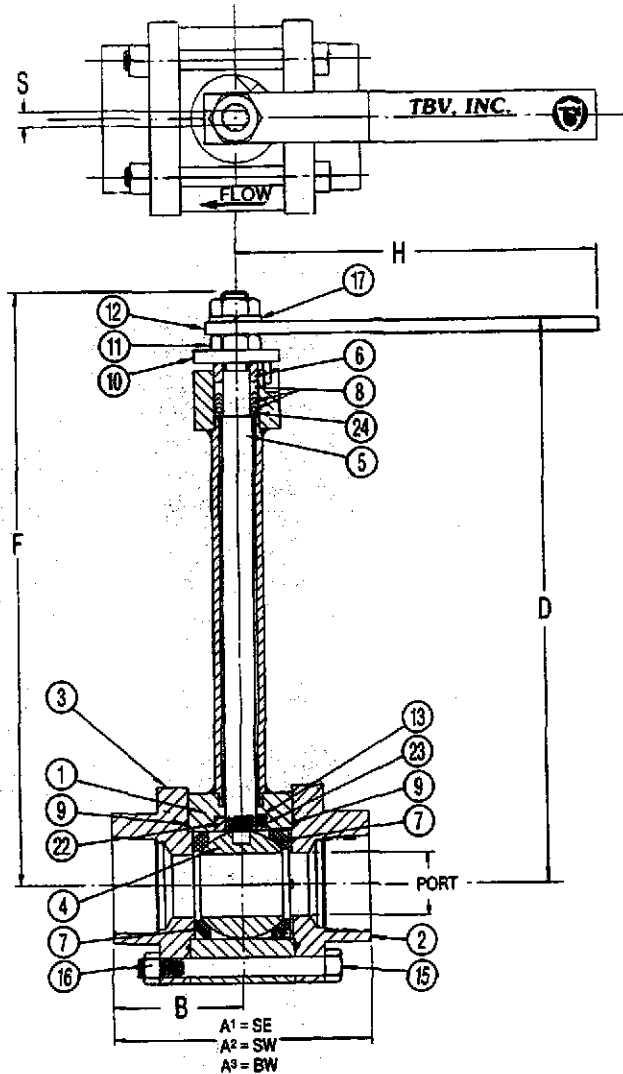
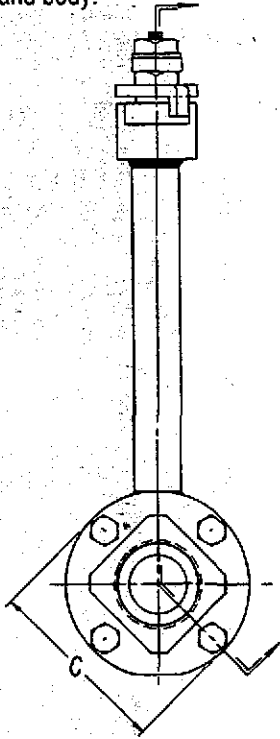
**Model Number:** 1-1/2" 21 SW 2 34 34 CT

**Quantity:** One of each tag. no:  
HV-107, HV-157, HV-207, HV-257, HV-307, HV-357  
HV-407, HV-507, HV-607, HV-657, HV-707, HV-807

SPECIFICATION		
Number		Rev.
<b>A</b>	V049-2-165	Ø

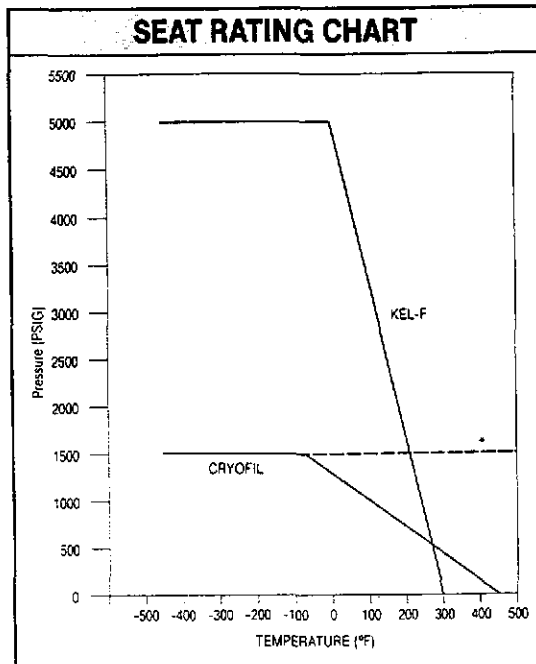
### FEATURES AND BENEFITS

1. One piece, high strength blowout proof stem.
2. Specially designed Cryofil seats provide leakproof operation to  $-452^{\circ}\text{F}$ .
3. Leakproof Chevron V-Ring packing.
4. Totally encapsulated body seal prevents "cold flow" of TFE.
5. Slotted upstream endplate provides positive cavity venting.
6. All welded bonnet construction.
7. Stainless Steel externals.
8. Automation available with optional mounting pad.
9. Optional grounding springs between ball and stem, and stem and body.



MAJOR DIMENSIONS									
Valve Size	Port	A <sup>1</sup>	A <sup>2</sup>	A <sup>3</sup>	B	C	D	F	H
1/2"	0.50	3.14	3.14	3.14	1.57	2.50	8.80	8.96	5.94
3/4"	0.50	3.14	3.14	3.14	1.57	2.50	8.80	8.96	5.94
1"	0.81	3.75	3.69	3.67	1.87	3.25	9.15	9.31	5.94
1 1/2"	1.25	4.82	4.76	4.70	2.35	4.12	11.31	11.66	8.40
2"	1.50	5.06	5.00	5.00	2.53	4.36	11.50	11.85	8.40
3"	2.50	8.25	8.25	8.25	4.13	7.25	18.98	17.47	14.50
4"	3.25	9.25	9.25	9.25	4.63	8.37	19.58	18.07	14.50
6"	4.38	10.25	10.25	10.25	5.13	11.00		21.46	

\*See Note 2



### SEAT MATERIAL IDENTIFICATION CODE

C - Cryofil<sup>3</sup> orange  
 K - Kel-F<sup>2</sup> translucent

<sup>2</sup>Registered Trade Mark of 3-M Company.

<sup>3</sup>Registered Trade Mark of TBV, Inc.

\*Consult factory for pressure exceeding 1500 PSI for special designs.

Attachment 1  
 V049-2-165, Rev. 0  
 Sht. 1 of 1

**SPECIFICATION FOR  
LIQUID NITROGEN THERMAL RELIEF VALVE  
FOR**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** David Moore

**QUALITY ASSURANCE:** [Signature]

**TECHNICAL DIRECTOR:** D. C. Williams

**PROJECT MANAGER:** [Signature]

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

Ø	DRM 10/29/96	RCS 10/29/96	Initial release for quote & purchase DEO HERR
REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>		
<b>INITIAL APPROVALS</b>	<b>PREPARED</b>	<b>DATE</b>	<b>APPROVED</b>	<b>DATE</b>	<b>Number A V049-2-166</b>	<b>Rev.</b>
	<u>DMoore</u>	<u>10/29/96</u>	<u>[Signature]</u>	<u>10/29/96</u>		<u>Ø</u>

**Title: SPECIFICATION FOR LIQUID NITROGEN THERMAL RELIEF VALVE**

**Supplier:** Circle Seal Controls

**Description:** Stainless steel popoff relief valve with vent cap

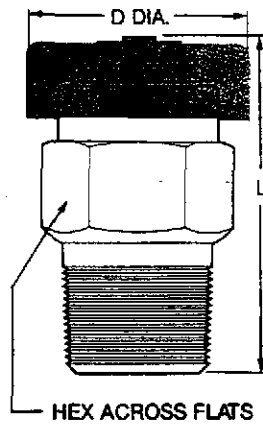
**Size:** 1/4". See Attachment 1 of this specification for dimensions.

**Set Pressure:** 55 psig

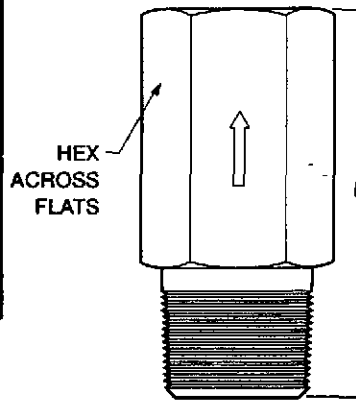
**Model Number:** D580T1-2M-G

**Quantity:** One of each tag. no:  
RV-108, RV-158, RV-208, RV-258, RV-308, RV-358  
RV-408, RV-508, RV-608, RV-658, RV-708, RV-808

SPECIFICATION		
Number		Rev.
<b>A</b>	V049-2-166	ϕ



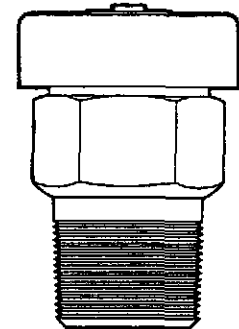
VENT TO ATMOSPHERE DIMENSIONS			
PIPE SIZE MALE	L	HEX	D DIA. MAX
1/8	1.14	1/2	.63
1/4	1.38	3/8	.90
3/8	1.43	3/4	1.21
1/2	1.98	1	1.45
3/4	2.31	1 1/8	1.45
1	3.16	1 1/2	1.89



INLINE DIMENSIONS		
PIPE SIZE MALE & FEMALE	L	HEX
1/4	1.62	3/8
3/8	2.08	3/8
1/2	2.34	1 1/8
3/4	2.72	1 1/4
1	3.62	1 1/2
1 1/4	4.67	1 3/4

\*Complete part number must include alpha code specifying cracking pressure. See chart on previous page.

MATERIAL AND STYLE	SIZE	MODEL NUMBER				
		559	533	532	524	
ALUMINUM	POPOFF	1/8	559A-1M-*	533A-1M-*	532A-1M-*	524A-1M-*
		1/4	559A-2M-*	533A-2M-*	532A-2M-*	524A-2M-*
		3/8	559A-3M-*	533A-3M-*	532A-3M-*	524A-3M-*
		1/2	559A-4M-*	533A-4M-*	532A-4M-*	524A-4M-*
		3/4	559A-6M-*	533A-6M-*	532A-6M-*	524A-6M-*
		1	559A-8M-*	533A-8M-*	532A-8M-*	524A-8M-*
		1	559A-8M-*	533A-8M-*	532A-8M-*	524A-8M-*
BRASS	POPOFF	1/8	559B-1M-*	533B-1M-*	532B-1M-*	524B-1M-*
		1/4	559B-2M-*	533B-2M-*	532B-2M-*	524B-2M-*
		3/8	559B-3M-*	533B-3M-*	532B-3M-*	524B-3M-*
		1/2	559B-4M-*	533B-4M-*	532B-4M-*	524B-4M-*
		3/4	559B-6M-*	533B-6M-*	532B-6M-*	524B-6M-*
		1	559B-8M-*	533B-8M-*	532B-8M-*	524B-8M-*
		1	559B-8M-*	533B-8M-*	532B-8M-*	524B-8M-*
	INLINE	1/4	559B-2MP-*	533B-2MP-*	532B-2MP-*	524B-2MP-*
		3/8	559B-3MP-*	533B-3MP-*	532B-3MP-*	524B-3MP-*
		1/2	559B-4MP-*	533B-4MP-*	532B-4MP-*	524B-4MP-*
		3/4	559B-6MP-*	533B-6MP-*	532B-6MP-*	524B-6MP-*
		1	559B-8MP-*	533B-8MP-*	532B-8MP-*	524B-8MP-*
		1 1/4	559B-10MP-*	533B-10MP-*	532B-10MP-*	524B-10MP-*
		1 1/4	559B-10MP-*	533B-10MP-*	532B-10MP-*	524B-10MP-*
316 S.S.	POPOFF	1/8	559T1-1M-*	533T1-1M-*	532T1-1M-*	524T1-1M-*
		1/4	559T1-2M-*	533T1-2M-*	532T1-2M-*	524T1-2M-*
		3/8	559T1-3M-*	533T1-3M-*	532T1-3M-*	524T1-3M-*
		1/2	559T1-4M-*	533T1-4M-*	532T1-4M-*	524T1-4M-*
		3/4	559T1-6M-*	533T1-6M-*	532T1-6M-*	524T1-6M-*
		1	559T1-8M-*	533T1-8M-*	532T1-8M-*	524T1-8M-*
		1	559T1-8M-*	533T1-8M-*	532T1-8M-*	524T1-8M-*
	INLINE	1/4	559T1-2MP-*	533T1-2MP-*	532T1-2MP-*	524T1-2MP-*
		1/2	559T1-4MP-*	533T1-4MP-*	532T1-4MP-*	524T1-4MP-*
		3/4	559T1-6MP-*	533T1-6MP-*	532T1-6MP-*	524T1-6MP-*
		3/4	559T1-6MP-*	533T1-6MP-*	532T1-6MP-*	524T1-6MP-*



For ASME code valve, available in 1/4 inch size only. Add ASME after valve number. For operation details see ASME Valve catalog sheet, Form Number CSP-366L.

### REPLACEMENT SPRINGS\*\*

C.P. RANGE	1M/2MP	2M/3MP	C.P. RANGE	3M/4MP	4M/6MP	6M/8MP	8M/10MP
0.2-0.9	22335-0.5	22336-0.5	.5-2.4	10362-1	10462-1	10662-1	10845-1
1.0-2.3	22335-1	22336-1	2.5-5.9	10362-4	10462-4	10662-4	10845-4
2.4-5.5	22335-4	22336-4	6.0-13.9	10362-10	10462-10	10662-10	10845-10
5.6-13.9	22335-10	22336-10	14.0-31.0	10362-20	10462-20	10662-20	10845-20
14.0-27.9	22335-20	22336-20	31.1-72.9	10362-50	10462-50	10662-50	10845-50
28.0-33.9	22335-30	22336-30	73.0-150.0	10362-100PH	10462-100PH	10662-100PH	10845-100PH
34.0-74.9	22335-55	22336-55					
75.0-104.9	22335-90PH	22336-90PH					
105.0-147.9	22335-125PH	22336-125PH					

\*\*Springs for each valve size are interchangeable. The Cracking Pressure range can be changed by replacing the spring with one covering the desired range.

Attachment 1  
V049-2-166, Rev 0  
Pg 1 of 1



**CIRCLE SEAL CONTROLS, INC.**

POST OFFICE BOX 3666  
ANAHEIM, CALIFORNIA 92803  
PHONE (714) 774-6110 • FAX (714) 772-7332



**Title: SPECIFICATION FOR LIQUID NITROGEN MANUAL COOLDOWN VALVE**

**Supplier:** The Wm. Powell Co.

**Description:** Stainless steel, extended stem, socket welded, manual globe valve

**Size:** 1/2". See Attachment 1 of this specification for dimensions.

**Operating Pressure:** 15 psig

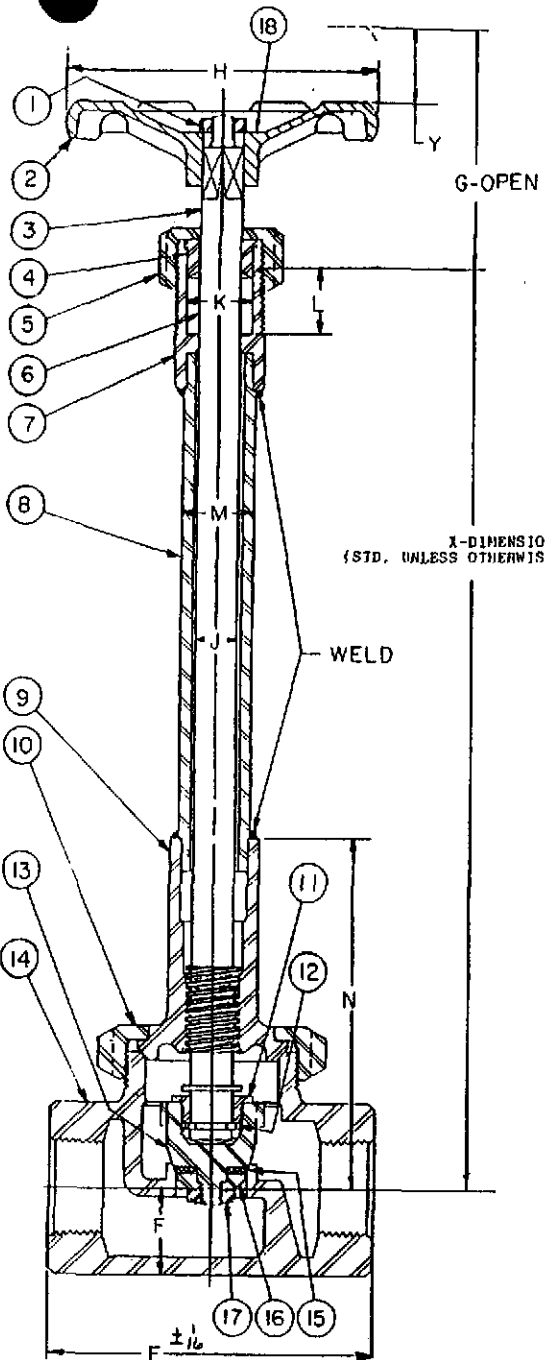
**Model Number:** 7K1861W48

**Quantity:** One of each tag. no:  
HV-194, HV-196, HV-294, HV-296, HV-394, HV-396  
HV-494, HV-594, HV-694, HV-696, HV-794, HV-894

SPECIFICATION		
Number		Rev.
<b>A</b>	V049-2-167	ϕ

REVISIONS

FILM	REV	CHANGE NOTICE	DESCRIPTION	DATE	BY	APPY.



X-DIMENSION  
(STD. UNLESS OTHERWISE SPECIFIED.)

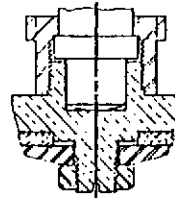
WELD

FIGURE NUMBER:  
7K1861 (TE)  
7K1861 (SWE)

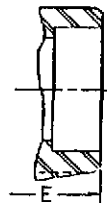
CLASS 200

PRESSURE  
TEMPERATURE RATING  
SEE DRAWING 061077

PRESSURE TESTS  
SEE DRAWING 061081



SIZES 1 1/2" & 2"



SOCKET WELDING END (SWE)  
NOTE: FOR DIMENSIONS  
SEE DWG. NO. C-050350

NOTE: ALL VALVES THOROUGHLY CLEANED, DEGREASED & PIPE ENDS SEALED TO PREVENT CONTAMINATION.

	SIZE OF VALVE								
	4	3	2	1 1/2	1	3/4	1/2	2	
A									
B									
C									
D									
E	END TO END	2 1/16	2 1/8	2 1/4	3 3/8	3 3/8	5 1/2	5 1/2	6
F	CENTER TO BOTTOM	5 3/8	5 3/8	5 3/8	5 3/8	5 3/8	12 1/2	12 1/2	17 1/8
G	PACKING SLEEVE TO TOP-OPEN	1 3/4	1 3/4	1 3/4	2 5/16	2 5/16	2 13/16	2 7/8	3 1/8
H	DIA OF HANDWHEEL	2 3/4	2 3/4	2 3/4	3 1/4	3 1/4	4 1/16	4 1/16	4 3/4
J	DIA OF STEM	1 1/16	1 1/16	1 1/16	2 7/64	2 7/64	9 1/16	9 1/16	2 1/2
K	DIA OF STUFFING BOX	3 1/16	3 1/16	3 1/16	4 1/16	4 1/16	1 1/8	1 1/8	1 3/8
L	DEPTH OF STUFFING BOX	2	2	2	1 1/16	1 1/16	7 1/8	7 1/8	1
M	DIA. OF COLUMN	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16
N	CENTER TO TOP OF BONNET	2 1/16	2 1/16	2 1/16	3 5/8	3 5/8	5 5/8	5 5/8	6 1/8
X	CENTER TO TOP OF STUFFING BOX	12	12	12	12	13	13	13	14
Y	LIFT	3 3/8	3 3/8	3 3/8	7 1/16	7 1/16	8 1/8	8 1/8	11 1/16

NO	DESCRIPTION	MATERIAL	SPECIFICATION
1	WHEEL NUT	STEEL	ASTM A-563 GRADE A OR B
2	HANDWHEEL	MALLEABLE IRON	ASTM A47 GRADE 32510
3	STEM	SI BR	ASTM B-371 C69400
4	PACKING GLAND	STAINLESS STEEL	ASTM A-276 TYPE 316
5	PACKING NUT	STAINLESS STEEL	ASTM A-278 TYPE 316
6	PACKING	TEFLON	COMM.
7	PACKING SLEEVE	STAINLESS STEEL	ASTM A-276 TYPE 316
8	EXTENSION COLUMN	STAINLESS STEEL	ASTM A-312 TYPE 304
9	BONNET WM	STAINLESS STEEL	ASTM A-351 GRADE CF8M
10	BONNET RING	STAINLESS STEEL	ASTM A-351 GRADE CF8M
11	LOCKNUT	STAINLESS STEEL	ASTM A-276 TYPE 316
12	HORSE SHOE RING	STAINLESS STEEL	300 SERIES
13	DISC HOLDER	SI BR	ASTM B-371 C69400
14	BODY	STAINLESS STEEL	ASTM A-351 GRADE CF8M
15	DISC	KEL-F	COMM.
16	DISC PLATE	BRASS	ASTM B-16
17	DISC NUT	STAINLESS STEEL	ASTM A-276 TYPE 316
18	IDENT PLATE	ALUMINUM	COMM.

\*\* 1/4", 3/8", & 1/2" VA. SIZES --- ASTM A-276 TYPE 316

SUPERSEDES 67041		THE WM. POWELL COMPANY 3503 Spring Grove Avenue, P.O. Box 11006, Chesapeake, Ohio 45814, U.S.A.	
DRAWN BY P.E. KEMER	DATE 10-7-82	TITLE NPS 1/4" to 2" GLOBE VA. INS DISC EXT. BONNET, TE, SWE	
CHECKED BY	DATE	APPROVED BY <i>K.S. 3/1/82</i>	DATE
CODE IDENT. NO. 48422	SIZE C	DWG. NO. 058332	REV. A
SCALE	WEIGHT	SHEET	FILM

Attachment 1 V049-2-167 Rev of Shd 10/1/81



Title: SPECIFICATION FOR FILTER IN LIQUID NITROGEN SUPPLY LINE

SPECIFICATION FOR  
FILTER IN LIQUID NITROGEN SUPPLY LINE  
FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

David Moore

QUALITY ASSURANCE:

NA

TECHNICAL DIRECTOR:

D. O. McMillen

PROJECT MANAGER:

Bob Bayly

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
Ø	DM 12/3/96	RS 12/5/96	Initial release for quote & purchase DEC # 380
PROCESS SYSTEMS INTERNATIONAL, INC.			SPECIFICATION
INITIAL APPROVALS	PREPARED DATE	APPROVED DATE	NumberA V049-2-176 Rev. Ø
	<u>DM 12/3/96</u>	<u>RS 12/5/96</u>	

**Title:**

**SPECIFICATION FOR FILTER IN LIQUID NITROGEN SUPPLY LINE**

**Supplier:** Cambridge Valve and Fitting Co.  
**Manufacturer:** Nupro  
**Description:** Stainless steel filter with Kel-F gasket, male NPT  
**Part Number:** SS-8TF2-KG-230  
**Size:** 1/2 inch  
**Tag Nos:** SM130, SM131, SM230, SM231, SM330, SM331  
SM430, SM530, SM630, SM631, SM730, SM830

**SPECIFICATION**

Number  
**A**

V049-2-176

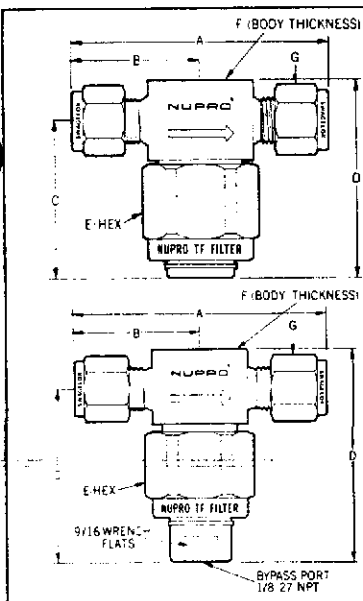
Rev.

ϕ

**"TF" SERIES TEE TYPE REMOVABLE FILTERS (continued)**  
**FLOW CAPACITIES**

PRESSURE DROP TO ATM (ΔP) PSI	"2TF" FILTERS		"2TF2" FILTERS		"2TF4-4TF-4TF2-4TF4-4TF-TW" FILTERS		ALL "6TF-8TF" FILTERS	
	AIR SCFM @ 70°F (21°C)	WATER GPM @ 70°F (21°C)	AIR SCFM @ 70°F (21°C)	WATER GPM @ 70°F (21°C)	AIR SCFM @ 70°F (21°C)	WATER GPM @ 70°F (21°C)	AIR SCFM @ 70°F (21°C)	WATER GPM @ 70°F (21°C)
	0.5 MICRON-MAX. FLOW C <sub>v</sub> = 0.029		0.5 MICRON-MAX. FLOW C <sub>v</sub> = 0.029		0.5 MICRON-MAX. FLOW C <sub>v</sub> = 0.029		0.5 MICRON-MAX. FLOW C <sub>v</sub> = 0.045	
10	0.42	0.09	0.42	0.09	0.42	0.09	0.63	0.14
50	1.11	0.21	1.11	0.21	1.11	0.21	1.73	0.32
100	1.97	0.29	1.97	0.29	1.97	0.29	3.06	0.45
	2 MICRON-MAX. FLOW C <sub>v</sub> = 0.035		2 MICRON-MAX. FLOW C <sub>v</sub> = 0.040		2 MICRON-MAX. FLOW C <sub>v</sub> = 0.040		2 MICRON-MAX. FLOW C <sub>v</sub> = 0.055	
10	0.51	0.11	0.55	0.13	0.55	0.13	0.78	0.18
50	1.33	0.25	1.53	0.28	1.53	0.28	2.10	0.39
100	2.31	0.35	2.71	0.40	2.71	0.40	3.72	0.53
	7 MICRON-MAX. FLOW C <sub>v</sub> = 0.046		7 MICRON-MAX. FLOW C <sub>v</sub> = 0.054		7 MICRON-MAX. FLOW C <sub>v</sub> = 0.056		7 MICRON-MAX. FLOW C <sub>v</sub> = 0.11	
10	0.64	0.15	0.75	0.17	0.77	0.18	1.52	0.35
50	1.76	0.33	2.07	0.38	2.14	0.40	4.21	0.78
100	3.12	0.46	3.66	0.54	3.80	0.56	7.46	1.10
	15 MICRON-MAX. FLOW C <sub>v</sub> = 0.053		15 MICRON-MAX. FLOW C <sub>v</sub> = 0.068		15 MICRON-MAX. FLOW C <sub>v</sub> = 0.074		15 MICRON-MAX. FLOW C <sub>v</sub> = 0.13	
10	0.73	0.17	0.94	0.22	1.02	0.23	1.80	0.41
50	2.03	0.37	2.60	0.48	2.83	0.52	4.97	0.92
100	3.59	0.53	4.61	0.68	5.02	0.74	8.82	1.30
	60 MICRON-MAX. FLOW C <sub>v</sub> = 0.089		60 MICRON-MAX. FLOW C <sub>v</sub> = 0.16		60 MICRON-MAX. FLOW C <sub>v</sub> = 0.22		60 MICRON-MAX. FLOW C <sub>v</sub> = 0.37	
10	1.23	0.28	2.21	0.51	3.04	0.70	5.12	1.17
50	3.40	0.63	6.12	1.13	8.42	1.56	14.15	2.62
100	6.04	0.89	10.85	1.60	14.92	2.20	25.09	3.70
	90 MICRON-MAX. FLOW C <sub>v</sub> = 0.094		90 MICRON-MAX. FLOW C <sub>v</sub> = 0.18		90 MICRON-MAX. FLOW C <sub>v</sub> = 0.28		90 MICRON-MAX. FLOW C <sub>v</sub> = 0.50	
10	1.30	0.30	2.49	0.57	3.87	0.89	6.92	1.58
50	3.60	0.66	6.89	1.27	10.21	1.98	19.13	3.54
100	6.37	0.94	12.21	1.80	18.99	2.80	33.91	5.00
	40, 140, 230 OR 440 MICRON MAX. FLOW C <sub>v</sub> = 0.10		40, 140, 230 OR 440 MICRON MAX. FLOW C <sub>v</sub> = 0.21		40, 140, 230 OR 440 MICRON MAX. FLOW C <sub>v</sub> = 0.37		40, 140, 230 OR 440 MICRON MAX. FLOW C <sub>v</sub> = 0.73	
10	1.38	0.32	2.91	0.66	5.12	1.17	10.10	2.31
50	3.83	0.71	8.03	1.48	14.15	2.62	27.92	5.16
100	6.78	1.00	14.24	2.10	25.09	3.70	49.50	7.30

**TABLE OF DIMENSIONS**



BASIC ORDERING NUMBER	ORIFICE		CONNECTION SIZE	DIMENSIONS						
	IN.	MM		NUT	OUTLET	A	D	D	HEX	Ø
-2TF-	0.094	2.4	1/8 SWAGelok	29/32	1 1/64	1 1/2	1 7/8	1	1	7/16
-2TF4-	0.172	4.4	1/8 Female NPT	2	1	1 1/2	1 7/8	1	1	—
-4TF-	0.172	4.4	1/4 SWAGelok	2 15/32	1 19/64	1 1/2	1 7/8	1	1	9/16
-4TF-F2-3	0.172	4.4	1/4 SWAGelok	2 15/32	1 19/64	1 23/32	2 3/32	1	1	9/16
-4TF2-	0.172	4.4	1/4 Male NPT	2 1/8	1 1/16	1 1/2	1 7/8	1	1	—
-4TF4-	0.172	4.4	1/4 Female NPT	2 1/8	1 1/16	1 1/2	1 7/8	1	1	—
-4TF-TW-	0.172	4.4	1/4 TSW / 3/8 MTW	1 11/16	2 7/32	1 1/2	1 7/8	1	1	—
-6TF-	0.213	5.4	3/8 SWAGelok	2 27/32	1 27/64	1 23/32	2 3/16	1 1/8	1 1/8	1 1/16
-6TF2-	0.250	6.4	3/8 Male NPT	2 3/8	1 3/16	1 23/32	2 3/16	1 1/8	1 1/8	—
-6TF-TW-	0.213	5.4	3/8 TSW / 1/2 MTW	2	1	1 23/32	2 3/16	1 1/8	1 1/8	—
-8TF-	0.250	6.4	1/2 SWAGelok	3 1/16	1 17/32	1 23/32	2 3/16	1 1/8	1 1/8	7/8
-8TF2-	0.250	6.4	1/2 Male NPT	2 3/4	1 3/8	1 23/32	2 3/16	1 1/8	1 1/8	—
-8TF-TW-	0.250	6.4	1/2 TSW / 3/4 MTW	2	1	1 23/32	2 3/16	1 1/8	1 1/8	—

\*For a complete ordering number, add B for brass or SS for 316 stainless steel as a prefix to the basic ordering number. For filters with sintered elements, add 05, 2, 7, 15, 60 or 90 as a suffix to the basic ordering number. Example: B-4TF-7. For filters with strainer elements, add 40, 140, 230 or 440 as a suffix to the basic ordering number. Example: SS-8TF-TW-230. Dimensions shown with SWAGelok nuts finger-tight, where applicable. All dimensions are in inches — for reference only, subject to change. Other models with the bypass option are available on special order.

**REPLACEMENT — SINTERED & STRAINER ELEMENTS FOR "TF" & "F" SERIES FILTERS**

**SINTERED CONSTRUCTION**  
Sintered 316 stainless steel filter elements in nominal micron sizes of 0.5 to 90, trap particulate contamination in the tortuous matrix. (Magnified 13X.)

**WIRE MESH CONSTRUCTION**  
316 stainless steel mesh strainer elements available in 40, 140, 230 and 440 micron sizes effectively remove large particle contamination. (Magnified 2X.)

**FILTRATION DEFINITIONS**  
**Micron** — One micron equals 1/25000 inch (.00004 inches/.001 mm). Microns are used to indicate mean pore diameter of a sintered element or mean particle diameter of fluid contamination.  
**Efficiency** — That portion of a filter which actually traps fluid contamination.  
**Initial Efficiency** — Initial removal of 95% to 98% of particles larger than a given size.  
**Flow Area** — The actual area available to flow in a filter element.  
**Filter Cake** — The accumulation of solids deposited on a filter element from usage.

FILTER	ELEMENT PART # NUMBER	STRAINER ELEMENT NOMINAL MICRON SIZE	SINTERED ELEMENT	
			NOMINAL MICRON SIZE	MICRON RANGE
2F	SS-2F-K4	NOT AVAILABLE	0.5	0.5-2
			2	1-4
			7	5-10
2TF-4TF-4F	SS-4F-K4	40, 140, 230, 440	15	11-25
			60	50-75
			90	75-150

\*To order spare sintered elements, add .05, 2, 7, 15, 60 or 90 as a suffix to the element part number. Add .40, .140, .230 or .440 to specify a strainer element. Example: SS-4F-K4-7-SS-8F-K4-140.

**SPECIFICATION FOR  
DERIME VALVES FOR 80K PUMP SUPPLY LINE  
FOR**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** \_\_\_\_\_

*David Moore*

**QUALITY ASSURANCE** \_\_\_\_\_

NA

**TECHNICAL DIRECTOR:** \_\_\_\_\_

*D. C. McWilliam*

**PROJECT MANAGER:** \_\_\_\_\_

*Paul Boyle*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

Φ	DM 12/4/96	R 2/3 12/4/96	Initial release for quotation & purchase		DEC # 351
REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE		
PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-177
	<i>DM</i>	12/4/96	<i>RSB</i>	12/5/96	Rev. Φ

**Title: SPECIFICATION FOR DERIME VALVES FOR 80K PUMP SUPPLY LINE**

**Supplier:** Cambridge Valve and Fitting Co.

**Manufacturer:** Nupro

**Description:** Stainless steel plug valve with swagelok ends

**Part Number:** SS-6P6T

**Size:** 3/8 inch

**Tag Nos:** HV100, HV108, HV150, HV158, HV200, HV208, HV250,  
HV258, HV300, HV308, HV350, HV358, HV400, HV408, HV500,  
HV508, HV600, HV608, HV650, HV658, HV700, HV708, HV800,  
HV808

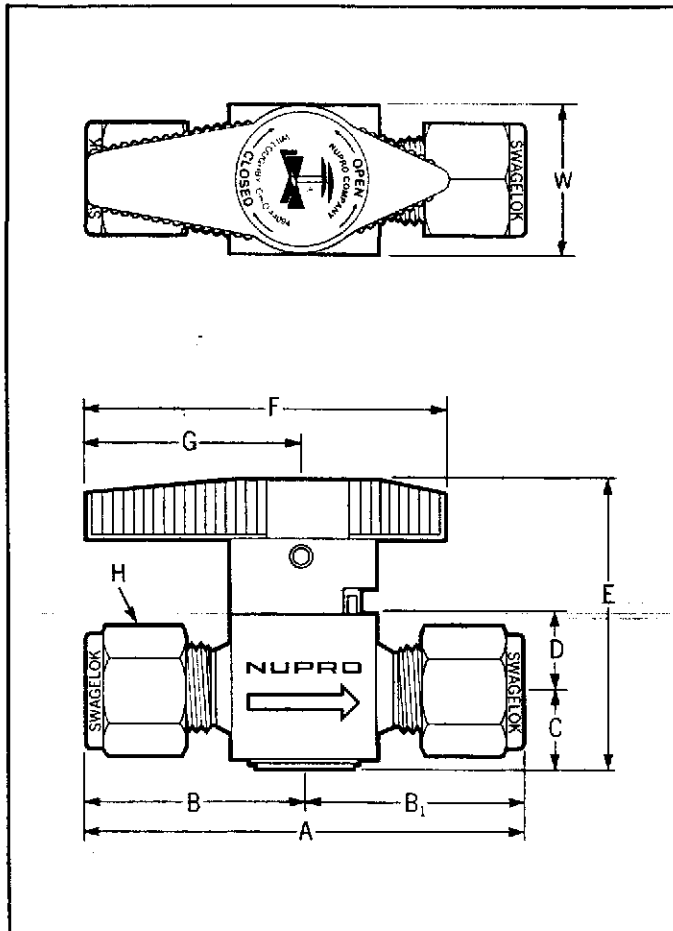
**SPECIFICATION**

Number  
**A**

**V049-2-177**

Rev.  $\phi$

# TABLE OF DIMENSIONS



# TECHNICAL DATA

Valve Series	Standard Material	Pressure Rating <sup>2</sup> at 70°F (21°C)	Temperature Rating
P4T	Brass & 316SS	3000 psig (206 bar)	-10° to 400°F (-23° to 204°C) with TFE coated Viton seals
P6T	Brass	2000 psig (137 bar)	
	316SS	3000 psig (206 bar)	

<sup>2</sup>If reverse flow occurs, differential pressure is limited to 150 psi (10 bar) max. In such cases, the valve should be actuated quickly to prevent O-Ring damage.

# FLOW CAPACITY DATA

Basic Ordering Number	C <sub>v</sub>	Pressure Drop To Atmosphere (Δp) psi					
		Air std ft <sup>3</sup> /min. at 70°F (21°C)			Water U.S. gal/min. at 70°F (21°C)		
		10	50	100	10	50	100
-2P4T	0.2	2.26	6.00	10.64	0.63	1.41	2.00
-2P4T2	1.0	11.30	30.01	53.20	3.16	7.07	10.00
-2P4T4	1.0	11.30	30.01	53.20	3.16	7.07	10.00
-4P4T	1.4	15.82	42.01	74.48	4.43	9.90	14.00
-4P4T1	1.4	15.82	42.01	74.48	4.43	9.90	14.00
-4P4T2	0.9	10.17	27.01	47.88	2.85	6.36	9.00
-4P4T4	0.9	10.17	27.01	47.88	2.85	6.36	9.00
-4P4T4-RT	0.9	10.17	27.01	47.88	2.85	6.36	9.00
-4P4T5	0.9	10.17	27.01	47.88	2.85	6.36	9.00
-6P4T	1.1	12.43	33.01	58.52	3.48	7.78	11.00
-6P4T-MM	1.4	25.99	69.02	122.36	7.27	16.26	23.00
-4P6T4	3.6	40.68	108.03	191.51	11.38	25.46	36.00
-6P6T	7.0	79.09	210.06	372.39	22.14	49.50	70.00
-8P6T	4.0	45.20	120.03	212.79	12.65	28.28	40.00
-8P6T2	2.3	25.99	69.02	122.36	7.27	16.26	23.00
-8P6T4	2.3	25.99	69.02	122.36	7.27	16.26	23.00
-8P6T4-RT	2.3	25.99	69.02	122.36	7.27	16.26	23.00
-10P6T-MM	5.7	64.40	171.05	303.23	18.02	40.31	57.00
-12P6T-MM	4.3	48.59	129.03	228.75	13.60	30.41	43.00

Plug Valves			End Connections		Dimensions <sup>④</sup>									
Basic <sup>③</sup> Ordering Number	Plug Orifice		Inlet	Outlet	A	B	B <sub>1</sub>	C	D	E	F	G	H Hex	W
	in.	mm												
-2P4T <sup>⑤</sup>	0.172	4.4	1/8 SWAGelok		1.99	0.99	0.99	0.45	0.37	1.52	1.88	1.14	7/16	0.75
-2P4T2			1/8 Male NPT		1.53	0.76	0.76						-	
-2P4T4			1/8 Female NPT		1.78	0.89	0.89						-	
-4P4T			1/4 SWAGelok		2.17	1.08	1.08						9/16	
-4P4T1			1/4 Male NPT   1/4 SWAGelok		2.03	0.95	1.08						9/16	
-4P4T2			1/4 Male NPT		1.90	0.95	0.95						-	
-4P4T4			1/4 Female NPT		2.09	1.05	1.05						-	
-4P4T4-RT			1/4 Female ISO/BSP Tapered <sup>⑥</sup>		2.21	1.11	1.11						-	
-4P4T5			1/4 Male NPT   1/4 Female NPT		2.00	0.95	1.05						-	
-6P4T	0.281	7.2	3/8 SWAGelok		2.29	1.14	1.14	0.66	0.56	2.13	2.49	1.50	11/16	1.12
-6P4T-MM			6mm SWAGelok		2.17	1.08	1.08						14mm	
-4P6T4			1/4 Female NPT		2.38	1.19	1.19						-	
-6P6T			3/8 SWAGelok		2.66	1.33	1.33						11/16	
-8P6T			1/2 SWAGelok		2.88	1.44	1.44						7/8	
-8P6T2			1/2 Male NPT		2.64	1.32	1.32						-	
-8P6T4			1/2 Female NPT		2.88	1.44	1.44						-	
-8P6T4-RT			1/2 Female ISO/BSP Tapered <sup>⑥</sup>		3.14	1.57	1.57						-	
-10P6T-MM			10mm SWAGelok		2.68	1.34	1.34						19mm	
-12P6T-MM			12mm SWAGelok		2.96	1.48	1.48						22mm	

<sup>③</sup> For a complete Ordering Number, use **B** for brass, **SS** for 316 stainless steel, or **S** for carbon steel as a prefix to the Basic Ordering Number. Examples: **B-4P4T2**; **SS-4P4T**; **S-8P6T4**

<sup>④</sup> Dimensions shown with SWAGelok nuts finger-tight, where applicable. All dimensions are in inches (except where mm is indicated) - for reference only, subject to change.

<sup>⑤</sup> Body orifice 0.093" (2.4mm).

<sup>⑥</sup> Reference Specifications: BS21 & ISO 7/1

V049-2-177 Rev. 0  
Pg. 3 of 3



PROCESS SYSTEMS INTERNATIONAL, INC. WESTBOROUGH, MA					TITLE: INSTRUMENT LIST	ENGINEERING CALCULATIONS	NO: V049-1-036
REV.	DES #	DATE	BY:	CHECK			PAGE 1 OF 28
1	0084	03/11/96	RJW	FAB			
2	0155	05/06/96	DJP	<i>F-Bank</i>			
PROJECT: LIGO						BY: <i>D. PARENTI</i>	DEPT: I/E
PURPOSE: Final Design Review (FDR)						PROJECT NO: V59049	
METHOD: NA							
ASSUMPTIONS: NA							
INPUTS: NA							
REFERENCES: LIGO—E950088-03E, ICD: VE-CC							
CALCULATIONS: PSI Rev I P&IDs V049-0-series							
CONCLUSIONS: NA							
NOTES: Supersedes V049-1-036, Rev I							



LIGO INSTRUMENT LIST

DATE: 5-7-96  
 PREPARED BY: D. PALEN TI  
 CHECKED BY: F. BOAK

V049-1-036, REV. 2

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
006	LIC - 0100	WACS	WCP1 80K Cryopump Level Control Loop Output	AO				1								
006	LT - 0100	WACS	WCP1 80K Cryopump Level Transmitter	AI			1					089	0	100	% Level	
006	LV - 0100	WACS	WCP1 80K Cryopump Level Control Valve	-								082				
006	LY - 0100	WACS	WCP1 80K Cryopump Level Control Loop Output	AO				1								
006	XV - 0100	WACS	WCP1 80K Cryopump Level Control Valve Solenoid	DO		1										
006	ZSC - 0100	WACS	WCP1 80K Cryopump Level Control Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555028	082			
006	PI - 0101	WACS	WCP1 80K Cryopump Discharge Pressure Indication	-												
006	PT - 0101	WACS	WCP1 80K Cryopump Discharge Pressure Transmitter	AI			1									
006	TE - 0102	WACS	WCP1 80K Cryopump Discharge Thermocouple	T/C					1				090	0	25	PSIG
006	TI - 0102	WACS	WCP1 80K Cryopump Discharge Temperature Indication	-												
006	JC - 0103	WACS	WCP1 80K Cryopump Regen SCR Controller	AI			1									
006	TIC - 0103	WACS	WCP1 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0103	WACS	WCP1 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0103	WACS	WCP1 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1								
006	TE - 0103A	WACS	WCP1 80K Cryopump Regen Loop Thermocouple	T/C-T					1				091	-320	700	Deg F
006	TE - 0103B	WACS	WCP1 80K Cryopump Regen Loop Thermocouple	T/C-K					1				056	32	2300	Deg F
006	TE - 0103C	WACS	WCP1 80K Cryopump Regen Loop Thermocouple	T/C-K					1				056	32	2300	Deg F
006	FE - 0104	WACS	WCP1 80K Cryopump Regen Loop Pilot Tube Flow Element	-									079	0	12,000	SCFH
006	FI - 0104	WACS	WCP1 80K Cryopump Regen Loop Flow Indicator	-									068	0	12,000	SCFH
006	LT - 0105	WACS	WCP1 80K Dewar Level Transmitter	AI			1						089	0	100	% Level
006	PI - 0105	WACS	WCP1 LN2 Dewar Pressure Indicator	-												
006	LI - 0105A	WACS	WCP1 LN2 Dewar Level Indicator	-												
006	LI - 0105B	WACS	WCP1 LN2 Dewar Level Indication	-												
006	RD - 0106	WACS	WCP1 LN2 Dewar Rupture Disc	-												
006	RV - 0106	WACS	WCP1 LN2 Dewar Relief Valve	-												
006	RD - 0107	WACS	WCP1 LN2 Dewar Rupture Disc	-												
006	RV - 0107	WACS	WCP1 LN2 Dewar Relief Valve	-												
006	RV - 0108	WACS	WCP1 LN2 Dewar Relief Valve	-												
013	HV - 0109	WACS	Vertex Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
013	ZSC - 0109	WACS	Vertex Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
013	ZSO - 0109	WACS	Vertex Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
003	II - 0111	WACS	WBSC1 75 L/S Ion Pump Current Indication	AI			1									
003	XIC - 0111	WACS	WBSC1 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0112	WACS	WCP1 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0113	WACS	WCP1 LN2 Dewar Vent Pressure Control Valve	-												
012	PE - 0114A	WACS	WCP1 Pirani Gauge Tube	-												
012	PI - 0114A	WACS	WCP1 Lo Vacuum Pressure Indication	-												
012	PT - 0114A	WACS	WCP1 Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
012	PE - 0114B	WACS	WCP1 Ion Gauge Tube	-												
012	PI - 0114B	WACS	WCP1 HI Vacuum Pressure Indication	-												
012	PT - 0114B	WACS	WCP1 Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
004	II - 0115	WACS	WHAM1 75 L/S Ion Pump Current Indication	AI			1									
004	XIC - 0115	WACS	WHAM1 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0117	WACS	WHAM2 75 L/S Ion Pump Current Indication	AI			1									
004	XIC - 0117	WACS	WHAM2 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
013	EV - 0119	WACS	Vertex Section Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag WVG1	554617	005			
013	HS - 0119	WACS	Vertex Section Isolation Valve Open/Close Switch	DO		1										
005	II - 0119	WACS	WGV1 25 L/S Ion Pump Current Indication	AI			1									
013	SC - 0119	WACS	Vertex Section Isolation Valve Controller	-												
013	XA - 0119	WACS	Vertex Section Isolation Valve Common Alarm	DI	1											
005	XIC - 0119	WACS	WGV1 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
013	ZSC - 0119	WACS	Vertex Section Isolation Valve Closed	-						GNB Corp	122CM, Gate Valve, Electric, Tag WVG1	554617	005			

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG VD49-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
013	ZSO - 0119	WACS	Vertex Section Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag WVG1	554617	005			
002	PC - 0120	WACS	WBSC2 Pressure Control Valve Controller	-									061			
002	PCV - 0120	WACS	WBSC2 Pressure Control Valve	-									061			
002	PY - 0120	WACS	WBSC2 Pressure Control Loop Output	AO				1								
002	PE - 0120A	WACS	WBSC2 Pirani Gauge Tube	-									007			
002	PI - 0120A	WACS	WBSC2 Lo Vacuum Pressure Indication	-												
002	PT - 0120A	WACS	WBSC2 Pirani Gauge Transmitter	AI				1						1 x 10-3	1000	TORR
002	PE - 0120B	WACS	WBSC2 Ion Gauge Tube	-									007			
002	PI - 0120B	WACS	WBSC2 HI Vacuum Pressure Indication	-												
002	PT - 0120B	WACS	WBSC2 Ion Gauge Transmitter	AI				1						3 x 10-11	1 x 10-2	TORR
002	II - 0121	WACS	WBSC2 75 L/S Ion Pump Current Indication	AI				1					004			
002	XIC - 0121	WACS	WBSC2 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	PI - 0122	WACS	WCP1 LN2 Dewar Pressure Control Indicator	-												
006	PCV - 0123	WACS	WCP1 LN2 Dewar Pressure Control Valve	-												
012	PE - 0124A	WACS	Left Manifold Beam Tube Pirani Gauge Tube	-									007			
012	PI - 0124A	WACS	Left Manifold Beam Tube Lo Vacuum Pressure Indication	-												
012	PT - 0124A	WACS	Left Manifold Beam Tube Pirani Gauge Transmitter	AI				1						1 x 10-3	1000	TORR
012	PE - 0124B	WACS	Left Manifold Beam Tube Ion Gauge Tube	-									007			
012	PI - 0124B	WACS	Left Manifold Beam Tube HI Vacuum Pressure Indication	-												
012	PT - 0124B	WACS	Left Manifold Beam Tube Ion Gauge Transmitter	AI				1						3 x 10-11	1 x 10-2	TORR
004	II - 0125	WACS	WHAM3 75 L/S Ion Pump Current Indication	AI				1					004			
004	XIC - 0125	WACS	WHAM3 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0127	WACS	WHAM4 75 L/S Ion Pump Current Indication	AI				1					004			
004	XIC - 0127	WACS	WHAM4 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
013	EV - 0129	WACS	Vertex Section Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag WVG2	554617	005			
013	HS - 0129	WACS	Vertex Section Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0129	WACS	WGV2 25 L/S Ion Pump Current Indication	AI				1					004			
013	SC - 0129	WACS	Vertex Section Isolation Valve Controller	-												
013	XA - 0129	WACS	Vertex Section Isolation Valve Common Alarm	DI		1										
005	XIC - 0129	WACS	WGV2 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554836	004			
013	ZSC - 0129	WACS	Vertex Section Isolation Valve Closed	DI		1				GNB Corp	122CM, Gate Valve, Electric, Tag WVG2	554617	005			
013	ZSO - 0129	WACS	Vertex Section Isolation Valve Open	DI		1				GNB Corp	122CM, Gate Valve, Electric, Tag WVG2	554617	005			
003	II - 0131	WACS	WBSC3 75 L/S Ion Pump Current Indication	AI				1					004			
003	XIC - 0131	WACS	WBSC3 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0132	WACS	WCP1 LN2 Dewar Pressure Control Relief Valve	-												
006	RV - 0133	WACS	WCP1 80K Cryopump Discharge Relief Valve	-												
015	PE - 0134A	WACS	WCP2 Pirani Gauge Tube	-									007			
015	PI - 0134A	WACS	WCP2 Lo Vacuum Pressure Indication	-												
015	PT - 0134A	WACS	WCP2 Pirani Gauge Transmitter	AI				1						1 x 10-3	1000	TORR
015	PE - 0134B	WACS	WCP2 Ion Gauge Tube	-									007			
015	PI - 0134B	WACS	WCP2 HI Vacuum Pressure Indication	-												
015	PT - 0134B	WACS	WCP2 Ion Gauge Transmitter	AI				1						3 x 10-11	1 x 10-2	TORR
004	II - 0135	WACS	WHAM5 75 L/S Ion Pump Current Indication	AI				1					004			
004	XIC - 0135	WACS	WHAM5 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0136	WACS	WCP1 LN2 Dewar Relief Valve	-												
004	II - 0137	WACS	WHAM6 75 L/S Ion Pump Current Indication	AI				1					004			
004	XIC - 0137	WACS	WHAM6 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
014	EV - 0139	WACS	Diagonal Section Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag WVG3	554617	005			
014	HS - 0139	WACS	Diagonal Section Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0139	WACS	WGV3 25 L/S Ion Pump Current Indication	AI				1					004			
014	SC - 0139	WACS	Diagonal Section Isolation Valve Controller	-												
014	XA - 0139	WACS	Diagonal Section Isolation Valve Common Alarm	DI		1										

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

V049-1-036, rev. 2

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
005	XIC - 0139	WACS	WGV3 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
014	ZSC - 0139	WACS	Diagonal Section Isolation Valve Closed	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag WVG3	554617	005			
014	ZSO - 0139	WACS	Diagonal Section Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag WVG3	554617	005			
002	PCV - 0140	WACS	WBSC4 Pressure Control Valve Controller	-									061			
002	PCV - 0140	WACS	WBSC4 Pressure Control Valve	-									061			
002	PY - 0140	WACS	WBSC4 Pressure Control Loop Output	AO				1								
002	PE - 0140A	WACS	WBSC4 Pirani Gauge Tube	-									007			
002	PI - 0140A	WACS	WBSC4 Lo Vacuum Pressure Indication	-												
002	PT - 0140A	WACS	WBSC4 Pirani Gauge Transmitter	AI				1						1 x 10-3	1000	TORR
002	PE - 0140B	WACS	WBSC4 Ion Gauge Tube	-									007			
002	PI - 0140B	WACS	WBSC4 Hi Vacuum Pressure Indication	-												
002	PT - 0140B	WACS	WBSC4 Ion Gauge Transmitter	AI				1						3 x 10-11	1 x 10-2	TORR
002	II - 0141	WACS	WBSC4 75 L/S Ion Pump Current Indication	AI				1					004			
002	XIC - 0141	WACS	WBSC4 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0142	WACS	WCP2 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0143	WACS	WCP2 LN2 Dewar Vent Pressure Control Valve	-												
015	PE - 0144A	WACS	Right Manifold Beam Tube Pirani Gauge Tube	-									007			
015	PI - 0144A	WACS	Right Manifold Beam Tube Lo Vacuum Pressure Indication	-												
015	PT - 0144A	WACS	Right Manifold Beam Tube Pirani Gauge Transmitter	AI				1						1 x 10-3	1000	TORR
015	PE - 0144B	WACS	Right Manifold Beam Tube Ion Gauge Tube	-									007			
015	PI - 0144B	WACS	Right Manifold Beam Tube Hi Vacuum Pressure Indication	-												
015	PT - 0144B	WACS	Right Manifold Beam Tube Ion Gauge Transmitter	AI				1						3 x 10-11	1 x 10-2	TORR
013	HV - 0145	WACS	Vertex Beam Tube 6" Pumpout Port Valve	-						Varian Vacu Products	6" SST Gate Valve	555029	006			
013	ZSC - 0145	WACS	Vertex Beam Tube 6" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
013	ZSO - 0145	WACS	Vertex Beam Tube 6" Pumpout Port Valve Open	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
012	HV - 0146	WACS	Left Manifold Beam Tube 6" Pumpout Port Valve	-						Varian Vacu Products	6" SST Gate Valve	555029	006			
012	ZSC - 0146	WACS	Left Manifold Beam Tube 6" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
012	ZSO - 0146	WACS	Left Manifold Beam Tube 6" Pumpout Port Valve Open	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
012	HV - 0147	WACS	Left Manifold Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
012	ZSC - 0147	WACS	Left Manifold Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
012	ZSO - 0147	WACS	Left Manifold Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
012	HV - 0148	WACS	WCP1 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
012	ZSC - 0148	WACS	WCP1 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
012	ZSO - 0148	WACS	WCP1 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
014	EV - 0149	WACS	Diagonal Section Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag WVG4	554617	005			
014	HS - 0149	WACS	Diagonal Section Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0149	WACS	WGV4 25 L/S Ion Pump Current Indication	AI				1					004			
014	SC - 0149	WACS	Diagonal Section Isolation Valve Controller	-												
014	XA - 0149	WACS	Diagonal Section Isolation Valve Common Alarm	DI	1											
005	XIC - 0149	WACS	WGV4 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
014	ZSC - 0149	WACS	Diagonal Section Isolation Valve Closed	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag WVG4	554617	005			
014	ZSO - 0149	WACS	Diagonal Section Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag WVG4	554617	005			
006	LIC - 0150	WACS	WCP2 80K Cryopump Level Control Loop Output	AO				1								
006	LT - 0150	WACS	WCP2 80K Cryopump Level Transmitter	AI				1					069	0	100	% Level
006	LV - 0150	WACS	WCP2 80K Cryopump Level Control Valve	-									062			
006	LY - 0150	WACS	WCP2 80K Cryopump Level Control Loop Output	AO				1								
006	XV - 0150	WACS	WCP2 80K Cryopump Level Control Valve Solenoid	DO		1										
006	ZSC - 0150	WACS	WCP2 80K Cryopump Level Control Valve Closed	DI	1								062			
006	PI - 0151	WACS	WCP2 80K Cryopump Discharge Pressure Indication	-												
006	PT - 0151	WACS	WCP2 80K Cryopump Discharge Pressure Transmitter	AI				1					090	0	25	PSIG
006	TE - 0152	WACS	WCP2 80K Cryopump Discharge Thermocouple	T/C				1								
006	TI - 0152	WACS	WCP2 80K Cryopump Discharge Temperature Indication	-												

V049-1-036, rev. 2

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
013	HS - 0163A	WACS	WIP3-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
013	II - 0163A	WACS	WIP3-1 2500 L/S Ion Pump Current Indication	AI			1									004
013	XA - 0163A	WACS	WIP3-1 2500 L/S Ion Pump Fault Alarm	DI	1											
013	EI - 0163B	WACS	WIP3-2 2500 L/S Ion Pump Voltage Indication	AI			1									004
013	HS - 0163B	WACS	WIP3-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
013	II - 0163B	WACS	WIP3-2 2500 L/S Ion Pump Current Indication	AI			1									004
013	XA - 0163B	WACS	WIP3-2 2500 L/S Ion Pump Fault Alarm	DI	1											
013	HS - 0163C	WACS	WIP3-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
013	HS - 0163D	WACS	WIP3-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
013	XIC - 0164	WACS	WIP4 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936				004
013	EI - 0164A	WACS	WIP4-1 2500 L/S Ion Pump Voltage Indication	AI			1									004
013	HS - 0164A	WACS	WIP4-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
013	II - 0164A	WACS	WIP4-1 2500 L/S Ion Pump Current Indication	AI			1									004
013	XA - 0164A	WACS	WIP4-1 2500 L/S Ion Pump Fault Alarm	DI	1											
013	EI - 0164B	WACS	WIP4-2 2500 L/S Ion Pump Voltage Indication	AI			1									004
013	HS - 0164B	WACS	WIP4-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
013	II - 0164B	WACS	WIP4-2 2500 L/S Ion Pump Current Indication	AI			1									004
013	XA - 0164B	WACS	WIP4-2 2500 L/S Ion Pump Fault Alarm	DI	1											
013	HS - 0164C	WACS	WIP4-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
013	HS - 0164D	WACS	WIP4-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
012	XIC - 0165	WACS	WIP5 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936				004
012	EI - 0165A	WACS	WIP5-1 2500 L/S Ion Pump Voltage Indication	AI			1									004
012	HS - 0165A	WACS	WIP5-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
012	II - 0165A	WACS	WIP5-1 2500 L/S Ion Pump Current Indication	AI			1									004
012	XA - 0165A	WACS	WIP5-1 2500 L/S Ion Pump Fault Alarm	DI	1											
012	EI - 0165B	WACS	WIP5-2 2500 L/S Ion Pump Voltage Indication	AI			1									004
012	HS - 0165B	WACS	WIP5-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
012	II - 0165B	WACS	WIP5-2 2500 L/S Ion Pump Current Indication	AI			1									004
012	XA - 0165B	WACS	WIP5-2 2500 L/S Ion Pump Fault Alarm	DI	1											
012	HS - 0165C	WACS	WIP5-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
012	HS - 0165D	WACS	WIP5-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
015	XIC - 0166	WACS	WIP6 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936				004
015	EI - 0166A	WACS	WIP6-1 2500 L/S Ion Pump Voltage Indication	AI			1									004
015	HS - 0166A	WACS	WIP6-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
015	II - 0166A	WACS	WIP6-1 2500 L/S Ion Pump Current Indication	AI			1									004
015	XA - 0166A	WACS	WIP6-1 2500 L/S Ion Pump Fault Alarm	DI	1											
015	EI - 0166B	WACS	WIP6-2 2500 L/S Ion Pump Voltage Indication	AI			1									004
015	HS - 0166B	WACS	WIP6-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
015	II - 0166B	WACS	WIP6-2 2500 L/S Ion Pump Current Indication	AI			1									004
015	XA - 0166B	WACS	WIP6-2 2500 L/S Ion Pump Fault Alarm	DI	1											
015	HS - 0166C	WACS	WIP6-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
015	HS - 0166D	WACS	WIP6-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
014	XIC - 0167	WACS	WIP7 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936				004
014	EI - 0167A	WACS	WIP7-1 2500 L/S Ion Pump Voltage Indication	AI			1									004
014	HS - 0167A	WACS	WIP7-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004
014	II - 0167A	WACS	WIP7-1 2500 L/S Ion Pump Current Indication	AI			1									004
014	XA - 0167A	WACS	WIP7-1 2500 L/S Ion Pump Fault Alarm	DI	1											
014	EI - 0167B	WACS	WIP7-2 2500 L/S Ion Pump Voltage Indication	AI			1									004
014	HS - 0167B	WACS	WIP7-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1										004
014	II - 0167B	WACS	WIP7-2 2500 L/S Ion Pump Current Indication	AI			1									004
014	XA - 0167B	WACS	WIP7-2 2500 L/S Ion Pump Fault Alarm	DI	1											
014	HS - 0167C	WACS	WIP7-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1										004

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	PI&D INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-3-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	TC	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
014	HS - 0167D	WACS	WIP7-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
014	XIC - 0168	WACS	WIP8 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004			
014	EI - 0168A	WACS	WIP8-1 2500 L/S Ion Pump Voltage Indication	AI			1						004			
014	HS - 0168A	WACS	WIP8-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
014	II - 0168A	WACS	WIP8-1 2500 L/S Ion Pump Current Indication	AI			1						004			
014	XA - 0168A	WACS	WIP8-1 2500 L/S Ion Pump Fault Alarm	DI	1											
014	EI - 0168B	WACS	WIP8-2 2500 L/S Ion Pump Voltage Indication	AI			1						004			
014	HS - 0168B	WACS	WIP8-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
014	II - 0168B	WACS	WIP8-2 2500 L/S Ion Pump Current Indication	AI			1						004			
014	XA - 0168B	WACS	WIP8-2 2500 L/S Ion Pump Fault Alarm	DI	1											
014	HS - 0168C	WACS	WIP8-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
014	HS - 0168D	WACS	WIP8-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
012	HS - 0169	WACS	WCP1 80K Cryopump Inlet Isolation Valve Oper/Close Switch	DO		1							005			
005	II - 0169	WACS	WGV6 25 L/S Ion Pump Current Indication	AI			1						004			
005	XIC - 0169	WACS	WGV6 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
012	XV - 0169	WACS	WCP1 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG6		554617	005		
012	XY - 0169	WACS	WCP1 80K Cryopump Inlet Isolation Valve Solenoid	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG6		554617	005		
012	ZSC - 0169	WACS	WCP1 80K Cryopump Inlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG6		554617	005		
012	ZSO - 0169	WACS	WCP1 80K Cryopump Inlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG6		554617	005		
002	PC - 0170	WACS	WBSC7 Pressure Control Valve Controller	-										061		
002	PCV - 0170	WACS	WBSC7 Pressure Control Valve	-										061		
002	PY - 0170	WACS	WBSC7 Pressure Control Loop Output	AO			1									
002	PE - 0170A	WACS	WBSC7 Pirani Gauge Tube	-										007		
002	PI - 0170A	WACS	WBSC7 Lo Vacuum Pressure Indication	-												
002	PT - 0170A	WACS	WBSC7 Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
002	PE - 0170B	WACS	WBSC7 Ion Gauge Tube	-										007		
002	PJ - 0170B	WACS	WBSC7 HI Vacuum Pressure Indication	-												
002	PT - 0170B	WACS	WBSC7 Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
002	II - 0171	WACS	WBSC7 75 L/S Ion Pump Current Indication	AI			1						004			
002	XIC - 0171	WACS	WBSC7 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	PI - 0172	WACS	WCP2 LN2 Dewar Pressure Control Indicator	-												
006	PCV - 0173	WACS	WCP2 LN2 Dewar Pressure Control Valve	-												
014	HV - 0174	WACS	Diagonal Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
014	ZSC - 0174	WACS	Diagonal Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
014	ZSO - 0174	WACS	Diagonal Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
018	PSV - 0175	WACS	Class 100 Air Pressure Safety Valve	-												
015	HV - 0176	WACS	Right Manifold Beam Tube 8" Pumpout Port Valve	-						Varian Vacu Products	8" SST Gate Valve	555029	006			
015	ZSC - 0176	WACS	Right Manifold Beam Tube 8" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	8" SST Gate Valve	555029	006			
015	ZSO - 0176	WACS	Right Manifold Beam Tube 8" Pumpout Port Valve Open	DI	1					Varian Vacu Products	8" SST Gate Valve	555029	006			
015	HV - 0177	WACS	Right Manifold Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
015	ZSC - 0177	WACS	Right Manifold Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
015	ZSO - 0177	WACS	Right Manifold Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
015	HV - 0178	WACS	WCP2 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
015	ZSC - 0178	WACS	WCP2 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
015	ZSO - 0178	WACS	WCP2 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
015	HS - 0179	WACS	WCP2 80K Cryopump Outlet Isolation Valve Oper/Close Switch	DO		1										
005	II - 0179	WACS	WGV7 25 L/S Ion Pump Current Indication	AI			1						004			
005	XIC - 0179	WACS	WGV7 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
015	XV - 0179	WACS	WCP2 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG7	554617	005			
015	XY - 0179	WACS	WCP2 80K Cryopump Outlet Isolation Valve Solenoid	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG7	554617	005			
015	ZSC - 0179	WACS	WCP2 80K Cryopump Outlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG7	554617	005			
015	ZSO - 0179	WACS	WCP2 80K Cryopump Outlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG7	554617	005			

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

LIGO INSTRUMENT LIST

V049-1-036, REV. 2

DWG	PI&D INFORMATION				I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC	SETTINGS (low-to-high or off-on)			
	VD49-0-	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	Y049-2-	LOW / OFF	HIGH / ON
002	PC - 0180	WACS	WBSC8 Pressure Control Valve Controller	-										061			
002	PCV - 0180	WACS	WBSC8 Pressure Control Valve	-										061			
002	PY - 0180	WACS	WBSC8 Pressure Control Loop Output	AO					1								
002	PE - 0180A	WACS	WBSC8 Pirani Gauge Tube	-										007			
002	PI - 0180A	WACS	WBSC8 Lo Vacuum Pressure Indication	-													
002	PT - 0180A	WACS	WBSC8 Pirani Gauge Transmitter	AI					1						1 x 10-3	1000	TORR
002	PE - 0180B	WACS	WBSC8 Ion Gauge Tube	-										007			
002	PI - 0180B	WACS	WBSC8 HI Vacuum Pressure Indication	-													
002	PT - 0180B	WACS	WBSC8 Ion Gauge Transmitter	AI					1						3 x 10-11	1 x 10-2	TORR
002	II - 0181	WACS	WBSC8 75 L/S Ion Pump Current Indication	AI					1					004			
002	XIC - 0181	WACS	WBSC8 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0182	WACS	WCP2 LN2 Dewar Pressure Control Relief Valve	-													
006	RV - 0183	WACS	WCP2 80K Cryopump Discharge Relief Valve	-													
018	PCV - 0184	WACS	Class 100 Air Seal Gas Pressure Control Valve	-													
018	PI - 0184	WACS	Class 100 Air Seal Gas Pressure Indicator	-													
004	II - 0185	WACS	WHAM7 75 L/S Ion Pump Current Indication	AI					1					004			
004	XIC - 0185	WACS	WHAM7 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
012	II - 0186	WACS	75 L/S Ion Pump Current Indication Left Beam Manifold	AI					1					004			
012	XIC - 0186	WACS	75 L/S Ion Pump Controller Left Beam Manifold	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0187	WACS	WHAM8 75 L/S Ion Pump Current Indication	AI					1					004			
004	XIC - 0187	WACS	WHAM8 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
015	II - 0188	WACS	75 L/S Ion Pump Current Indication Right Beam Manifold	AI					1					004			
015	XIC - 0188	WACS	75 L/S Ion Pump Controller Right Beam Manifold	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
015	HS - 0189	WACS	WCP2 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO					1					005			
005	II - 0189	WACS	WGV8 25 L/S Ion Pump Current Indication	AI					1					004			
005	XIC - 0189	WACS	WGV8 25 L/S Ion Pump Controller	-							Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
015	XV - 0189	WACS	WCP2 80K Cryopump Inlet Isolation Valve	-							GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG8	554617	005			
015	XY - 0189	WACS	WCP2 80K Cryopump Inlet Isolation Valve Solenoid	-							GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG8	554617	005			
015	ZSC - 0189	WACS	WCP2 80K Cryopump Inlet Isolation Valve Closed	DI					1		GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG8	554617	005			
015	ZSO - 0189	WACS	WCP2 80K Cryopump Inlet Isolation Valve Open	DI					1		GNB Corp	112CM, Gate Valve, Pneumatic, Tag WVG8	554617	005			
006	RV - 0190	WACS	WCP2 LN2 Dewar Relief Valve	-													
004	II - 0191	WACS	WHAM9 75 L/S Ion Pump Current Indication	AI					1					004			
004	XIC - 0191	WACS	WHAM9 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0193	WACS	WHAM10 75 L/S Ion Pump Current Indication	AI					1					004			
004	XIC - 0193	WACS	WHAM10 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0195	WACS	WHAM11 75 L/S Ion Pump Current Indication	AI					1					004			
004	XIC - 0195	WACS	WHAM11 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0197	WACS	WHAM12 75 L/S Ion Pump Current Indication	AI					1					004			
004	XIC - 0197	WACS	WHAM12 75 L/S Ion Pump Controller	-							Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
018	PCV - 0198	WACS	Class 100 Air Pressure Control Valve	-													
018	PI - 0198	WACS	Class 100 Air Pressure Indicator	-													
006	LIC - 0200	WAMS	WCP3 80K Cryopump Level Control Loop Output	AO						1							
006	LT - 0200	WAMS	WCP3 80K Cryopump Level Transmitter	AI						1				089	0	100	% Level
006	LV - 0200	WAMS	WCP3 80K Cryopump Level Control Valve	-										062			
006	LY - 0200	WACS	WCP3 80K Cryopump Level Control Loop Output	AO						1							
006	XV - 0200	WAMS	WCP3 80K Cryopump Level Control Valve Solenoid	DO						1							
006	ZSC - 0200	WAMS	WCP3 80K Cryopump Level Control Valve Closed	DI						1				062			
006	PI - 0201	WAMS	WCP3 80K Cryopump Discharge Pressure Indication	-													
006	PT - 0201	WAMS	WCP3 80K Cryopump Discharge Pressure Transmitter	AI						1				090	0	25	PSIG
006	TE - 0202	WAMS	WCP3 80K Cryopump Discharge Thermocouple	T/C						1							
006	TI - 0202	WAMS	WCP3 80K Cryopump Discharge Temperature Indication	-													
006	JC - 0203	WACS	WCP3 80K Cryopump Regen SCR Controller	AI						1							

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

LIGO INSTRUMENT LIST

V049-1-036, REV. 2

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
006	TIC - 0203	WAMS	WCP3 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0203	WAMS	WCP3 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0203	WAMS	WCP3 80K Cryopump Regen Loop Temperature Control Loop Output	-												
006	TE - 0203A	WAMS	WCP3 80K Cryopump Regen Loop Thermocouple	T/C-T								091	-320	700	Deg F	
006	TE - 0203B	WAMS	WCP3 80K Cryopump Regen Loop Thermocouple	T/C-K								056	32	2300	Deg F	
006	TE - 0203C	WAMS	WCP3 80K Cryopump Regen Loop Thermocouple	T/C-K								056	32	2300	Deg F	
006	FE - 0204	WAMS	WCP3 80K Cryopump Regen Loop Pilot Tube Flow Element	-								079	0	12,000	SCFH	
006	FI - 0204	WAMS	WCP3 80K Cryopump Regen Loop Flow Indicator	-								088	0	12,000	SCFH	
006	LT - 0205	WAMS	WCP3 LN2 Dewar Level Transmitter	AI				1				089	0	100	% Level	
006	PI - 0205	WAMS	WCP3 LN2 Dewar Pressure Indicator	-												
006	LI - 0205A	WAMS	WCP3 LN2 Dewar Level Indicator	-												
006	LI - 0205B	WAMS	WCP3 LN2 Dewar Level Indicator	-												
006	RD - 0206	WAMS	WCP3 LN2 Dewar Rupture Disc	-												
006	RV - 0206	WAMS	WCP3 LN2 Dewar Relief Valve	-												
006	RD - 0207	WAMS	WCP3 LN2 Dewar Rupture Disc	-												
006	RV - 0207	WAMS	WCP3 LN2 Dewar Relief Valve	-												
006	RV - 0208	WAMS	WCP3 LN2 Dewar Relief Valve	-												
011	EV - 0209	WAMS	WCP3 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG9	554617	005			
011	HS - 0209	WAMS	WCP3 80K Cryopump Outlet Isolation Valve Oper/Close Switch	DO				1								
005	II - 0209	WAMS	WGV9 25 L/S Ion Pump Current Indication	AI				1								
011	SC - 0209	WAMS	WCP3 80K Cryopump Outlet Isolation Valve Controller	-												
011	XA - 0209	WAMS	WCP3 80K Cryopump Outlet Isolation Valve Common Alarm	DI				1								
005	XIC - 0209	WAMS	WGV9 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
011	ZSC - 0209	WAMS	WCP3 80K Cryopump Outlet Isolation Valve Closed	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag WVG9	554617	005			
011	ZSO - 0209	WAMS	WCP3 80K Cryopump Outlet Isolation Valve Open	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag WVG9	554617	005			
002	PC - 0210	WAMS	WBSC6 Pressure Control Valve Controller	-											061	
002	PCV - 0210	WAMS	WBSC6 Pressure Control Valve	-											061	
002	PY - 0210	WAMS	WBSC6 Pressure Control Loop Output	AO				1								
002	PE - 0210A	WAMS	WBSC6 Pirani Gauge Tube	-											007	
002	PI - 0210A	WAMS	WBSC6 Lo Vacuum Pressure Indication	-												
002	PT - 0210A	WAMS	WBSC6 Pirani Gauge Transmitter	AI				1						1 x 10-3	1000	TORR
002	PE - 0210B	WAMS	WBSC6 Ion Gauge Tube	-												
002	PI - 0210B	WAMS	WBSC6 Hi Vacuum Pressure Indication	-												
002	PT - 0210B	WAMS	WBSC6 Ion Gauge Transmitter	AI				1						3 x 10-11	1 x 10-2	TORR
002	II - 0211	WAMS	WBSC6 75 L/S Ion Pump Current Indication	AI				1								004
002	XIC - 0211	WAMS	WBSC6 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0212	WAMS	WCP3 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0213	WAMS	WCP3 LN2 Dewar Vent Pressure Control Valve	-												
011	EV - 0219	WAMS	WCP3 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG10	554617	005			
011	HS - 0219	WAMS	WCP3 80K Cryopump Inlet Isolation Valve Oper/Close Switch	DO				1								005
005	II - 0219	WAMS	WGV10 25 L/S Ion Pump Current Indication	AI				1								004
011	SC - 0219	WAMS	WCP3 80K Cryopump Inlet Isolation Valve Controller	-												
011	XA - 0219	WAMS	WCP3 80K Cryopump Inlet Isolation Valve Common Alarm	DI				1								
005	XIC - 0219	WAMS	WGV10 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
011	ZSC - 0219	WAMS	WCP3 80K Cryopump Inlet Isolation Valve Closed	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag WVG10	554617	005			
011	ZSO - 0219	WAMS	WCP3 80K Cryopump Inlet Isolation Valve Open	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag WVG10	554617	005			
006	PI - 0222	WAMS	WCP3 LN2 Dewar Pressure Control Indicator	-												
006	PCV - 0223	WAMS	WCP3 LN2 Dewar Pressure Control Valve	-												
011	EV - 0229	WAMS	WCP4 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG11	554617	005			
011	HS - 0229	WAMS	WCP4 80K Cryopump Outlet Isolation Valve Oper/Close Switch	DO				1								005
005	II - 0229	WAMS	WGV11 25 L/S Ion Pump Current Indication	AI				1								004
011	SC - 0229	WAMS	WCP4 80K Cryopump Outlet Isolation Valve Controller	-												

## LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
PREPARED BY: \_\_\_\_\_  
CHECKED BY: \_\_\_\_\_

DWG	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC	SETTINGS (low-to-high or off-on)				
	V049-0-	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER		MODEL No.	P. O. #	V049-2-	LOW / OFF	HIGH / ON
011	XA - 0229	WAMS	WCP4 80K Cryopump Outlet Isolation Valve Common Alarm	DI	1												
005	XIC - 0229	WAMS	WGV11 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
011	ZSC - 0229	WAMS	WCP4 80K Cryopump Outlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG11	554617	005				
011	ZSO - 0229	WAMS	WCP4 80K Cryopump Outlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG11	554617	005				
006	RV - 0232	WAMS	WCP3 LN2 Dewar Pressure Control Relief Valve	-													
006	RV - 0233	WAMS	WCP3 80K Cryopump Discharge Relief Valve	-													
006	RV - 0236	WACS	WCP3 LN2 Dewar Relief Valve	-													
011	EV - 0239	WAMS	WCP4 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG12	554617	005				
011	HS - 0239	WAMS	WCP4 80K Cryopump Inlet Isolation Valve Oper/Close Switch	DO		1											
005	II - 0239	WAMS	WGV12 25 L/S Ion Pump Current Indication	AI			1										
011	SC - 0239	WAMS	WCP4 80K Cryopump Inlet Isolation Valve Controller	-													
011	XA - 0239	WAMS	WCP4 80K Cryopump Inlet Isolation Valve Common Alarm	DI	1												
005	XIC - 0239	WAMS	WGV12 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
011	ZSC - 0239	WAMS	WCP4 80K Cryopump Inlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG12	554617	006				
011	ZSO - 0239	WAMS	WCP4 80K Cryopump Inlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG12	554617	006				
011	HV - 0240	WAMS	WCP3 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
011	ZSC - 0240	WAMS	WCP3 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
011	ZSO - 0240	WAMS	WCP3 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
011	HV - 0241	WAMS	Left Mid Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
011	ZSC - 0241	WAMS	Left Mid Beam Tube Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
011	ZSO - 0241	WAMS	Left Mid Beam Tube Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
011	HV - 0242	WAMS	WCP4 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
011	ZSC - 0242	WAMS	WCP4 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
011	ZSO - 0242	WAMS	WCP4 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
011	PE - 0243A	WAMS	Left Mid Beam Tube Pirani Gauge Tube	-													
011	PI - 0243A	WAMS	Left Mid Beam Tube Lo Vacuum Pressure Indication	-													
011	PT - 0243A	WAMS	Left Mid Beam Tube Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
011	PE - 0243B	WAMS	Left Mid Beam Tube Ion Gauge Tube	-													
011	PI - 0243B	WAMS	Left Mid Beam Tube HI Vacuum Pressure Indication	-													
011	PT - 0243B	WAMS	Left Mid Beam Tube Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
011	PE - 0244A	WAMS	WCP3 Pirani Gauge Tube	-													
011	PI - 0244A	WAMS	WCP3 Lo Vacuum Pressure Indication	-													
011	PT - 0244A	WAMS	WCP3 Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
011	PE - 0244B	WAMS	WCP3 Ion Gauge Tube	-													
011	PI - 0244B	WAMS	WCP3 HI Vacuum Pressure Indication	-													
011	PT - 0244B	WAMS	WCP3 Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
011	PE - 0245A	WAMS	WCP4 Pirani Gauge Tube	-													
011	PI - 0245A	WAMS	WCP4 Lo Vacuum Pressure Indication	-													
011	PT - 0245A	WAMS	WCP4 Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
011	PE - 0245B	WAMS	WCP4 Ion Gauge Tube	-													
011	PI - 0245B	WAMS	WCP4 HI Vacuum Pressure Indication	-													
011	PT - 0245B	WAMS	WCP4 Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
011	PE - 0246A	WAMS	Left Mid Beam Tube Pirani Gauge Tube	-													
011	PI - 0246A	WAMS	Left Mid Beam Tube Lo Vacuum Pressure Indication	-													
011	PT - 0246A	WAMS	Left Mid Beam Tube Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
011	PE - 0246B	WAMS	Left Mid Beam Tube Ion Gauge Tube	-													
011	PI - 0246B	WAMS	Left Mid Beam Tube HI Vacuum Pressure Indication	-													
011	PT - 0246B	WAMS	Left Mid Beam Tube Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
011	XIC - 0247	WAMS	WIP9 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004				
011	EJ - 0247A	WAMS	WIP9-1 2500 L/S Ion Pump Voltage Indication	AI			1										
011	HS - 0247A	WAMS	WIP9-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1											
011	II - 0247A	WAMS	WIP9-1 2500 L/S Ion Pump Current Indication	AI			1										



LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC	SETTINGS (low-to-high or off-on)				
	V049-0-	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER		MODEL No.	P. O. #	V049-2-	LOW / OFF	HIGH / ON
011	XA - 0247A	WAMS	WIP9-1 2500 L/S Ion Pump Fault Alarm	DI	1												
011	EI - 0247B	WAMS	WIP9-2 2500 L/S Ion Pump Voltage Indication	AI			1						004				
011	HS - 0247B	WAMS	WIP9-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004				
011	II - 0247B	WAMS	WIP9-2 2500 L/S Ion Pump Current Indication	AI			1						004				
011	XA - 0247B	WAMS	WIP9-2 2500 L/S Ion Pump Fault Alarm	DI	1												
011	HS - 0247C	WAMS	WIP9-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004				
011	HS - 0247D	WAMS	WIP9-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004				
006	LIC - 0250	WAMS	WCP4 80K Cryopump Level Control Loop Output	AO				1									
006	LT - 0250	WAMS	WCP4 80K Cryopump Level Transmitter	AI			1						069	0	100		% Level
006	LV - 0250	WAMS	WCP4 80K Cryopump Level Control Valve	-									062				
006	LY - 0250	WACS	WCP4 80K Cryopump Level Control Loop Output	AO				1									
006	XV - 0250	WAMS	WCP4 80K Cryopump Level Control Valve Solenoid	DO		1											
006	ZSC - 0250	WAMS	WCP4 80K Cryopump Level Control Valve Closed	DI	1								026				
006	PI - 0251	WAMS	WCP4 80K Cryopump Discharge Pressure Indication	-													
006	PT - 0251	WAMS	WCP4 80K Cryopump Discharge Pressure Transmitter	AI			1						090	0	25		PSIG
006	TE - 0252	WAMS	WCP4 80K Cryopump Discharge Thermocouple	T/C					1								
006	TI - 0252	WAMS	WCP4 80K Cryopump Discharge Temperature Indication	-													
006	JC - 0253	WACS	WCP4 80K Cryopump Regen SCR Controller	AI			1										
006	TIC - 0253	WAMS	WCP4 80K Cryopump Regen Loop Temperature Control	-													
006	TSH - 0253	WAMS	WCP4 80K Cryopump Regen Loop HI Temperature	-													
006	TY - 0253	WAMS	WCP4 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1									
006	TE - 0253A	WAMS	WCP4 80K Cryopump Regen Loop Thermocouple	T/C-T					1				051	-320	700		Deg F
006	TE - 0253B	WAMS	WCP4 80K Cryopump Regen Loop Thermocouple	T/C-K					1				056	32	2300		Deg F
006	TE - 0253C	WAMS	WCP4 80K Cryopump Regen Loop Thermocouple	T/C-K					1				056	32	2300		Deg F
006	FE - 0254	WAMS	WCP4 80K Cryopump Regen Loop Pilot Tube Flow Element	-									079	0	12,000		SCFH
006	FI - 0254	WAMS	WCP4 80K Cryopump Regen Loop Flow Indicator	-									069	0	12,000		SCFH
006	LT - 0255	WAMS	WCP4 LN2 Dewar Level Transmitter	AI			1						069	0	100		% Level
006	PI - 0255	WAMS	WCP4 LN2 Dewar Pressure Indicator	-													
006	LI - 0255A	WAMS	WCP4 LN2 Dewar Level Indicator	-													
006	LI - 0255B	WAMS	WCP4 LN2 Dewar Level Indication	-													
006	RD - 0256	WAMS	WCP4 LN2 Dewar Rupture Disc	-													
006	RV - 0256	WAMS	WCP4 LN2 Dewar Relief Valve	-													
006	RD - 0257	WAMS	WCP4 LN2 Dewar Rupture Disc	-													
006	RV - 0257	WAMS	WCP4 LN2 Dewar Relief Valve	-													
006	RV - 0258	WAMS	WCP4 LN2 Dewar Relief Valve	-													
011	PSV - 0260	WAMS	Class 100 Air Pressure Safety Valve	-													
011	PCV - 0261	WAMS	Class 100 Air Seal Gas Pressure Control Valve	-													
011	PI - 0261	WAMS	Class 100 Air Seal Gas Pressure Indicator	-													
006	RV - 0262	WAMS	WCP4 LN2 Dewar Pressure Control Relief Valve	-													
006	PCV - 0263	WAMS	WCP4 LN2 Dewar Vent Pressure Control Valve	-													
006	PI - 0272	WAMS	WCP4 LN2 Dewar Pressure Control Indicator	-													
006	PCV - 0273	WAMS	WCP4 LN2 Dewar Pressure Control Valve	-													
006	RV - 0282	WAMS	WCP4 LN2 Dewar Pressure Control Relief Valve	-													
006	RV - 0283	WAMS	WCP4 80K Cryopump Discharge Relief Valve	-													
011	PCV - 0284	WAMS	Class 100 Air Pressure Control Valve	-													
011	PI - 0284	WAMS	Class 100 Air Pressure Indicator	-													
006	RV - 0290	WACS	WCP4 LN2 Dewar Relief Valve	-													
006	LIC - 0300	WAMS	WCP5 80K Cryopump Level Control Output	AO				1									
006	LT - 0300	WAMS	WCP5 80K Cryopump Level Transmitter	AI			1						069	0	100		% Level
006	LV - 0300	WAMS	WCP5 80K Cryopump Level Control Valve	-									062				
006	LY - 0300	WACS	WCP5 80K Cryopump Level Control Loop Output	AO				1									
006	XV - 0300	WAMS	WCP5 80K Cryopump Level Control Valve Solenoid	DO		1											

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG Y049-0-	P&ID INFORMATION				I/O BREAKDOWN					EQUIPMENT INFORMATION		SPEC Y049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
006	ZSC - 0300	WAMS	WCP5 80K Cryopump Level Control Valve Closed	DI	1							028				
006	PI - 0301	WAMS	WCP5 80K Cryopump Discharge Pressure Indication	-												
006	PT - 0301	WAMS	WCP5 80K Cryopump Discharge Pressure Transmitter	AI			1					080	0	25	PSIG	
006	TE - 0302	WAMS	WCP5 80K Cryopump Discharge Thermocouple	T/C					1							
006	TI - 0302	WAMS	WCP5 80K Cryopump Discharge Temperature Indication	-												
006	JC - 0303	WACS	WCP5 80K Cryopump Regen SCR Controller	AI			1									
006	TIC - 0303	WAMS	WCP5 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0303	WAMS	WCP5 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0303	WAMS	WCP5 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1								
006	TE - 0303A	WAMS	WCP5 80K Cryopump Regen Loop Thermocouple	T/C-T					1			091	-320	375°F	Deg F	
006	TE - 0303B	WAMS	WCP5 80K Cryopump Regen Loop Thermocouple	T/C-K					1			058	32	2300	Deg F	
006	TE - 0303C	WAMS	WCP5 80K Cryopump Regen Loop Thermocouple	T/C-K					1			058	32	2300	Deg F	
006	FE - 0304	WAMS	WCP5 80K Cryopump Regen Loop Pilot Tube Flow Element	-								079	0	12,000	SCFH	
006	FI - 0304	WAMS	WCP5 80K Cryopump Regen Loop Flow Indicator	-								068	0	12,000	SCFH	
006	LT - 0305	WAMS	WCP5 LN2 Dewar Level Transmitter	AI			1					069	0	100	% Level	
006	PI - 0305	WAMS	WCP5 LN2 Dewar Pressure Indicator	-												
006	LJ - 0305A	WAMS	WCP5 LN2 Dewar Level Indicator	-												
006	LJ - 0305B	WAMS	WCP5 LN2 Dewar Level Indication	-												
006	RD - 0306	WAMS	WCP5 LN2 Dewar Rupture Disc	-												
006	RV - 0306	WAMS	WCP5 LN2 Dewar Relief Valve	-												
006	RD - 0307	WAMS	WCP5 LN2 Dewar Rupture Disc	-												
006	RV - 0307	WAMS	WCP5 LN2 Dewar Relief Valve	-												
006	RV - 0308	WAMS	WCP5 LN2 Dewar Relief Valve	-												
016	EV - 0309	WAMS	WCP5 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG13	554617	005			
016	HS - 0309	WAMS	WCP5 80K Cryopump Outlet Isolation Valve Opern/Close Switch	DO		1							005			
005	II - 0309	WAMS	WGV13 25 L/S Ion Pump Current Indication	AI			1						004			
016	SC - 0309	WAMS	WCP5 80K Cryopump Outlet Isolation Valve Controller	-												
016	XA - 0309	WAMS	WCP5 80K Cryopump Outlet Isolation Valve Common Alarm	DI		1										
005	XIC - 0309	WAMS	WGV13 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
016	ZSC - 0309	WAMS	WCP5 80K Cryopump Outlet Isolation Valve Closed	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG13	554617	005			
016	ZSO - 0309	WAMS	WCP5 80K Cryopump Outlet Isolation Valve Open	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG13	554617	005			
002	PC - 0310	WAMS	WBSC5 Pressure Control Valve Controller	-									061			
002	PCV - 0310	WAMS	WBSC5 Pressure Control Valve	-									061			
002	PY - 0310	WAMS	WBSC5 Pressure Control Loop Output	AO				1								
002	PE - 0310A	WAMS	WBSC5 Pirani Gauge Tube	-									007			
002	PI - 0310A	WAMS	WBSC5 Lo Vacuum Pressure Indication	-												
002	PT - 0310A	WAMS	WBSC5 Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
002	PE - 0310B	WAMS	WBSC5 Ion Gauge Tube	-									007			
002	PI - 0310B	WAMS	WBSC5 HI Vacuum Pressure Indication	-												
002	PT - 0310B	WAMS	WBSC5 Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
002	II - 0311	WAMS	WBSC5 75 L/S Ion Pump Current Indication	AI			1						004			
002	XIC - 0311	WAMS	WBSC5 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0312	WAMS	WCP5 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0313	WAMS	WCP5 LN2 Dewar Vent Pressure Control Valve	-												
016	EV - 0319	WAMS	WCP5 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG14	554617	005			
016	HS - 0319	WAMS	WCP5 80K Cryopump Inlet Isolation Valve Opern/Close Switch	DO			1						005			
005	II - 0319	WAMS	WGV14 25 L/S Ion Pump Current Indication	AI			1						004			
016	SC - 0319	WAMS	WCP5 80K Cryopump Inlet Isolation Valve Controller	-												
016	XA - 0319	WAMS	WCP5 80K Cryopump Inlet Isolation Valve Common Alarm	DI			1									
005	XIC - 0319	WAMS	WGV14 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
016	ZSC - 0319	WAMS	WCP5 80K Cryopump Inlet Isolation Valve Closed	DI			1			GNB Corp	112CM, Gate Valve, Electric, Tag WVG14	554617	005			
016	ZSO - 0319	WAMS	WCP5 80K Cryopump Inlet Isolation Valve Open	DI			1			GNB Corp	112CM, Gate Valve, Electric, Tag WVG14	554617	005			

V049-1-036, rev. 2

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high gr off-on)				
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	TC	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS	
006	PI - 0322	WAMS	WCP5 LN2 Dewar Pressure Control Indicator	-													
006	PCV - 0323	WAMS	WCP5 LN2 Dewar Pressure Control Valve	-													
016	EV - 0329	WAMS	WCP6 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG15	554617	005				
016	HS - 0329	WAMS	WCP6 80K Cryopump Outlet Isolation Valve Open/Close Switch	DO		1							005				
005	II - 0329	WAMS	WGV15 25 L/S Ion Pump Current Indication	AI			1						004				
016	SC - 0329	WAMS	WCP6 80K Cryopump Outlet Isolation Valve Controller	-													
016	XA - 0329	WAMS	WCP6 80K Cryopump Outlet Isolation Valve Common Alarm	DI	1												
005	XIC - 0329	WAMS	WGV15 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
016	ZSC - 0329	WAMS	WCP6 80K Cryopump Outlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG15	554617	005				
016	ZSO - 0329	WAMS	WCP6 80K Cryopump Outlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG15	554617	005				
006	RV - 0332	WAMS	WCP5 LN2 Dewar Pressure Control Relief Valve	-													
006	RV - 0333	WAMS	WCP5 80K Cryopump Discharge Relief Valve	-													
006	RV - 0336	WACS	WCP5 LN2 Dewar Relief Valve	-													
016	EV - 0339	WAMS	WCP6 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG16	554617	005				
016	HS - 0339	WAMS	WCP6 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO		1							005				
005	II - 0339	WAMS	WGV16 25 L/S Ion Pump Current Indication	AI			1						004				
016	SC - 0339	WAMS	WCP6 80K Cryopump Inlet Isolation Valve Controller	-													
016	XA - 0339	WAMS	WCP6 80K Cryopump Inlet Isolation Valve Common Alarm	DI	1												
005	XIC - 0339	WAMS	WGV16 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
016	ZSC - 0339	WAMS	WCP6 80K Cryopump Inlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG16	554617	005				
016	ZSO - 0339	WAMS	WCP6 80K Cryopump Inlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag WVG16	554617	005				
016	HV - 0340	WAMS	WCP5 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
016	ZSC - 0340	WAMS	WCP5 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
016	ZSO - 0340	WAMS	WCP5 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
016	HV - 0341	WAMS	Right Mid Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
016	ZSC - 0341	WAMS	Right Mid Beam Tube Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
016	ZSO - 0341	WAMS	Right Mid Beam Tube Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
016	HV - 0342	WAMS	WCP6 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
016	ZSC - 0342	WAMS	WCP6 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
016	ZSO - 0342	WAMS	WCP6 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006				
016	PE - 0343A	WAMS	Right Mid Beam Tube Pirani Gauge Tube	-									007				
016	PI - 0343A	WAMS	Right Mid Beam Tube Lo Vacuum Pressure Indication	-													
016	PT - 0343A	WAMS	Right Mid Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR	
016	PE - 0343B	WAMS	Right Mid Beam Tube Ion Gauge Tube	-									007				
016	PI - 0343B	WAMS	Right Mid Beam Tube HI Vacuum Pressure Indication	-													
016	PT - 0343B	WAMS	Right Mid Beam Tube Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
016	PE - 0344A	WAMS	WCP5 Pirani Gauge Tube	-									007				
016	PI - 0344A	WAMS	WCP5 Lo Vacuum Pressure Indication	-													
016	PT - 0344A	WAMS	WCP5 Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
016	PE - 0344B	WAMS	WCP5 Ion Gauge Tube	-									007				
016	PI - 0344B	WAMS	WCP5 HI Vacuum Pressure Indication	-													
016	PT - 0344B	WAMS	WCP5 Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
016	PE - 0345A	WAMS	WCP6 Pirani Gauge Tube	-									007				
016	PI - 0345A	WAMS	WCP6 Lo Vacuum Pressure Indication	-													
016	PT - 0345A	WAMS	WCP6 Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
016	PE - 0345B	WAMS	WCP6 Ion Gauge Tube	-									007				
016	PI - 0345B	WAMS	WCP6 HI Vacuum Pressure Indication	-													
016	PT - 0345B	WAMS	WCP6 Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
016	PE - 0346A	WAMS	Right Mid Beam Tube Pirani Gauge Tube	-									007				
016	PI - 0346A	WAMS	Right Mid Beam Tube Lo Vacuum Pressure Indication	-													
016	PT - 0346A	WAMS	Right Mid Beam Tube Pirani Gauge Transmitter	AI											1 x 10-3	1000	TORR
016	PE - 0346B	WAMS	Right Mid Beam Tube Ion Gauge Tube	-									007				

VD49-1-036, REV. 2

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	PI&D INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
016	PI - 0346B	WAMS	Right Mid Beam Tube HI Vacuum Pressure Indication	-												
016	PT - 0346B	WAMS	Right Mid Beam Tube Ion Gauge Transmitter	AI			1									
016	XIC - 0347	WAMS	WIP10 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004	3 x 10-11	1 x 10-2	TORR
016	EI - 0347A	WAMS	WIP10-1 2500 L/S Ion Pump Voltage Indication	AI			1						004			
016	HS - 0347A	WAMS	WIP10-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
016	II - 0347A	WAMS	WIP10-1 2500 L/S Ion Pump Current Indication	AI			1						004			
016	XA - 0347A	WAMS	WIP10-1 2500 L/S Ion Pump Fault Alarm	DI	1											
016	EI - 0347B	WAMS	WIP10-2 2500 L/S Ion Pump Voltage Indication	AI			1						004			
016	HS - 0347B	WAMS	WIP10-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
016	II - 0347B	WAMS	WIP10-2 2500 L/S Ion Pump Current Indication	AI			1						004			
016	XA - 0347B	WAMS	WIP10-2 2500 L/S Ion Pump Fault Alarm	DI	1											
016	HS - 0347C	WAMS	WIP10-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
016	HS - 0347D	WAMS	WIP10-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
006	LIC - 0350	WAMS	WCP6 80K Cryopump Level Control Loop Output	AO			1									
006	LT - 0350	WAMS	WCP6 80K Cryopump Level Transmitter	AI			1						069	0	100	% Level
006	LV - 0350	WAMS	WCP6 80K Cryopump Level Control Valve	-									062			
006	LY - 0350	WACS	WCP6 80K Cryopump Level Control Loop Output	AO			1									
006	XV - 0350	WAMS	WCP6 80K Cryopump Level Control Valve Solenoid	DO		1										
006	ZSC - 0350	WAMS	WCP6 80K Cryopump Level Control Valve Closed	DI	1								028			
006	PI - 0351	WAMS	WCP6 80K Cryopump Discharge Pressure Indication	-												
006	PT - 0351	WAMS	WCP6 80K Cryopump Discharge Pressure Transmitter	AI			1						090	0	25	PSIG
006	TE - 0352	WAMS	WCP6 80K Cryopump Discharge Thermocouple	T/C				1								
006	TI - 0352	WAMS	WCP6 80K Cryopump Discharge Temperature Indication	-												
006	JC - 0353	WACS	WCP6 80K Cryopump Regen SCR Controller	AI			1									
006	TIC - 0353	WAMS	WCP6 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0353	WAMS	WCP6 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0353	WAMS	WCP6 80K Cryopump Regen Loop Temperature Control Loop Output	AO			1									
006	TE - 0353A	WAMS	WCP6 80K Cryopump Regen Loop Thermocouple	T/C-T				1					091	-320	700	Deg F
006	TE - 0353B	WAMS	WCP6 80K Cryopump Regen Loop Thermocouple	T/C-K				1					058	32	2300	Deg F
006	TE - 0353C	WAMS	WCP6 80K Cryopump Regen Loop Thermocouple	T/C-K				1					058	32	2300	Deg F
006	FE - 0354	WAMS	WCP6 80K Cryopump Regen Loop Pilot Tube Flow Element	-									079	0	12,000	SCFH
006	FI - 0354	WAMS	WCP6 80K Cryopump Regen Loop Flow Indicator	-									068	0	12,000	SCFH
006	LT - 0355	WAMS	WCP6 LN2 Dewar Level Transmitter	AI			1						069	0	190	% Level
006	PI - 0355	WAMS	WCP6 LN2 Dewar Pressure Indicator	-												
006	LI - 0355A	WAMS	WCP6 LN2 Dewar Level Indicator	-												
006	LI - 0355B	WAMS	WCP6 LN2 Dewar Level Indication	-												
006	RD - 0356	WAMS	WCP6 LN2 Dewar Rupture Disc	-												
006	RV - 0356	WAMS	WCP6 LN2 Dewar Relief Valve	-												
006	RD - 0357	WAMS	WCP6 LN2 Dewar Rupture Disc	-												
006	RV - 0357	WAMS	WCP6 LN2 Dewar Relief Valve	-												
006	RV - 0358	WAMS	WCP6 LN2 Dewar Relief Valve	-												
016	PSV - 0360	WAMS	Class 100 Air Pressure Safety Valve	-												
016	PCV - 0361	WAMS	Class 100 Air Seal Gas Pressure Control Valve	-												
016	PI - 0361	WAMS	Class 100 Air Seal Gas Pressure Indicator	-												
006	RV - 0362	WAMS	WCP6 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0363	WAMS	WCP6 LN2 Dewar Vent Pressure Control Valve	-												
006	PI - 0372	WAMS	WCP6 LN2 Dewar Pressure Control Indicator	-												
006	PCV - 0373	WAMS	WCP6 LN2 Dewar Pressure Control Valve	-												
006	RV - 0382	WAMS	WCP6 LN2 Dewar Pressure Control Relief Valve	-												
006	RV - 0383	WAMS	WCP6 80K Cryopump Discharge Relief Valve	-												
016	PCV - 0384	WAMS	Class 100 Air Pressure Control Valve	-												
016	PI - 0384	WAMS	Class 100 Air Pressure Indicator	-												

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

LIGO INSTRUMENT LIST

V049-1-036, rev. 2

DWG V049-0	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2	SETTINGS (low-to-high or off-on)		
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON
006	RV - 0390	WACS	WCP8LN2 Dewar Relief Valve	-											
006	LIC - 0400	WAES	WCP7 80K Cryopump Level Control Loop Output	AO				1							
006	LT - 0400	WAES	WCP7 80K Cryopump Level Transmitter	AI			1					089	0	100	% Level
006	LV - 0400	WAES	WCP7 80K Cryopump Level Control Valve	-								082			
006	LY - 0400	WACS	WCP7 80K Cryopump Level Control Loop Output	AO				1							
006	XV - 0400	WAMS	WCP7 80K Cryopump Level Control Valve Solenoid	DO		1									
006	ZSC - 0400	WAES	WCP7 80K Cryopump Level Control Valve Closed	DI	1							026			
006	PI - 0401	WAES	WCP7 80K Cryopump Discharge Pressure Indication	-											
006	PT - 0401	WAES	WCP7 80K Cryopump Discharge Pressure Transmitter	AI			1					090	0	25	PSIG
006	TE - 0402	WAES	WCP7 80K Cryopump Discharge Thermocouple	T/C				1							
006	TI - 0402	WAES	WCP7 80K Cryopump Discharge Temperature Indication	-											
006	JC - 0403	WACS	WCP7 80K Cryopump Regen SCR Controller	AI			1								
006	TIC - 0403	WAES	WCP7 80K Cryopump Regen Loop Temperature Control	-											
006	TSH - 0403	WAES	WCP7 80K Cryopump Regen Loop HI Temperature	-											
006	TY - 0403	WAES	WCP7 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1							
006	TE - 0403A	WAES	WCP7 80K Cryopump Regen Loop Thermocouple	T/C-T				1				091	-320	700	Deg F
006	TE - 0403B	WAES	WCP7 80K Cryopump Regen Loop Thermocouple	T/C-K				1				056	32	2300	Deg F
006	TE - 0403C	WAES	WCP7 80K Cryopump Regen Loop Thermocouple	T/C-K				1				056	32	2300	Deg F
006	FE - 0404	WAES	WCP7 80K Cryopump Regen Loop Pilot Tube Flow Element	-								079	0	12,000	SCFH
006	FI - 0404	WAES	WCP7 80K Cryopump Regen Loop Flow Indicator	-								088	0	12,000	SCFH
006	LT - 0405	WAES	WCP7 LN2 Dewar Level Transmitter	AI			1					089	0	100	% Level
006	PI - 0405	WAES	WCP7 LN2 Dewar Pressure Indicator	-											
006	LI - 0405A	WAES	WCP7 LN2 Dewar Level Indicator	-											
006	LI - 0405B	WAES	WCP7 LN2 Dewar Level Indication	-											
006	RD - 0406	WAES	WCP7 LN2 Dewar Rupture Disc	-											
006	RV - 0406	WAES	WCP7 LN2 Dewar Relief Valve	-											
006	RD - 0407	WAES	WCP7 LN2 Dewar Rupture Disc	-											
006	RV - 0407	WAES	WCP7 LN2 Dewar Relief Valve	-											
006	RV - 0408	WAES	WCP7 LN2 Dewar Relief Valve	-											
010	EV - 0409	WAES	WCP7 80K Cryopump Outlet Isolation Valve	-					GNB Corp	112CM, Gate Valve, Electric, Tag WVG17	554817	005			
010	HS - 0409	WAES	WCP7 80K Cryopump Outlet Isolation Valve Open/Close Switch	DO		1						005			
005	II - 0409	WAES	WGV17 25 L/S Ion Pump Current Indication	AI			1					004			
010	SC - 0409	WAES	WCP7 80K Cryopump Outlet Isolation Valve Controller	-											
010	XA - 0409	WAES	WCP7 80K Cryopump Outlet Isolation Valve Common Alarm	DI	1										
005	XIC - 0409	WAES	WGV17 25 L/S Ion Pump Controller	-					Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
010	ZSC - 0409	WAES	WCP7 80K Cryopump Outlet Isolation Valve Closed	DI	1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG17	554817	005			
010	ZSO - 0409	WAES	WCP7 80K Cryopump Outlet Isolation Valve Open	DI	1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG17	554817	005			
002	PC - 0410	WACS	WBSC10 Pressure Control Valve Controller	-								081			
002	PCV - 0410	WACS	WBSC10 Pressure Control Valve	-								081			
002	PY - 0410	WACS	WBSC10 Pressure Control Loop Output	AO				1				007			
002	PE - 0410A	WACS	WBSC10 Pirani Gauge Tube	-											
002	PI - 0410A	WACS	WBSC10 Lo Vacuum Pressure Indication	-											
002	PT - 0410A	WACS	WBSC10 Pirani Gauge Transmitter	AI			1						1 x 10-3	1000	TORR
002	PE - 0410B	WACS	WBSC10 Ion Gauge Tube	-								007			
002	PI - 0410B	WACS	WBSC10 HI Vacuum Pressure Indication	-											
002	PT - 0410B	WACS	WBSC10 Ion Gauge Transmitter	AI			1						3 x 10-11	1 x 10-2	TORR
002	II - 0411	WACS	WBSC10 75 L/S Ion Pump Current Indication	AI			1					004			
002	XIC - 0411	WACS	WBSC10 75 L/S Ion Pump Controller	-					Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
010	EV - 0418	WAES	WCP7 80K Cryopump Inlet Isolation Valve	-					GNB Corp	112CM, Gate Valve, Electric, Tag WVG18	554817	005			
010	HS - 0418	WAES	WCP7 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO		1						005			
005	II - 0419	WAES	WGV18 25 L/S Ion Pump Current Indication	AI			1					004			
010	SC - 0419	WAES	WCP7 80K Cryopump Inlet Isolation Valve Controller	-											

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

V049-1-036, rev. 2

LIGO INSTRUMENT LIST

DWG	P&ID INFORMATION				I/O BREAKDOWN					EQUIPMENT INFORMATION		SPEC	SETTINGS (low-to-high or off-on)				
	Y049-0-	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER		MODEL No.	P. O. #	V049-2-	LOW / OFF	HIGH / ON
010	XA - 0419	WAES	WCP7 80K Cryopump Inlet Isolation Valve Common Alarm	DI	1												
005	XIC - 0419	WAES	WGV18 25 L/S Ion Pump Controller	-							Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
010	ZSC - 0419	WAES	WCP7 80K Cryopump Inlet Isolation Valve Closed	DI	1						GNB Corp	112CM, Gate Valve, Electric, Tag WVG18	554617	005			
010	ZSO - 0419	WAES	WCP7 80K Cryopump Inlet Isolation Valve Open	DI	1						GNB Corp	112CM, Gate Valve, Electric, Tag WVG18	554617	005			
010	HV - 0420	WAES	WCP7 80K Cryopump Pumpout Port Valve	-							Varian Vacu Products	10" SST Gate Valve	555029	006			
010	ZSC - 0420	WAES	WCP7 80K Cryopump Pumpout Port Valve Closed	DI	1						Varian Vacu Products	10" SST Gate Valve	555029	006			
010	ZSO - 0420	WAES	WCP7 80K Cryopump Pumpout Port Valve Open	DI	1						Varian Vacu Products	10" SST Gate Valve	555029	006			
010	HV - 0421	WAES	Left End Beam Tube 10" Pumpout Port Valve	-							Varian Vacu Products	10" SST Gate Valve	555029	006			
010	ZSC - 0421	WAES	Left End Beam Tube Pumpout Port Valve Closed	DI	1						Varian Vacu Products	10" SST Gate Valve	555029	006			
010	ZSO - 0421	WAES	Left End Beam Tube Pumpout Port Valve Open	DI	1						Varian Vacu Products	10" SST Gate Valve	555029	006			
010	XIC - 0422	WAES	WIP11 2500 L/S Ion Pump Controller	-							Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004			
010	EI - 0422A	WAES	WIP11-1 2500 L/S Ion Pump Voltage Indication	AI			1							004			
010	HS - 0422A	WAES	WIP11-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1								004			
010	II - 0422A	WAES	WIP11-1 2500 L/S Ion Pump Current Indication	AI			1							004			
010	XA - 0422A	WAES	WIP11-1 2500 L/S Ion Pump Fault Alarm	DI	1									004			
010	EI - 0422B	WAES	WIP11-2 2500 L/S Ion Pump Voltage Indication	AI			1							004			
010	HS - 0422B	WAES	WIP11-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1								004			
010	II - 0422B	WAES	WIP11-2 2500 L/S Ion Pump Current Indication	AI			1							004			
010	XA - 0422B	WAES	WIP11-2 2500 L/S Ion Pump Fault Alarm	DI	1									004			
010	HS - 0422C	WAES	WIP11-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1								004			
010	HS - 0422D	WAES	WIP11-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1								004			
010	PE - 0423A	WAES	WCP7 Pirani Gauge Tube	-										007			
010	PI - 0423A	WAES	WCP7 Low Vacuum Pressure Indication	-										007			
010	PT - 0423A	WAES	WCP7 Pirani Gauge Transmitter	AI			1							007	1 x 10-3	1000	TORR
010	PE - 0423B	WAES	WCP7 Ion Gauge Tube	-										007			
010	PI - 0423B	WAES	WCP7 Hi Vacuum Pressure Indication	-										007			
010	PT - 0423B	WAES	WCP7 Ion Gauge Transmitter	AI			1							007	3 x 10-11	1 x 10-2	TORR
010	PE - 0424A	WAES	Left End Beam Tube Pirani Gauge Tube	-										007			
010	PI - 0424A	WAES	Left End Beam Tube Lo Vacuum Pressure Indication	-										007			
010	PT - 0424A	WAES	Left End Beam Tube Pirani Gauge Transmitter	AI			1							007	1 x 10-3	1000	TORR
010	PE - 0424B	WAES	Left End Beam Tube Ion Gauge Tube	-										007			
010	PI - 0424B	WAES	Left End Beam Tube Hi Vacuum Pressure Indication	-										007			
010	PT - 0424B	WAES	Left End Beam Tube Ion Gauge Transmitter	AI			1							007	3 x 10-11	1 x 10-2	TORR
010	PSV - 0425	WAES	Class 100 Air Pressure Safety Valve	-													
010	PCV - 0426	WAES	Class 100 Air Seal Gas Pressure Control Valve	-													
010	PI - 0426	WAES	Class 100 Air Seal Gas Pressure Indicator	-													
010	PCV - 0427	WAES	Class 100 Air Pressure Control Valve	-													
010	PI - 0427	WAES	Class 100 Air Pressure Indicator	-													
006	RV - 0436	WACS	WCP7 LN2 Dewar Relief Valve	-													
006	RV - 0482	WAES	WCP7 LN2 Dewar Pressure Control Relief Valve	-													
006	PCV - 0463	WAES	WCP7 LN2 Dewar Vent Pressure Control Valve	-													
006	PI - 0472	WAES	WCP7 LN2 Dewar Pressure Control Indicator	-													
006	PCV - 0473	WAES	WCP7 LN2 Dewar Pressure Control Valve	-													
006	RV - 0482	WAES	WCP7 LN2 Dewar Pressure Control Relief Valve	-													
006	RV - 0483	WAES	WCP7 80K Cryopump Discharge Relief Valve	-													
006	LIC - 0500	WAES	WCP8 80K Cryopump Level Control Loop Output	AO				1									
006	LT - 0500	WAES	WCP8 80K Cryopump Level Transmitter	AI				1						089	0	100	% Level
006	LV - 0500	WAES	WCP8 80K Cryopump Level Control Valve	-										062			
006	LY - 0500	WACS	WCP8 80K Cryopump Level Control Loop Output	AO				1									
006	XV - 0500	WAMS	WCP8 80K Cryopump Level Control Valve Solenoid	DO			1										
006	ZSC - 0500	WAES	WCP8 80K Cryopump Level Control Valve Closed	DI	1									026			
006	PI - 0501	WAES	WCP8 80K Cryopump Discharge Pressure Indication	-													

V049-1-036, REV. 2

## LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
PREPARED BY: \_\_\_\_\_  
CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
006	PT - 0501	WAES	WCP8 80K Cryopump Discharge Pressure Transmitter	AI			1						090	0	25	PSIG
006	TE - 0502	WAES	WCP8 80K Cryopump Discharge Thermocouple	T/C					1							
006	TI - 0502	WAES	WCP8 80K Cryopump Discharge Temperature Indication	-												
006	JC - 0503	WACS	WCP8 80K Cryopump Regen SCR Controller	AI			1									
006	TIC - 0503	WAES	WCP8 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0503	WAES	WCP8 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0503	WAES	WCP8 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1								
006	TE - 0503A	WAES	WCP8 80K Cryopump Regen Loop Thermocouple	T/C-T					1				091	-320	700	Deg F
006	TE - 0503B	WAES	WCP8 80K Cryopump Regen Loop Thermocouple	T/C-K					1				056	32	2300	Deg F
006	TE - 0503C	WAES	WCP8 80K Cryopump Regen Loop Thermocouple	T/C-K					1				056	32	2300	Deg F
006	FE - 0504	WAES	WCP8 80K Cryopump Regen Loop Pilot Tube Flow Element	-									079	0	12,000	SCFH
006	FI - 0504	WAES	WCP8 80K Cryopump Regen Loop Flow Indicator	-									068	0	12,000	SCFH
006	LT - 0505	WAES	WCP8 LN2 Dewar Level Transmitter	AI			1						069	0	100	% Level
006	PI - 0505	WAES	WCP8 LN2 Dewar Pressure Indicator	-												
006	LI - 0505A	WAES	WCP8 LN2 Dewar Level Indicator	-												
006	LI - 0505B	WAES	WCP8 LN2 Dewar Level Indication	-												
006	RD - 0506	WAES	WCP8 LN2 Dewar Rupture Disc	-												
006	RV - 0506	WAES	WCP8 LN2 Dewar Relief Valve	-												
006	RD - 0507	WAES	WCP8 LN2 Dewar Rupture Disc	-												
006	RV - 0507	WAES	WCP8 LN2 Dewar Relief Valve	-												
006	RV - 0508	WAES	WCP8 LN2 Dewar Relief Valve	-												
017	EV - 0509	WAES	WCP8 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG19	554617	005			
017	HS - 0509	WAES	WCP8 80K Cryopump Outlet Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0509	WAES	WGV19 25 L/S Ion Pump Current Indication	AI			1						004			
017	SC - 0509	WAES	WCP8 80K Cryopump Outlet Isolation Valve Controller	-												
017	XA - 0509	WAES	WCP8 80K Cryopump Outlet Isolation Valve Common Alarm	DI		1										
005	XIC - 0509	WAES	WGV19 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
017	ZSC - 0509	WAES	WCP8 80K Cryopump Outlet Isolation Valve Closed	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG19	554617	005			
017	ZSO - 0509	WAES	WCP8 80K Cryopump Outlet Isolation Valve Open	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG19	554617	005			
002	PC - 0510	WACS	WBSC9 Pressure Control Valve Controller	-									061			
002	PCV - 0510	WACS	WBSC9 Pressure Control Valve	-									061			
002	PY - 0510	WACS	WBSC9 Pressure Control Loop Output	AO				1								
002	PE - 0510A	WACS	WBSC9 Pirani Gauge Tube	-									007			
002	PI - 0510A	WACS	WBSC9 Lo Vacuum Pressure Indication	-												
002	PT - 0510A	WACS	WBSC9 Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
002	PE - 0510B	WACS	WBSC9 Ion Gauge Tube	-									007			
002	PI - 0510B	WACS	WBSC9 HI Vacuum Pressure Indication	-												
002	PT - 0510B	WACS	WBSC9 Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
002	II - 0511	WACS	WBSC9 75 L/S Ion Pump Current Indication	AI			1						004			
002	XIC - 0511	WACS	WBSC9 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
017	EV - 0519	WAES	WCP8 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag WVG20	554617	005			
017	HS - 0519	WAES	WCP8 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0519	WAES	WGV20 25 L/S Ion Pump Current Indication	AI			1						004			
017	SC - 0519	WAES	WCP8 80K Cryopump Inlet Isolation Valve Controller	-												
017	XA - 0519	WAES	WCP8 80K Cryopump Inlet Isolation Valve Common Alarm	DI		1										
005	XIC - 0519	WAES	WGV20 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
017	ZSC - 0519	WAES	WCP8 80K Cryopump Inlet Isolation Valve Closed	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG20	554617	005			
017	ZSO - 0519	WAES	WCP8 80K Cryopump Inlet Isolation Valve Open	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag WVG20	554617	005			
017	HV - 0520	WAES	WCP8 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
017	ZSC - 0520	WAES	WCP8 80K Cryopump Pumpout Port Valve Closed	DI		1				Varian Vacu Products	10" SST Gate Valve	555029	006			
017	ZSO - 0520	WAES	WCP8 80K Cryopump Pumpout Port Valve Open	DI		1				Varian Vacu Products	10" SST Gate Valve	555029	006			
017	HV - 0521	WAES	Right End Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			

V049-1-036, rev. 2

## LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
PREPARED BY: \_\_\_\_\_  
CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION		SPEC V049-2-	SETTINGS (low-to-high or off-on)				
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER		MODEL No.	P. O. #	LOW / OFF	HIGH / ON	UNITS
017	ZSC - 0521	WAES	Right End Beam Tube Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
017	ZSO - 0521	WAES	Right End Beam Tube Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
017	XIC - 0522	WAES	WIP12 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004			
017	EI - 0522A	WAES	WIP12-1 2500 L/S Ion Pump Voltage Indication	AI			1						004			
017	HS - 0522A	WAES	WIP12-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
017	II - 0522A	WAES	WIP12-1 2500 L/S Ion Pump Current Indication	AI			1						004			
017	XA - 0522A	WAES	WIP12-1 2500 L/S Ion Pump Fault Alarm	DI	1								004			
017	EI - 0522B	WAES	WIP12-2 2500 L/S Ion Pump Voltage Indication	AI			1						004			
017	HS - 0522B	WAES	WIP12-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
017	II - 0522B	WAES	WIP12-2 2500 L/S Ion Pump Current Indication	AI			1						004			
017	XA - 0522B	WAES	WIP12-2 2500 L/S Ion Pump Fault Alarm	DI	1								004			
017	HS - 0522C	WAES	WIP12-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
017	HS - 0522D	WAES	WIP12-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
017	PE - 0523A	WAES	Right End Beam Tube Pirani Gauge Tube	-									007			
017	PI - 0523A	WAES	Right End Beam Tube Lo Vacuum Pressure Indication	-									007			
017	PT - 0523A	WAES	Right End Beam Tube Pirani Gauge Transmitter	AI			1						007	1 x 10-3	1000	TORR
017	PE - 0523B	WAES	Right End Beam Tube Ion Gauge Tube	-									007			
017	PI - 0523B	WAES	Right End Beam Tube HI Vacuum Pressure Indication	-									007			
017	PT - 0523B	WAES	Right End Beam Tube Ion Gauge Transmitter	AI			1						007	3 x 10-11	1 x 10-2	TORR
017	PE - 0524A	WAES	WCP8 Pirani Gauge Tube	-									007			
017	PI - 0524A	WAES	WCP8 Lo Vacuum Pressure Indication	-									007			
017	PT - 0524A	WAES	WCP8 Pirani Gauge Transmitter	AI			1						007	1 x 10-3	1000	TORR
017	PE - 0524B	WAES	WCP8 Ion Gauge Tube	-									007			
017	PI - 0524B	WAES	WCP8 HI Vacuum Pressure Indication	-									007			
017	PT - 0524B	WAES	WCP8 Ion Gauge Transmitter	AI			1						007	3 x 10-11	1 x 10-2	TORR
017	PSV - 0525	WAES	Class 100 Air Pressure Safety Valve	-									007			
017	PCV - 0526	WAES	Class 100 Air Seal Gas Pressure Control Valve	-									007			
017	PI - 0526	WAES	Class 100 Air Seal Gas Pressure Indicator	-									007			
017	PCV - 0527	WAES	Class 100 Air Pressure Control Valve	-									007			
017	PI - 0527	WAES	Class 100 Air Pressure Indicator	-									007			
006	RV - 0536	WACS	WCP8 LN2 Dewar Relief Valve	-									006			
006	RV - 0562	WAES	WCP8 LN2 Dewar Pressure Control Relief Valve	-									006			
006	PCV - 0563	WAES	WCP8 LN2 Dewar Vent Pressure Control Valve	-									006			
006	PI - 0572	WAES	WCP8 LN2 Dewar Pressure Control Indicator	-									006			
006	PCV - 0573	WAES	WCP8 LN2 Dewar Pressure Control Valve	-									006			
006	RV - 0582	WAES	WCP8 LN2 Dewar Pressure Control Relief Valve	-									006			
006	RV - 0583	WAES	WCP8 80K Cryopump Discharge Relief Valve	-									006			
006	LIC - 0600	LACS	LCP1 80K Cryopump Level Control Loop Output	AO				1					006			
006	LT - 0600	LACS	LCP1 80K Cryopump Level Transmitter	AI			1						006	0	100	% Level
006	LV - 0600	LACS	LCP1 80K Cryopump Level Control Valve	-									006			
006	LY - 0600	LACS	LCP1 80K Cryopump Level Control Loop Output	AO				1					006			
006	XV - 0600	LACS	LCP1 80K Cryopump Level Control Valve Solenoid	DO		1							006			
006	ZSC - 0600	LACS	LCP1 80K Cryopump Level Control Valve Closed	DI	1								006			
006	PI - 0601	LACS	LCP1 80K Cryopump Discharge Pressure Indication	-									006			
006	PT - 0601	LACS	LCP1 80K Cryopump Discharge Pressure Transmitter	AI			1						006	0	25	PSIG
006	TE - 0602	LACS	LCP1 80K Cryopump Discharge Thermocouple	T/C				1					006			
006	TI - 0602	LACS	LCP1 80K Cryopump Discharge Temperature Indication	-									006			
006	JC - 0603	LACS	LCP1 80K Cryopump Regen SCR Controller	AI			1						006			
006	TIC - 0603	LACS	LCP1 80K Cryopump Regen Loop Temperature Control	-									006			
006	TSH - 0603	LACS	LCP1 80K Cryopump Regen Loop HI Temperature	-									006			
006	TY - 0603	LACS	LCP1 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1					006			
006	TE - 0603A	LACS	LCP1 80K Cryopump Regen Loop Thermocouple	T/C-T				1					006	-320	700	Deg F



V049-1-036, rev. 2

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION		SPEC V049-2-	SETTINGS (low-to-high or off-on)				
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER		MODEL No.	P. O. #	LOW / OFF	HIGH / ON	UNITS
006	TE - 0603B	LACS	LCP1 80K Cryopump Regen Loop Thermocouple	T/C-K					1				058	32	2300	Deg F
006	TE - 0603C	LACS	LCP1 80K Cryopump Regen Loop Thermocouple	T/C-K					1				058	32	2300	Deg F
006	FE - 0604	LACS	LCP1 80K Cryopump Regen Loop Pitot Tube Flow Element	-									079	0	12,000	SCFH
006	FI - 0604	LACS	LCP1 80K Cryopump Regen Loop Flow Indicator	-									088	0	12,000	SCFH
006	LT - 0605	LACS	LCP1 LN2 Dewar Level Transmitter	AI					1				089	0	100	% Level
006	PI - 0605	LACS	LCP1 LN2 Dewar Pressure Indicator	-												
006	LI - 0605A	LACS	LCP1 LN2 Dewar Level Indicator	-												
006	LI - 0605B	LACS	LCP1 LN2 Dewar Level Indicator	-												
006	RD - 0606	LACS	LCP1 LN2 Dewar Rupture Disc	-												
006	RV - 0606	LACS	LCP1 LN2 Dewar Relief Valve	-												
006	RD - 0607	LACS	LCP1 LN2 Dewar Rupture Disc	-												
006	RV - 0607	LACS	LCP1 LN2 Dewar Relief Valve	-												
006	RV - 0608	LACS	LCP1 LN2 Dewar Relief Valve	-												
023	HV - 0609	LACS	Vertex Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	008			
023	ZSC - 0609	LACS	Vertex Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	008			
023	ZSO - 0609	LACS	Vertex Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	008			
003	II - 0611	LACS	LBSC1 75 L/S Ion Pump Current Indication	AI					1							004
003	XIC - 0611	LACS	LBSC1 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0612	LACS	LCP1 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0613	LACS	LCP1 LN2 Dewar Vent Pressure Control Valve	-												
022	PE - 0614A	LACS	LCP1 Pirani Gauge Tube	-									007			
022	PI - 0614A	LACS	LCP1 Lo Vacuum Pressure Indication	-												
022	PT - 0614A	LACS	LCP1 Pirani Gauge Transmitter	AI					1					1 x 10-3	1000	TORR
022	PE - 0614B	LACS	LCP1 Ion Gauge Tube	-									007			
022	PI - 0614B	LACS	LCP1 HI Vacuum Pressure Indication	-												
022	PT - 0614B	LACS	LCP1 Ion Gauge Transmitter	AI					1					3 x 10-11	1 x 10-2	TORR
004	II - 0615	LACS	LHAM1 75 L/S Ion Pump Current Indication	AI					1							004
004	XIC - 0615	LACS	LHAM1 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0617	LACS	LHAM2 75 L/S Ion Pump Current Indication	AI					1							004
004	XIC - 0617	LACS	LHAM2 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
023	EV - 0619	LACS	Vertex Section Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag LVG1	554617	005			
023	HS - 0619	LACS	Vertex Section Isolation Valve Oper/Close Switch	DO					1							005
005	II - 0619	LACS	LGV1 25 L/S Ion Pump Current Indication	AI					1							004
023	SC - 0619	LACS	Vertex Section Isolation Valve Controller	-												
023	XA - 0619	LACS	Vertex Section Isolation Valve Common Alarm	DI	1											
005	XIC - 0619	LACS	LGV1 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
023	ZSC - 0619	LACS	Vertex Section Isolation Valve Closed	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG1	554617	005			
023	ZSO - 0619	LACS	Vertex Section Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG1	554617	005			
002	PC - 0620	LACS	LBSC2 Pressure Control Valve Controller	-												061
002	PCV - 0620	LACS	LBSC2 Pressure Control Valve	-												061
002	PY - 0620	LACS	LBSC2 Pressure Control Loop Output	AO					1							
002	PE - 0620A	LACS	LBSC2 Pirani Gauge Tube	-									007			
002	PI - 0620A	LACS	LBSC2 Lo Vacuum Pressure Indication	-												
002	PT - 0620A	LACS	LBSC2 Pirani Gauge Transmitter	AI					1					1 x 10-3	1000	TORR
002	PE - 0620B	LACS	LBSC2 Ion Gauge Tube	-									007			
002	PI - 0620B	LACS	LBSC2 HI Vacuum Pressure Indication	-												
002	PT - 0620B	LACS	LBSC2 Ion Gauge Transmitter	AI					1					3 x 10-11	1 x 10-2	TORR
002	II - 0621	LACS	LBSC2 75 L/S Ion Pump Current Indication	AI					1							004
002	XIC - 0621	LACS	LBSC2 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	PI - 0622	LACS	LCP1 LN2 Dewar Pressure Control Indicator	-												
006	PCV - 0623	LACS	LCP1 LN2 Dewar Pressure Control Valve	-												
022	PE - 0624A	LACS	Left Manifold Beam Tube Pirani Gauge Tube	-									007			

V049-1-036, REV. 2

## LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
PREPARED BY: \_\_\_\_\_  
CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
022	PI - 0624A	LACS	Left Manifold Beam Tube Lo Vacuum Pressure Indication	-												
022	PT - 0624A	LACS	Left Manifold Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
022	PE - 0624B	LACS	Left Manifold Beam Tube Ion Gauge Tube	-								007				
022	PI - 0624B	LACS	Left Manifold Beam Tube HI Vacuum Pressure Indication	-												
022	PT - 0624B	LACS	Left Manifold Beam Tube Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
004	II - 0625	LACS	LHAM3 75 L/S Ion Pump Current Indication	AI			1						004			
004	XIC - 0625	LACS	LHAM3 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
004	II - 0627	LACS	LHAM4 75 L/S Ion Pump Current Indication	AI			1						004			
004	XIC - 0627	LACS	LHAM4 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
023	EV - 0629	LACS	Vertex Section Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag LVG2	554617	005			
023	HS - 0629	LACS	Vertex Section Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0629	LACS	LGV2 25 L/S Ion Pump Current Indication	AI			1						004			
023	SC - 0629	LACS	Vertex Section Isolation Valve Controller	-												
023	XA - 0629	LACS	Vertex Section Isolation Valve Common Alarm	DI	1											
005	XIC - 0629	LACS	LGV2 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
023	ZSC - 0629	LACS	Vertex Section Isolation Valve Closed	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG2	554617	005			
023	ZSO - 0629	LACS	Vertex Section Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG2	554617	005			
003	II - 0631	LACS	LBSC3 75 L/S Ion Pump Current Indication	AI			1						004			
003	XIC - 0631	LACS	LBSC3 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0632	LACS	LCP1 LN2 Dewar Pressure Control Relief Valve	-												
006	RV - 0633	LACS	LCP1 80K Cryopump Discharge Relief Valve	-												
024	PE - 0634A	LACS	LCP2 Pirani Gauge Tube	-								007				
024	PI - 0634A	LACS	LCP2 Lo Vacuum Pressure Indication	-												
024	PT - 0634A	LACS	LCP2 Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
024	PE - 0634B	LACS	LCP2 Ion Gauge Tube	-								007				
024	PI - 0634B	LACS	LCP2 HI Vacuum Pressure Indication	-												
024	PT - 0634B	LACS	LCP2 Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
004	II - 0635	LACS	LHAM5 75 L/S Ion Pump Current Indication	AI			1						004			
004	XIC - 0635	LACS	LHAM5 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0636	WACS	LCP1 LN2 Dewar Relief Valve	-												
004	II - 0637	LACS	LHAM6 75 L/S Ion Pump Current Indication	AI			1						004			
004	XIC - 0637	LACS	LHAM6 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
006	RV - 0642	LACS	LCP2 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0643	LACS	LCP2 LN2 Dewar Vent Pressure Control Valve	-												
024	PE - 0644A	LACS	Right Manifold Beam Tube Pirani Gauge Tube	-								007				
024	PI - 0644A	LACS	Right Manifold Beam Tube Lo Vacuum Pressure Indication	-												
024	PT - 0644A	LACS	Right Manifold Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
024	PE - 0644B	LACS	Right Manifold Beam Tube Ion Gauge Tube	-								007				
024	PI - 0644B	LACS	Right Manifold Beam Tube HI Vacuum Pressure Indication	-												
024	PT - 0644B	LACS	Right Manifold Beam Tube Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
023	HV - 0645	LACS	Vertex Beam Tube 6" Pumpout Port Valve	-						Varian Vacu Products	6" SST Gate Valve	555029	006			
023	ZSC - 0645	LACS	Vertex Beam Tube 6" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
023	ZSO - 0645	LACS	Vertex Beam Tube 6" Pumpout Port Valve Open	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
022	HV - 0646	LACS	Left Manifold Beam Tube 6" Pumpout Port Valve	-						Varian Vacu Products	6" SST Gate Valve	555029	006			
022	ZSC - 0646	LACS	Left Manifold Beam Tube 6" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
022	ZSO - 0646	LACS	Left Manifold Beam Tube 6" Pumpout Port Valve Open	DI	1					Varian Vacu Products	6" SST Gate Valve	555029	006			
022	HV - 0647	LACS	Left Manifold Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
022	ZSC - 0647	LACS	Left Manifold Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
022	ZSO - 0647	LACS	Left Manifold Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
022	HV - 0648	LACS	LCP1 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
022	ZSC - 0648	LACS	LCP1 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			
022	ZSO - 0648	LACS	LCP1 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029	006			

V049-1036, rev. 2

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	PI&D INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.	P. O. #	LOW / OFF	HIGH / ON	UNITS
006	LIC - 0650	LACS	LCP2 80K Cryopump Level Control Loop Output	AO				1							
006	LT - 0650	LACS	LCP2 80K Cryopump Level Transmitter	AI			1					069	0	100	% Level
006	LV - 0650	LACS	LCP2 80K Cryopump Level Control Valve	-								062			
006	LY - 0650	LACS	LCP2 80K Cryopump Level Control Loop Output	AO				1							
006	XV - 0650	LACS	LCP2 80K Cryopump Level Control Valve Solenoid	DO		1									
006	ZSC - 0650	LACS	LCP2 80K Cryopump Level Control Valve Closed	DI	1							026			
006	PI - 0651	LACS	LCP2 80K Cryopump Discharge Pressure Indication	-											
006	PT - 0651	LACS	LCP2 80K Cryopump Discharge Pressure Transmitter	AI			1					090	0	25	PSIG
006	TE - 0652	LACS	LCP2 80K Cryopump Discharge Thermocouple	T/C					1						
006	TI - 0652	LACS	LCP2 80K Cryopump Discharge Temperature Indication	-											
006	JC - 0653	LACS	LCP2 80K Cryopump Regen SCR Controller	AI			1								
006	TIC - 0653	LACS	LCP2 80K Cryopump Regen Loop Temperature Control	-											
006	TSH - 0653	LACS	LCP2 80K Cryopump Regen Loop HI Temperature	-											
006	TY - 0653	LACS	LCP2 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1							
006	TE - 0653A	LACS	LCP2 80K Cryopump Regen Loop Thermocouple	T/C-T					1			091	-320	700	Deg F
006	TE - 0653B	LACS	LCP2 80K Cryopump Regen Loop Thermocouple	T/C-K					1			056	32	2300	Deg F
006	TE - 0653C	LACS	LCP2 80K Cryopump Regen Loop Thermocouple	T/C-K					1			056	32	2300	Deg F
006	FE - 0654	LACS	LCP2 80K Cryopump Regen Loop Pitot Tube Flow Element	-								079	0	12,000	SCFH
006	FI - 0654	LACS	LCP2 80K Cryopump Regen Loop Flow Indicator	-								088	0	12,000	SCFH
006	LT - 0655	LACS	LCP2 LN2 Dewar Level Transmitter	AI			1					089	0	100	% Level
006	PI - 0655	LACS	LCP2 LN2 Dewar Pressure Indicator	-											
006	LI - 0655A	LACS	LCP2 LN2 Dewar Level Indicator	-											
006	LI - 0655B	LACS	LCP2 LN2 Dewar Level Indication	-											
006	RD - 0656	LACS	LCP2 LN2 Dewar Rupture Disc	-											
006	RV - 0656	LACS	LCP2 LN2 Dewar Relief Valve	-											
006	RD - 0657	LACS	LCP2 LN2 Dewar Rupture Disc	-											
006	RV - 0657	LACS	LCP2 LN2 Dewar Relief Valve	-											
006	RV - 0658	LACS	LCP2 LN2 Dewar Relief Valve	-											
022	HS - 0659	LACS	LCP1 80K Cryopump Outlet Isolation Valve Oper/Close Switch	DO		1							005		
005	II - 0659	LACS	LGV3 25 L/S Ion Pump Current Indication	AI			1						004		
005	XIC - 0659	LACS	LGV3 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004		
022	XV - 0659	LACS	LCP1 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG3	554617	005		
022	XY - 0659	LACS	LCP1 80K Cryopump Outlet Isolation Valve Solenoid	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG3	554617	005		
022	ZSC - 0659	LACS	LCP1 80K Cryopump Outlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG3	554617	005		
022	ZSO - 0659	LACS	LCP1 80K Cryopump Outlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG3	554617	005		
023	XIC - 0661	LACS	LIP1 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004		
023	EI - 0661A	LACS	LIP1-1 2500 L/S Ion Pump Voltage Indication	AI			1						004		
023	HS - 0661A	LACS	LIP1-1 2800 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004		
023	II - 0661A	LACS	LIP1-1 2500 L/S Ion Pump Current Indication	AI			1						004		
023	XA - 0661A	LACS	LIP1-1 2500 L/S Ion Pump Fault Alarm	DI	1								004		
023	EI - 0661B	LACS	LIP1-2 2500 L/S Ion Pump Voltage Indication	AI			1						004		
023	HS - 0661B	LACS	LIP1-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004		
023	II - 0661B	LACS	LIP1-2 2500 L/S Ion Pump Current Indication	AI			1						004		
023	XA - 0661B	LACS	LIP1-2 2500 L/S Ion Pump Fault Alarm	DI	1								004		
023	HS - 0661C	LACS	LIP1-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004		
023	HS - 0661D	LACS	LIP1-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004		
023	XIC - 0662	LACS	LIP2 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004		
023	EI - 0662A	LACS	LIP2-1 2500 L/S Ion Pump Voltage Indication	AI			1						004		
023	HS - 0662A	LACS	LIP2-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004		
023	II - 0662A	LACS	LIP2-1 2500 L/S Ion Pump Current Indication	AI			1						004		
023	XA - 0662A	LACS	LIP2-1 2500 L/S Ion Pump Fault Alarm	DI	1								004		
023	EI - 0662B	LACS	LIP2-2 2500 L/S Ion Pump Voltage Indication	AI			1						004		

V049-1-036, REV. 2

LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
023	HS - 0662B	LACS	LIP2-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1									004	
023	II - 0662B	LACS	LIP2-2 2500 L/S Ion Pump Current Indication	AI			1								004	
023	XA - 0662B	LACS	LIP2-2 2500 L/S Ion Pump Fault Alarm	DI	1											
023	HS - 0662C	LACS	LIP2-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1									004	
023	HS - 0662D	LACS	LIP2-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1									004	
023	XIC - 0663	LACS	LIP3 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936			004	
023	EI - 0663A	LACS	LIP3-1 2500 L/S Ion Pump Voltage Indication	AI			1								004	
023	HS - 0663A	LACS	LIP3-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1									004	
023	II - 0663A	LACS	LIP3-1 2500 L/S Ion Pump Current Indication	AI			1								004	
023	XA - 0663A	LACS	LIP3-1 2500 L/S Ion Pump Fault Alarm	DI	1											
023	EI - 0663B	LACS	LIP3-2 2500 L/S Ion Pump Voltage Indication	AI			1								004	
023	HS - 0663B	LACS	LIP3-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1									004	
023	II - 0663B	LACS	LIP3-2 2500 L/S Ion Pump Current Indication	AI			1								004	
023	XA - 0663B	LACS	LIP3-2 2500 L/S Ion Pump Fault Alarm	DI	1											
023	HS - 0663C	LACS	LIP3-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1									004	
023	HS - 0663D	LACS	LIP3-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1									004	
023	XIC - 0664	LACS	LIP4 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936			004	
023	EI - 0664A	LACS	LIP4-1 2500 L/S Ion Pump Voltage Indication	AI			1								004	
023	HS - 0664A	LACS	LIP4-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1									004	
023	II - 0664A	LACS	LIP4-1 2500 L/S Ion Pump Current Indication	AI			1								004	
023	XA - 0664A	LACS	LIP4-1 2500 L/S Ion Pump Fault Alarm	DI	1											
023	EI - 0664B	LACS	LIP4-2 2500 L/S Ion Pump Voltage Indication	AI			1								004	
023	HS - 0664B	LACS	LIP4-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1									004	
023	II - 0664B	LACS	LIP4-2 2500 L/S Ion Pump Current Indication	AI			1								004	
023	XA - 0664B	LACS	LIP4-2 2500 L/S Ion Pump Fault Alarm	DI	1											
023	HS - 0664C	LACS	LIP4-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1									004	
023	HS - 0664D	LACS	LIP4-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1									004	
022	HS - 0669	LACS	LCP1 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO		1									005	
005	II - 0669	LACS	LGV4 25 L/S Ion Pump Current Indication	AI			1								004	
005	XIC - 0669	LACS	LGV4 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936			004	
022	XV - 0669	LACS	LCP1 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG4	554617			005	
022	XY - 0669	LACS	LCP1 80K Cryopump Inlet Isolation Valve Solenoid	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG4	554617			005	
022	ZSC - 0669	LACS	LCP1 80K Cryopump Inlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG4	554617			005	
022	ZSO - 0669	LACS	LCP1 80K Cryopump Inlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG4	554617			005	
024	PE - 0670A	LACS	Right Manifold Beam Tube Pirani Gauge Tube	-											007	
024	PI - 0670A	LACS	Right Manifold Beam Tube Lo Vacuum Pressure Indication	-												
024	PT - 0670A	LACS	Right Manifold Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
024	PE - 0670B	LACS	Right Manifold Beam Tube Ion Gauge Tube	-												
024	PI - 0670B	LACS	Right Manifold Beam Tube HI Vacuum Pressure Indication	-												
024	PT - 0670B	LACS	Right Manifold Beam Tube Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
006	PI - 0672	LACS	LCP2 LN2 Dewar Pressure Control Indicator	-												
006	PCV - 0673	LACS	LCP2 LN2 Dewar Pressure Control Valve	-												
026	PSV - 0675	LAES	Class 100 Air Pressure Safety Valve	-												
024	HV - 0676	LACS	Right Manifold Beam Tube 6" Pumpout Port Valve	-						Varian Vacu Products	6" SST Gate Valve	555029			006	
024	ZSC - 0676	LACS	Right Manifold Beam Tube 6" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	6" SST Gate Valve	555029			006	
024	ZSO - 0676	LACS	Right Manifold Beam Tube 6" Pumpout Port Valve Open	DI	1					Varian Vacu Products	6" SST Gate Valve	555029			006	
024	HV - 0677	LACS	Right Manifold Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029			006	
024	ZSC - 0677	LACS	Right Manifold Beam Tube 10" Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029			006	
024	ZSO - 0677	LACS	Right Manifold Beam Tube 10" Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029			006	
024	HV - 0678	LACS	LCP2 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029			006	
024	ZSC - 0678	LACS	LCP2 80K Cryopump Pumpout Port Valve Closed	DI	1					Varian Vacu Products	10" SST Gate Valve	555029			006	
024	ZSO - 0678	LACS	LCP2 80K Cryopump Pumpout Port Valve Open	DI	1					Varian Vacu Products	10" SST Gate Valve	555029			006	

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

LIGO INSTRUMENT LIST

V049-1-036, rev. 2

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
024	HS - 0679	LACS	LCP2 80K Cryopump Outlet Isolation Valve Open/Close Switch	DO	1							005				
005	II - 0679	LACS	LGV5 25 L/S Ion Pump Current Indication	AI		1						004				
005	XIC - 0679	LACS	LGV5 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
024	XV - 0679	LACS	LCP2 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG5	554617	005			
024	XY - 0679	LACS	LCP2 80K Cryopump Outlet Isolation Valve Solenoid	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG5	554617	005			
024	ZSC - 0679	LACS	LCP2 80K Cryopump Outlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG5	554617	005			
024	ZSO - 0679	LACS	LCP2 80K Cryopump Outlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG5	554617	005			
022	PE - 0680A	LACS	Left Manifold Beam Tube Pirani Gauge Tube	-									007			
022	PI - 0680A	LACS	Left Manifold Beam Tube Lo Vacuum Pressure Indication	-												
022	PT - 0680A	LACS	Left Manifold Beam Tube Pirani Gauge Transmitter	AI		1								1 x 10-3	1000	TORR
022	PE - 0680B	LACS	Left Manifold Beam Tube Ion Gauge Tube	-									007			
022	PI - 0680B	LACS	Left Manifold Beam Tube HI Vacuum Pressure Indication	-												
022	PT - 0680B	LACS	Left Manifold Beam Tube Ion Gauge Transmitter	AI		1								3 x 10-11	1 x 10-2	TORR
006	RV - 0682	LACS	LCP2 LN2 Dewar Pressure Control Relief Valve	-												
006	RV - 0683	LACS	LCP2 80K Cryopump Discharge Relief Valve	-												
026	PCV - 0684	LAES	Class 100 Air Seal Gas Pressure Control Valve	-												
026	PI - 0684	LAES	Class 100 Air Seal Gas Pressure Indicator	-												
022	II - 0686	LACS	75 L/S Ion Pump Current Indication Left Beam Manifold	AI		1							004			
022	XIC - 0686	LACS	75 L/S Ion Pump Controller Left Beam Manifold	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
024	II - 0688	LACS	75 L/S Ion Pump Current Indication Right Beam Manifold	AI		1							004			
024	XIC - 0688	LACS	75 L/S Ion Pump Controller Right Beam Manifold	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
024	HS - 0689	LACS	LCP2 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO	1								005			
005	II - 0689	LACS	LGV6 25 L/S Ion Pump Current Indication	AI		1							004			
005	XIC - 0689	LACS	LGV6 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
024	XV - 0689	LACS	LCP2 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG6	554617	005			
024	XY - 0689	LACS	LCP2 80K Cryopump Inlet Isolation Valve Solenoid	-						GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG6	554617	005			
024	ZSC - 0689	LACS	LCP2 80K Cryopump Inlet Isolation Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG6	554617	005			
024	ZSO - 0689	LACS	LCP2 80K Cryopump Inlet Isolation Valve Open	DI	1					GNB Corp	112CM, Gate Valve, Pneumatic, Tag LVG6	554617	005			
006	RV - 0690	WACS	LCP2 LN2 Dewar Relief Valve	-												
026	PCV - 0690	LAES	Class 100 Air Pressure Control Valve	-												
026	PI - 0690	LAES	Class 100 Air Pressure Indicator	-												
006	LIC - 0700	LAES	LCP3 80K Cryopump Level Control Loop Output	AO				1								
006	LT - 0700	LAES	LCP3 80K Cryopump Level Control Transmitter	AI		1							069	0	100	% Level
006	LV - 0700	LAES	LCP3 80K Cryopump Level Control Valve	-									062			
006	LY - 0700	LACS	LCP3 80K Cryopump Level Control Loop Output	AO				1								
006	XV - 0700	LAES	LCP3 80K Cryopump Level Control Valve Solenoid	DO		1										
006	ZSC - 0700	LAES	LCP3 80K Cryopump Level Control Valve Closed	DI	1								026			
006	PI - 0701	LAES	LCP3 80K Cryopump Discharge Pressure Indication	-												
006	PT - 0701	LAES	LCP3 80K Cryopump Discharge Pressure Transmitter	AI		1							090	0	25	PSIG
006	TE - 0702	LAES	LCP3 80K Cryopump Discharge Thermocouple	T/C				1								
006	TI - 0702	LAES	LCP3 80K Cryopump Discharge Temperature Indication	-												
006	JC - 0703	LACS	LCP3 80K Cryopump Regen SCR Controller	AI		1										
006	TIC - 0703	LAES	LCP3 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0703	LAES	LCP3 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0703	LAES	LCP3 80K Cryopump Regen Loop Temperature Control Loop Output	AO				1								
006	TE - 0703A	LAES	LCP3 80K Cryopump Regen Loop Thermocouple	T/C-T				1					091	-320	700	Deg F
006	TE - 0703B	LAES	LCP3 80K Cryopump Regen Loop Thermocouple	T/C-K				1					056	32	2300	Deg F
006	TE - 0703C	LAES	LCP3 80K Cryopump Regen Loop Thermocouple	T/C-K				1					056	32	2300	Deg F
006	FE - 0704	LAES	LCP3 80K Cryopump Regen Loop Pilot Tube Flow Element	-									079	0	12,000	SCFH
006	FI - 0704	LAES	LCP3 80K Cryopump Regen Loop Flow Indicator	-									068	0	12,000	SCFH
006	LT - 0705	LAES	LCP3 LN2 Dewar Level Transmitter	-									069	0	100	% Level
006	PI - 0705	LAES	LCP3 LN2 Dewar Pressure Indicator	-												

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

V049-1-036, REV. 2

LIGO INSTRUMENT LIST

DWG	PI&D INFORMATION				I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC	SETTINGS (low to high at off-on)			
	V049-0-	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	TC	MANUFACTURER	MODEL No.		P. O. #	V049-2-	LOW / OFF	HIGH / ON
006	LI - 0705A	LAES	LCP3 LN2 Dewar Level Indicator	-													
006	LI - 0705B	LAES	LCP3 LN2 Dewar Level Indication	-													
006	RD - 0706	LAES	LCP3 LN2 Dewar Rupture Disc	-													
006	RV - 0706	LAES	LCP3 LN2 Dewar Relief Valve	-													
006	RD - 0707	LAES	LCP3 LN2 Dewar Rupture Disc	-													
006	RV - 0707	LAES	LCP3 LN2 Dewar Relief Valve	-													
006	RV - 0708	LAES	LCP3 LN2 Dewar Relief Valve	-													
020	EV - 0709	LAES	LCP3 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag LVG9	554617	005				
020	HS - 0709	LAES	LCP3 80K Cryopump Outlet Isolation Valve Open/Close Switch	DO		1							005				
005	II - 0709	LAES	LGV9 25 L/S Ion Pump Current Indication	AI			1						004				
020	SC - 0709	LAES	LCP3 80K Cryopump Outlet Isolation Valve Controller	-													
020	XA - 0709	LAES	LCP3 80K Cryopump Outlet Isolation Valve Common Alarm	DI		1											
005	XIC - 0709	LAES	LGV9 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
020	ZSC - 0709	LAES	LCP3 80K Cryopump Outlet Isolation Valve Closed	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag LVG9	554617	005				
020	ZSO - 0709	LAES	LCP3 80K Cryopump Outlet Isolation Valve Open	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag LVG9	554617	005				
002	PC - 0710	LAES	LBSC5 Pressure Control Valve Controller	-									061				
002	PCV - 0710	LAES	LBSC5 Pressure Control Valve	-									061				
002	PV - 0710	LAES	LBSC5 Pressure Control Loop Output	AO				1									
002	PE - 0710A	LAES	LBSC5 Pirani Gauge Tube	-									007				
002	PI - 0710A	LAES	LBSC5 Lo Vacuum Pressure Indication	-													
002	PT - 0710A	LAES	LBSC5 Pirani Gauge Transmitter	AI			1								1 x 10-3	1000	TORR
002	PE - 0710B	LAES	LBSC5 Ion Gauge Tube	-									007				
002	PI - 0710B	LAES	LBSC5 Hi Vacuum Pressure Indication	-													
002	PT - 0710B	LAES	LBSC5 Ion Gauge Transmitter	AI			1								3 x 10-11	1 x 10-2	TORR
002	II - 0711	LAES	LBSC5 75 L/S Ion Pump Current Indication	AI			1						004				
002	XIC - 0711	LAES	LBSC5 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004				
020	EV - 0719	LAES	LCP3 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag LVG10	554617	005				
020	HS - 0719	LAES	LCP3 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO		1							005				
005	II - 0719	LAES	LGV10 25 L/S Ion Pump Current Indication	AI			1						004				
020	SC - 0719	LAES	LCP3 80K Cryopump Inlet Isolation Valve Controller	-													
020	XA - 0719	LAES	LCP3 80K Cryopump Inlet Isolation Valve Common Alarm	DI		1											
005	XIC - 0719	LAES	LGV10 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
020	ZSC - 0719	LAES	LCP3 80K Cryopump Inlet Isolation Valve Closed	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag LVG10	554617	005				
020	ZSO - 0719	LAES	LCP3 80K Cryopump Inlet Isolation Valve Open	DI		1				GNB Corp	112CM, Gate Valve, Electric, Tag LVG10	554617	005				
020	HV - 0720	LAES	LCP3 80K Cryopump Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
020	ZSC - 0720	LAES	LCP3 80K Cryopump Pumpout Port Valve Closed	DI		1				Varian Vacu Products	10" SST Gate Valve	555029	006				
020	ZSO - 0720	LAES	LCP3 80K Cryopump Pumpout Port Valve Open	DI		1				Varian Vacu Products	10" SST Gate Valve	555029	006				
020	HV - 0721	LAES	Left End Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006				
020	ZSC - 0721	LAES	Left End Beam Tube Pumpout Port Valve Closed	DI		1				Varian Vacu Products	10" SST Gate Valve	555029	006				
020	ZSO - 0721	LAES	Left End Beam Tube Pumpout Port Valve Open	DI		1				Varian Vacu Products	10" SST Gate Valve	555029	006				
020	XIC - 0722	LAES	LIP5 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004				
020	EI - 0722A	LAES	LIP5-1 2500 L/S Ion Pump Voltage Indication	AI			1						004				
020	HS - 0722A	LAES	LIP5-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004				
020	II - 0722A	LAES	LIP5-1 2500 L/S Ion Pump Current Indication	AI			1						004				
020	XA - 0722A	LAES	LIP5-1 2500 L/S Ion Pump Fault Alarm	DI		1											
020	EI - 0722B	LAES	LIP5-2 2500 L/S Ion Pump Voltage Indication	AI			1						004				
020	HS - 0722B	LAES	LIP5-1 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004				
020	II - 0722B	LAES	LIP5-2 2500 L/S Ion Pump Current Indication	AI			1						004				
020	XA - 0722B	LAES	LIP5-2 2500 L/S Ion Pump Fault Alarm	DI		1											
020	HS - 0722C	LAES	LIP5-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004				
020	HS - 0722D	LAES	LIP5-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004				
020	PE - 0723A	LAES	Left End Beam Tube Pirani Gauge Tube	-									007				

V049-1-036, REV. 2

## LIGO INSTRUMENT LIST

DATE: \_\_\_\_\_  
PREPARED BY: \_\_\_\_\_  
CHECKED BY: \_\_\_\_\_

DWG	PI&O INFORMATION				I/O BREAKDOWN					EQUIPMENT INFORMATION			SPEC	SETTINGS (low-to-high or off-on)			
	V049-0-	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	V049-2-	LOW / OFF	HIGH / ON
020	PI - 0723A	LAES	Left End Beam Tube Lo Vacuum Pressure Indication	-													
020	PT - 0723A	LAES	Left End Beam Tube Pirani Gauge Transmitter	AI				1							1 x 10-3	1000	TORR
020	PE - 0723B	LAES	Left End Beam Tube Ion Gauge Tube	-									007				
020	PI - 0723B	LAES	Left End Beam Tube HI Vacuum Pressure Indication	-													
020	PT - 0723B	LAES	Left End Beam Tube Ion Gauge Transmitter	AI				1							3 x 10-11	1 x 10-2	TORR
020	PE - 0724A	LAES	LCP3 Pirani Gauge Tube	-									007				
020	PI - 0724A	LAES	LCP3 Lo Vacuum Pressure Indication	-													
020	PT - 0724A	LAES	LCP3 Pirani Gauge Transmitter	AI				1							1 x 10-3	1000	TORR
020	PE - 0724B	LAES	LCP3 Ion Gauge Tube	-									007				
020	PI - 0724B	LAES	LCP3 HI Vacuum Pressure Indication	-													
020	PT - 0724B	LAES	LCP3 Ion Gauge Transmitter	AI				1							3 x 10-11	1 x 10-2	TORR
020	PSV - 0725	LAES	Class 100 Air Pressure Safety Valve	-													
020	PCV - 0726	LAES	Class 100 Air Seal Gas Pressure Control Valve	-													
020	PI - 0726	LAES	Class 100 Air Seal Gas Pressure Indicator	-													
020	PCV - 0727	LAES	Class 100 Air Pressure Control Valve	-													
020	PI - 0727	LAES	Class 100 Air Pressure Indicator	-													
006	RV - 0736	WACS	LCP3 LN2 Dewar Relief Valve	-													
021	EV - 0750	LAMJ	Left Mid Joint Isolation Valve	-						GNB Corp	122CM, Gate Valve, Electric, Tag LVG7	554617	005				
021	HS - 0750	LAMJ	Left Mid Joint Isolation Valve Open/Close Switch	DO		1											005
005	II - 0750	LAMJ	LGV7 25 L/S Ion Pump Current Indication	AI				1									004
021	SC - 0750	LAMJ	Left Mid Joint Isolation Valve Controller	-													
021	XA - 0750	LAMJ	Left Mid Joint Isolation Valve Common Alarm	DI	1												
005	XIC - 0750	LAMJ	LGV7 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004				
021	ZSC - 0750	LAMJ	Left Mid Joint Isolation Valve Closed	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG7	554617	005				
021	ZSO - 0750	LAMJ	Left Mid Joint Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG7	554617	005				
021	PE - 0751A	LAMJ	Left Mid Joint Beam Tube Pirani Gauge Tube	-													007
021	PJ - 0751A	LAMJ	Left Mid Joint Beam Tube Lo Vacuum Pressure Indication	-													
021	PT - 0751A	LAMJ	Left Mid Joint Beam Tube Pirani Gauge Transmitter	AI				1							1 x 10-3	1000	TORR
021	PE - 0751B	LAMJ	Left Mid Joint Beam Tube Ion Gauge Tube	-									007				
021	PI - 0751B	LAMJ	Left Mid Joint Beam Tube HI Vacuum Pressure Indication	-													
021	PT - 0751B	LAMJ	Left Mid Joint Beam Tube Ion Gauge Transmitter	AI				1							3 x 10-11	1 x 10-2	TORR
021	PE - 0752A	LAMJ	Left Mid Joint Beam Tube Pirani Gauge Tube	-									007				
021	PI - 0752A	LAMJ	Left Mid Joint Beam Tube Lo Vacuum Pressure Indication	-													
021	PT - 0752A	LAMJ	Left Mid Joint Beam Tube Pirani Gauge Transmitter	AI				1							1 x 10-3	1000	TORR
021	PE - 0752B	LAMJ	Left Mid Joint Beam Tube Ion Gauge Tube	-									007				
021	PI - 0752B	LAMJ	Left Mid Joint Beam Tube HI Vacuum Pressure Indication	-													
021	PT - 0752B	LAMJ	Left Mid Joint Beam Tube Ion Gauge Transmitter	AI				1							3 x 10-11	1 x 10-2	TORR
006	RV - 0762	LAES	LCP3 LN2 Dewar Pressure Control Relief Valve	-													
006	PCV - 0763	LAES	LCP3 LN2 Dewar Vent Pressure Control Valve	-													
006	PI - 0772	LAES	LCP3 LN2 Dewar Pressure Control Indicator	-													
006	PCV - 0773	LAES	LCP3 LN2 Dewar Pressure Control Valve	-													
006	RV - 0782	LAES	LCP3 LN2 Dewar Pressure Control Relief Valve	-													
006	RV - 0783	LAES	LCP3 80K Cryopump Discharge Relief Valve	-													
006	LIC - 0800	LAES	LCP4 80K Cryopump Level Control Loop Output	AO				1									
006	LT - 0800	LAES	LCP4 80K Cryopump Level Transmitter	AI				1					069	0	100	% Level	
006	LV - 0800	LAES	LCP4 80K Cryopump Level Control Valve	-									062				
006	LY - 0800	LACS	LCP4 80K Cryopump Level Control Loop Output	AO				1									
006	XV - 0800	LAES	LCP4 80K Cryopump Level Control Valve Solenoid	DO		1											
006	ZSC - 0800	LAES	LCP4 80K Cryopump Level Control Valve Closed	DI	1					GNB Corp	112CM, Gate Valve, Electric, Tag LVG11	554617	005				
006	PI - 0801	LAES	LCP4 80K Cryopump Discharge Pressure Indication	-													
006	PT - 0801	LAES	LCP4 80K Cryopump Discharge Pressure Transmitter	AI				1					090	0	25	PSIG	
006	TE - 0802	LAES	LCP4 80K Cryopump Discharge Thermocouple	T/C													

DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

LIGO INSTRUMENT LIST

V049-1-036, rev. 2

DWG V049-0	TAG #	AREA	PI&O INFORMATION	VO BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2	SETTINGS (low-to-high pg off-on)			
			SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
006	TI - 0802	LAES	LCP4 80K Cryopump Discharge Temperature Indication	-												
006	JC - 0803	LACS	LCP4 80K Cryopump Regen SCR Controller	AI				1								
006	TIC - 0803	LAES	LCP4 80K Cryopump Regen Loop Temperature Control	-												
006	TSH - 0803	LAES	LCP4 80K Cryopump Regen Loop HI Temperature	-												
006	TY - 0803	LAES	LCP4 80K Cryopump Regen Loop Temperature Control Loop Output	AO												
006	TE - 0803A	LAES	LCP4 80K Cryopump Regen Loop Thermocouple	T/C-T								091	320	700	Deg F	
006	TE - 0803B	LAES	LCP4 80K Cryopump Regen Loop Thermocouple	T/C-K								056	32	2300	Deg F	
006	TE - 0803C	LAES	LCP4 80K Cryopump Regen Loop Thermocouple	T/C-K								056	32	2300	Deg F	
006	FE - 0804	LAES	LCP4 80K Cryopump Regen Loop Pilot Tube Flow Element	-								079	0	12,000	SCFH	
006	FI - 0804	LAES	LCP4 80K Cryopump Regen Loop Flow Indicator	-								088	0	12,000	SCFH	
006	LT - 0805	LAES	LCP4 LN2 Dewar Level Transmitter	AI				1				089	0	100	% Level	
006	PI - 0805	LAES	LCP4 LN2 Dewar Pressure Indicator	-												
006	LI - 0805A	LAES	LCP4 LN2 Dewar Level Indicator	-												
006	LI - 0805B	LAES	LCP4 LN2 Dewar Level Indication	-												
006	RD - 0806	LAES	LCP4 LN2 Dewar Rupture Disc	-												
006	RV - 0806	LAES	LCP4 LN2 Dewar Relief Valve	-												
006	RD - 0807	LAES	LCP4 LN2 Dewar Rupture Disc	-												
006	RV - 0807	LAES	LCP4 LN2 Dewar Relief Valve	-												
006	RV - 0808	LAES	LCP4 LN2 Dewar Relief Valve	-												
025	EV - 0809	LAES	LCP4 80K Cryopump Outlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag LVG11	554617	005			
025	HS - 0809	LAES	LCP4 80K Cryopump Outlet Isolation Valve Open/Close Switch	DO				1					005			
005	II - 0809	LAES	LGV11 25 L/S Ion Pump Current Indication	AI					1				004			
025	SC - 0809	LAES	LCP4 80K Cryopump Outlet Isolation Valve Controller	-												
025	XA - 0809	LAES	LCP4 80K Cryopump Outlet Isolation Valve Common Alarm	DI				1								
005	XIC - 0809	LAES	LGV11 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
025	ZSC - 0809	LAES	LCP4 80K Cryopump Outlet Isolation Valve Closed	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag LVG12	554617	005			
025	ZSQ - 0809	LAES	LCP4 80K Cryopump Outlet Isolation Valve Open	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag LVG11	554617	005			
002	PC - 0810	LAES	LBSC4 Pressure Control Valve Controller	-												
002	PCV - 0810	LAES	LBSC4 Pressure Control Valve	-												
002	PY - 0810	LAES	LBSC4 Pressure Control Loop Output	AO					1							
002	PE - 0810A	LAES	LBSC4 Pirani Gauge Tube	-												
002	PI - 0810A	LAES	LBSC4 Lo Vacuum Pressure Indication	-												
002	PT - 0810A	LAES	LBSC4 Pirani Gauge Transmitter	AI					1					1 x 10 <sup>-3</sup>	1000	TORR
002	PE - 0810B	LAES	LBSC4 Ion Gauge Tube	-										007		
002	PI - 0810B	LAES	LBSC4 HI Vacuum Pressure Indication	-												
002	PT - 0810B	LAES	LBSC4 Ion Gauge Transmitter	AI					1					3 x 10 <sup>-11</sup>	1 x 10 <sup>-2</sup>	TORR
002	II - 0811	LAES	LBSC4 75 L/S Ion Pump Current Indication	AI					1					004		
002	XIC - 0811	LAES	LBSC4 75 L/S Ion Pump Controller	-						Varian Vacu Products	75 L/S Noble Diode Ion Pump Controller	554936	004			
025	EV - 0819	LAES	LCP4 80K Cryopump Inlet Isolation Valve	-						GNB Corp	112CM, Gate Valve, Electric, Tag LVG12	554617	005			
025	HS - 0819	LAES	LCP4 80K Cryopump Inlet Isolation Valve Open/Close Switch	DO				1					005			
005	II - 0819	LAES	LGV12 25 L/S Ion Pump Current Indication	AI					1					004		
025	SC - 0819	LAES	LCP4 80K Cryopump Inlet Isolation Valve Controller	-												
025	XA - 0819	LAES	LCP4 80K Cryopump Inlet Isolation Valve Common Alarm	DI				1								
005	XIC - 0819	LAES	LGV12 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
025	ZSC - 0819	LAES	LCP4 80K Cryopump Inlet Isolation Valve Closed	DI				1						005		
025	ZSO - 0819	LAES	LCP4 80K Cryopump Inlet Isolation Valve Open	DI				1		GNB Corp	112CM, Gate Valve, Electric, Tag LVG12	554617	005			
025	HV - 0820	LAES	LCP4 80K Cryopump 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
025	ZSC - 0820	LAES	LCP4 80K Cryopump Pumpout Port Valve Closed	DI				1		Varian Vacu Products	10" SST Gate Valve	555029	006			
025	ZSO - 0820	LAES	LCP4 80K Cryopump Pumpout Port Valve Open	DI				1		Varian Vacu Products	10" SST Gate Valve	555029	006			
025	HV - 0821	LAES	Right End Beam Tube 10" Pumpout Port Valve	-						Varian Vacu Products	10" SST Gate Valve	555029	006			
025	ZSC - 0821	LAES	Right End Beam Tube Pumpout Port Valve Closed	DI				1		Varian Vacu Products	10" SST Gate Valve	555029	006			
025	ZSO - 0821	LAES	Right End Beam Tube Pumpout Port Valve Open	DI				1		Varian Vacu Products	10" SST Gate Valve	555029	006			



DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

LIGO INSTRUMENT LIST

V049-1-036, REV. 2

DWG V049-0-	PI&D INFORMATION			VO BREAKDOWN					EQUIPMENT INFORMATION			SPEC V049-2-	SETTINGS (low-to-high or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER	MODEL No.		P. O. #	LOW / OFF	HIGH / ON	UNITS
025	XIC - 0822	LAES	LIP6 2500 L/S Ion Pump Controller	-						Varian Vacu Products	2500 L/S Noble Diode Ion Pump Controller	554936	004			
025	EI - 0822A	LAES	LIP6-1 2500 L/S Ion Pump Voltage Indication	AI			1						004			
025	HS - 0822A	LAES	LIP6-1 2500 L/S Ion Pump Remote High Voltage Start Switch	DO	1								004			
025	II - 0822A	LAES	LIP6-1 2500 L/S Ion Pump Current Indication	AI			1						004			
025	XA - 0822A	LAES	LIP6-1 2500 L/S Ion Pump Fault Alarm	DI	1											
025	EI - 0822B	LAES	LIP6-2 2500 L/S Ion Pump Voltage Indication	AI			1						004			
025	HS - 0822B	LAES	LIP6-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
025	II - 0822B	LAES	LIP6-2 2500 L/S Ion Pump Current Indication	AI			1						004			
025	XA - 0822B	LAES	LIP6-2 2500 L/S Ion Pump Fault Alarm	DI	1											
025	HS - 0822C	LAES	LIP6-2 2500 L/S Ion Pump Remote High Voltage Start Switch	DO		1							004			
025	HS - 0822D	LAES	LIP6-2 2500 L/S Ion Pump Remote High Voltage Stop Switch	DO		1							004			
025	PE - 0823A	LAES	Right End Beam Tube Pirani Gauge Tube	-												
025	PI - 0823A	LAES	Right End Beam Tube Lo Vacuum Pressure Indication	-												
025	PT - 0823A	LAES	Right End Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
025	PE - 0823B	LAES	Right End Beam Tube Ion Gauge Tube	-												
025	PI - 0823B	LAES	Right End Beam Tube HI Vacuum Pressure Indication	-												
025	PT - 0823B	LAES	Right End Beam Tube Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
025	PE - 0824A	LAES	CLP4 Pirani Gauge Tube	-												
025	PI - 0824A	LAES	CLP4 Lo Vacuum Pressure Indication	-												
025	PT - 0824A	LAES	CLP4 Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
025	PE - 0824B	LAES	CLP4 Ion Gauge Tube	-												
025	PI - 0824B	LAES	CLP4 HI Vacuum Pressure Indication	-												
025	PT - 0824B	LAES	CLP4 Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
025	PSV - 0825	LAES	Class 100 Air Pressure Safety Valve	-												
025	PCV - 0826	LAES	Class 100 Air Seal Gas Pressure Control Valve	-												
025	PI - 0826	LAES	Class 100 Air Seal Gas Pressure Indicator	-												
025	PCV - 0827	LAES	Class 100 Air Pressure Control Valve	-												
025	PI - 0827	LAES	Class 100 Air Pressure Indicator	-												
006	RV - 0836	WACS	LCP4 LN2 Dewar Relief Valve	-												
021	EV - 0850	LAMJ	Right Mid Joint Isolation Valve	DO						GNB Corp	122CM, Gate Valve, Electric, Tag LVG8	554617	005			
021	HS - 0850	LAMJ	Right Mid Joint Isolation Valve Open/Close Switch	DO		1							005			
005	II - 0850	LAMJ	LGVS 25 L/S Ion Pump Current Indication	AI			1						004			
021	SC - 0850	LAMJ	Right Mid Joint Isolation Valve Controller	-												
021	XA - 0850	LAMJ	Right Mid Joint Isolation Valve Common Alarm	DI	1											
005	XIC - 0850	LAMJ	LGVS 25 L/S Ion Pump Controller	-						Varian Vacu Products	25 L/S Noble Diode Ion Pump Controller	554936	004			
021	ZSC - 0850	LAMJ	Right Mid Joint Isolation Valve Closed	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG8	554617	005			
021	ZSO - 0850	LAMJ	Right Mid Joint Isolation Valve Open	DI	1					GNB Corp	122CM, Gate Valve, Electric, Tag LVG8	554617	005			
021	PE - 0851A	LAMJ	Right Mid Joint Beam Tube Pirani Gauge Tube	-												
021	PI - 0851A	LAMJ	Right Mid Joint Beam Tube Lo Vacuum Pressure Indication	-												
021	PT - 0851A	LAMJ	Right Mid Joint Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
021	PE - 0851B	LAMJ	Right Mid Joint Beam Tube Ion Gauge Tube	-												
021	PI - 0851B	LAMJ	Right Mid Joint Beam Tube HI Vacuum Pressure Indication	-												
021	PT - 0851B	LAMJ	Right Mid Joint Beam Tube Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
021	PE - 0852A	LAMJ	Right Mid Joint Beam Tube Pirani Gauge Tube	-												
021	PI - 0852A	LAMJ	Right Mid Joint Beam Tube Lo Vacuum Pressure Indication	-												
021	PT - 0852A	LAMJ	Right Mid Joint Beam Tube Pirani Gauge Transmitter	AI			1							1 x 10-3	1000	TORR
021	PE - 0852B	LAMJ	Right Mid Joint Beam Tube Ion Gauge Tube	-												
021	PI - 0852B	LAMJ	Right Mid Joint Beam Tube HI Vacuum Pressure Indication	-												
021	PT - 0852B	LAMJ	Right Mid Joint Beam Tube Ion Gauge Transmitter	AI			1							3 x 10-11	1 x 10-2	TORR
006	RV - 0862	LAES	LCP4 LN2 Dewar Pressure Control Relief Valve	-												
006	PCV - 0863	LAES	LCP4 LN2 Dewar Vent Pressure Control Valve	-												
006	PI - 0872	LAES	LCP4 LN2 Dewar Pressure Control Indicator	-												

V049-1-036, rev. 2

LIGO INSTRUMENT LIST

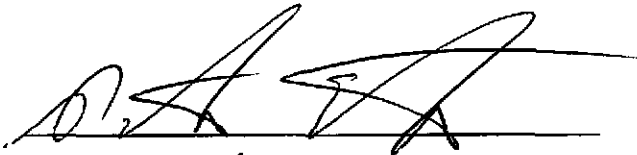
DATE: \_\_\_\_\_  
 PREPARED BY: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_

DWG V049-0-	P&ID INFORMATION			I/O BREAKDOWN					EQUIPMENT INFORMATION		SPEC V049-2-	SETTINGS (low-to-High or off-on)			
	TAG #	AREA	SERVICE DESCRIPTION	TYPE	DI	DO	AI	AO	T/C	MANUFACTURER		MODEL No.	P. O. #	LOW / OFF	HIGH / ON
006	PCV - 0873	LAES	LCP4 LN2 Dewar Pressure Control Valve	-											
006	RV - 0882	LAES	LCP4 LN2 Dewar Pressure Control Relief Valve	-											
006	RV - 0883	LAES	LCP4 80K Cryopump Discharge Relief Valve	-											

**SPECIFICATION FOR  
 BAKEOUT SYSTEM PERSONNEL COMPUTERS  
 FOR  
 LIGO VACUUM EQUIPMENT**

Hanford, Washington  
 and  
 Livingston, Louisiana

**PREPARED BY:**



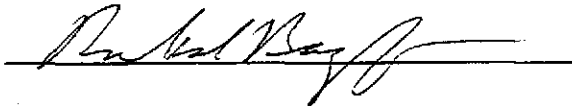
**QUALITY ASSURANCE:**



**TECHNICAL DIRECTOR:**



**PROJECT MANAGER:**



Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
0	PDS 1/26/96	D.M.W.	Issued per Purchase DEO # 051

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-049
	PDS	1/26/96	D.M.W.	1-26	Rev. 0

**Title SPECIFICATION FOR BAKEOUT SYSTEM PERSONNEL COMPUTERS**

1. Gateway 2000 Personnel Computers with the following :

- Intel 120 Pentium Processor
- 16 MB EDO DRAM
- 256L pipelined burst SRAM cache
- 1.2 GB 11ms EIDE Western Digital HD
- PCI Enhanced IDE interface
- PCI local-bus graphics with 2MB DRAM
- 6X CD-ROM with EIDE interface
- 3.5" 1.44 MB DD
- 17" CrystalScan Monitor
- Slots: (2) 16-bit ISA, (3) 32-bit PCI, (1) PCI/ISA
- Desktop Case
- 104+ Keyboard (NO ANYKEY)
- Microsoft Mouse
- Microsoft NT Workstation 3.51
- Microsoft Office Pro 95
- Gateway Gold Premium Service(3 year on-site)

Number  
Rev.

**SPECIFICATION**

Number	A	V049-2-049	Rev.	Ø
--------	---	------------	------	---

**Title: SPECIFICATION FOR BAKEOUT SYSTEM THERMOCOUPLE MEASUREMENT SYSTEM**

**SPECIFICATION FOR  
BAKEOUT SYSTEM THERMOCOUPLE MEASUREMENT SYSTEM  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** *DA S/R*

**QUALITY ASSURANCE:** *Bob Bradbrook*

**TECHNICAL DIRECTOR:** *D. A. Williams*

**PROJECT MANAGER:** *RICHARD BAGLEY*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
2	<i>Apr 10/2/96</i>	<i>D. m. w.</i>	<i>ISSUE FOR PURCHASE DEO # 0287</i>
1	<i>PPS 3/12/96</i>	<i>D. m. w.</i>	<i>ISSUED for Purchase DEO # 0090</i>
0	<i>PPS 1/24/96</i>	<i>D. m. w.</i>	<i>ISSUED for Purchase DEO # 051</i>

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number <b>A V049-2-050</b>
	<i>PPS</i>	<i>1/06/96</i>	<i>D. m. w.</i>	<i>1-26 96</i>	Rev. <b>2</b>
					Page <b>1</b> of <b>2</b>

Title

# SPECIFICATION FOR BAKEOUT SYSTEM THERMOCOUPLE MEASUREMENT SYSTEM

1. I/O Tech Thermocouple Measurement System As Follows :
  - a) (1) TEMPSCAN-1000A  
Hi speed thermocouple measurement Main Chassis
  - b) (1) EXP/11A  
10 slot expansion chassis for Tempscan/1000A, includes rackmount kit and CA-35-1 master/slave cable
  - c) (7) TEMPTC-32A  
32 Channel T/C Scanning Module for Non-Grounded T/C's

NOTE: 2 year warranty standard

Number  
Rev.

## SPECIFICATION

Number **A** V049-2-050 Rev.

Page \_\_\_\_\_ of \_\_\_\_\_

**SPECIFICATION FOR  
BAKEOUT SYSTEM T/C MEASUREMENT PLC INTERFACE  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY:

*[Signature]*

QUALITY ASSURANCE:

*[Signature]*

TECHNICAL DIRECTOR:

*D. C. M. W. Williams*

PROJECT MANAGER:

*RICHARD BAGLEY*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1	PPS 10/12/96	KEB 10/23/96	ISSUED FOR PURCHASE DEO #0051
2	PPS 1/26/96	D.M.W.	ISSUED FOR PURCHASE DEO #0051

<b>PROCESS SYSTEMS INTERNATIONAL, INC.</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	NumberA V049-2-051
	PPS	1/26/96	D.M.W.	1-26-96	Rev. <u>1</u>

**Title** SPECIFICATION FOR BAKEOUT SYSTEM T/C MEASUREMENT PLC  
INTERFACE

Allen-Bradley PLC Interface Modules As Follows :

1. 1771-DMC  
Control Co-Processor Main Module with 256 KBYTE

Number

Rev.

<b>SPECIFICATION</b>		
Number	V049-2-05	Rev. 1



Title: SPECIFICATION FOR BAKEOUT SYSTEM PC - ALLEN BRADLEY PLC INTERFACE  
MODULE FOR LIGO

SPECIFICATION FOR  
BAKEOUT SYSTEM PC - ALLEN BRADLEY PLC INTERFACE  
FOR  
LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

I/C: *[Signature]*  
 ELECTRICAL: *[Signature]*  
 MANAGER: *[Signature]*  
 PROJECT MANAGER: *[Signature]*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.


<i>φ</i>	<i>PPS 2/21/96</i>	<i>D M W 2-21-96</i>	<i>Issued per Purchase DEO # 66</i>
REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION			
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number	V049-2-057	Rev. 0
	<i>PPS</i>	<i>2/21/96</i>	<i>D M W</i>	<i>2-21-96</i>			

Title

**SPECIFICATION FOR BAKEOUT SYSTEM PC - ALLEN BRADLEY  
PLC INTERFACE MODULE FOR LIGO**

PC - Allen Bradley PLC Interface Module as Follows:

1. 1784 - KTX  
DH+, DH-485, REM I/O Interface Module

Number  
Rev.

**SPECIFICATION**

Number	<b>A</b>	V049-2-057	Rev.
--------	----------	------------	------

Title: SPECIFICATION FOR BAKEOUT SYSTEM PC - INTERFACE SOFTWARE FOR LIGO

**SPECIFICATION FOR  
BAKEOUT SYSTEM PC - INTERFACE SOFTWARE  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

I/C:

*[Signature]*

ELECTRICAL:

*[Signature]*

DIRECTOR:

*[Signature]*

PROJECT MANAGER:

*[Signature]*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV	LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1		PPS 10/23/96	RES 10/23/96	Issued per Purchase DEO# 0062
2				Issued per Purchase DEO# 0069

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number	Rev.
	PPS	2/22/96	RES	2/22/96	V049-2-058	1

Title

**SPECIFICATION FOR BAKEOUT SYSTEM PC - INTERFACE  
SOFTWARE FOR LIGO**

PC - Interface Software running on Windows NT/95 as follows:

- A. Full Function Runtime SCADA node including:
  - i. Distributed Networking
  - ii. SCADA
  - iii. Object Graphics
  - iv. Historical Trending/Collection
  - v. DDE Client/Server
  - vi. Excel Macros
  - vii. Batch Blocks
  
- B. ABK I/O driver for Windows 95/NT (only 1 required for entire project)
  
- C. Cyberlogic Windows 95 driver

Number

Rev.

**SPECIFICATION**

Number	V049-2-058	Rev.
<b>A</b>		<b>4</b>

Title:

**SPECIFICATION FOR FLOW METER**

**SPECIFICATION**

**FOR**

**FLOW METER**

**LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY** Thomas Murphy

**ELECTRICAL** F. Bark

**QUALITY ASSURANCE** Geo Senechal

**TECHNICAL DIRECTOR** Da Mullen

**PROJECT MANAGER** M. Byrd

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements and shall not be disclosed to any other party.

REV LTR	BY—DATE	APP.—DATE	DESCRIPTION OF ACTION
1	DP 9-6-96	F. Bark 9-6-96	RELEASED FOR PURCHASE PER DED # 258
0	TM 5-2-96	F. Bark 5-2-96	RELEASED FOR FDR PER DED # 156.

<b>PROCESS SYSTEMS INTERNATIONAL, INC</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED BY	DATE	APPROVED BY	DATE	Number
	T. Murphy	5-2-96	F. Bark	5-2-96	A V049-2-079
					Rev 1

Title:

**SPECIFICATION FOR FLOW METER**

**TABLE OF CONTENTS**

- 1.0 SCOPE
- 2.0 CODES AND STANDARDS
- 3.0 GENERAL REQUIREMENTS
- 4.0 MARKING
- 5.0 RESPONSIBILITY
- 6.0 REQUIRED DOCUMENTATION
- 7.0 INSPECTION
- 8.0 PREPARATION FOR SHIPMENT

**ATTACHMENTS**

- A) LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY
- B) DATA SHEET
- C) SPECIFICATION FOR EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS: SPEC.# V049-2-034

**SPECIFICATION**

Number

**A V049-2-079**

Rev

**1**

Title:

## SPECIFICATION FOR FLOW METER

### 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of instrumentation for the LIGO vacuum system.

The following specifications refer to the Buyer - Process Systems International (PSI), the Owner - California Institute of technology in partnership with Massachusetts Institute of Technology, under a grant from the National Science Foundation, and Vendor/Seller. The Vendor/Seller is the successful system bidder.

The Vendor shall be responsible for updating any and all references to codes and other standards to reflect the requirements of the latest editions in effect on date of purchase order except as noted.

All attachments are incorporated herein by reference and made a part of this specification.

### 2.0 CODES AND STANDARDS

#### 2.1 Priority of Codes and Standards

1. Codes
2. Standards
3. Data Sheets
4. This Specification

2.2 All conflicts shall be brought to the attention of PSI for a written resolution prior to award of a purchase order. If more than one document applies to a technical requirement, the more stringent requirement shall have precedence.

2.3 The assembly shall comply with applicable parts of latest editions of publications by the following organizations:

American National Standards Institute, Inc. (ANSI)

Code of Federal Regulations (CFR) Title 47, Part 15

Electrical Standards for Industrial Machinery (NFPA 79) unless otherwise indicated

## SPECIFICATION

Number

**A** V049-2-079

Rev

1

Title:

## SPECIFICATION FOR FLOW METER

Factory Mutual (FM)

Federal Communications Commission (FCC) Part 15

Institute of Electrical and Electronics Engineers (IEEE)

Insulated Cable Engineers Association (ICEA)

National Electric Code (NFPA 70)

National Electrical Manufacturers Association (NEMA)

Underwriter's Laboratories (UL) or equipment and installation standards by other nationally recognized testing companies

### 3.0 GENERAL REQUIREMENTS

- 3.1 The overall process and mechanical requirements for this specific application are given in data sheets attached to this specification.
- 3.2 The equipment shall be designed for a minimum serviceable life of 20 years.
- 3.3 Vendor shall specify all bolt torque requirements in the equipment operating and maintenance manual.
- 3.4 Instrumentation shall be of industrial quality and shall be subject to the acceptance of the Buyer.
- 3.5 External carbon steel surfaces shall be cleaned and painted. The Vendor's standard is acceptable if it meets specification requirements and is compatible with federal standard 209 class 50,000.

### 4.0 MARKING

Plates are to be stamped to show the following information:

- a. Manufacturer's name, catalog number
- b. Serial number
- c. Adjustable range
- d. Maximum working pressure
- e. Set range
- f. Output signal
- g. Tag number (as listed on attached data sheet)
- h. Tags may be permanently attached or attached with a stainless steel wire.

## SPECIFICATION

Number

**A** V049-2-079

Rev

1



Title:

## SPECIFICATION FOR FLOW METER

### 5.0 RESPONSIBILITY

The Seller shall be completely responsible that the equipment and/or material furnished under this specification is of high quality in every respect, with first-class workmanship throughout and entirely suitable for the purpose outlined herein or reasonably inferred therefrom. Therefore, if any requirement of this specification is deemed by the Vendor/Seller to be unacceptable or technically incorrect, he shall specifically delineate his objections and the reasons therefore in his proposal so that they may be resolved before the order is placed. In all respects, the Seller, by accepting the order, shall be deemed to have agreed that conformance with the requirements of the specification will not prejudice in any way the Buyer's right under warranty.

### 6.0 REQUIRED DOCUMENTATION

Vendor shall furnish documentation in accordance with specific inquiry, requisition and purchase order requirements. All Vendor documents shall bear the purchase order number and PSI's equipment tag number. The following is a list of minimum documentation required:

#### 5.1 MECHANICAL DATA REQUIREMENTS

Outline dimension drawings and weight.

#### 5.2 MANUALS

Five (5) copies of operational/maintenance manuals.

#### 5.3 TEST REPORTS

Calibration report.

### 7.0 INSPECTION

The responsibility for inspection rests with the manufacturer; however, the Buyer, Owner, Government, and Owner representatives reserve the right to conduct a non-escort inspection of equipment at any time during fabrication to assure that the materials and workmanship are in accordance with this specification. This will include access to fabrication, assembly, cleaning and testing areas for the purpose of monitoring activities.

## SPECIFICATION

Number

**A** V049-2-079

Rev

1

Title:

## SPECIFICATION FOR FLOW METER

### 8.0 PREPARATION FOR SHIPMENT

- 8.1 Items shall be completely drained and dried.
- 8.2 Bolted connections shall be made up before shipment.
- 8.3 Aluminum plate shipping covers shall be attached with bolts to flanged connections, and with suitable attachments to other connections.
- 8.4 Units shall be completely covered for protection against the ambient and weather conditions expected during transportation. Units shall be adequately protected for unsheltered storage at the sites.
- 8.5 The Vendor shall have a signed "Release for Shipment" form provided by the Buyer's Quality Assurance representative prior to full or partial shipment of product.
- 8.6 Shipping crates shall have the Buyer's purchase order number, Vendor's name and list of tag numbers or part numbers on the outside of each crate.

### SPECIFICATION

Number

**A** V049-2-079

Rev

**1**

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: FLOW METER	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-079
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	<u>Remarks:</u>  <u>Inspector:</u>  <u>Date:</u>
OPERATION & MAINTENANCE MANUALS				5		

PROCESS SYSTEMS INTERNATIONAL.  ATTACHMENT "B".		ROTAMETERS (VARIABLE AREA FLOWMETERS)				SHEET <u>1</u> OF <u>3</u>			
		NO		BY		DATE		REVISION	
				FB		9-6-96		1	
						SPEC. NO.		REV.	
						1049-2-079		1	
						CONTRACT		DATE	
								9-6-96	
						REQ.		P.O.	
						BY		CHK'D	
						FB		FAB	
								APPR.	

GENERAL	1	Tag Number	FI-104		FI-154		FI-204		FI-254	
	2	Service	NITROGEN GAS		NITROGEN GAS		NITROGEN GAS		NITROGEN GAS.	
	3	Line No./Vessel No.	1127		1130		242		245	
	4	Function								
	5	Mounting	1.5" NPT HORIZONTAL		1.5" NPT HORIZONTAL		1.5" NPT HORIZONTAL		1.5" NPT HORIZONTAL	
	6	Power Supply								
	7	Conn. Size								
	8	Inlet Dir.	LEFT		RIGHT		LEFT		RIGHT	
	9	Fitting Material	ETHYLENE PROPYL		ETHYLENE PROPYL		ETHYLENE PROPYL		ETHYLENE PROPYL	
	10	Packing or O-Ring Mtl.	ETHYLENE PROPYL		ETHYLENE PROPYL		ETHYLENE PROPYL		ETHYLENE PROPYL	
	11	Enclosure Type								
METER	12	Size								
	13	Tube Mtl.								
	14	Meter Scale: Length & Type								
	15	Meter Scale Range	0-12000 SCFH		0-12000 SCFH		0-12000 SCFH		0-12000 SCFH	
	16	Meter Factor								
	17	Rated Accuracy	± 3% FS		± 3% FS		± 3% FS		± 3% FS	
	18	Hydraulic Calib. Required								
FLUID DATA	19	Fluid								
	20	Color or Transparency								
	21	Maximum Flow Rate	12000 SCFH		12000 SCFH		12000 SCFH		12000 SCFH	
	22	Norm Flow	2650 SCFH		2650 SCFH		2650 SCFH		2650 SCFH	
	23	Oper. Specific Gravity (Liq)								
	24	Max Oper. Viscosity								
	25	Oper. Press.	10 PSIG		10 PSIG		10 PSIG		10 PSIG	
	26	Oper. Temp.	-156°F		-156°F		-156°F		-156°F	
	27	Oper. Density (Gases)								
	28	Std. Density								
EXT	29	Max. Allowable Press. Drop	2.0 PSIG		2.0 PSIG		2.0 PSIG		2.0 PSIG	
	30	DESIGN PRESSURE	10 PSIG		10 PSIG		10 PSIG		10 PSIG	
	31	Extension Well Mtl.								
	32	Gasket Mtl.								
XMTR	33	Transmitter Output								
	34	Trans. Enclosure Class								
	35	Scale Range								
ALARM	36	No. of Contacts								
	37	Rating								
	38	Action								
	39	Form								
OPTIONS	40	Valve Size & Material								
	41	Valve Location								
	42	Const. Diff. Relay Mtl.								
	43	Purge Meter Tubing								
	43a	Airset								
	44	Manufacturer	ERDCO		ERDCO		ERDCO		ERDCO	
	45	Model Number	3211-06-T1		3211-06-T1		3211-06-T1		3211-06-T1	
	46	Tube Number								
	47	Float Number								

Notes:

		ROTAMETERS (VARIABLE AREA FLOWMETERS)								SHEET <u>2</u> OF <u>3</u>					
		NO				BY				SPEC. NO.		REV.			
		DATE		REVISION						CONTRACT		DATE			
										REQ.		P.O.			
										BY		CHK'D		APPR.	
GENERAL	1	Tag Number		FI-304		FI-354		FI-404		FI-504					
	2	Service		N <sub>2</sub> GAS		N <sub>2</sub> GAS		N <sub>2</sub> GAS		N <sub>2</sub> GAS					
	3	Line No./Vessel No.		342		345		452		532					
	4	Function													
	5	Mounting		1.5" NPT HORIZONTAL		1.5" NPT HORIZONTAL		1.5" NPT HORIZONTAL		1.5" NPT HORIZONTAL					
	6	Power Supply													
	7	Conn. Size	Type												
	8	Inlet Dir.	Outlet Dir.	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT		
	9	Fitting Material													
	10	Packing or O-Ring Mtl.		ETHYLENE PROPYL		ETHYLENE PROPYL		ETHYLENE PROPYL		ETHYLENE PROPYL					
	11	Enclosure Type													
METER	12	Size	Float Guide												
	13	Tube Mtl.	Float Mtl.												
	14	Meter Scale: Length & Type													
	15	Meter Scale Range		0-12000 SCFH		0-12000 SCFH		0-12000 SCFH		0-12000 SCFH					
	16	Meter Factor													
	17	Rated Accuracy		± 3% FS		± 3% FS		± 3% FS		± 3% FS					
	18	Hydraulic Calib. Required													
FLUID DATA	19	Fluid													
	20	Color or Transparency													
	21	Maximum Flow Rate		12000 SCFH		12000 SCFH		12000 SCFH		12000 SCFH					
	22	Norm Flow	Min Flow	2650 SCFH		2650 SCFH		2650 SCFH		2650 SCFH					
	23	Oper. Specific Gravity (Liq)													
	24	Max Oper. Viscosity													
	25	Oper. Press.	Oper. Temp.	10 PSIG	-156.96°F	10 PSIG	-156.96°F	10 PSIG	-156.96°F	10 PSIG	-156.96°F				
	26	Oper. Density (Gases)													
	27	Std. Density	Mol. Wgt.												
	28	Max. Allowable Press. Drop		2.0 PSIG		2.0 PSIG		2.0 PSIG		2.0 PSIG					
29	DESIGN PRESSURE		10 PSIG		10 PSIG		10 PSIG		10 PSIG						
EXT	30	Extension Well Mtl.													
	31	Gasket Mtl.													
XMTR	32	Transmitter Output													
	33	Trans. Enclosure Class													
	34	Scale Range													
ALARM	35	No. of Contacts	Form												
	36	Rating	Housing												
	37	Action													
	38														
OPTIONS	39	Valve Size & Material													
	40	Valve Location													
	41	Const. Diff. Relay Mtl.													
	42	Purge Meter Tubing													
	43	Airset													
43a															
	44	Manufacturer		ERDCO		ERDCO		ERDCO		ERDCO					
	45	Model Number		3211-06-T1		3211-06-T1		3211-06-T1		3211-06-T1					
	46	Tube Number													
	47	Float Number													

Notes:

Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

ISA S20

SHEET 3 OF 3

ROTAMETERS  
(VARIABLE AREA FLOWMETERS)

NO	BY	DATE	REVISION

SPEC. NO.	REV.	
CONTRACT	DATE	
REQ.	P.O.	
BY	CHK'D	APPR.

GENERAL

1	Tag Number	FI-604	FI-654	FI-704	FI-804
2	Service	N <sub>2</sub> GAS	N <sub>2</sub> GAS	N <sub>2</sub> GAS	N <sub>2</sub> GAS
3	Line No./Vessel No.	692	695	733	833
4	Function				
5	Mounting	1.5" NPT HORIZONTAL	1.5" NPT HORIZONTAL	1.5" NPT HORIZONTAL	1.5" NPT HORIZONTAL
6	Power Supply				
7	Conn. Size				
7	Type				
8	Inlet Dir.	LEFT	RIGHT	LEFT	RIGHT
8	Outlet Dir.	LEFT	RIGHT	LEFT	RIGHT
9	Fitting Material				
10	Packing or O-Ring Mtl.	ETHYLENE PROPYL	ETHYLENE PROPYL	ETHYLENE PROPYL	ETHYLENE PROPYL
11	Enclosure Type				

METER

12	Size				
12	Float Guide				
13	Tube Mtl.				
13	Float Mtl.				
14	Meter Scale: Length & Type				
15	Meter Scale Range	0-12000 SCFH	0-12000 SCFH	0-12000 SCFH	0-12000 SCFH
16	Meter Factor				
17	Rated Accuracy	± 3% FS	± 3% FS	± 3% FS	± 3% FS
18	Hydraulic Calib. Required				

FLUID DATA

19	Fluid				
20	Color or Transparency				
21	Maximum Flow Rate	12000 SCFH	12000 SCFH	12000 SCFH	12000 SCFH
22	Norm Flow				
22	Min Flow	5300 SCFH	5300 SCFH	5300 SCFH	5300 SCFH
23	Oper. Specific Gravity (Liq)				
24	Max Oper. Viscosity				
25	Oper. Press.	10 PSIG	10 PSIG	10 PSIG	10 PSIG
25	Oper. Temp.	-156.96°F	-156.96°F	-156.96°F	-156.96°F
26	Oper. Density (Gases)				
27	Std. Density				
27	Mol. Wgt.				
28	Max. Allowable Press. Drop	2.0 PSIG	2.0 PSIG	2.0 PSIG	2.0 PSIG
29	DESIGN PRESSURE	10 PSIG	10 PSIG	10 PSIG	10 PSIG

EXT

30	Extension Well Mtl.				
31	Gasket Mtl.				

XMTR

32	Transmitter Output				
33	Trans. Enclosure Class				
34	Scale Range				

ALARM

35	No. of Contacts	Form			
36	Rating	Housing			
37	Action				
38					

OPTIONS

39	Valve Size & Material				
40	Valve Location				
41	Const. Diff. Relay Mtl.				
42	Purge Meter Tubing				
43	Airset				
43a					

44	Manufacturer	ERDCO	ERDCO	ERDCO	ERDCO
45	Model Number	3211-06-T1	3211-06-T1	3211-06-T1	3211-06-T1
46	Tube Number				
47	Float Number				

Notes: ISA FORM S20.22

Title:

**SPECIFICATION FOR DIFFERENTIAL PRESSURE GAUGES**

**SPECIFICATION  
FOR  
DIFFERENTIAL PRESSURE GAUGES  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY** Thomas Murphy

**ELECTRICAL** F. Barb

**QUALITY ASSURANCE** Alan H. Buddbrook

**TECHNICAL DIRECTOR** D. O. McWilliams

**PROJECT MANAGER** Richard Bagley

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements and shall not be disclosed to any other party.


0	T.M. 5-2-96	F. Barb 5-2-96	RELEASED FOR FDZ PEN DEO # 156
REV LTR	BY—DATE	APP.—DATE	DESCRIPTION OF ACTION

<b>PROCESS SYSTEMS INTERNATIONAL, INC</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED BY	DATE	APPROVED BY	DATE	Number
	T. Murphy	5-2-96	F. Barb	5-2-96	A V049-2-088
					Rev 0

Title:

**SPECIFICATION FOR DIFFERENTIAL PRESSURE GAUGES**

**TABLE OF CONTENTS**

- 1.0 SCOPE
- 2.0 CODES AND STANDARDS
- 3.0 GENERAL REQUIREMENTS
- 4.0 MARKING
- 5.0 RESPONSIBILITY
- 6.0 REQUIRED DOCUMENTATION
- 7.0 INSPECTION
- 8.0 PREPARATION FOR SHIPMENT

**ATTACHMENTS**

- A) LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY
- B) DATA SHEET
- C) SPECIFICATION FOR EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS: SPEC.# V049-2-034

**SPECIFICATION**

Number

**A V049-2-088**

Rev

**0**



Title:

## SPECIFICATION FOR DIFFERENTIAL PRESSURE GAUGES

### 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of instrumentation for the LIGO vacuum system.

The following specifications refer to the Buyer - Process Systems International (PSI), the Owner - California Institute of technology in partnership with Massachusetts Institute of Technology, under a grant from the National Science Foundation, and Vendor/Seller. The Vendor/Seller is the successful system bidder.

The Vendor shall be responsible for updating any and all references to codes and other standards to reflect the requirements of the latest editions in effect on date of purchase order except as noted.

All attachments are incorporated herein by reference and made a part of this specification.

### 2.0 CODES AND STANDARDS

#### 2.1 Priority of Codes and Standards

1. Codes
2. Standards
3. Data Sheets
4. This Specification

2.2 All conflicts shall be brought to the attention of PSI for a written resolution prior to award of a purchase order. If more than one document applies to a technical requirement, the more stringent requirement shall have precedence.

2.3 The assembly shall comply with applicable parts of latest editions of publications by the following organizations:

American National Standards Institute, Inc. (ANSI)

Code of Federal Regulations (CFR) Title 47, Part 15

Electrical Standards for Industrial Machinery (NFPA 79) unless otherwise indicated

## SPECIFICATION

Number

**A** V049-2-088

Rev

**0**

Title:

**SPECIFICATION FOR DIFFERENTIAL PRESSURE GAUGES**

Factory Mutual (FM)

Federal Communications Commission (FCC) Part 15

Institute of Electrical and Electronics Engineers (IEEE)

Insulated Cable Engineers Association (ICEA)

National Electric Code (NFPA 70)

National Electrical Manufacturers Association (NEMA)

Underwriter's Laboratories (UL) or equipment and installation standards by other nationally recognized testing companies

3..0 GENERAL REQUIREMENTS

- 3.1 The overall process and mechanical requirements for this specific application are given in data sheets attached to this specification.
- 3.2 The equipment shall be designed for a minimum serviceable life of 20 years.
- 3.3 Vendor shall specify all bolt torque requirements in the equipment operating and maintenance manual.
- 3.4 Instrumentation shall be of industrial quality and shall be subject to the acceptance of the Buyer.
- 3.5 External carbon steel surfaces shall be cleaned and painted. The Vendor's standard is acceptable if it meets specification requirements and is compatible with federal standard 209 class 50,000.

4.0 MARKING

Plates are to be stamped to show the following information:

- a. Manufacturer's name, catalog number
- b. Serial number
- c. Adjustable range
- d. Maximum working pressure
- e. Set range
- f. Output signal
- g. Tag number (as listed on attached data sheet)
- h. Tags may be permanently attached or attached with a stainless steel wire.

**SPECIFICATION**

Number

**A** V049-2-088

Rev

0

Title:

## SPECIFICATION FOR DIFFERENTIAL PRESSURE GAUGES

### 5.0 RESPONSIBILITY

The Seller shall be completely responsible that the equipment and/or material furnished under this specification is of high quality in every respect, with first-class workmanship throughout and entirely suitable for the purpose outlined herein or reasonably inferred therefrom. Therefore, if any requirement of this specification is deemed by the Vendor/Seller to be unacceptable or technically incorrect, he shall specifically delineate his objections and the reasons therefore in his proposal so that they may be resolved before the order is placed. In all respects, the Seller, by accepting the order, shall be deemed to have agreed that conformance with the requirements of the specification will not prejudice in any way the Buyer's right under warranty.

### 6.0 REQUIRED DOCUMENTATION

Vendor shall furnish documentation in accordance with specific inquiry, requisition and purchase order requirements. All Vendor documents shall bear the purchase order number and PSI's equipment tag number. The following is a list of minimum documentation required:

#### 5.1 MECHANICAL DATA REQUIREMENTS

Outline dimension drawings and weight.

#### 5.2 MANUALS

Five (5) copies of operational/maintenance manuals.

#### 5.3 TEST REPORTS

Calibration report.

### 7.0 INSPECTION

The responsibility for inspection rests with the manufacturer; however, the Buyer, Owner, Government, and Owner representatives reserve the right to conduct a non-escort inspection of equipment at any time during fabrication to assure that the materials and workmanship are in accordance with this specification. This will include access to fabrication, assembly, cleaning and testing areas for the purpose of monitoring activities.

## SPECIFICATION

Number

**A** V049-2-088

Rev

**0**

Title:

**SPECIFICATION FOR DIFFERENTIAL PRESSURE GAUGES**

8.0 PREPARATION FOR SHIPMENT

- 8.1 Items shall be completely drained and dried.
- 8.2 Bolted connections shall be made up before shipment.
- 8.3 Aluminum plate shipping covers shall be attached with bolts to flanged connections, and with suitable attachments to other connections.
- 8.4 Units shall be completely covered for protection against the ambient and weather conditions expected during transportation. Units shall be adequately protected for unsheltered storage at the sites.
- 8.5 Shipping crates shall have the Buyer's purchase order number, Vendor's name and list of tag numbers or part numbers on the outside of each crate.

**SPECIFICATION**

Number

**A V049-2-088**

Rev

**0**

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: DIFFERENTIAL PRESSURE GAUGE	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPEC NO: V049-2-088
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	<u>Remarks:</u>  <u>Inspector:</u>  <u>Date:</u>
OPERATION & MAINTENANCE MANUALS				5		

## ATTACHMENT "B"

INSTRUMENT DATA SHEET  
DIFFERENTIAL PRESSURE GAUGESLIGO  
V049-2-088, Rev 1

TAG NUMBER	FI-104	FI-154	FI-204	FI-254		
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006		
LINE NUMBER	1127	1130	242	245		
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN		
FLUID	GAS	GAS	GAS	GAS		
PRESSURE PSIG	10	10	10	10		
TEMPERATURE DEGREES F	-5 to 95	-5 to 95	-5 to 95	-5 to 95		
MOUNTING	SURFACE	SURFACE	SURFACE	SURFACE		
DIAL SIZE	4.5 inches	4.5 inches	4.5 inches	4.5 inches		
ELEMENT TYPE	DIAPHRAM	DIAPHRAM	DIAPHRAM	DIAPHRAM		
RANGE IN H <sub>2</sub> O	0 to 25	0 to 25	0 to 25	0 to 25		
BODY MATERIAL	aluminum	aluminum	aluminum	aluminum		
BODY PRESSURE RATING PSIG	25	25	25	25		
MAXIMUM D.P. RATING IN H <sub>2</sub> O	25	25	25	25		
ELEMENT MATERIAL	Buna-N	Buna-N	Buna-N	Buna-N		
ELEMENT FILL	Dry	Dry	Dry	Dry		
PROCESS CONNECTIONS SIZE / TYPE	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT		
SCALE	0 to 12000	0 to 12000	0 to 12000	0 to 12000		
LEGEND	SCFH	SCFH	SCFH	SCFH		
ACCURACY, FULL SCALE	5%	5%	5%	5%		
QUANTITY	1	1	1	1		
MANUFACTURER						
MODEL						
	BY	DATE	NOTES			
INSTRUMENT ENGINEER	TMK	8/12/96				
ENGINEERING APPROVAL	DM	8/13/96				
PROJECT APPROVAL	F. Bark	8-13-96				
	REVISION	NO.	DATE	APP.	APP.	APP.

## ATTACHMENT "B"

INSTRUMENT DATA SHEET  
DIFFERENTIAL PRESSURE GAUGESLIGO  
V049-2-088, Rev 1

TAG NUMBER	FI-304	FI-354	FI-404	FI-504		
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006		
LINE NUMBER	342	345	432	532		
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN		
FLUID	GAS	GAS	GAS	GAS		
PRESSURE PSIG	10	10	10	10		
TEMPERATURE DEGREES F	-5 to 95	-5 to 95	-5 to 95	-5 to 95		
MOUNTING	SURFACE	SURFACE	SURFACE	SURFACE		
DIAL SIZE	4.5 inches	4.5 inches	4.5 inches	4.5 inches		
ELEMENT TYPE	DIAPHRAM	DIAPHRAM	DIAPHRAM	DIAPHRAM		
RANGE IN H <sub>2</sub> O	0 to 25	0 to 25	0 to 25	0 to 25		
BODY MATERIAL	aluminum	aluminum	aluminum	aluminum		
BODY PRESSURE RATING PSIG	25	25	25	25		
MAXIMUM D.P. RATING IN H <sub>2</sub> O	25	25	25	25		
ELEMENT MATERIAL	Buna-N	Buna-N	Buna-N	Buna-N		
ELEMENT FILL	Dry	Dry	Dry	Dry		
PROCESS CONNECTIONS SIZE / TYPE	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT		
SCALE	0 to 12000	0 to 12000	0 to 12000	0 to 12000		
LEGEND	SCFH	SCFH	SCFH	SCFH		
ACCURACY, FULL SCALE	5%	5%	5%	5%		
QUANTITY	1	1	1	1		
MANUFACTURER						
MODEL						
	BY	DATE	NOTES			
INSTRUMENT ENGINEER	T.M.	8/13/96				
ENGINEERING APPROVAL	T.M.	8-13-96				
PROJECT APPROVAL	F. Barb	8-13-96				
	REVISION	NO.	DATE	APP.	APP.	APP.

ATTACHMENT "B"

INSTRUMENT DATA SHEET  
DIFFERENTIAL PRESSURE GAUGES

LIGO  
V049-2-088, Rev 1

TAG NUMBER	FI-604	FI-654	FI-704	FI-804		
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006		
LINE NUMBER	692	695	733	833		
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN		
FLUID	GAS	GAS	GAS	GAS		
PRESSURE PSIG	10	10	10	10		
TEMPERATURE DEGREES F	-5 to 95	-5 to 95	-5 to 95	-5 to 95		
MOUNTING	SURFACE	SURFACE	SURFACE	SURFACE		
DIAL SIZE	4.5 inches	4.5 inches	4.5 inches	4.5 inches		
ELEMENT TYPE	DIAPHRAM	DIAPHRAM	DIAPHRAM	DIAPHRAM		
RANGE IN H <sub>2</sub> O	0 to 25	0 to 25	0 to 25	0 to 25		
BODY MATERIAL	aluminum	aluminum	aluminum	aluminum		
BODY PRESSURE RATING PSIG	25	25	25	25		
MAXIMUM D.P. RATING IN H <sub>2</sub> O	25	25	25	25		
ELEMENT MATERIAL	Buna-N	Buna-N	Buna-N	Buna-N		
ELEMENT FILL	Dry	Dry	Dry	Dry		
PROCESS CONNECTIONS SIZE / TYPE	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT		
SCALE	0 to 12000	0 to 12000	0 to 12000	0 to 12000		
LEGEND	SCFH	SCFH	SCFH	SCFH		
ACCURACY, FULL SCALE	5%	5%	5%	5%		
QUANTITY	1	1	1	1		
MANUFACTURER						
MODEL						
	BY	DATE	NOTES			
INSTRUMENT ENGINEER	<i>TM</i>	8-13-96				
ENGINEERING APPROVAL	<i>TM</i>	8/13/96				
PROJECT APPROVAL	<i>F. Rank</i>	8-13-96				
	REVISION	NO.	DATE	APP.	APP.	APP.



Title:

**SPECIFICATION FOR LEVEL TRANSMITTERS**

**SPECIFICATION  
FOR  
LEVEL TRANSMITTERS  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY** Thomas Murphy

**ELECTRICAL** F. Bark

**QUALITY ASSURANCE** Alan R. Birdwood

**TECHNICAL DIRECTOR** D. C. McWeller

**PROJECT MANAGER** Barclay Bayly

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements and shall not be disclosed to any other party.

REV LTR	BY-DATE	APP.-DATE	DESCRIPTION OF ACTION
3	TM 10-2-96	F. Bark 10-2-96	Released For Purchase PER DED# 284
2	DP 9-6-96	F. Bark 9-6-96	RELEASED FOR PURCHASE PER DED# 0259
1	DP 7-26-96	F. Bark 8-7-96	RELEASED FOR QUOTE PER DED# 0233
0	TM 5-2-96	F. Bark 5-2-96	RELEASED FOR FDIR PER DED# 156

**PROCESS SYSTEMS INTERNATIONAL, INC**

**SPECIFICATION**

INITIAL APPROVALS	PREPARED BY <u>T. Murphy</u>	DATE <u>5-2-96</u>	APPROVED BY <u>F. Bark</u>	DATE <u>5-2-96</u>	Number <b>A V049-2-089</b>	Rev <b>3</b>
-------------------	---------------------------------	-----------------------	-------------------------------	-----------------------	-------------------------------	-----------------

Title:

**SPECIFICATION FOR LEVEL TRANSMITTERS**

**TABLE OF CONTENTS**

- 1.0 SCOPE
- 2.0 CODES AND STANDARDS
- 3.0 GENERAL REQUIREMENTS
- 4.0 MARKING
- 5.0 RESPONSIBILITY
- 6.0 REQUIRED DOCUMENTATION
- 7.0 INSPECTION
- 8.0 PREPARATION FOR SHIPMENT

**ATTACHMENTS**

- A) LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY
- B) DATA SHEET
- C) SPECIFICATION FOR EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS: SPEC.# V049-2-034

**SPECIFICATION**

Number

**A** V049-2-089

Rev

**3**

Title:

## SPECIFICATION FOR LEVEL TRANSMITTERS

### 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of instrumentation for the LIGO vacuum system.

The following specifications refer to the Buyer - Process Systems International (PSI), the Owner - California Institute of technology in partnership with Massachusetts Institute of Technology, under a grant from the National Science Foundation, and Vendor/Seller. The Vendor/Seller is the successful system bidder.

The Vendor shall be responsible for updating any and all references to codes and other standards to reflect the requirements of the latest editions in effect on date of purchase order except as noted.

All attachments are incorporated herein by reference and made a part of this specification.

### 2.0 CODES AND STANDARDS

#### 2.1 Priority of Codes and Standards

1. Codes
2. Standards
3. Data Sheets
4. This Specification

2.2 All conflicts shall be brought to the attention of PSI for a written resolution prior to award of a purchase order. If more than one document applies to a technical requirement, the more stringent requirement shall have precedence.

2.3 The assembly shall comply with applicable parts of latest editions of publications by the following organizations:

American National Standards Institute, Inc. (ANSI)

Code of Federal Regulations (CFR) Title 47, Part 15

Electrical Standards for Industrial Machinery (NFPA 79) unless otherwise indicated

## SPECIFICATION

Number

**A** V049-2-089

Rev

**3**

Title:

## SPECIFICATION FOR LEVEL TRANSMITTERS

Factory Mutual (FM)

Federal Communications Commission (FCC) Part 15

Institute of Electrical and Electronics Engineers (IEEE)

Insulated Cable Engineers Association (ICEA)

National Electric Code (NFPA 70)

National Electrical Manufacturers Association (NEMA)

Underwriter's Laboratories (UL) or equipment and installation standards by other nationally recognized testing companies

### 3.0 GENERAL REQUIREMENTS

- 3.1 The overall process and mechanical requirements for this specific application are given in data sheets attached to this specification.
- 3.2 The equipment shall be designed for a minimum serviceable life of 20 years.
- 3.3 Vendor shall specify all bolt torque requirements in the equipment operating and maintenance manual.
- 3.4 Instrumentation shall be of industrial quality and shall be subject to the acceptance of the Buyer.
- 3.5 External carbon steel surfaces shall be cleaned and painted. The Vendor's standard is acceptable if it meets specification requirements and is compatible with federal standard 209 class 50,000.

### 4.0 MARKING

Plates are to be stamped to show the following information:

- a. Manufacturer's name, catalog number
- b. Serial number
- c. Adjustable range
- d. Maximum working pressure
- e. Set range
- f. Output signal
- g. Tag number (as listed on attached data sheet)
- h. Tags may be permanently attached or attached with a stainless steel wire.

## SPECIFICATION

Number

**A** V049-2-089

Rev

**3.**

Title:

## SPECIFICATION FOR LEVEL TRANSMITTERS

### 5.0 RESPONSIBILITY

The Seller shall be completely responsible that the equipment and/or material furnished under this specification is of high quality in every respect, with first-class workmanship throughout and entirely suitable for the purpose outlined herein or reasonably inferred therefrom. Therefore, if any requirement of this specification is deemed by the Vendor/Seller to be unacceptable or technically incorrect, he shall specifically delineate his objections and the reasons therefore in his proposal so that they may be resolved before the order is placed. In all respects, the Seller, by accepting the order, shall be deemed to have agreed that conformance with the requirements of the specification will not prejudice in any way the Buyer's right under warranty.

### 6.0 REQUIRED DOCUMENTATION

Vendor shall furnish documentation in accordance with specific inquiry, requisition and purchase order requirements. All Vendor documents shall bear the purchase order number and PSI's equipment tag number. The following is a list of minimum documentation required:

#### 5.1 MECHANICAL DATA REQUIREMENTS

Outline dimension drawings and weight.

#### 5.2 MANUALS

Five (5) copies of operational/maintenance manuals.

#### 5.3 TEST REPORTS

Calibration report.

### 7.0 INSPECTION

The responsibility for inspection rests with the manufacturer; however, the Buyer, Owner, Government, and Owner representatives reserve the right to conduct a non-escort inspection of equipment at any time during fabrication to assure that the materials and workmanship are in accordance with this specification. This will include access to fabrication, assembly, cleaning and testing areas for the purpose of monitoring activities.

## SPECIFICATION

Number

**A** V049-2-089

Rev

**3**

Title:

## SPECIFICATION FOR LEVEL TRANSMITTERS

### 8.0 PREPARATION FOR SHIPMENT

- 8.1 Items shall be completely drained and dried.
- 8.2 Bolted connections shall be made up before shipment.
- 8.3 Aluminum plate shipping covers shall be attached with bolts to flanged connections, and with suitable attachments to other connections.
- 8.4 Units shall be completely covered for protection against the ambient and weather conditions expected during transportation. Units shall be adequately protected for unsheltered storage at the sites.
- 8.5 Shipping crates shall have the Buyer's purchase order number, Vendor's name and list of tag numbers or part numbers on the outside of each crate.

### SPECIFICATION

Number

**A** V049-2-089

Rev

**3**

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: LEVEL TRANSMITTERS	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-089
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	<u>Remarks:</u>  <u>Inspector:</u>  <u>Date:</u>
OPERATION & MAINTENANCE MANUALS				5		

## ATTACHMENT "B"

## INSTRUMENT DATA SHEET

LIGO

## LEVEL TRANSMITTER (DIFFERENTIAL PRESSURE TYPE)

V049-2-089, Rev 3

TAG NUMBER	LT-100		LT-150		LT-200		LT-250		
FLOW SHEET NO.	V049-0-006		V049-0-006		V049-0-006		V049-0-006		
LINE NUMBER	—		—		—		—		
SERVICE	NITROGEN		NITROGEN		NITROGEN		NITROGEN		
FLUID	LIQUID		LIQUID		LIQUID		LIQUID		
PRESSURE	PSIG	10 to 25		10 to 25		10 to 25		10 to 25	
TEMPERATURE	DEGREES F	15 to 96		15 to 96		15 to 96		15 to 96	
ADJUSTABLE RANGE	IN H <sub>2</sub> O	0 to 150		0 to 150		0 to 150		0 to 150	
CALIBRATED RANGE	IN H <sub>2</sub> O	41		41		41		41	
TYPE: CAPACITANCE / OTHER	CAPACITANCE		CAPACITANCE		CAPACITANCE		CAPACITANCE		
OUTPUT	4 to 20 mA		4 to 20 mA		4 to 20 mA		4 to 20 mA		
READOUT	% level		% level		% level		% level		
ENCLOSURE NEMA RATING REQD.	4		4		4		4		
MATERIAL: FLANGES / CAPSULE	CS	SST	CS	SST	CS	SST	CS	SST	
MATERIAL: NUTS & BOLTS	SST		SST		SST		SST		
PRESSURE RATING	PSIG	50		50		50		50	
MAXIMUM D.P. RATING	IN H <sub>2</sub> O	50		50		50		50	
CAPSULE FILL	Silicone		Silicone		Silicone		Silicone		
PROCESS CONNECTIONS	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
MINIMUM ACCURACY REQD.	0.25%		0.25%		0.25%		0.25%		
SMART ELECTRONICS REQD.	NO		NO		NO		NO		
MOUNTING BRACKET REQD.	YES		YES		YES		YES		
CONDUIT CONNECTION SIZE	1/2" NPT		1/2" NPT		1/2" NPT		1/2" NPT		
QUANTITY	1		1		1		1		
MANUFACTURER	Rosemount		Rosemount		Rosemount		Rosemount		
MODEL	1151DP 4 E 52 B4 Q4		1151DP 4 E 52 B4 Q4		1151DP 4 E 52 B4 Q4		1151DP 4 E 52 B4 Q4		
	BY		DATE		NOTES				
INSTRUMENT ENGINEER									
ENGINEERING APPROVAL									
PROJECT APPROVAL									
	REVISION		NO.		DATE		APP.	APP.	APP.



## ATTACHMENT "B"

## INSTRUMENT DATA SHEET

LIGO

## LEVEL TRANSMITTER (DIFFERENTIAL PRESSURE TYPE)

V049-2-089, Rev 3

TAG NUMBER	LT-300	LT-350	LT-400	LT-500		
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006		
LINE NUMBER	—	—	—	—		
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN		
FLUID	LIQUID	LIQUID	LIQUID	LIQUID		
PRESSURE PSIG	10 to 25	10 to 25	10 to 25	10 to 25		
TEMPERATURE DEGREES F	15 to 96	15 to 96	15 to 96	15 to 96		
ADJUSTABLE RANGE IN H <sub>2</sub> O	0 to 150	0 to 150	0 to 150	0 to 150		
CALIBRATED RANGE IN H <sub>2</sub> O	41	41	41	41		
TYPE: CAPACITANCE / OTHER	CAPACITANCE	CAPACITANCE	CAPACITANCE	CAPACITANCE		
OUTPUT	4 to 20 mA	4 to 20 mA	4 to 20 mA	4 to 20 mA		
READOUT	% level	% level	% level	% level		
ENCLOSURE NEMA RATING REQD.	4	4	4	4		
MATERIAL: FLANGES / CAPSULE	CS   SST	CS   SST	CS   SST	CS   SST		
MATERIAL: NUTS & BOLTS	SST	SST	SST	SST		
PRESSURE RATING PSIG	50	50	50	50		
MAXIMUM D.P. RATING IN H <sub>2</sub> O	50	50	50	50		
CAPSULE FILL	Silicone	Silicone	Silicone	Silicone		
PROCESS CONNECTIONS	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT		
MINIMUM ACCURACY REQD.	0.25%	0.25%	0.25%	0.25%		
SMART ELECTRONICS REQD.	NO	NO	NO	NO		
MOUNTING BRACKET REQD.	YES	YES	YES	YES		
CONDUIT CONNECTION SIZE	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT		
QUANTITY	1	1	1	1		
MANUFACTURER	Rosemount	Rosemount	Rosemount	Rosemount		
MODEL	1151DP 4 E 52 B4 Q4	1151DP 4 E 52 B4 Q4	1151DP 4 E 52 B4 Q4	1151DP 4 E 52 B4 Q4		
	BY	DATE	NOTES			
INSTRUMENT ENGINEER						
ENGINEERING APPROVAL						
PROJECT APPROVAL						
	REVISION	NO.	DATE	APP.	APP.	APP.









Title:

**SPECIFICATION FOR PRESSURE TRANSMITTERS**

**SPECIFICATION  
FOR  
PRESSURE TRANSMITTERS  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY** Thomas Murphy

**ELECTRICAL** F. Bank

**QUALITY ASSURANCE** Alan L. Bradbrook

**TECHNICAL DIRECTOR** D.A. McWilliam

**PROJECT MANAGER** Barbel Bagly

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements and shall not be disclosed to any other party.

REV LTR	BY-DATE	APP.-DATE	DESCRIPTION OF ACTION
4	TM 11-5-96	F. Bank 11-5-96	RELEASE FOR PURCHASE PER DED# 284
3	DP 9/6/96	F. Bank 9-6-96	RELEASE FOR PURCHASE PER DED# 0259
2	DP 7/29/96	F. Bank 8-7-96	RELEASE FOR QUOTE PER DED# 0233
1	TM 5/2/96	F. Bank 5-7-96	REVISED PER DED# 0179
0	TM 5-2-96	F. Bank 5-2-96	RELEASED FOR FDR PER DED# 156

<b>PROCESS SYSTEMS INTERNATIONAL, INC</b>				<b>SPECIFICATION</b>	
INITIAL APPROVALS	PREPARED BY	DATE	APPROVED BY	DATE	Number
	T. Murphy	5-2-96	F. Bank	5-2-96	A V049-2-090
					Rev 4

Title:

**SPECIFICATION FOR PRESSURE TRANSMITTERS**

**TABLE OF CONTENTS**

- 1.0 SCOPE
- 2.0 CODES AND STANDARDS
- 3.0 GENERAL REQUIREMENTS
- 4.0 MARKING
- 5.0 RESPONSIBILITY
- 6.0 REQUIRED DOCUMENTATION
- 7.0 INSPECTION
- 8.0 PREPARATION FOR SHIPMENT

**ATTACHMENTS**

- A) LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY
- B) DATA SHEET
- C) SPECIFICATION FOR EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS: SPEC.# V049-2-034

**SPECIFICATION**

Number

**A V049-2-090**

Rev

**4**

Title:

## SPECIFICATION FOR PRESSURE TRANSMITTERS

### 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of instrumentation for the LIGO vacuum system.

The following specifications refer to the Buyer - Process Systems International (PSI), the Owner - California Institute of technology in partnership with Massachusetts Institute of Technology, under a grant from the National Science Foundation, and Vendor/Seller. The Vendor/Seller is the successful system bidder.

The Vendor shall be responsible for updating any and all references to codes and other standards to reflect the requirements of the latest editions in effect on date of purchase order except as noted.

All attachments are incorporated herein by reference and made a part of this specification.

### 2.0 CODES AND STANDARDS

#### 2.1 Priority of Codes and Standards

1. Codes
2. Standards
3. Data Sheets
4. This Specification

2.2 All conflicts shall be brought to the attention of PSI for a written resolution prior to award of a purchase order. If more than one document applies to a technical requirement, the more stringent requirement shall have precedence.

2.3 The assembly shall comply with applicable parts of latest editions of publications by the following organizations:

American National Standards Institute, Inc. (ANSI)

Code of Federal Regulations (CFR) Title 47, Part 15

Electrical Standards for Industrial Machinery (NFPA 79) unless otherwise indicated

## SPECIFICATION

Number

**A** V049-2-090

Rev



Title:

## SPECIFICATION FOR PRESSURE TRANSMITTERS

Factory Mutual (FM)

Federal Communications Commission (FCC) Part 15

Institute of Electrical and Electronics Engineers (IEEE)

Insulated Cable Engineers Association (ICEA)

National Electric Code (NFPA 70)

National Electrical Manufacturers Association (NEMA)

Underwriter's Laboratories (UL) or equipment and installation standards by other nationally recognized testing companies

### 3.0 GENERAL REQUIREMENTS

- 3.1 The overall process and mechanical requirements for this specific application are given in data sheets attached to this specification.
- 3.2 The equipment shall be designed for a minimum serviceable life of 20 years.
- 3.3 Vendor shall specify all bolt torque requirements in the equipment operating and maintenance manual.
- 3.4 Instrumentation shall be of industrial quality and shall be subject to the acceptance of the Buyer.
- 3.5 External carbon steel surfaces shall be cleaned and painted. The Vendor's standard is acceptable if it meets specification requirements and is compatible with federal standard 209 class 50,000.

### 4.0 MARKING

Plates are to be stamped to show the following information:

- a. Manufacturer's name, catalog number
- b. Serial number
- c. Adjustable range
- d. Maximum working pressure
- e. Set range
- f. Output signal
- g. Tag number (as listed on attached data sheet)
- h. Tags may be permanently attached or attached with a stainless steel wire.

## SPECIFICATION

Number

**A** V049-2-090

Rev

2/

Title:

## SPECIFICATION FOR PRESSURE TRANSMITTERS

### 5.0 RESPONSIBILITY

The Seller shall be completely responsible that the equipment and/or material furnished under this specification is of high quality in every respect, with first-class workmanship throughout and entirely suitable for the purpose outlined herein or reasonably inferred therefrom. Therefore, if any requirement of this specification is deemed by the Vendor/Seller to be unacceptable or technically incorrect, he shall specifically delineate his objections and the reasons therefore in his proposal so that they may be resolved before the order is placed. In all respects, the Seller, by accepting the order, shall be deemed to have agreed that conformance with the requirements of the specification will not prejudice in any way the Buyer's right under warranty.

### 6.0 REQUIRED DOCUMENTATION

Vendor shall furnish documentation in accordance with specific inquiry, requisition and purchase order requirements. All Vendor documents shall bear the purchase order number and PSI's equipment tag number. The following is a list of minimum documentation required:

#### 5.1 MECHANICAL DATA REQUIREMENTS

Outline dimension drawings and weight.

#### 5.2 MANUALS

Five (5) copies of operational/maintenance manuals.

#### 5.3 TEST REPORTS

Calibration report.

### 7.0 INSPECTION

The responsibility for inspection rests with the manufacturer; however, the Buyer, Owner, Government, and Owner representatives reserve the right to conduct a non-escort inspection of equipment at any time during fabrication to assure that the materials and workmanship are in accordance with this specification. This will include access to fabrication, assembly, cleaning and testing areas for the purpose of monitoring activities.

## SPECIFICATION

Number

**A** V049-2-090

Rev

4

Title:

## SPECIFICATION FOR PRESSURE TRANSMITTERS

### 8.0 PREPARATION FOR SHIPMENT

- 8.1 Items shall be completely drained and dried.
- 8.2 Bolted connections shall be made up before shipment.
- 8.3 Aluminum plate shipping covers shall be attached with bolts to flanged connections, and with suitable attachments to other connections.
- 8.4 Units shall be completely covered for protection against the ambient and weather conditions expected during transportation. Units shall be adequately protected for unsheltered storage at the sites.
- 8.5 Shipping crates shall have the Buyer's purchase order number, Vendor's name and list of tag numbers or part numbers on the outside of each crate.

### SPECIFICATION

Number

**A** V049-2-090

Rev

4

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: PRESSURE TRANSMITTERS	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPEC NO.: V049-2-090
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	<u>Remarks:</u>  <u>Inspector:</u>  <u>Date:</u>
OPERATION & MAINTENANCE MANUALS				5		

**INSTRUMENT DATA SHEET  
PRESSURE TRANSMITTERS**

**LIGO  
V049-2-090 Rev 4**

TAG NUMBER	PT-101	PT-151	PT-201	PT-251	
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006	
LINE NUMBER	---	---	---	---	
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN	
FLUID	GAS	GAS	GAS	GAS	
PRESSURE PSIG	0 to 10	0 to 10	0 to 10	0 to 10	
TEMPERATURE DEGREES F	15 to 96	15 to 96	15 to 96	15 to 96	
ADJUSTABLE RANGE PSIG	0 to 30	0 to 30	0 to 30	0 to 30	
CALIBRATED RANGE PSIG	0 to 25	0 to 25	0 to 25	0 to 25	
OUTPUT	4 to 20 mA	4 to 20 mA	4 to 20 mA	4 to 20 mA	
READOUT	PSIG	PSIG	PSIG	PSIG	
ENCLOSURE NEMA RATING REQD.	1	1	1	1	
MATERIAL: PROCESS WETTED PARTS	SST	SST	SST	SST	
MATERIAL: ELECTRONICS HOUSING	ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM	
MATERIAL: NUTS & BOLTS	SST	SST	SST	SST	
PRESSURE RATING PSIG	25	25	25	25	
CAPSULE FILL	Silicone	Silicone	Silicone	Silicone	
PROCESS CONNECTIONS	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	
MINIMUM ACCURACY REQD.	0.25%	0.25%	0.25%	0.25%	
SMART ELECTRONICS REQD.	NO	NO	NO	NO	
MOUNTING BRACKET REQD.	YES	YES	YES	YES	
CONDUIT CONNECTION SIZE	1/2"	1/2"	1/2"	1/2"	
MANUFACTURER	Rosemount	Rosemount	Rosemount	Rosemount	
MODEL	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	
	<b>APPROVED</b>	<b>DATE</b>	<b>NOTES</b>		
INSTRUMENT ENGINEER	<i>TM 10-2-96</i>				
ENGINEERING APPROVAL					
PROJECT APPROVAL					
	<b>REVISION</b>	<b>NO.</b>	<b>DATE</b>	<b>APP.</b>	<b>APP.</b>

**INSTRUMENT DATA SHEET  
PRESSURE TRANSMITTERS**

**LIGO  
V049-2-090 Rev 4**

TAG NUMBER	PT-301	PT-351	PT-401	PT-501	
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006	
LINE NUMBER	—	—	—	—	
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN	
FLUID	GAS	GAS	GAS	GAS	
PRESSURE PSIG	0 to 10	0 to 10	0 to 10	0 to 10	
TEMPERATURE DEGREES F	15 to 96	15 to 96	15 to 96	15 to 96	
ADJUSTABLE RANGE PSIG	0 to 30	0 to 30	0 to 30	0 to 30	
CALIBRATED RANGE PSIG	0 to 25	0 to 25	0 to 25	0 to 25	
OUTPUT	4 to 20 mA	4 to 20 mA	4 to 20 mA	4 to 20 mA	
READOUT	PSIG	PSIG	PSIG	PSIG	
ENCLOSURE NEMA RATING REQD.	1	1	1	1	
MATERIAL: PROCESS WETTED PARTS	SST	SST	SST	SST	
MATERIAL: ELECTRONICS HOUSING	ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM	
MATERIAL: NUTS & BOLTS	SST	SST	SST	SST	
PRESSURE RATING PSIG	25	25	25	25	
CAPSULE FILL	Silicone	Silicone	Silicone	Silicone	
PROCESS CONNECTIONS	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	
MINIMUM ACCURACY REQD.	0.25%	0.25%	0.25%	0.25%	
SMART ELECTRONICS REQD.	NO	NO	NO	NO	
MOUNTING BRACKET REQD.	YES	YES	YES	YES	
CONDUIT CONNECTION SIZE	1/2"	1/2"	1/2"	1/2"	
MANUFACTURER	Rosemount	Rosemount	Rosemount	Rosemount	
MODEL	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	
	<b>APPROVED</b>	<b>DATE</b>	<b>NOTES</b>		
INSTRUMENT ENGINEER	<i>Tm 10-2-96</i>				
ENGINEERING APPROVAL					
PROJECT APPROVAL					
<b>REVISION</b>	<b>NO.</b>	<b>DATE</b>	<b>APP.</b>	<b>APP.</b>	<b>APP.</b>

**INSTRUMENT DATA SHEET  
PRESSURE TRANSMITTERS**

**LIGO**  
V049-2-090 Rev 4

TAG NUMBER	PT-601	PT-651	PT-701	PT-801	
FLOW SHEET NO.	V049-0-006	V049-0-006	V049-0-006	V049-0-006	
LINE NUMBER	—	—	—	—	
SERVICE	NITROGEN	NITROGEN	NITROGEN	NITROGEN	
FLUID	GAS	GAS	GAS	GAS	
PRESSURE PSIG	0 to 10	0 to 10	0 to 10	0 to 10	
TEMPERATURE DEGREES F	15 to 96	15 to 96	15 to 96	15 to 96	
ADJUSTABLE RANGE PSIG	0 to 30	0 to 30	0 to 30	0 to 30	
CALIBRATED RANGE PSIG	0 to 25	0 to 25	0 to 25	0 to 25	
OUTPUT	4 to 20 mA	4 to 20 mA	4 to 20 mA	4 to 20 mA	
READOUT	PSIG	PSIG	PSIG	PSIG	
ENCLOSURE NEMA RATING REQD.	1	1	1	1	
MATERIAL: PROCESS WETTED PARTS	SST	SST	SST	SST	
MATERIAL: ELECTRONICS HOUSING	ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM	
MATERIAL: NUTS & BOLTS	SST	SST	SST	SST	
PRESSURE RATING PSIG	25	25	25	25	
CAPSULE FILL	Silicone	Silicone	Silicone	Silicone	
PROCESS CONNECTIONS	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	
MINIMUM ACCURACY REQD.	0.25%	0.25%	0.25%	0.25%	
SMART ELECTRONICS REQD.	NO	NO	NO	NO	
MOUNTING BRACKET REQD.	YES	YES	YES	YES	
CONDUIT CONNECTION SIZE	1/2"	1/2"	1/2"	1/2"	
MANUFACTURER	Rosemount	Rosemount	Rosemount	Rosemount	
MODEL	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	2088G 1 A 22 A 1 B4 Q4	
	<b>APPROVED</b>	<b>DATE</b>	<b>NOTES</b>		
INSTRUMENT ENGINEER	<i>JM 10-7-06</i>				
ENGINEERING APPROVAL					
PROJECT APPROVAL					
	<b>REVISION</b>	<b>NO.</b>	<b>DATE</b>	<b>APP.</b>	<b>APP.</b>

3

3

3

Title:

**SPECIFICATION FOR TEMPERATURE ELEMENTS**

**SPECIFICATION  
FOR  
TEMPERATURE ELEMENTS  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY** Thomas Murphy

**ELECTRICAL** F. Bark

**QUALITY ASSURANCE** Alan L. Bealbrook

**TECHNICAL DIRECTOR** D. C. M. W. ...

**PROJECT MANAGER** Robert Bagly

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements and shall not be disclosed to any other party.


0	T.M. 5-2-96	F. Bark 5-2-96	RELEASED FOR FDR PER DED # 156
REV LTR	BY-DATE	APP.-DATE	DESCRIPTION OF ACTION

<b>PROCESS SYSTEMS INTERNATIONAL, INC</b>				<b>SPECIFICATION</b>		
INITIAL APPROVALS	PREPARED BY	DATE	APPROVED BY	DATE	Number	Rev
	T. Murphy	5-2-96	F. Bark	5-2-96	A V049-2-091	0



Title:

**SPECIFICATION FOR TEMPERATURE ELEMENTS**

**TABLE OF CONTENTS**

- 1.0 SCOPE
- 2.0 CODES AND STANDARDS
- 3.0 GENERAL REQUIREMENTS
- 4.0 MARKING
- 5.0 RESPONSIBILITY
- 6.0 REQUIRED DOCUMENTATION
- 7.0 INSPECTION
- 8.0 PREPARATION FOR SHIPMENT

ATTACHMENTS

- A) LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY
- B) DATA SHEET
- C) SPECIFICATION FOR EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS: SPEC.# V049-2-034

**SPECIFICATION**

Number

**A** V049-2-091

Rev

0

Title:

## SPECIFICATION FOR TEMPERATURE ELEMENTS

### 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of instrumentation for the LIGO vacuum system.

The following specifications refer to the Buyer - Process Systems International (PSI), the Owner - California Institute of technology in partnership with Massachusetts Institute of Technology, under a grant from the National Science Foundation, and Vendor/Seller. The Vendor/Seller is the successful system bidder.

The Vendor shall be responsible for updating any and all references to codes and other standards to reflect the requirements of the latest editions in effect on date of purchase order except as noted.

All attachments are incorporated herein by reference and made a part of this specification.

### 2.0 CODES AND STANDARDS

#### 2.1 Priority of Codes and Standards

1. Codes
2. Standards
3. Data Sheets
4. This Specification

2.2 All conflicts shall be brought to the attention of PSI for a written resolution prior to award of a purchase order. If more than one document applies to a technical requirement, the more stringent requirement shall have precedence.

2.3 The assembly shall comply with applicable parts of latest editions of publications by the following organizations:

American National Standards Institute, Inc. (ANSI)

Code of Federal Regulations (CFR) Title 47, Part 15

Electrical Standards for Industrial Machinery (NFPA 79) unless otherwise indicated

## SPECIFICATION

Number

**A** V049-2-091

Rev

○

Title:

## SPECIFICATION FOR TEMPERATURE ELEMENTS

Factory Mutual (FM)

Federal Communications Commission (FCC) Part 15

Institute of Electrical and Electronics Engineers (IEEE)

Insulated Cable Engineers Association (ICEA)

National Electric Code (NFPA 70)

National Electrical Manufacturers Association (NEMA)

Underwriter's Laboratories (UL) or equipment and installation standards by other nationally recognized testing companies

### 3.0 GENERAL REQUIREMENTS

- 3.1 The overall process and mechanical requirements for this specific application are given in data sheets attached to this specification.
- 3.2 The equipment shall be designed for a minimum serviceable life of 20 years.
- 3.3 Vendor shall specify all bolt torque requirements in the equipment operating and maintenance manual.
- 3.4 Instrumentation shall be of industrial quality and shall be subject to the acceptance of the Buyer.
- 3.5 External carbon steel surfaces shall be cleaned and painted. The Vendor's standard is acceptable if it meets specification requirements and is compatible with federal standard 209 class 50,000.

### 4.0 MARKING

Plates are to be stamped to show the following information:

- a. Manufacturer's name, catalog number
- b. Serial number
- c. Adjustable range
- d. Maximum working pressure
- e. Set range
- f. Output signal
- g. Tag number (as listed on attached data sheet)
- h. Tags may be permanently attached or attached with a stainless steel wire.

## SPECIFICATION

Number

**A** V049-2-091

Rev

0

5.0 RESPONSIBILITY

The Seller shall be completely responsible that the equipment and/or material furnished under this specification is of high quality in every respect, with first-class workmanship throughout and entirely suitable for the purpose outlined herein or reasonably inferred therefrom. Therefore, if any requirement of this specification is deemed by the Vendor/Seller to be unacceptable or technically incorrect, he shall specifically delineate his objections and the reasons therefore in his proposal so that they may be resolved before the order is placed. In all respects, the Seller, by accepting the order, shall be deemed to have agreed that conformance with the requirements of the specification will not prejudice in any way the Buyer's right under warranty.

6.0 REQUIRED DOCUMENTATION

Vendor shall furnish documentation in accordance with specific inquiry, requisition and purchase order requirements. All Vendor documents shall bear the purchase order number and PSI's equipment tag number. The following is a list of minimum documentation required:

5.1 MECHANICAL DATA REQUIREMENTS

Outline dimension drawings and weight.

5.2 MANUALS

Five (5) copies of operational/maintenance manuals.

5.3 TEST REPORTS

Calibration report.

7.0 INSPECTION

The responsibility for inspection rests with the manufacturer; however, the Buyer, Owner, Government, and Owner representatives reserve the right to conduct a non-escort inspection of equipment at any time during fabrication to assure that the materials and workmanship are in accordance with this specification. This will include access to fabrication, assembly, cleaning and testing areas for the purpose of monitoring activities.

**SPECIFICATION**

Number

**A** V049-2-091

Rev

0

Title:

## SPECIFICATION FOR TEMPERATURE ELEMENTS

### 8.0 PREPARATION FOR SHIPMENT

- 8.1 Items shall be completely drained and dried.
- 8.2 Bolted connections shall be made up before shipment.
- 8.3 Aluminum plate shipping covers shall be attached with bolts to flanged connections, and with suitable attachments to other connections.
- 8.4 Units shall be completely covered for protection against the ambient and weather conditions expected during transportation. Units shall be adequately protected for unsheltered storage at the sites.
- 8.5 The Vendor shall have a signed "Release for Shipment" form provided by the Buyer's Quality Assurance representative prior to full or partial shipment of product.
- 8.6 Shipping crates shall have the Buyer's purchase order number, Vendor's name and list of tag numbers or part numbers on the outside of each crate.

### SPECIFICATION

Number

**A** V049-2-091

Rev

0

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: TEMPERATURE ELEMENTS	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-091
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:  Inspector:  Date:
MILESTONE SCHEDULE						
VENDOR Q.A. PLAN						
PREP FOR SHIPMENT PROCEDURE						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
IN-PROCESS INSPECTIONS						Prior to release for fabrication.
OPERATION & MAINTENANCE MANUALS				5		
SHOP TEST PLAN						Prior to release for fabrication.
SHOP TEST (WITH REPORT)						Prior to release for shipment.



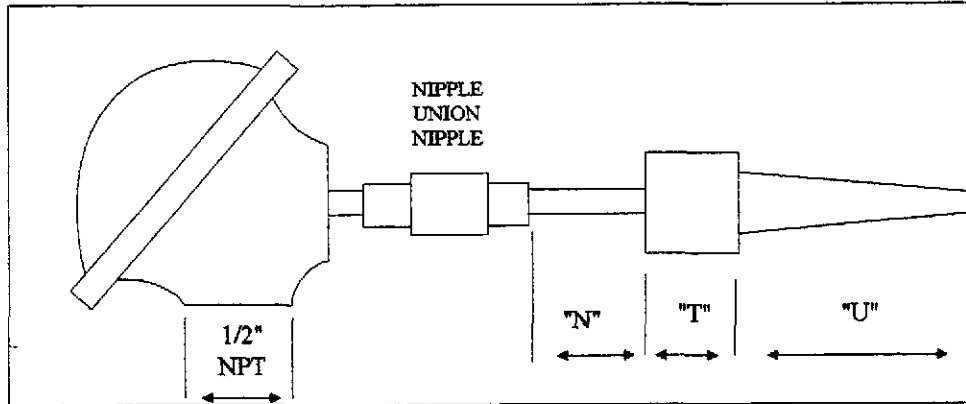




# ATTACHMENT "B"

INSTRUMENT DATA SHEET  
TEMPERATURE ELEMENTS

LIGO  
V049-2-091, Rev 0





**TABLE OF CONTENTS**

1.	Vacuum System Overview	Page
1.0	Interlock / Permissive Overview	3
1.1	Software Alarming Overview	3
1.2	Emergency Shutdown Overview	3

**(Attachment Index)**

<b>Washington Site Interlocks/Permissives</b>	<b>Attachment-A</b>
<b>Louisiana Site Interlocks / Permissives</b>	<b>Attachment-B</b>
<b>Washington Site Software Alarm Listing</b>	<b>Attachment-C</b>
<b>Louisiana Site Software Alarm Listing</b>	<b>Attachment-D</b>

**SPECIFICATION**

Number	Rev
<b>A V049-2-092</b>	<b>0</b>

**1 VACUUM CONTROL SYSTEM INTERLOCKS / PERMISSIVES / SOFTWARE ALARMS**

**1.0 INTERLOCK AND PERMISSIVE OVERVIEW**

See Attachment-A for details on Interlocks and Permissives for the Washington Site.  
See Attachment-B for details on Interlocks and Permissives for the Louisiana Site.

Attachments A and B contain a summary of all Vacuum Control System controlled device proposed interlocks and permissives.

**1.1 SOFTWARE ALARM OVERVIEW**

See Attachment C for a detailed Software Alarm Listing for the Washington Site.  
See Attachment D for a detailed Software Alarm Listing for the Louisiana Site.

Attachments C and D contain a listing of Vacuum Control System proposed software generated alarms only.

All hardwired alarm inputs into the Vacuum Control System are listed in the LIGO instrument list V049-1-036.

**1.2 EMERGENCY SHUTDOWN OVERVIEW**

A control system emergency shutdown function (ESD) should be provided at each site to bring all controlled devices to a safe state in the case of an emergency.

**SPECIFICATION**

Number	Rev
<b>A V049-2-092</b>	<b>0</b>

**ATTACHMENT-A  
WASHINGTON SITE  
PERMISSIVES  
AND  
INTERLOCKS**

**SPECIFICATION**

Number	Rev
<b>A V049-2-092 AT-A</b>	<b>0</b>

## V049-2-092 ATTACHMENT-A REV 0

### Washington site

#### LEGEND

BSCx	Beam splitter chamber number x
WCPx	Cryopump number x
WGVx	Gate valve number x
LBMT	Left Beam Manifold Tube
LMSBT	Left Mid Station Beam Tube
LESBT	Left End Station Beam Tube
RBMBT	Right Beam Manifold Beam Tube
RMSBT	Right Mid Station Beam Tube
RESBT	Right End Station Beam Tube
PT-xA	Pirani vacuum gauge number x with location
PT-xB	Ion vacuum gauge number x with location
HS-x	Hand switch number
(xxx)	P&ID V049-0-xxx drawing

#### LOGIC, CONTROL, LEGEND

"WL1"	Do not open valve unless the difference in absolute vacuum gauge pressure is within one decade (factor of 10 of each other).
"WL2"	Do not close valve when LASER is activate.
"WL3"	Reset controller after clearing fault condition, then restart.
"WL4"	If XY-xxx is deenergized, then deactivate corresponding LIC-xxx.
"WL5"	If TE-xxx is above <i>TBD</i> °F, then deactivate corresponding JC-xxx.

**WASHINGTON SITE**

**Beam tube valve—opening restrictions**

Input—Cause	Output—Effect WGV1 (013) HS-0119	WGV2 (013) HS-0129	WGV3 (014) HS-0139	WGV4 (014) HS-0149	WGV5 (012) HS-0129	WGV6 (012) HS-0169	WGV7 (015) HS-0179	WGV8 (015) HS-0189	WGV9 (011) HS-0209	WGV10 (011) HS-0219	WGV11 (011) HS-0229	WGV12 (011) HS-0239	WGV13 (016) HS-0309	WGV14 (016) HS-0319	WGV15 (016) HS-0329	WGV16 (016) HS-0339	WGV17 (010) HS-0409	WGV18 (010) HS-0419	WGV19 (017) HS-0509	WGV20 (017) HS-0519
PT-0120A&B, WBSC2 (002)	WL1																			
PT-0180A&B, WBSC8 (002)																				
PT-0120A&B, WBSC2 (002)		WL1																		
PT-0170A&B, WBSC7 (002)			WL1																	
PT-0140A&B, WBSC4 (002)				WL1																
PT-0140A&B, WBSC4 (002)					WL1															
PT-0170A&B, WBSC7 (002)																				
PT-0180A&B, WBSC8 (002)						WL1														
PT-0114A&B, WCP1 (012)																				
PT-0114A&B, WCP1 (012)																				
PT-0124A&B, LMBT (012)							WL1													
PT-0170A&B, WBSC7 (002)																				
PT-0134A&B, WCP2 (015)								WL1												
PT-0134A&B, WCP2 (015)																				
PT-0144A&B, RMBT (015)																				
PT-0144A&B, RMBT (015)																				

**WASHINGTON SITE**

**Beam tube valve—opening restrictions**

Input—Cause	Output—Effect WGV1 (013) HS-0119	WGV2 (013) HS-0129	WGV3 (014) HS-0139	WGV4 (014) HS-0149	WGV5 (012) HS-0129	WGV6 (012) HS-0169	WGV7 (015) HS-0179	WGV8 (015) HS-0189	WGV9 (011) HS-0209	WGV10 (011) HS-0219	WGV11 (011) HS-0229	WGV12 (011) HS-0239	WGV13 (016) HS-0309	WGV14 (016) HS-0319	WGV15 (016) HS-0329	WGV16 (016) HS-0339	WGV17 (010) HS-0409	WGV18 (010) HS-0419	WGV19 (017) HS-0509	WGV20 (017) HS-0519
PT-0243A&B, LMSBT (011) PT-0244A&B, WCP3 (011)									WL1											
PT-0244A&B, WCP3 (011) PT-0210A&B, WBSC6 (002)										WL1										
PT-0210A&B, WBSC6 (012) PT-0245A&B, WCP4 (011)											WL1									
PT-0245A&B, WCP4 (011) PT-0246A&B, LMSBT (011)												WL1								
PT-0343A&B, RMSBT (016) PT-0344A&B, WCP5 (016)													WL1							
PT-0344A&B, WCP5 (016) PT-0310A&B, WBSC5 (002)														WL1						
PT-0310A&B, WBSC5 (002) PT-0345A&B, WCP6 (016)															WL1					
PT-0345A&B, WCP6 (016) PT-0346A&B, RMSBT (016)																WL1				



**WASHINGTON SITE**

**Beam tube valve—opening restrictions**

Input—Cause	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect	Output—Effect		
	WGV1 (013) HS-0119	WGV2 (013) HS-0129	WGV3 (014) HS-0139	WGV4 (014) HS-0149	WGV5 (012) HS-0129	WGV6 (012) HS-0169	WGV7 (015) HS-0179	WGV8 (015) HS-0189	WGV9 (011) HS-0209	WGV10 (011) HS-0219	WGV11 (011) HS-0229	WGV12 (011) HS-0239	WGV13 (016) HS-0309	WGV14 (016) HS-0319	WGV15 (016) HS-0329	WGV16 (016) HS-0339	WGV17 (010) HS-0409	WGV18 (010) HS-0419	WGV19 (017) HS-0509	WGV20 (017) HS-0519	
PT-0423A&B, WCP7(010)																					
PT-0424A&B, LESBT (010)																	WL1				
PT-0424A&B, WCP7 (010)																		WL1			
PT- 0410A&B,WBS																					
PT-0523A&B, RESBT (017)																					
PT-0524A&B, WCP8 (017)																			WL1		
PT-0524A&B, WCP8 (017)																					
PT- 0510A&B,WBS																					WL1

**WASHINGTON SITE****Beam tube valve—closing restrictions**

Input—Cause	Output—Effect
LASER active	WGV1 (013) HS-0119
WL2	WGV2 (013) HS-0129
WL2	WGV3 (014) HS-0139
WL2	WGV4 (014) HS-0149
WL2	WGV5 (012) HS-0129
WL2	WGV6 (012) HS-0169
WL2	WGV7 (015) HS-0179
WL2	WGV8 (015) HS-0189
WL2	WGV9 (011) HS-0209
WL2	WGV10 (011) HS-0219
WL2	WGV11 (011) HS-0229
WL2	WGV12 (011) HS-0239
WL2	WGV13 (016) HS-0309
WL2	WGV14 (016) HS-0319
WL2	WGV15 (016) HS-0329
WL2	WGV16 (016) HS-0339
WL2	WGV17 (010) HS-0409
WL2	WGV18 (010) HS-0419
WL2	WGV19 (017) HS-0509
WL2	WGV20 (017) HS-0519

**WASHINGTON SITE**

**2500 L/S Ion pumps—fault & restart**

Input/Cause	Output/Effect	WIP1-1 (013) HS-0161A (START)	WIP1-2 (013) HS-0161C (START)	WIP2-1 (013) HS-0162A (START)	WIP2-2 (013) HS-0162C (START)	WIP3-1 (013) HS-0163A (START)	WIP3-2 (013) HS-0163C (START)	WIP4-1 (013) HS-0164A (START)	WIP4-2 (013) HS-0164C (START)	WIP5-1 (012) HS-0165A (START)	WIP5-2 (012) HS-0164C (START)	WIP6-1 (015) HS-0166A (START)	WIP6-2 (015) HS-0166C (START)	WIP7-1 (014) HS-0167A (START)	WIP7-2 (014) HS-0167C (START)	WIP8-1 (014) HS-0168A (START)	WIP8-2 (014) HS-0168C (START)
WIP1-1 (013), XA-161A WIP1-2 (013), XA-161B	WL3		WL3														
WIP2-1 (013), XA-162A WIP2-2 (013) XA-162B				WL3	WL3												
WIP3-1 (013) XA-163A WIP3-2 (013) XA-163B						WL3	WL3										
WIP4-1 (013) XA-164A WIP4-2 (013) XA-164B								WL3	WL3								
WIP5-1 (012) XA-165A WIP5-2 (012) XA-165B										WL3	WL3						
WIP6-1 (015) XA-166A WIP6-2 (015) XA-166B												WL3	WL3				
WIP7-1 (014) XA-167A WIP7-2 (014) XA-167B														WL3	WL3		
WIP8-1 (014) XA-168A WIP8-2 (014) XA-168B																WL3	WL3
WIP9-1 (011) XA-247A WIP9-2 (011) XA-247B																	
WIP10-1 (016) XA-347A WIP10-2 (016) XA-347B																	
WIP11-1 (0106) XA-422A WIP11-2 (010) XA-422B																	
WIP12-1 (0107) XA-522A WIP12-2 (017) XA-522B																	

**WASHINGTON SITE**  
**2500 L/S Ion pumps—fault & r**

Input/Cause	Output/Effect WIP9-1 (011) HS-0247A (START)	WIP9-2 (011) HS-0247C (START)	WIP10-1 (016) HS-0347A (START)	WIP10-2 (016) HS-0347C (START)	WIP11-1 (010) HS-0422A (START)	WIP11-2 (010) HS-0422C (START)	WIP12-1 (017) HS-0522A (START)	WIP12-2 (017) HS-0522C (START)
WIP1-1 (013), XA-161A WIP1-2 (013), XA-161B								
WIP2-1 (013), XA-162A WIP2-2 (013) XA-162B								
WIP3-1 (013) XA-163A WIP3-2 (013) XA-163B								
WIP4-1 (013) XA-164A WIP4-2 (013) XA-164B								
WIP5-1 (012) XA-165A WIP5-2 (012) XA-165B								
WIP6-1 (015) XA-166A WIP6-2 (015) XA-166B								
WIP7-1 (014) XA-167A WIP7-2 (014) XA-167B								
WIP8-1 (014) XA-168A WIP8-2 (014) XA-168B								
WIP9-1 (011) XA-247A WIP9-2 (011) XA-247B	WL3	WL3						
WIP10-1 (016) XA-347A WIP10-2 (016) XA-347B			WL3	WL3				
WIP11-1 (0106) XA-422A WIP11-2 (010) XA-422B					WL3	WL3		
WIP12-1 (0107) XA-522A WIP12-2 (017) XA-522B							WL3	WL3

**WASHINGTON SITE**  
**Crypump—liquid level control**

Input/Cause	Output/Effect	WCP1 (006), LIC-100	WCP2 (006), LIC-150	WCP3 (006), LIC-200	WCP4 (006), LIC-250	WCP5 (006), LIC-300	WCP6 (006), LIC-350	WCP7 (006), LIC-400	WCP8 (006), LIC-500
WCP1 (006) XY-100	WL4								
WCP2 (006) XY-150		WL4							
WCP3 (006) XY-200			WL4						
WCP4 (006) XY-250				WL4					
WCP5 (006) XY-300					WL4				
WCP6 (006) XY-350						WL4			
WCP7 (006) XY-400							WL4		
WCP8 (006) XY-500								WL4	

**WASHINGTON SITE**  
**Cryopump regen electric heater—SCR controller**

Input/Cause	Output/Effect	WCP1 (006), JC-103	WCP2 (006), JC-153	WCP3 (006), JC-203	WCP4 (006), JC-253	WCP5 (006), JC-303	WCP6 (006), JC-353	WCP7 (006), JC-403	WCP8 (006), JC-503
WCP1 (006) TE-103B/C	WL5								
WCP2 (006) TE-153B/C		WL5							
WCP3 (006) TE-203B/C			WL5						
WCP4 (006) TE-253B/C				WL5					
WCP5 (006) TE-303B/C					WL5				
WCP6 (006) TE-353B/C						WL5			
WCP7 (006) TE-403B/C							WL5		
WCP8 (006) TE-503B/C								WL5	

**ATTACHMENT-B**

**LOUISIANA SITE  
PERMISSIVES  
AND  
INTERLOCKS**

**SPECIFICATION**

Number

**A V049-2-092 AT-B**

Rev

**0**

## V049-2-092 ATTACHMENT-B REV 0

### Louisiana site

#### LEGEND

BSCx	Beam splitter chamber number x
LCPx	Cryopump number x
LGVx	Gate valve number x
LMBT	Left Manifold Beam Tube
LMJBT	Left Mid Joint Beam Tube
LESBT	Left End Station Beam Tube
RMBT	Right Manifold Beam Tube
RMJBT	Right Mid Joint Beam Tube
RESBT	Right End Station Beam Tube
PT-xA	Pirani vacuum gauge number x with location
PT-xB	Ion vacuum gauge number x with location
HS-x	Hand switch number
(xxx)	P&ID V049-0-xxx drawing
NIC	Not In Contract

#### LOGIC, CONTROL, LEGEND

"LL1"	Do not open valve unless the difference in absolute vacuum gauge pressure is within one decade (factor of 10 of each other).
"LL2"	Do not close valve when LASER is activate.
"LL3"	Reset controller after clearing fault condition, then restart.
"LL4"	If XY-xxx is deenergized, then deactivate corresponding LIC-xxx.
"LL5"	If TE-xxx is above TBD °F, then deactivate corresponding JC-xxx.



**LOUISIANA SITE**

**Beam tube valve—opening restrictions**

Input/Cause	Output	LGV1 (023) HS-0619	LGV2 (023) HS-0629	LGV3 (022) HS-0659	LGV4 (022) HS-0669	LGV5 (024) HS-0679	LGV6 (024) HS-0689	LGV7 (021) HS-0750	LGV8 (021) HS-0850	LGV9 (020) HS-0709	LGV10 (020) HS-0719	LGV11 (025) HS-0809	LGV12 (025) HS-0819
PT-0620A&B, LBSC2 (002) PT-0680A&B, LMBT (022)	LL1												
PT-0620A&B, LBSC2 (002) PT-0670A&B, RMBT (024)		LL1											
PT-0680A&B, LMBT (022) PT-0614A&B, LCP1 (022)				LL1									
PT-0614A&B, LCP1 (022) PT-0624A&B, LMBT (022)					LL1								
PT-0670A&B, RMBT (002) PT-0634A&B, LCP2 (024)						LL1							
PT-0634A&B, LCP2 (024) PT-0644A&B, RMBT (024)							LL1						
NIC, PT-0751A&B NMJBT (021) PT-0752A&B LMJBT (021)								LL1					

**LOUISIANA SITE**

**Beam tube valve—opening restrictions**

Input/Cause	Output	LGV1 (023) HS-0619	LGV2 (023) HS-0629	LGV3 (022) HS-0659	LGV4 (022) HS-0669	LGV5 (024) HS-0679	LGV6 (024) HS-0689	LGV7 (021) HS-0750	LGV8 (021) HS-0850	LGV9 (020) HS-0709	LGV10 (020) HS-0719	LGV11 (025) HS-0809	LGV12 (025) HS-0819
NIC PT-0851A&B RMJBT (021) PT-0852A&B, RMJBT (021)									LL1				
PT-0723A&B, LESBT (020) PT-0724A&B, LCP3 (002)										LL1			
PT-0724A&B, LCP3 (020) PT-0710A&B, LBSC5 (002)											LL1		
PT-0823A&B, RESBT (025) PT-0824A&B, LCP4 (025)												LL1	
PT-0824A&B, LCP4 (025) PT-0810A&B, LBSC4 (002)													LL1

**LOUISIANA SITE**

**Beam tube valve—closing restrictions**

Input/Cause	Output/Effect
LASER active	LGV1 (023) HS-0619
LL2	LGV2 (023) HS-0629
LL2	LGV3 (022) HS-0659
LL2	LGV4 (022) HS-0669
LL2	LGV5 (024) HS-0679
LL2	LGV6 (024) HS-0689
LL2	LGV7 (021) HS-0750
LL2	LGV8 (021) HS-0850
LL2	LGV9 (020) HS-0709
LL2	LGV10 (020) HS-0719
LL2	LGV11 (025) HS-0809
LL2	LGV12 (025) HS-0819

**LOUISIANA SITE**

**2500 L/S Ion pumps—fault & restart**

Input/Cause	Output/Effect	LIP1-1 (023) HS-0661A (START)	LIP1-2 (023) HS-0661C (START)	LIP2-1 (023) HS-0662A (START)	LIP2-2 (023) HS-0662C (START)	LIP3-1 (023) HS-0663A (START)	LIP3-2 (023) HS-0663C (START)	LIP4-1 (023) HS-0664A (START)	LIP4-2 (023) HS-0664C (START)	LIP5-1 (020) HS-0722A (START)	LIP5-2 (020) HS-0722C (START)	LIP6-1 (025) HS-0822A (START)	LIP6-2 (025) HS-0822C (START)
LIP1-1 (023) XA-661A	LL3												
LIP1-2 (023) XA-661B		LL3											
LIP2-1 (023) XA-662A			LL3										
LIP2-2 (023) XA-662B				LL3									
LIP3-1 (023) XA-663A					LL3								
LIP3-2 (023) XA-663B						LL3							
LIP4-1 (023) XA-664A							LL3						
LIP4-2 (023) XA-664B								LL3					
LIP5-1 (020) XA-722A									LL3				
LIP5-2 (020) XA-722B										LL3			
LIP6-1 (025) XA-822A												LL3	
LIP6-2 (025) XA-822B													LL3

**LOUISIANA SITE**

**Cryopump—liquid level control**

Input/Cause	Output/Effect	LCP1 (006), LIC-600	LCP2 (006), LIC-650	LCP3 (006), LIC-700	LCP4 (006), LIC-800
LCP1 (006) XY-600	LL4				
LCP2 (006) XY-650		LL4			
LCP3 (006) XY-700			LL4		
LCP4 (006) XY-800				LL4	

**LOUISIANA SITE**

**Crypump regen electric  
heater—SCR controller**

Input/Cause	Output/Effect	LCP1 (006), JC-603	LCP2 (006), JC-653	LCP3 (006), JC-703	LCP4 (006), JC-803
LCP1 (006) TE-803B/C	LL5				
LCP2 (006) TE-653B/C			LL5		
LCP3 (006) TE-703B/C				LL5	
LCP4 (006) TE-803B/C					LL5

Title: **SPECIFICATION FOR VACUUM CONTROL SYSTEM INTERLOCKS, PERMISSIVES  
AND SOFTWARE ALARMS**

**ATTACHMENT-C**

**WASHINGTON SITE  
SOFTWARE ALARM  
LISTING**

**SPECIFICATION**

Number	Rev
<b>A V049-2-092 AT-C</b>	<b>0</b>

WASHINGTON SITE SOFTWARE ALARM LISTING				RANGE SETTINGS			PROPOSED ALARMING		
V049-2-092 ATTACHMENT-C REV. 0				LOW RANGE	HIGH RANGE	UNITS	ALARM TRIP ELEMENT	TRIP SET POINT OR SWITCH TRIP ACTION	DELAY TIME (SECONDS)
TAG #	PID #	SERVICE DESCRIPTION	OFF-IND.	ON-IND.					
Cryopump WCP1									
LAH	100	006	Cryopump WCP1 High Level Alarm	0	100	%	LT-100	LT-100 >=98	
LAL	100	006	Cryopump WCP1 Low Level Alarm	0	100	%	LT-100	LT-100 <= 83	
PAH	101	006	Cryopump WCP1 High Pressure Alarm	0	25	PSIG	PT-101	PT-101 >= 10	
TAH	102	006	Cryopump WCP1 High Temp Alarm	-320	700	Deg F	TE-102	TE-102 >= 185	
TAH	103A	006	Cryopump WCP1 Heater High Temp Alarm	-320	700	Deg F	TE-103A	TE-103A >= 200	
TAH	103B	006	Cryopump WCP1 Heater High Temp Alarm	-320	700	Deg F	TE-103B/C	TE-103B >= TBD	
LAL	105	006	Dewer WCP1 Low Level Alarm	0	100	%	LT-105	LT-105 <= 10	
Cryopump WCP2									
LAH	150	006	Cryopump WCP2 High Level Alarm	0	100	%	LT-150	LT-150 >=98	
LAL	150	006	Cryopump WCP2 Low Level Alarm	0	100	%	LT-150	LT-150 <= 83	
PAH	151	006	Cryopump WCP2 High Pressure Alarm	0	25	PSIG	PT-151	PT-151 >= 10	
TAH	152	006	Cryopump WCP2 High Temp Alarm	-320	700	Deg F	TE-152	TE-152 >= 185	
TAH	153A	006	Cryopump WCP2 Heater High Temp Alarm	-320	700	Deg F	TE-153A	TE-153A >= 200	
TAH	153B	006	Cryopump WCP2 Heater High Temp Alarm	-320	700	Deg F	TE-153B/C	TE-153B >= TBD	
LAL	155	006	Dewer WCP2 Low Level Alarm	0	100	%	LT-155	LT-155 <= 10	
Cryopump WCP3									
LAH	200	006	Cryopump WCP3 High Level Alarm	0	100	%	LT-200	LT-200 >=98	
LAL	200	006	Cryopump WCP3 Low Level Alarm	0	100	%	LT-200	LT-200 <= 83	
PAH	201	006	Cryopump WCP3 High Pressure Alarm	0	25	PSIG	PT-201	PT-201 >= 10	
TAH	202	006	Cryopump WCP3 High Temp Alarm	-320	700	Deg F	TE-202	TE-202 >= 185	
TAH	203A	006	Cryopump WCP3 Heater High Temp Alarm	-320	700	Deg F	TE-203A	TE-203A >= 200	
TAH	203B	006	Cryopump WCP3 Heater High Temp Alarm	-320	700	Deg F	TE-203B/C	TE-203B >= TBD	
LAL	205	006	Dewer WCP3 Low Level Alarm	0	100	%	LT-205	LT-205 <= 10	
Cryopump WCP4									
LAH	250	006	Cryopump WCP4 High Level Alarm	0	100	%	LT-250	LT-250 >=98	
LAL	250	006	Cryopump WCP4 Low Level Alarm	0	100	%	LT-250	LT-250 <= 83	
PAH	251	006	Cryopump WCP4 High Pressure Alarm	0	25	PSIG	PT-251	PT-251 >= 10	
TAH	252	006	Cryopump WCP4 High Temp Alarm	-320	700	Deg F	TE-252	TE-252 >= 185	
TAH	253A	006	Cryopump WCP4 Heater High Temp Alarm	-320	700	Deg F	TE-253A	TE-253A >= 200	
TAH	253B	006	Cryopump WCP4 Heater High Temp Alarm	-320	700	Deg F	TE-253B/C	TE-253B >= TBD	
LAL	255	006	Dewer WCP4 Low Level Alarm	0	100	%	LT-255	LT-255 <= 10	



WASHINGTON SITE SOFTWARE ALARM LISTING				RANGE SETTINGS			PROPOSED ALARMING		
V049-2-092 ATTACHMENT-C REV. 0				LOW RANGE	HIGH RANGE	UNITS	ALARM TRIP ELEMENT	TRIP SET POINT OR SWITCH TRIP ACTION	DELAY TIME (SECONDS)
TAG #	PID #	SERVICE DESCRIPTION	OFF-IND.	ON-IND.					
Cryopump WCP5									
LAH	300	006	Cryopump WCP5 High Level Alarm	0	100	%	LT-300	LT-300 >=98	
LAL	300	006	Cryopump WCP5 Low Level Alarm	0	100	%	LT-300	LT-300 <= 83	
PAH	301	006	Cryopump WCP5 High Pressure Alarm	0	25	PSIG	PT-301	PT-301 >= 10	
TAH	302	006	Cryopump WCP5 High Temp Alarm	-320	700	Deg F	TE-302	TE-302 >= 185	
TAH	303A	006	Cryopump WCP5 Heater High Temp Alarm	-320	700	Deg F	TE-303A	TE-303A >= 200	
TAH	303B	006	Cryopump WCP5 Heater High Temp Alarm	-320	700	Deg F	TE-303B/C	TE-303B >= TBD	
LAL	305	006	Dewer WCP5 Low Level Alarm	0	100	%	LT-305	LT-305 <= 10	
Cryopump WCP6									
LAH	350	006	Cryopump WCP6 High Level Alarm	0	100	%	LT-350	LT-350 >=98	
LAL	350	006	Cryopump WCP6 Low Level Alarm	0	100	%	LT-350	LT-350 <= 83	
PAH	351	006	Cryopump WCP6 High Pressure Alarm	0	25	PSIG	PT-351	PT-351 >= 10	
TAH	352	006	Cryopump WCP6 High Temp Alarm	-320	700	Deg F	TE-352	TE-352 >= 185	
TAH	353A	006	Cryopump WCP6 Heater High Temp Alarm	-320	700	Deg F	TE-353A	TE-353A >= 200	
TAH	353B	006	Cryopump WCP6 Heater High Temp Alarm	-320	700	Deg F	TE-353B/C	TE-353B >= TBD	
LAL	355	006	Dewer WCP6 Low Level Alarm	0	100	%	LT-355	LT-355 <= 10	
Cryopump WCP7									
LAH	400	006	Cryopump WCP7 High Level Alarm	0	100	%	LT-400	LT-400 >=98	
LAL	400	006	Cryopump WCP7 Low Level Alarm	0	100	%	LT-400	LT-400 <= 83	
PAH	401	006	Cryopump WCP7 High Pressure Alarm	0	25	PSIG	PT-401	PT-401 >= 10	
TAH	402	006	Cryopump WCP7 High Temp Alarm	-320	700	Deg F	TE-402	TE-402 >= 185	
TAH	403A	006	Cryopump WCP7 Heater High Temp Alarm	-320	700	Deg F	TE-403A	TE-403A >= 200	
TAH	403B	006	Cryopump WCP7 Heater High Temp Alarm	-320	700	Deg F	TE-403B/C	TE-403B >= TBD	
LAL	405	006	Dewer WCP7 Low Level Alarm	0	100	%	LT-405	LT-405 <= 10	
Cryopump WCP8									
LAH	500	006	Cryopump WCP8 High Level Alarm	0	100	%	LT-500	LT-500 >=98	
LAL	500	006	Cryopump WCP8 Low Level Alarm	0	100	%	LT-500	LT-500 <= 83	
PAH	501	006	Cryopump WCP8 High Pressure Alarm	0	25	PSIG	PT-501	PT-501 >= 10	
TAH	502	006	Cryopump WCP8 High Temp Alarm	-320	700	Deg F	TE-502	TE-502 >= 185	
TAH	503A	006	Cryopump WCP8 Heater High Temp Alarm	-320	700	Deg F	TE-503A	TE-503A >= 200	
TAH	503B	006	Cryopump WCP8 Heater High Temp Alarm	-320	700	Deg F	TE-503B/C	TE-503B >= TBD	
LAL	505	006	Dewer WCP8 Low Level Alarm	0	100	%	LT-505	LT-505 <= 10	

**Title: SPECIFICATION FOR VACUUM CONTROL SYSTEM INTERLOCKS, PERMISSIVES  
AND SOFTWARE ALARMS**

**ATTACHMENT-D**

**LOUISIANA SITE  
SOFTWARE ALARM  
LISTING**

**SPECIFICATION**

Number

**A V049-2-092 AT-D**

Rev

**0**

LOUISIANA SITE SOFTWARE ALARM LISTING				RANGE SETTINGS			PROPOSED ALARMING		
V049-2-092 ATTACHMENT-D REV. 0				LOW RANGE	HIGH RANGE	UNITS	ALARM TRIP ELEMENT	TRIP SET POINT OR SWITCH TRIP ACTION	DELAY TIME (SECONDS)
				OFF-IND.	ON-IND.				
TAG #	PID #	SERVICE DESCRIPTION							
<b>Cryopump LCP1</b>									
LAH	600	006	Cryopump LCP1 High Level Alarm	0	100	%	LT-600	LT-600 >=98	
LAL	600	006	Cryopump LCP1 Low Level Alarm	0	100	%	LT-600	LT-600 <= 83	
PAH	601	006	Cryopump LCP1 High Pressure Alarm	0	25	PSIG	PT-601	PT-601 >= 10	
TAH	602	006	Cryopump LCP1 High Temp Alarm	-320	700	Deg F	TE-602	TE-602 >= 185	
TAH	603A	006	Cryopump LCP1 Heater High Temp Alarm	-320	700	Deg F	TE-603A	TE-603A >= 200	
TAH	603B	006	Cryopump LCP1 Heater High Temp Alarm	-320	700	Deg F	TE-603B/C	TE-603B >= TBD	
LAL	605	006	Dewer LCP1 Low Level Alarm	0	100	%	LT-605	LT-605 <= 10	
<b>Cryopump LCP2</b>									
LAH	650	006	Cryopump LCP2 High Level Alarm	0	100	%	LT-650	LT-650 >=98	
LAL	650	006	Cryopump LCP2 Low Level Alarm	0	100	%	LT-650	LT-650 <= 83	
PAH	651	006	Cryopump LCP2 High Pressure Alarm	0	25	PSIG	PT-651	PT-651 >= 10	
TAH	652	006	Cryopump LCP2 High Temp Alarm	-320	700	Deg F	TE-652	TE-652 >= 185	
TAH	653A	006	Cryopump LCP2 Heater High Temp Alarm	-320	700	Deg F	TE-653A	TE-653A >= 200	
TAH	653B	006	Cryopump LCP2 Heater High Temp Alarm	-320	700	Deg F	TE-653B/C	TE-653B >= TBD	
LAL	655	006	Dewer LCP2 Low Level Alarm	0	100	%	LT-655	LT-655 <= 10	
<b>Cryopump LCP3</b>									
LAH	700	006	Cryopump LCP3 High Level Alarm	0	100	%	LT-700	LT-700 >=98	
LAL	700	006	Cryopump LCP3 Low Level Alarm	0	100	%	LT-700	LT-700 <= 83	
PAH	701	006	Cryopump LCP3 High Pressure Alarm	0	25	PSIG	PT-701	PT-701 >= 10	
TAH	702	006	Cryopump LCP3 High Temp Alarm	-320	700	Deg F	TE-702	TE-702 >= 185	
TAH	703A	006	Cryopump LCP3 Heater High Temp Alarm	-320	700	Deg F	TE-703A	TE-703A >= 200	
TAH	703B	006	Cryopump LCP3 Heater High Temp Alarm	-320	700	Deg F	TE-703B/C	TE-703B >= TBD	
LAL	705	006	Dewer LCP3 Low Level Alarm	0	100	%	LT-705	LT-705 <= 10	
<b>Cryopump LCP4</b>									
LAH	800	006	Cryopump LCP4 High Level Alarm	0	100	%	LT-800	LT-800 >=98	
LAL	800	006	Cryopump LCP4 Low Level Alarm	0	100	%	LT-800	LT-800 <= 83	
PAH	801	006	Cryopump LCP4 High Pressure Alarm	0	25	PSIG	PT-801	PT-801 >= 10	
TAH	802	006	Cryopump LCP4 High Temp Alarm	-320	700	Deg F	TE-802	TE-802 >= 185	
TAH	803A	006	Cryopump LCP4 Heater High Temp Alarm	-320	700	Deg F	TE-803A	TE-803A >= 200	
TAH	803B	006	Cryopump LCP4 Heater High Temp Alarm	-320	700	Deg F	TE-803B/C	TE-803B >= TBD	
LAL	805	006	Dewer LCP4 Low Level Alarm	0	100	%	LT-805	LT-805 <= 10	

Title:

LIGO VACUUM EQUIPMENT; V59049

O RING SPECIFICATION

PROJECT ENGINEER A. Moten

TECHNICAL DIRECTOR D.O. McWilliam

QUALITY ASSURANCE A. R. Bradburn

PROJECT MANAGER Paul Bagley

Number

Rev

4	SM 10/9/96	D.M.W. 10-96	Released per DEU 0297
3	SM 9/17/96	D.M.W. 9-11-96	Released per DEU 0268
2	SM 8/21/96	D.M.W. 8-21-96	Released per DEU 0247
1	SM 7/16/96	D.M.W. 7-16-96	RELEASED PER DEU 0223
φ	SM 12/27/95	D.M.W. 12-96	RELEASED PER DEU 0035

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
----------	---------	------------	-----------------------

PROCESS SYSTEMS INTERNATIONAL, INC.

SPECIFICATION

INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number:	Rev.
	SM	12/27/95	<u>DEB</u>	12/27/95	A V049-2-045	4

Title

O RING SPEC. V049-2-045

SM LIGOV7.WB1

SERVICE : ULTRA HIGH VACUUM SEALS

MATERIAL: EXTRUDED CORD STOCK; CERTIFIED DUPONT VITON A-500

DUROMETER : 70-75

JOINTS : VULCANIZED SPLICE

CROSS-SECTION DIAMETER : 0.275 + - 0.006 INCHES

DEVELOPED LENGTH : SEE TABLE 1

SPECIAL REQUIREMENTS:

1. O RINGS SHALL BE SUPPLIED SUITABLE FOR ULTRA HIGH VACUUM SERVICE. ORINGS MUST BE SUPPLIED CONSISTENT WITH CLASS 100 CLEAN ROOM STANDARDS. HANDLING AND PACKAGING TO PREVENT CONTAMINATION FROM DIRT, HYDROCARBONS (OILS, GREASES, FINGERPRINTS ETC.), GRIT, CHIPS, MANUFACTURING RESIDUES, PARTICULATES (DUST, HAIR, LINT ETC.) IS REQUIRED. SUPPLIER MUST SUBMIT HANDLING AND PACKAGING PROCEDURES TO PSI, FOR APPROVAL, PRIOR TO MANUFACTURING O RINGS.
2. O RINGS SHALL BE INDIVIDUALLY PACKAGED IN SEALED PROTECTIVE POLYETHYLENE PLASTIC BAGS. BAGS SHALL BE PUNCTURE RESISTANT AND AIR TIGHT. BAGS SHALL BE MARKED WITH PART NO., FLANGE SIZE, CORD LENGTH, AND LOT NO.
3. O RINGS WILL BE VACUUM BAKED BY PSI TO REMOVE (OFF-GAS) WATER, VOLATILE COMPOUNDS, AND GASSES, REMAINING IN THE BULK VITON. BAKING WILL BE DONE AT 170 C (338 F) IN A PURE N2 ATMOSPHERE, AT A PRESSURE = 1 TORR, FOR A 12 HOUR DURATION.
4. PRIOR TO OBTAINING A RELEASE FOR SHIPMENT, VENDOR MUST CERTIFY THAT ALL SPLICED JOINTS HAVE BEEN VISUALLY INSPECTED AND TESTED IN ACCORDANCE WITH ASTM STANDARD D2527-83 (REAPPROVED 1992). JOINT CLASSIFICATION IS CLASS 3.

**SPECIFICATION**

Number	<b>A</b> V049-2-045	Rev.	<b>4</b>
--------	---------------------	------	----------

Page 2 of 3

Number

Rev.

Title

O RING SPEC. V049-2-045

SM LIGOV7.WB1

TABLE 1

PART NO.	FLANGE SIZE	CROSS SECT. INCHES	CORD LENGTH INCHES	REF. DWG.
V049M016	104	0.275 + - 0.006	337.5	V049-4-022
V049M017	104	0.275 + - 0.006	328.125	V049-4-022
V049M018	84	0.275 + - 0.006	274.375	V049-4-021
V049M019	84	0.275 + - 0.006	265.125	V049-4-021
V049M020	72	0.275 + - 0.006	237.125	V049-4-020
V049M021	72	0.275 + - 0.006	227.75	V049-4-020
V049M022	60	0.275 + - 0.006	200.625	V049-4-019
V049M023	60	0.275 + - 0.006	191.25	V049-4-019
V049M024	48	0.275 + - 0.006	162.5	V049-4-018
V049M025	48	0.275 + - 0.006	153.125	V049-4-018
V049M026	44.25	0.275 + - 0.006	150	V049-4-017
V049M027	44.25	0.275 + - 0.006	140.75	V049-4-017
V049M030 *	60	0.275 + - 0.006	213	V049-4-067
V049M031 *	60	0.275 + - 0.006	203.75	V049-4-067
V049M032	44.625	0.275 + - 0.006	151.25	V049-4-132
V049M033	44.625	0.275 + - 0.006	203.75	V049-4-132

\* BE-3A'S ONLY

Number

Rev.

**SPECIFICATION**

Number **A** V049-2-045 Rev. **4**

Page 3 of 3

Title: SPECIFICATION FOR STAINLESS STEEL VESSEL PLATE

**SPECIFICATION FOR  
STAINLESS STEEL VESSEL PLATE  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY: D. Curtis *D. Curtis*  
 STRUCTURAL ENGINEER: *R. D. Ciatto*  
 QUALITY ASSURANCE: *A. L. Budbrook*  
 TECHNICAL DIRECTOR: *D. A. McWilleen*  
 PROJECT MANAGER: *Robert Bagley*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
3	<i>REL. 7/30/96</i>	<i>ARB</i>	<i>Pg. 4 &amp; 5 REVISED SIZE OF P/N V049M174, WAS 1/4" X 54 X 192</i>
2	<i>REL. 5/7/96</i>		<i>REVISED SIZE OF P/N V049M155, WAS 1/4" X 72 X 229. DEO REVISED QTY. OF P/N V049M166, WAS QTY. 4</i>
1	<i>REL. 4/26/96</i>	<i>D.M.W.</i>	<i>RELEASED FOR FDR AND MAT'L PURCHASE 0142</i>
0	<i>D.M.W.</i>		<i>RELEASE PER DEO 0021 (MAT'L PROCUREMENT)</i>

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number
	<i>REL.</i>	<i>11/21/95</i>	<i>ARB</i>	<i>11/27/95</i>	<b>V049-2-041</b>
					Rev. <b>3</b>





## SPECIFICATION FOR STAINLESS STEEL VESSEL PLATE

## 1.0 SCOPE

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the plate to be used for manufacturing ultra high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

## 2.0 SCHEDULE AND DELIVERY

Plate shall be delivered in lots as follows:

PSI Part No.	Lot No.	Plate Size	Qty	Destination	Date
V049M149	1	1/4 x 84 x 254	2	PSI, Westborough	1 July 1996
V049M150	1	1/4 x 63 x 254	2	PSI, Westborough	1 July 1996
V049M151	1	1/4 x 80 x 144	2	PSI, Westborough	1 July 1996
V049M152	1	1/4 x 49 x 254	2	PSI, Westborough	1 July 1996
V049M153	1	1/4 x 62 x 192	2	PSI, Westborough	1 July 1996
V049M154	1	1/4 x 120 x 229	13	PSI, Westborough	1 July 1996
V049M155	1	3/8 x 96 x 230	1	PSI, Westborough	1 July 1996
V049M156	1	1/4 x 99 x 120	6	PSI, Westborough	1 July 1996
V049M157	1	1/4 x 90 x 98	4	PSI, Westborough	1 July 1996
V049M158	1	1/4 x 66 x 142	2	PSI, Westborough	1 July 1996
V049M159	1	1/4 x 96 x 142	1	PSI, Westborough	1 July 1996
V049P7815	14	1/2 x 76 x 270	7	PSI, Westborough	1 July 1996
V049P7817	14	1/2 x 62 x 195	6	PSI, Westborough	1 July 1996
V049M163	1	1/4 x 72 x 154	4	PSI, Westborough	1 July 1996
V049M164	1	1/4 x 96 x 229	1	PSI, Westborough	1 July 1996
V049M166	1	1/4 x 88 x 154	2	PSI, Westborough	1 July 1996
V049P7801	14	1/2 x 91 1/2 x 333	5	PSI, Westborough	1 July 1996
V049P7802	14	1/4 x 60 x 332	5	PSI, Westborough	1 July 1996
V049P7803	14	1/2 x 72 x 195	5	PSI, Westborough	1 July 1996

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

Page 3 of 9

Title

**SPECIFICATION FOR STAINLESS STEEL VESSEL PLATE**

PSI Part No.	Lot No.	Plate Size	Qty	Destination	Date	
V049M170	1	2.	1/4 x 40 x 144	2	PSI, Westborough	1 November 1996
V049M171	1	2.	1/4 x 84 x 229	2	PSI, Westborough	1 November 1996
V049M154	1	2.	1/4 x 120 x 229	2	PSI, Westborough	1 November 1996
V049M156	1	2.	1/4 x 99 x 120	6	PSI, Westborough	1 November 1996
V049M174	1	2.	1/4 x 57 x 192	2	PSI, Westborough	1 November 1996
V049M175	1	2.	1/4 x 70 x 229	8	PSI, Westborough	1 November 1996
V049M158	1	2.	1/4 x 66 x 142	2	PSI, Westborough	1 November 1996
V049M177	1	2.	3/8 x 96 x 192	2	PSI, Westborough	1 November 1996
V049M178	1	2.	1/4 x 88 x 142	2	PSI, Westborough	1 November 1996
V049M159	1	2.	1/4 x 96 x 142	2	PSI, Westborough	1 November 1996
V049M166	1	2.	1/4 x 88 x 154	2	PSI, Westborough	1 November 1996
V049P7815	14	2.	1/2 x 76 x 270	6	PSI, Westborough	1 November 1996
V049P7817	14	2.	1/2 x 62 x 195	6	PSI, Westborough	1 November 1996
V049P7801	14	2.	1/2 x 91 1/2 x 333	5	PSI, Westborough	1 November 1996
V049P7802	14	2.	1/4 x 60 x 332	5	PSI, Westborough	1 November 1996
V049P7803	14	2.	1/2 x 72 x 195	5	PSI, Westborough	1 November 1996
V049M152	1	2.	1/4 x 49 x 254	3	PSI, Westborough	1 November 1996

Number  
Rev.

<b>SPECIFICATION</b>		
Number	V049-2-041	Rev.
<b>A</b>		<b>3</b>

Title

**SPECIFICATION FOR STAINLESS STEEL VESSEL PLATE**

PSI Part No.	Lot No.	Plate Size	Qty.	Destination	Date
V049M174 1	3.	1/4 x 57 x 192	1	PSI, Westborough	1 February 1997
V049M175 1	3.	1/4 x 70 x 229	4	PSI, Westborough	1 February 1997
V049M149 1	3.	1/4 x 84 x 254	2	PSI, Westborough	1 February 1997
V049M150 1	3.	1/4 x 63 x 254	2	PSI, Westborough	1 February 1997
V049M152 1	3.	1/4 x 49 x 254	4	PSI, Westborough	1 February 1997
V049M170 1	3.	1/4 x 40 x 144	6	PSI, Westborough	1 February 1997
V049M157 1	3.	1/4 x 90 x 98	2	PSI, Westborough	1 February 1997
V049M156 1	3.	1/4 x 99 x 120	6	PSI, Westborough	1 February 1997
V049M154 1	3.	1/4 x 120 x 229	16	PSI, Westborough	1 February 1997
V049M159 1	3.	1/4 x 96 x 142	2	PSI, Westborough	1 February 1997
V049M198 1	3.	1/4 x 55 x 154	2	PSI, Westborough	1 February 1997
V049M164 1	3.	1/4 x 96 x 229	1	PSI, Westborough	1 February 1997
V049M153 1	3.	1/4 x 62 x 192	2	PSI, Westborough	1 February 1997
V049M177 1	3.	3/8 x 96 x 192	1	PSI, Westborough	1 February 1997
V049M158 1	3.	1/4 x 66 x 142	2	PSI, Westborough	1 February 1997
V049M155 1	3.	3/8 x 96 x 230	1	PSI, Westborough	1 February 1997
V049P7801 14	3.	1/2 x 91 1/2 x 333	5	PSI, Westborough	1 February 1997
V049P7802 14	3.	1/4 x 60 x 332	5	PSI, Westborough	1 February 1997
V049P7803 14	3.	1/2 x 72 x 195	5	PSI, Westborough	1 February 1997
V049P7817 14	3.	1/2 x 62 x 195	7	PSI, Westborough	1 February 1997
V049P7815 14	3.	1/2 x 76 x 270	7	PSI, Westborough	1 February 1997

Number

Rev.

<b>SPECIFICATION</b>		
Number	V049-2-041	Rev.
<b>A</b>		<b>3</b>

### 3.0 MATERIAL REQUIREMENTS

3.1 This material shall conform to the requirements of ASME Specification SA-240 Type 304/304L with the additional supplementary requirements described in this specification. The material is to be dual certified to meet the material grade of 304 and 304L.

#### 3.2 Applicable Codes

3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", the 1992 Edition with the 1994 Addenda.

3.2.2 ASTM A-480, "Standard Specification for General Requirements for Flat-Roll Stainless and Heat-Resisting Steel Plate, Sheet, and Strip".

3.2.3 ASTM A-700, "Standard Packages for Packaging, marking, and Loading Methods for Steel Products for Domestic Shipment".

3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

### 4.0 MANUFACTURE

#### 4.1 Thickness Tolerance

The material shall be furnished in the thickness(es) specified in the purchase order. The thickness tolerance shall meet ASTM A-480 requirements.

#### 4.2 Width and Length Tolerance

The plate material shall be cut to the minimum size specified in the purchase order. The width and length plus tolerance of the finished material shall not exceed the tolerances specified in ASME SA-480 specification, the minus tolerance is 0.0 in..

#### 4.3 Surface Finish

Hot rolled, Annealed, and Pickled (HRAP) mill finish is acceptable.

#### 4.4 Chemistry and Mechanical Properties

The material shall meet the chemistry requirements as specified in SA 240 Type 304L, and the mechanical requirement of SA240 Type 304 material specification.

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

Page 6 of 9

4.4.1 The material shall be dual certified as type 304/304L.

4.5-- After final cleaning and pickling, no grinding with abrasive wheels, cloth or stones is permitted. No iron, carbon steel or other contaminants (such as grease, chloride compounds, oil hydrocarbons) to come in contact with the plate.

#### 4.6 Cleanliness

This material is intended for use in a high vacuum application. Potential hydrocarbon contamination shall be eliminated. Also, the material shall be wrapped and covered at all times the material is not being processed to minimize possible exposure to contaminants. The plate shall be cleaned prior to shipment.

### 5.0 MATERIAL TESTING

5.1 A 2" wide coupon, the width of one plate is to be supplied for each heat number supplied. The coupon must be pickled the same as the plate.

### 6.0 INSPECTION/WITNESS

6.1 The purchaser shall have the right to witness all manufacturing processes.

### 7.0 REJECTIONS AND REPAIR OF DEFECTS

7.1 No weld splices or repair welding is permitted to the material.

### 8.0 IDENTIFICATION

8.1 Identification of the material shall be maintained through all manufacturing processes.

8.2 If material identity is lost, the plate shall be requalified by making all tests that were required for the material or as indicated in this specification.

8.3 Marking the finished materials with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking one side only of the finished plate. All other marking methods must be approved by the purchaser prior to use. All plates shall be marked 6" in from both edges in one corner. When stacked for shipment, all markings shall be in the same corner for easy identification upon receipt at PSI. The minimum marking is to be the heat/lot number.

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

**9.0 DOCUMENTATION**

- 9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser a minimum of 48 hours prior to shipment of the material.
- 9.2 A record of the material thickness for each group of materials is required. Thickness shall be measured and recorded at both edges and the center of the plates.

**10.0 PACKAGING, STORING AND SHIPPING**

- 10.1 The material shall be packaged for shipment as described in ASTM A700-94, Section 11.3.3 and Figure 56 (wrapped package on skids) with the additional supplementary requirements as described herein.
- 10.2 The plate material shall be wrapped in waterproof polyethylene and covered with a tarp immediately after all steel processing operations have been completed to minimize contamination. The material shall remain packaged and covered until it is necessary to remove the covering and packaging material for further processing.
- 10.2 The material shall be shipped as specified in the purchase order.

**11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT**

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to all areas where material is being processed and stored.

Number  
Rev.

<b>SPECIFICATION</b>		
Number	V049-2-041	Rev.
<b>A</b>		<b>3</b>

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049
EQUIPMENT: Vacuum Vessel Plate	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-041
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:
						Date:
MILESTONE SCHEDULE			X	2	X	
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
WELDING PROCEDURES						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
CERTIFIED MATERIAL TEST REPORTS			X	2	X	
IN-PROCESS INSPECTIONS		X		2	X	
OPERATION & MAINTENANCE MANUALS						
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION		X		2	X	

**SPECIFICATION FOR  
STAINLESS STEEL FLANGE FORGINGS  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** D. Curtis *D. Curtis*

**STRUCTURAL ENGINEER:** R. O. Watts *R. O. Watts*

**QUALITY ASSURANCE:** A. R. Bradbrook *A. R. Bradbrook*

**TECHNICAL DIRECTOR:** D. A. McWilliam *D. A. McWilliam*

**PROJECT MANAGER:** Bruce Bagby *Bruce Bagby*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

6	REC 6/17/96	D.M.W.	DELETED P/N V049M248-1 E/V049M249-1 FROM SATS. 7 OF 10 & 9 OF 10. DEO #0201
5	REC 6/14/96	PFH/IEB 6/14/96	ADDED 1.97" OFFSET TO P/N V049M248-1 & V049M249-1 DEO #0197
4	REC 5/29/96	RES 5/30/96	ADDED ATTACHMENT "B" SIZE QUANTITIES REVISED FOR PURCHASE DEO #0189
3	REC 4/11/96	MES 4/11/96	REVISED TOLERANCES IN SECTION 4.0. ADDED SCHEDULE SECTION 2.0 DEO #0117
2	D.M.W. 3-15-95	REC FOR RB	REV SECT 3.5 (MAX SULFUR CONTENT) PER DEO #0094
1	REC 12/22/95	D.M.W.	REVISED SECT. 3.4, 3.5, 8.1, 9.1 DEO #0037
0	D.M.W.		ISSUED PER DEO #0021 (MAT'L PROCUREMENT)
REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE

PROCESS SYSTEMS INTERNATIONAL, INC.

**SPECIFICATION**

INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number <b>A V049-2-040</b>	Rev.  6
	<i>REC</i>	<i>11/21/95</i>	<i>RES</i>	<i>11/27/95</i>		



SPECIFICATION TABLE OF CONTENTS

- 1.0 Scope
- 2.0 Schedule of Deliveries
- 3.0 Material Requirements
- 4.0 Manufacture Requirements
- 5.0 Material Testing
- 6.0 Inspection/Witness
- 7.0 Rejections and Repair of Defects
- 8.0 Identification
- 9.0 Documentation
- 10.0 Packaging, Storing and Shipping
- 11.0 Non-escort Privileges and Inspection Right

Attachment A LIGO Quality Assurance Requirements Summary

Attachment B Schedule of Deliveries in Lots With Sizes and Quantities

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**

**1.0 SCOPE**

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the flange forgings to be used for manufacturing ultra high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

**2.0 SCHEDULE OF DELIVERIES**

2.1 Flange rings shall be delivered in lots with sizes and quantities as specified in Attachment "B".

**3.0 MATERIAL REQUIREMENTS**

3.1 This material shall conform to the requirements of ASME Specification SA-182 Grade F Type 304L as given in the ASME Code 1992 Edition through 1994 Addenda with the additional supplementary requirements described in this specification.

**3.2 Applicable Codes**

3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", 1992 Edition through 1994 Addenda.

3.2.2 ASTM A-700, "Standard Packages for Packaging, marking, and Loading Methods for Steel Products for Domestic Shipment".

3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

6

Page 3 of 10

**4.0 MANUFACTURE.****4.1 Thickness Tolerance, + .06 - 0**

The forgings shall be rough machined to the thickness(es) specified in the purchase order.

**4.2 ID/OD Tolerance, ID -.06+0, OD + .06-0**

The forgings shall be furnished in the diameters as specified in the purchase order.

4.2.1 The ID/OD are to be concentric within  $\pm 1/32$ ".

**4.3 Flatness Tolerance**

The machined forgings shall be flat to  $\pm 1/32$ " across the diameter.

**4.4 Surface Finish**

The surface finish of the forgings shall be 250/500 RMS on four sides.

**4.5 Chemistry and Mechanical Properties**

The material shall meet the chemistry and mechanical requirements as specified in SA 182 Grade F, 304L material specification. The final content of sulfur is to be limited to 0.006%.

**4.6 No grinding with abrasive wheels, cloths or stones is permitted. No iron carbon steel or other contaminants (such as grease, oil or hydrocarbons) to come in contact with the forging after the cleaning process. Machining fluids shall be water soluble and free of oil, sulfur, and chlorides.****4.7 Cleanliness**

The forgings are intended for use in a high vacuum application. Potential hydrocarbon contamination shall be eliminated.

**5.0 MATERIAL TESTING****5.1 2" x 2" material coupons for each heat of material, must be supplied to PSI for approval prior to release for shipment. The coupons are to be cut from the same heat number, lot and thickness of material to be supplied.**

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**Page 4 of 10

**SPECIFICATION FOR STAINLESS STEEL FLANGE FORGINGS**

Title

**6.0 INSPECTION/WITNESS**

- 6.1 The purchaser shall have the right to witness all manufacturing processes.
- 6.2 The purchaser shall be informed 5 working days before the forging material is formed.

**7.0 REJECTIONS AND REPAIR OF DEFECTS**

- 7.1 No weld splices or repair welding is permitted to the material and forgings.

**8.0 IDENTIFICATION**

- 8.1 Identification of the material shall be maintained through all manufacturing processes.
- 8.2 If material identity is lost, the forging shall be requalified by making all tests that were required for the material or as indicated in this specification.
- 8.3 Marking the finished materials with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking the outside only of the finished materials. All other marking methods must be approved by the purchaser prior to use.

**9.0 DOCUMENTATION**

- 9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser with the shipment of the material, and available for review during inspection visits prior to shipment.
- 9.2 A record of the material thickness for each flange forging is required.

**10.0 PACKAGING, STORING AND SHIPPING**

- 10.1 The material shall be cleaned and protected from contamination prior to shipment. The material shall be shipped covered in a closed trailer or tightly wrapped with a waterproof covering if shipped on an open bed.

**11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT**

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to fabrication, assembly, cleaning and test areas for the purpose of monitoring activities.

Number  
Rev.

**SPECIFICATION**

Number	A	V049-2-040	Rev.	6
--------	---	------------	------	---

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049
EQUIPMENT: Flange Forgings	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-040
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:  Date:
MILESTONE SCHEDULE			X	2	X	
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
WELDING PROCEDURES						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
CERTIFIED MATERIAL TEST REPORTS			X	2	X	
IN-PROCESS INSPECTIONS		X		2	X	
OPERATION & MAINTENANCE MANUALS						
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION		X		2	X	

pg. 6 of 10  
Rev. 6

ATTACHMENT "B"Schedule of Deliveries in Lots with Sizes and Quantities

Flange rings shall be delivered in lots as follows:

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	1	104.25 x 112.5 x 1.5	4	PSI Westboro	1 July 1996
V049M004-1	1	104.25 x 112.5 x 1.25	4	PSI Westboro	1 July 1996
V049M133-1	1	84.0 x 92.25 x 1.63	12	PSI Westboro	1 July 1996
V049M136-1	1	83.75 x 92.25 x 1.38	12	PSI Westboro	1 July 1996
V049M135-1	1	60.0 x 68.5 x 1.63	30	PSI Westboro	1 July 1996
V049M243-1	1	60.0 x 68.5 x 1.25	26	PSI Westboro	1 July 1996
V049M244-1	1	44.0 x 52.25 x 1.5	14	PSI Westboro	1 July 1996
V049M245-1	1	44.0 x 52.25 x 1.25	6	PSI Westboro	1 July 1996
V049M242-1	1	48.0 x 56.25 x 1.5	12	PSI Westboro	1 July 1996
V049M241-1	1	48.0 x 56.25 x 1.25	4	PSI Westboro	1 July 1996
V049M250-1	1	56.3 x 72.5 x 1.25	2	PSI Westboro	1 July 1996
V049M246-1	1	72.00 x 80.25 x 1.63	10	PSI Westboro	1 July 1996
V049M247-1	1	72.00 x 80.25 x 1.25	6	PSI Westboro	1 July 1996
Total			142		

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**Page 7 of 10

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	2	104.25 x 112.5 x 1.5	4	PSI Westboro	1 Nov. 1996
V049M004-1	2	104.25 x 112.5 x 1.25	4	PSI Westboro	1 Nov. 1996
V049M133-1	2	84.0 x 92.25 x 1.63	10	PSI Westboro	1 Nov. 1996
V049M136-1	2	83.75 x 92.25 x 1.38	10	PSI Westboro	1 Nov. 1996
V049M135-1	2	60.0 x 68.5 x 1.63	24	PSI Westboro	1 Nov. 1996
V049M243-1	2	60.0 x 68.5 x 1.25	26	PSI Westboro	1 Nov. 1996
V049M244-1	2	44.0 x 52.25 x 1.5	14	PSI Westboro	1 Nov. 1996
V049M245-1	2	44.0 x 52.25 x 1.25	4	PSI Westboro	1 Nov. 1996
V049M246-1	2	72.0 x 80.25 x 1.63	4	PSI Westboro	1 Nov. 1996
Total			100		

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**Page 8 of 10

**SPECIFICATION FOR STAINLESS STEEL FLANGE FORGINGS**

Title

Sheet 3 of 4

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	3	104.25 x 112.5 x 1.5	4	PSI Westboro	1 Feb. 1997
V049M004-1	3	104.25 x 112.5 x 1.25	4	PSI Westboro	1 Feb. 1997
V049M133-1	3	84.0 x 92.25 x 1.63	8	PSI Westboro	1 Feb. 1997
V049M136-1	3	83.75 x 92.25 x 1.38	8	PSI Westboro	1 Feb. 1997
V049M135-1	3	60.0 x 68.5 x 1.63	21	PSI Westboro	1 Feb. 1997
V049M243-1	3	60.0 x 68.5 x 1.25	11	PSI Westboro	1 Feb. 1997
V049M244-1	3	44.0 x 52.25 x 1.5	10	PSI Westboro	1 Feb. 1997
V049M245-1	3	44.0 x 52.25 x 1.25	2	PSI Westboro	1 Feb. 1997
V049M242-1	3	48.0 x 56.25 x 1.5	4	PSI Westboro	1 Feb. 1997
V049M250-1	3	56.3 x 72.5 x 1.25	1	PSI Westboro	1 Feb. 1997
V049M246-1	3	72.00 x 80.25 x 1.63	12	PSI Westboro	1 Feb. 1997
V049M247-1	3	72.00 x 80.25 x 1.25	8	PSI Westboro	1 Feb. 1997
Total			93		

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

6



<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	4	104.25 x 112.5 x 1.5	3	PSI Westboro	15 Apr. 1997
V049M004-1	4	104.25 x 112.5 x 1.25	3	PSI Westboro	15 Apr. 1997
V049M133-1	4	84.0 x 92.25 x 1.63	6	PSI Westboro	15 Apr. 1997
V049M136-1	4	83.75 x 92.25 x 1.38	6	PSI Westboro	15 Apr. 1997
V049M135-1	4	60.0 x 68.5 x 1.63	10	PSI Westboro	15 Apr. 1997
V049M244-1	4	44.0 x 52.25 x 1.5	10	PSI Westboro	15 Apr. 1997
V049M245-1	4	44.0 x 52.25 x 1.25	2	PSI Westboro	15 Apr. 1997
V049M246-1	4	72.00 x 80.25 x 1.63	2	PSI Westboro	15 Apr. 1997
Total			42		

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**Page 10 of 10

Title: SPECIFICATION FOR STAINLESS STEEL VESSEL HEADS

**SPECIFICATION FOR  
STAINLESS STEEL VESSEL HEADS  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** D. Curtis *D. Curtis*

**STRUCTURAL ENGINEER:** R. J. Liato *R. J. Liato*

**QUALITY ASSURANCE:** Alan J. Budbrook *Alan J. Budbrook*

**TECHNICAL DIRECTOR:** D. A. McWilliams *D. A. McWilliams*

**PROJECT MANAGER:** Richard Bagley *Richard Bagley*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
4	R.E.S. 6/20/96	D.M.W.	ADDED P/N V049m260-1 ADDED ATTACHMENT "B" DEO # 0209
3	R.E.S. 5/20/96	D.M.W.	REVISED SECTIONS 4.3, 4.5, 4.7, 4.8, 10.1 & 10.2 DEO # 0183
2	R.E.S. 4/8/96	D.M.W.	ADDED DELIVERY SCHEDULE DEO # 0115
1	R.E.S. 12/28/95	D.M.W.	REVISED SECT. 3.7 & 8.1 DEO # 0037
0	D.M.W.		ISSUE PER DEO 0021 (MAT'L. PROCUREMENT)

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number
	R.E.S.	11/21/95	R.E.S.	11/27/95	A V049-2-039
					Rev. 4

## SPECIFICATION TABLE OF CONTENTS

- 1.0 Scope
- 2.0 Schedule
- 3.0 Material Requirements
- 4.0 Manufacture Requirements
- 5.0 Material Testing
- 6.0 Inspection/Witness
- 7.0 Rejections and Repair of Defects
- 8.0 Identification
- 9.0 Documentation
- 10.0 Packaging, Storing and Shipping
- 11.0 Non-escort Privileges and Inspection Right

Attachment A LIGO Quality Assurance Requirements  
Summary

Attachment B Head End Prep. Details

Number

Rev.

## SPECIFICATION

Number

A

Rev.

4

V049-2-039

Page

2

of

8

## SPECIFICATION FOR STAINLESS STEEL VESSEL HEADS

## 1.0 SCOPE

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the heads to be used for manufacturing ultra-high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

## 2.0 SCHEDULE

2.1 Head delivery shall be as follows:

<u>ITEM NO.</u>	<u>PART NO.</u>	<u>ID.</u>	<u>QTY.</u>	<u>DELIVERY SITE</u>	<u>DATE</u>
1	V049M001-1	104.5	6	PSI, Westborough	19 July 1996
2	V049M001-1	104.5	6	PSI, Westborough	1 Nov. 1996
3	V049M001-1	104.5	3	PSI, Westborough	1 Feb. 1997
4	V049M010-1	104.5	6	PSI, Westborough	19 July 1996
5	V049M010-1	104.5	6	PSI, Westborough	1 Nov. 1996
6	V049M010-1	104.5	3	PSI, Westborough	1 Feb. 1997
7	V049M132-1	84.25	12	PSI, Westborough	19 July 1996
8	V049M132-1	84.25	12	PSI, Westborough	1 Nov. 1996
9	V049M132-1	84.25	12	PSI, Westborough	1 Feb. 1997
10	V049M002-1	60.5	14	PSI, Westborough	19 July 1996
11	V049M002-1	60.5	8	PSI, Westborough	1 Nov. 1996
12	V049M002-1	60.5	6	PSI, Westborough	1 Feb. 1997
13	V049M138-1	79.5	3	PSI, Westborough	19 July 1996
14	V049M260-1	79.5	3	PSI, Westborough	19 July 1996
15	V049M138-1	79.5	3	PSI, Westborough	1 Nov. 1996
16	V049M260-1	79.5	3	PSI, Westborough	1 Nov. 1996
17	V049M138-1	79.5	3	PSI, Westborough	1 Feb. 1997
18	V049M260-1	79.5	3	PSI, Westborough	1 Feb. 1997
19	V049M138-1	79.5	3	PSI, Westborough	15 Apr. 1997
20	V049M260-1	79.5	3	PSI, Westborough	15 Apr. 1997

## SPECIFICATION

Number

A

Rev.

4

V049-2-039

Page

3

of 3

Number

Rev.

### 3.0 MATERIAL REQUIREMENTS

- 3.1 This material shall conform to the requirements of ASME Specification SA-240 Type 304L with the additional supplementary requirements described in this specification. The material used shall be hot rolled, annealed and pickled. If the material is supplied dual certified to grade 304/304L, this will be acceptable to PSI.
- 3.2 Applicable Codes
- 3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", the 1992 Edition through the 1994 Addenda.
- 3.2.2 ASTM A-480, "Standard Specification for General Requirements for Flat-Roll Stainless and Heat-Resisting Steel Plate, Sheet, and Strip".
- 3.2.3 ASTM A-700, "Standard Packages for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment".
- 3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

Number

Rev.

## SPECIFICATION

Number

A

Rev.

4

V049-2-039

Page 4 of 8

4

## SPECIFICATION FOR STAINLESS STEEL VESSEL HEADS

**4.0 MANUFACTURE**

## 4.1 Thickness Tolerance

The heads shall be furnished in the minimum thickness(es) specified in the purchase order.

4.2 Circumference Tolerance  $\pm 1/8''$ 

## 4.3 Out-of-Round Tolerance = within 1/2% of head I.D.

4.4 Heads to be square trimmed by manufacturer to a flatness tolerance of  $\pm 1/8''$ .

## 4.5 Heads to be manufactured with or without center holes as specified in P.O.

## 4.6 Surface Finish.

Cold rolled and pickled surface finish is acceptable.

## 4.7 No grinding with abrasive wheels, cloth or stones is permitted after final cleaning. No iron, carbon steel or other contaminants (such as grease, oil, hydrocarbons or chlorides) to come in contact with the heads after the pickle process. Machining fluids shall be water soluble and free of oil and sulfur.

## 4.8 Cleanliness - After Pickling

The heads are intended for use in a high vacuum application. Potential hydrocarbon or chloride contamination shall be eliminated. Also, the material shall be wrapped and covered at all times with polyethylene sheet, for protection.

**5.0 MATERIAL TESTING**

## 5.1 2" x 2" material coupons must be supplied to PSI with shipment. The coupons are to be cut from the same heat number, lot and thickness of material to be supplied.

**6.0 INSPECTION/WITNESS**

## 6.1 The purchaser shall have the right to witness all manufacturing processes.

## 6.2 The purchaser shall be informed 5 working days before the head material is formed.

Number

Rev.

**SPECIFICATION**

Number

**A**

Rev.

**4**

V049-2-039

Page

**5**of **8**

## SPECIFICATION FOR STAINLESS STEEL VESSEL HEADS

**7.0 REJECTIONS AND REPAIR OF DEFECTS**

7.1 No weld splices or repair welding is permitted to the material or formed heads.

**8.0 IDENTIFICATION**

8.1 Identification of the material shall be maintained through all manufacturing processes.

8.2 If material identity of the heads is lost, they shall be requalified by making all tests that were required for the material or as indicated in this specification.

8.3 Marking the finished heads with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking the outside only of the finished materials. All other marking methods must be approved by the purchaser prior to use. All heads shall be marked in the straight flange area 2" up from the edge.

**9.0 DOCUMENTATION**

9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser with the shipment of the material and available for review during inspection visits prior to shipment.

9.2 A record of the material thickness for each head is required. Thickness shall be measured and recorded at both the knuckle and the center of the head.

**10.0 PACKAGING, STORING AND SHIPPING**

10.1 The head material shall be wrapped in waterproof polyethylene and covered with a tarp immediately after pickle processing operations have been completed to minimize contamination.

10.2 The heads shall be shipped wrapped in waterproof polyethylene and covered with tarps to prevent any roadway contamination.

**11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT**

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to fabrication, assembly, cleaning and test areas for the purpose of monitoring activities.

Number

Rev.

**SPECIFICATION**

Number

**A**

Rev.

**4**

Page VI 49-2-039

of 8

6

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049
EQUIPMENT: Vacuum Vessel Heads	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-039
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:
						Date:
MILESTONE SCHEDULE			X	2	X	
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
WELDING PROCEDURES						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
CERTIFIED MATERIAL TEST REPORTS				2	X	
IN-PROCESS INSPECTIONS		X		2	X	
OPERATION & MAINTENANCE MANUALS						
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION		X		2	X	

Pg 7 of 8

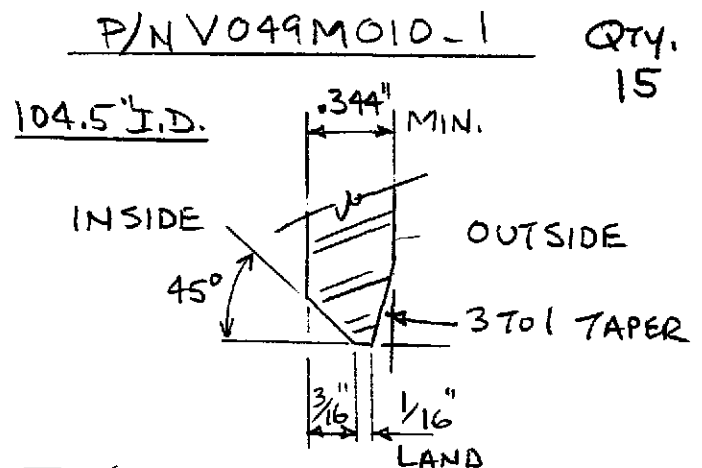
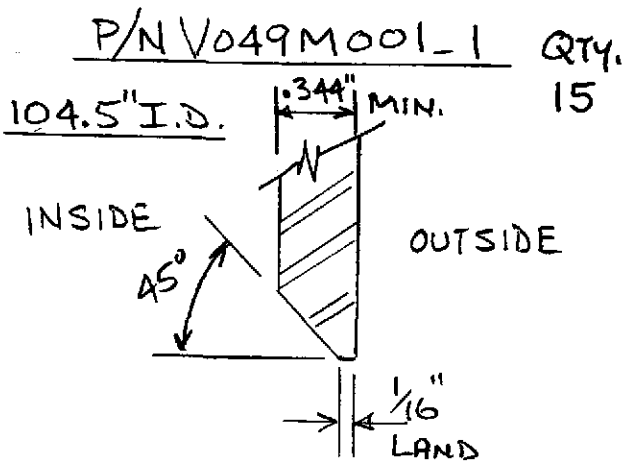
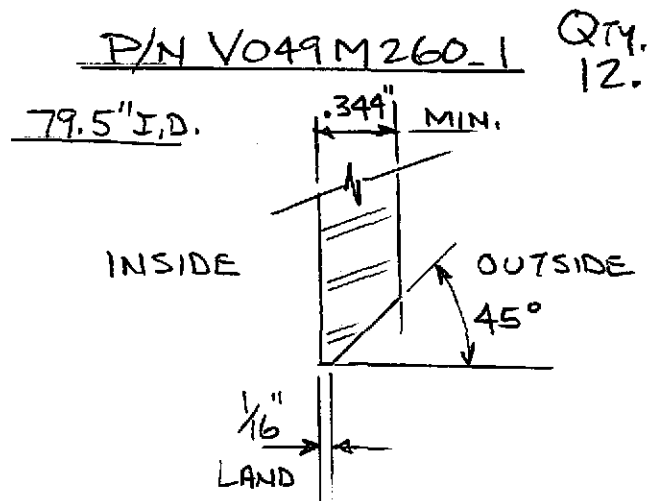
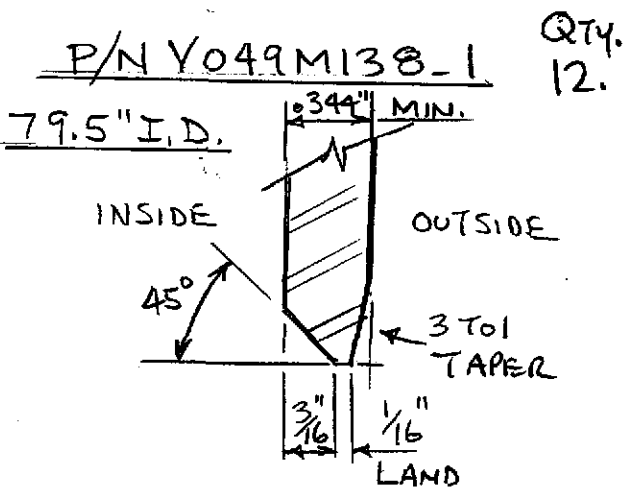
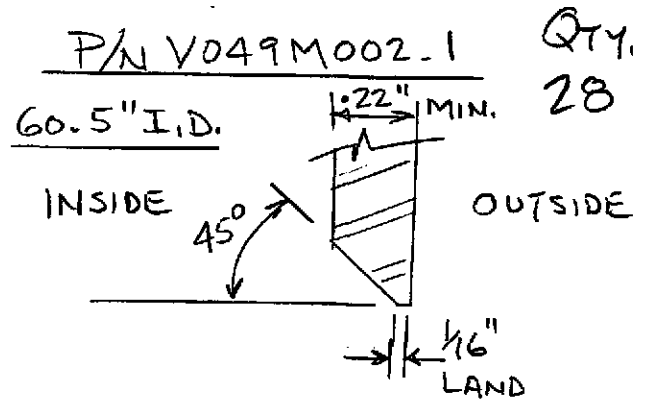
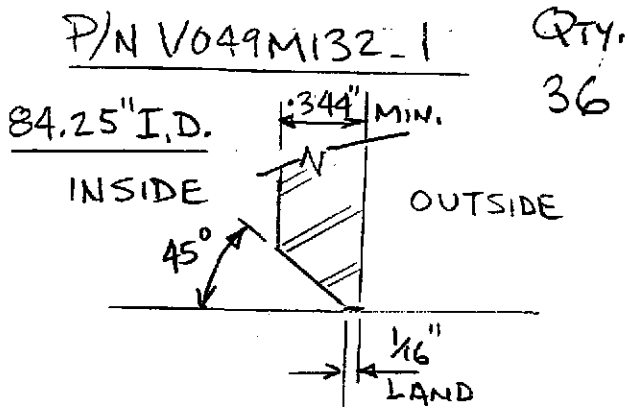
Spec. V049-2-039 Rev. 4.



# ATTACHMENT "B"

By: D. CURTIS 21 JUNE 96

## HEAD WELD PREP BEVELS BY HEAD MANUFACTURER





Title:

**SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

**SPECIFICATION FOR  
PIPING DESIGN AND MATERIAL  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
And  
Livingston, Louisiana

PROCESS ENGINEER: Robert Tham  
PROJECT ENGINEER: S. Motaw  
CIVIL/STRUC. ENGINEER: R. D. Watts  
MANUFACTURING ENGINEER: Phillip F. Jones  
QUALITY ASSURANCE ENGINEER: Alan S. Burdlock  
PROJECT MANAGER: Stan Rydz

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
3	BIR 10/16/96	D.M.W. 10-17-96	Added "CC", Spec. Sh. for cryogenic copper 1.125. REVISED 1B1-FLANGES DEO#0317
2	REL 8/24/96	PHW/REB 9/28/96	REVISED "T4" SPEC. SH. 17, ITEM 5. RELEASED FOR PURCHASE. DEO. 249
1	REL 7/26/96	ES 8/13/96	REVISED "T4" SPEC. SH. 17. RELEASED FOR PURCHASE DEO#0236
0	REL 1-19-96	D.M.W.	RELEASED FOR DESIGN & QUOTES DEO#0044
PROCESS SYSTEMS INTERNATIONAL, INC.			SPECIFICATION
INITIAL APPROVALS	PREPARED	DATE	APPROVED DATE
	R. Curtis	1-11-96	D.M.W. 1-18-96
Number			Rev.
AV049-2-037			3

TABLE OF CONTENTS

1.0	SCOPE
2.0	CODES AND STANDARDS
3.0	MATERIAL/MANUFACTURING REQUIREMENTS
4.0	EXAMINATION AND TESTING
5.0	LINE NUMBER SYSTEM
6.0	VALVE AND INSTRUMENT NUMBERING SYSTEM
7.0	PIPING DESIGN AND MATERIAL SPECIFICATIONS
1B1	150# CLASS STAINLESS STEEL 304 - CRYOGENIC
1B2	150# CLASS STAINLESS STEEL 304 - NON-CRYOGENIC
C2	TYPE "L" COPPER TUBING - GENERAL NON-CRYOGENIC
T1	316 STAINLESS STEEL TUBING - CRYOGENIC
T2	304 STAINLESS STEEL TUBING - GENERAL NON-CRYOGENIC
T3	304L STAINLESS STEEL TUBING - VACUUM
T4	304L STAINLESS STEEL TUBING - ULTRA HIGH VACUUM
T5	304L STAINLESS STEEL TUBING - CLASS 100 CLEAN AIR
VJ	304 STAINLESS STEEL - CRYOGENIC VACUUM JACKETED SEE SPEC. V049-2-016
C1	TYPE "L" COPPER TUBING - CRYOGENIC

ATTACHMENT A

LIGO QUALITY ASSURANCE SUMMARY

**SPECIFICATION**

Number

**A**

V036-2-037

Rev.

3

**1.0 SCOPE**

The following piping and material specifications define the piping and fittings to be used for the LIGO Vacuum Equipment.

**2.0 CODES AND STANDARDS****2.1 Priority of Codes and Standards**

Priority of documents shall be as follows:

1. Codes (highest priority)
2. This specification

**2.2 Applicable Codes and Standards**

ANSI - American National Standards Institute

B31.3 Chemical Plant and Petroleum Refinery Piping (for process piping only)

B31.5 Refrigeration Piping

B36.19 Stainless Steel Pipe

B16.5 Pipe Flanges and Flange Fittings

ASTM - American Society of Testing and Materials

A380-88 Standard Practice for Cleaning and Descaling  
Stainless Steel

E427-71(81) Standard Practice for Testing for Leaks Using the  
Halogen Leak Detector

E493-73(80) Standard Practice for Testing for Leaks Using the  
Mass Spectrometer Leak Detector in the inside-Out  
Testing Mode

E498-73(80) Standard Test Method for Leaks Using the Mass  
Spectrometer Leak Detector or Residual Gas  
Analyzer in the Tracer Probe Mode

E499-73(80) Standard Methods of Testing for Leaks Using the  
Mass Spectrometer Leak Detector Probe Mode

Number

Rev.

**SPECIFICATION**

Number **A** V049-2-037

Rev. **3**

Page **3** of **20**

**2.3 Specification Compliance**

The equipment shall comply with any drawings, data sheets, specifications, codes and standards (latest editions) referred to or attached as part of this specification. State or local codes or regulations, if applicable, will be provided as an attachment to this specification. The Vendor is responsible for compliance with such standards, specifications, codes and regulations, if attached.

**3.0 MATERIAL/MANUFACTURING REQUIREMENTS**

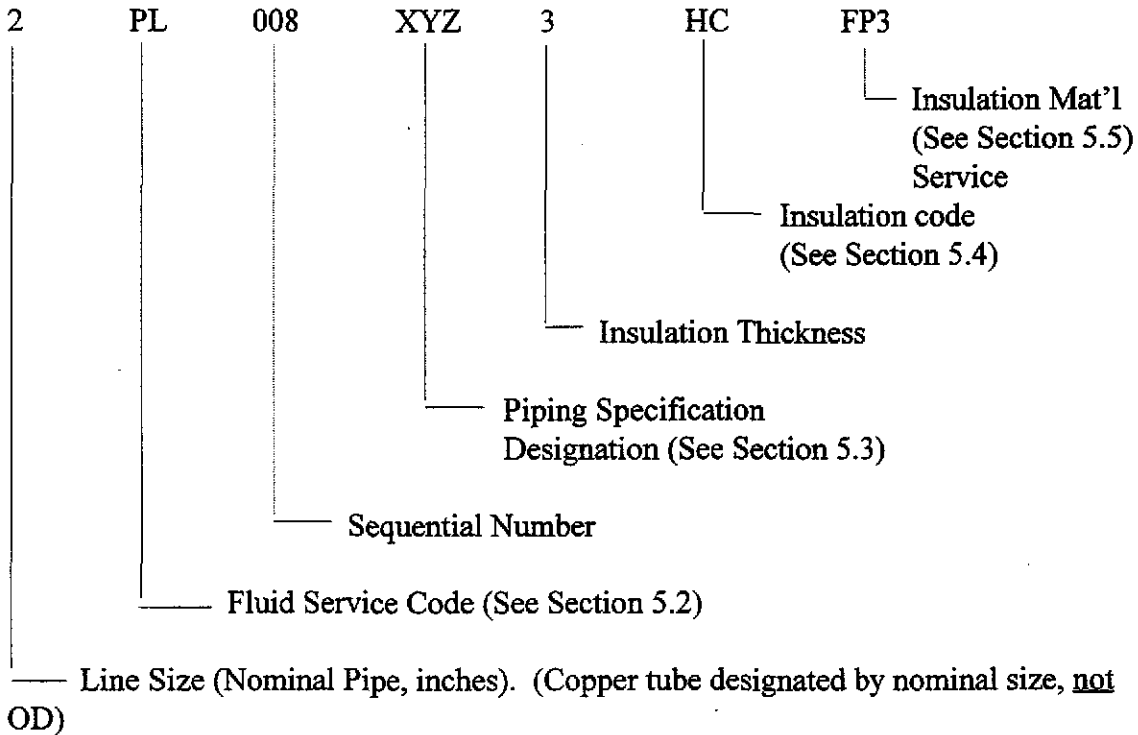
3.1 All materials used to manufacture the piping, tubing, flanges or fittings, as designated per this specification, are to be of U.S.A. origin and manufacture.

**4.0 EXAMINATION AND TESTING**

Examination and Pressure Testing as required by ANSI B31.3-1990 Chapter VI.

**5.0 LINE NUMBER SYSTEM**

4.1 Lines shall be numbered according to the following chart:



Number  
Rev.

**SPECIFICATION**

Number **A** V049-2-037 Rev. **3**

## 5.2 Fluid Codes

<u>Code</u>	<u>Fluid</u>
IA	Instrument Air
CA	Class 100 Clean Air
CWS	Cooling Water Supply
CWR	Cooling Water Return
NGS	Natural Gas Supply
LN2	Liquid Nitrogen
GN2	Gaseous Nitrogen
PV	Process Vacuum
PUV	Process Ultra High Vacuum
VA	Vent and Relief To ATM
N2	Nitrogen Gas
N	Nitrogen (Either Gas or Liquid)

## 5.3 Piping Specification Designation

4.4.1 "X" First Digit Identifiers

1 = 150 # ANSI

4.4.2 "Y" Second Digit Identifiers

A = 6061 T6 Aluminum  
 B = 304 Stainless Steel  
 C = Type L Copper Tubing  
 T = Stainless Steel Tubing

4.4.3 "Z" Third Digit Identifiers

1 = Cryogenic  
 2 = Non-Cryogenic  
 3 = Vacuum  
 4 = Ultra High Vacuum  
 5 = Class 100 Clean Air

## 5.4 Insulation Service

<u>Insulation Symbol</u>	<u>Insulation Service</u>
HC	Hot and Cold
C	Cold Conservation
PC	Personnel Protection COLD
PH	Personnel Protection HOT
VJ	Vacuum Jacketed

## SPECIFICATION

Number **A** V049-2-037Rev. **3**Page 5 of 20

Number

Rev.

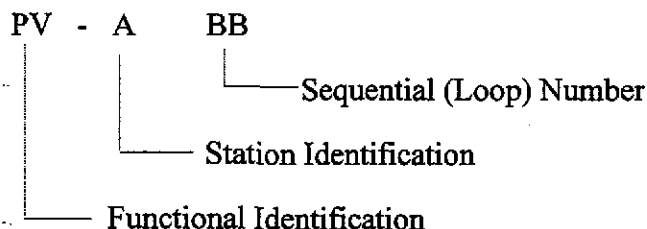
**5.5 Insulation Material Codes**

FP3	1" Fiberglass Inner	2" Polyisocyanurate Outer
FP3.5	1" Fiberglass Inner	2 1/2" Polyisocyanurate Outer
FP4	1" Fiberglass Inner	3" Polyisocyanurate Outer

If no insulation material code appears in the line number then it shall be understood that no insulation is required.

**6.0 VALVE AND INSTRUMENT NUMBER SYSTEM**

Control valves, manual valves and associated instruments shall be designated according to P&ID Drawing Symbols. If the required designation is not specified on the drawing, then ISA-S5.1, Table 1 will take precedence.



Manual valves that do not carry an instrument loop numbers (described above) shall be assigned one of the following valve type descriptions, preceded by the valve size in inches.

Type	Description
GVHV	Gate Valve, High Vacuum, SS, Viton Seals, Handwheel or Lever, CF Conn.
GVUH	Gate Valve, Ultra High Vacuum, SS, Viton Seals, Handwheel, CF Conn.
AVHV	Angle Valve, High Vacuum, SS, Viton Seals, Handwheel, ISOKF or K Conn.
AVUV	Angle Valve, Ultra High Vacuum, SS, Metal Seals, Handwheel, CF Conn.
IRV	Instrument Root Valve, SS
VJV	Vacuum Jacketed Valve, SS
BVCR	Ball Valve, Cryogenic, SS, 3 Piece
BVCA	Ball Valve, Class 100 Clean Air, SS, 3 Piece
GLV	Globe Valve
BVU	Ball Valve, Utility, Brass or Bronze
VSOV	Vacuum Seal-Off Valve, SS
VSOO	Vacuum Seal-Off Valve Operator, SS

**SPECIFICATION**Number **A** V049-2-037Rev. **3**Page **6** of **20**

Number

Rev.



Title

**SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

VSOV Vacuum Seal-Off Valve, SS  
 VSOO Vacuum Seal-Off Valve Operator, SS

1B1

**PIPING DESIGN AND MATERIAL SPECIFICATION**

Service: Cryogenic  
Primary Rating: 150# ANSI 304 SSTL

Design Conditions:  
 Pressure 0 to 192 psig  
 Temperature -320°F to 350°F  
 Corrosion Allowance Zero

Pipe:  
 12" and smaller ASTM A312 TP304

Pipe Schedule:  
 1 1/2" and smaller Schedule 10S SMLS  
 8" and smaller Schedule 10S SMLS or EFW  
 10" thru 12" Schedule 10S EFW

Note: Vacuum jacketed piping will be designed and fabricated in accordance with the manufacturer's standard, and PSI spec. V049-2-016.

Fittings:  
 1 1/2" and smaller Socket Welded 3000#  
 2" and larger Butt Weld  
 ASTM A403 WP304 WPS, WPW  
 O'Let's ASTM A182-F304

Flanges: Not allowed, except on atmospheric vent lines as indicated on P&ID's.

Valves: Valves shall be furnished under their own unique specification.

Continued on Next Page

Number  
Rev.

V036-2-037

**SPECIFICATION**

Number

**A**

Rev.

Title

# SPECIFICATION FOR PIPING DESIGN AND MATERIAL

1B1

### Branch Connections:

Run  
Size "

1/2	04												04 - Tee
3/4	06	04											05 - Sockolet
1	12	06	04										06 - Tee Then
1 1/2	05	05	06	04									Reducer or
2	05	05	06	06	04								Reducing Tee
3	05	05	05	05	06	04							12 - BW O'let
4	05	05	05	05	12	06	04						
6	05	05	05	05	12	12	06	04					
8	05	05	05	05	12	12	12	06	04				
10	05	05	05	05	12	12	12	12	06	04			
12	05	05	05	05	12	12	12	12	12	06	04		

Branch Size    1/2       3/4       1       1 1/2       2       3       4       6       8       10       12

Number

Rev.

## SPECIFICATION

Number **A** V049-2-037

Rev. **3**

Title

**SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

**1B2**

**PIPING DESIGN AND MATERIAL SPECIFICATION**

Service: Non-Cryogenic - Clean

Primary Rating: 150# ANSI 304 SSSL

Design Conditions:

Pressure 0 to 192 psig  
Temperature -20>°F to 350°F  
Corrosion Allowance Zero

Pipe:

12" and smaller ASTM A312 TP304

Pipe Schedule:

1 1/2" and smaller Schedule 10S SMLS  
8" and smaller Schedule 10S SMLS or EFW  
10" thru 12" Schedule 10S EFW

Fittings:

1 1/2" and smaller Socket Welded 3000#  
2" and larger Butt Weld  
ASTM A403 WP304 WPS, WPW  
Elbow O'Let ASTM A182-F304

Flanges: 2" and larger ANSI 150# RF, ASTM A182 F304, Weldneck with o-ring gaskets.

Gaskets: O-ring, Viton non-lubricated, cleaned and sealed for shipment.

Valves: Valves shall be furnished under their own unique specification.

Continued on next page.

Number

Rev.

**SPECIFICATION**

Number **A** V049-2-037

Rev. **3**

## 1B2

Branch Connections:Run  
Size "

1/2	04												04 - Tee
3/4	06	04											05 - Sockolet
1	12	06	04										06 - Tee Then
1 1/2	05	05	06	04									Reducer or
2	05	05	06	06	04								Reducing Tee
3	05	05	05	05	06	04							12 - BW O'let
4	05	05	05	05	12	06	04						
6	05	05	05	05	12	12	06	04					
8	05	05	05	05	12	12	12	06	04				
10	05	05	05	05	12	12	12	12	06	04			
12	05	05	05	05	12	12	12	12	12	06	04		
Branch Size	1/2	3/4	1	1 1/2	2	3	4	6	8	10	12		

## Note:

1. Piping and fittings to be internally cleaned, dried and ends sealed during shipping, storing and installation.
2. ID of pipe and fittings to be free of hydrocarbon contamination, or dirt. of any kind.
3. Surface finish to be standard white pickled ID and O.D.
4. Tube Bending - The following is not allowed: Sand packing, Mechanical scratches on tube I.D., Any type of lubricant.
5. Material manufactures certificate of compliance to applicable ASTM specifications are required and must accompany shipment.
6. Tubing, flanges and fittings to be etched or stamped with manufacturers name, part number and material type.

Number

Rev.

## SPECIFICATION

Number **A** V049-2-037Rev. **3**Page 10 of 20

Title

**SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

C2

**PIPING DESIGN AND MATERIAL SPECIFICATION**

Service: Gaseous Nitrogen, Cooling Water, Instrument Air

Design Conditions:

Pressure	200 PSIG
Temperature	-20°F to 150°F
Corrosion Allowance	Zero

Tube: All sizes Type "L" Copper - Hard Drawn ASTM B88, B280, Copper Tube designated by its Nominal sizes, not OD on P&ID's and piping drawings..

Note: Copper tube and fittings are to be specified on PSI BOM's by the actual O.D. of the tube.

Fittings: All sizes Wrought Copper ASTM B75  
All Fittings to be female solder cup ends.  
Brass Parker CPI tube fittings (or equal).

Unions: 1/4" to 1" Brass Parker CPI tube fittings (or equal) may also be used.

Valves: Valves shall be furnished under their own unique specification.

Soldering: All joints in wrought copper fittings shall be soldered using 95-5 Tin-Antimony.

Notes:

1. Tubing is to be internally cleaned and the ends sealed during shipping, storing and installation. Spools are to have all flux residue, grit, splatters or dirt removed before installation.
2. Fittings are to be cleaned after manufacturing and sealed in plastic during shipping, storing and installation.

Number

Rev.

**SPECIFICATION**

Number **A** V049-2-037

Rev. **3**

Title **SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

T1

**PIPING DESIGN AND MATERIAL SPECIFICATION**

Service: Cryogenic

Design Conditions:

Pressure 0 to 300 psig  
Temperature -320°F to 350°F  
Corrosion Allowance Zero

Tube:

All sizes ASTM A269 GR 304L SMLS  
Tube sizes designated by OD dimensions.

Tube Size (OD): Minimum Wall Thickness (Inches)

1/4"	0.035"
3/8"	0.035"
1/2"	0.049"
3/4"	0.049"
1"	0.065"

Fittings: All Fittings to be Parker Weld tube fittings SA479 or ASTM A276 GR TP316 and ASTM A182 GR TP316, or equal.

Valves: Valves shall be furnished under their own unique specification.

Note:

1. Tubing to be internally cleaned, dried and ends sealed during shipping, storing and installation. Tube ID to be free of hydrocarbon contamination.
2. Fittings to be cleaned after manufacturing and sealed in plastic bags during shipping, storing and installation.
3. Tubing surface finish to be standard white pickled I.D. & O.D.

Number  
Rev.

**SPECIFICATION**

Number	V049-2-037	Rev.
<b>A</b>		<b>3</b>

Title

**SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

T2

**PIPING DESIGN AND MATERIAL SPECIFICATION**

Service: Non-Cryogenic

Design Conditions:

Pressure	0 to 300 psig
Temperature	-20°F to 350°F
Corrosion Allowance	Zero

Tube:

All sizes	ASTM A269 GR TP304 SMLS Tube sizes designated by OD dimensions.
-----------	--

<u>Tube Size (OD):</u>	<u>Minimum Wall Thickness (Inches)</u>
------------------------	--

1/4"	0.035"
3/8"	0.035"
1/2"	0.049"
3/4"	0.049"
1"	0.065"

Fittings: All Fittings to be Parker A-LOK tube fittings SA479 or ASTM A276 GR TP316 and ASTM A182 GR TP316 or equal.

Valves: Valves shall be furnished under their own unique specification.

Note:

1. Tubing to be internally cleaned, dried and ends sealed during shipping, storing and installation. Tube ID to be free of hydrocarbon contamination.
2. Fittings to be cleaned after manufacturing and sealed in plastic bags during shipping, storing and installation.
3. Tubing surface finish to be standard white pickled I.D. & O.D.

Number
Rev.

**SPECIFICATION**

Number	V049-2-037	Rev.
<b>A</b>		<b>3</b>

Title

## SPECIFICATION FOR PIPING DESIGN AND MATERIAL

T3

## PIPING DESIGN AND MATERIAL SPECIFICATION

Service: Process VacuumDesign Conditions:

Pressure Vacuum  $10^{-5}$  Torr to 2 psig  
 Temperature -20°F to 150°F  
 Corrosion Allowance Zero

Tube: (Tube sizes designated by OD dimensions)

All sizes up to 1" ASTM A269 GR TP304L SMLS  
 1 1/2" and larger ASTM A26 GRTP304L SMLS or Welded.

<u>Tube Size (OD):</u>	<u>Minimum Wall Thickness (Inches)</u>	<u>Conflat Flange Size</u>	<u>No. Bolts</u>	<u>B.C. Dia.</u>	<u>Thru Hole Dia.</u>
1/4"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
3/8"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
1/2"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
3/4"	0.035"	2 1/8" Nom. O.D.	4	1.625"	.265"
1"	0.065"	2 3/4" Nom. O.D.	6	2.312"	.265"
1 1/2"	0.065"	2 3/4" Nom. O.D.	6	2.312"	.265"
2"	0.065"	3 3/8" Nom. O.D.	8	2.85"	.332"
2 1/2"	0.065"	4 1/2" Nom. O.D.	8	3.628"	.332"
4"	0.083"	6" Nom. O.D.	16	5.128"	.332"
6"	0.083	8" Nom. O.D.	20	7.128"	.332"
8"	0.120	10" Nom. O.D.	24	9.128"	.332"
10"	0.120	12" Nom. O.D.	32	11.181"	.332"
12"	0.120	14" Nom. O.D.	30	12.810"	.390"
14"	0.120	16 1/2" Nom. O.D.	36	15.310"	.390"

Flanges: All Flanges to be Conflat, ISO Large Flange or KF tube fittings 304L Stainless Steel.

Continued on next page.

## SPECIFICATION

Number	V049-2-037	Rev.
A		3

Page 14 of 20

Number

Rev.



## T3

Fittings: All fittings to be 304L butt weld or flanged O.D. tube, wall thickness to match tube wall thickness listed above.

Valves: Valves shall be furnished under their own unique specification.

## Notes:

1. Tubing to be internally cleaned, dried and ends sealed during shipping, storing and installation. Tube ID to be free of hydrocarbon contamination.
2. Fittings to be cleaned after manufacturing and sealed in plastic bags during shipping, storing and installation.
3. Tubing surface finish to be standard white pickled I.D. & O.D.
4. Tube Bending - The following is not allowed: Sand packing, Mechanical scratches on tube I.D., or any type of lubricant.
5. Material manufactures certificate of compliance to applicable ASTM specifications are required and must accompany shipment.
6. Tubing, flanges and fittings to be etched or stamped with manufacturers name, part number and material type.
7. Conflat flanges to be made from either electro slag remelt, vacuum remelt or cross forged material.

Number

Rev.

## SPECIFICATION

Number

A

V049-2-037

Rev.

3

Page 15 of 20

Title

## SPECIFICATION FOR PIPING DESIGN AND MATERIAL

T4

## PIPING DESIGN AND MATERIAL SPECIFICATION

Service: Process Ultra High VacuumDesign Conditions:

Pressure	Vacuum $10^{-10}$ Torr to 2 psig
Temperature	-20°F to 150°F
Corrosion Allowance	Zero

Tube: (Tube sizes designated by OD dimensions)

All sizes up to 1" 1 1/2" and larger	ASTM A269 GR TP304L SMLS ASTM A269 GRTP304L SMLS or welded.
---	--

<u>Tube Size (OD):</u>	<u>Minimum Wall Thickness (Inches)</u>	<u>Conflat Flange Size</u>	<u>No. Bolts</u>	<u>B.C. Dia.</u>	<u>Thru Hole Dia.</u>
1/4"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
3/8"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
1/2"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
3/4"	0.035"	2 1/8" Nom. O.D.	4	1.625"	.265"
1"	0.065"	2 3/4" Nom. O.D.	6	2.312"	.265"
1 1/2"	0.065"	2 3/4" Nom. O.D.	6	2.312"	.265"
2"	0.065"	3 3/8" Nom. O.D.	8	2.85"	.332"
2 1/2"	0.065"	4 1/2" Nom. O.D.	8	3.628"	.332"
4"	0.083"	6" Nom. O.D.	16	5.128"	.332"
6"	0.083"	8" Nom. O.D.	20	7.128"	.332"
8"	0.120"	10" Nom. O.D.	24	9.128"	.332"
10"	0.120"	12" Nom. O.D.	32	11.181"	.332"
12"	0.120"	14" Nom. O.D.	30	12.810"	.390"
14"	0.120"	16 1/2" Nom. O.D.	36	15.310"	.390"

Continued on next page.

## SPECIFICATION

Number

A

V049-2-037

Rev.

3

Page 16 of 20

Number

Rev.

## T4

**Flanges:** All Flanges to be Conflat, 304L Stainless Steel. Flanges with 1/2 nipples to have a minimum wall thickness per table (page 16), also see note 7.

**Fittings:** All fittings to be 304L butt weld or flanged O.D. tube. Wall thickness to match tube wall thickness listed in Table (Page 16).

**Valves:** Valves shall be furnished under their own unique specification. Valves whose seats form part of the UHV boundary shall be all metal.

**Cleaning:** Surfaces exposed to vacuum shall be cleaned and protected by PSI approved procedures suitable for UHV service.

## Note:

1. Tubing to be internally cleaned, dried and ends sealed during shipping, storing and installation. Tube ID to be free of hydrocarbon contamination.
2. Fittings and conflat - 1/2 nipples to be cleaned after manufacturing and sealed in plastic bags during shipping, storing and installation.
3. Tubing surface finish to be standard white pickled I.D. & O.D.
4. Material manufacturers Certificate of Compliance to applicable ASTM specifications are required and must accompany shipment.
5. Tubing, flanges and fittings to be etched or stamped with manufacturers name, part number, material type and customers PO number on the outside surface.
6. Conflats shall be made from 304L material suitable for ultra high vacuum service.
7. All welding exposed to vacuum shall be done by the tungsten-arc inert-gas (TIG) process. Exceptions may be allowed subject to PSI approval. Welding techniques shall be made in accordance with the best ultra high vacuum practice to eliminate any virtual leaks in the welds; i.e., all vacuum welds shall be, wherever possible, internal and continuous; all external welds added to these for structural purposes shall be intermittent to eliminate trapped volumes. Defective welds shall be repaired by removal to sound metal and rewelding. All vacuum weld procedures shall include steps to avoid contamination of the heat affected zone with air, hydrogen, or water. This requires that inert purge gas, such as argon, be used to flood the vacuum side of heated portions. Vendors to provide weld procedures, with weld cleaning procedures to PSI for approval.

Number

Rev.

## SPECIFICATION

Number

A

V049-2-037

Rev.

3

Page 17 of 20

Title

## SPECIFICATION FOR PIPING DESIGN AND MATERIAL

T5

## PIPING DESIGN AND MATERIAL SPECIFICATION

Service: Class 100 Clean AirDesign Conditions:

Pressure	Vacuum to 2 psig
Temperature	-20°F to 150°F
Corrosion Allowance	Zero

Tube: (Tube sizes designated by OD dimensions)

All sizes up to 1"	ASTM A269 GR TP304 SMLS
1 1/2" and larger	ASTM A269 GRTP304 SMLS or Welded.

Tube Size (OD):	Minimum Wall Thickness (Inches)	Conflat Flange Size	No. Bolts	B.C. Dia.	Thru Hole Dia.
1/4"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
3/8"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
1/2"	0.035"	1 1/3" Nom. O.D.	6	1.062"	.172"
3/4"	0.035"	2 1/8" Nom. O.D.	4	1.625"	.265"
1"	0.065"	2 3/4" Nom. O.D.	6	2.312"	.265"
1 1/2"	0.065"	2 3/4" Nom. O.D.	6	2.312"	.265"
2"	0.065"	3 3/8" Nom. O.D.	8	2.85"	.332"
2 1/2"	0.065"	4 1/2" Nom. O.D.	8	3.628"	.332"
4"	0.083"	6" Nom. O.D.	16	5.128"	.332"
6"	0.083"	8" Nom. O.D.	20	7.128"	.332"
8"	0.120"	10" Nom. O.D.	24	9.128"	.332"
10"	0.120"	12" Nom. O.D.	32	11.181"	.332"
12"	0.120"	14" Nom. O.D.	30	12.810"	.390"
14"	0.120"	16 1/2" Nom. O.D.	36	15.310"	.390"

Continued on next page.

## SPECIFICATION

Number

A

V049-2-037

Rev.

3

Page 18 of 20

Number

Rev.

**T5**

Flanges: All Flanges to be Conflat tube fittings 304 Stainless Steel.

Fittings: All Fittings to be 304 butt weld or flanged O.D. tube. Wall thickness to match the tube wall thickness.

Valves: Valves shall be furnished under their own unique specification

Cleaning: Internal surfaces shall be cleaned and protected by PSI approved procedures suitable for Class 100 air service.

Note:

1. Tubing to be internally cleaned, dried and ends sealed during shipping, storing and installation. Tube ID to be free of hydrocarbon contamination.
2. Fittings to be cleaned after manufacturing and sealed in plastic bags during shipping, storing and installation.
3. Tubing surface finish to be standard white pickled I.D. & O.D.
4. Material manufactures Certificate of Compliance to applicable ASTM specifications are required and must accompany shipment.
5. Tubing, flanges and fittings to be etched or stamped with manufacturers name, part number and material type.
6. Conflat flanges to be made from either electro slag remelt, vacuum remelt or crossforged material.

Number

Rev.

**SPECIFICATION**

Number **A** V049-2-037

Rev. **3**

Title:

**SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

C1

**PIPING DESIGN AND MATERIAL SPECIFICATION**

Service: Cryogenic

Design Conditions:

Pressure 150 PSIG

Temperature -320°F to 350°F

Corrosion Allowance None

Tube:

All sizes Type "L" Copper - Hard Drawn

ASTM B88, B280, copper tube designated by its nominal sizes, not OD (UON).

Fittings:

All sizes Wrought copper

ASTM B75

All fittings to be female solder cup ends.

Valves:

Valves shall be furnished under their own unique specification.

Brazing:

All joints shall be brazed using brazing alloy BCuP-5 (American Welding Society Designation). No flux is required.

**SPECIFICATION**

Number  
**A**

V036-2-037

Rev.  
**3**

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR:					JOB NO.: V59049
EQUIPMENT: PIPE, TUBING & FITTINGS	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-037
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:
						Date:
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
CERTIFICATE OF COMPLIANCE				2	X	

V049-2-002      *REV. 5*      *Pg. 20.*      SPEC V049-2-037

Title: SPECIFICATION FOR STAINLESS STEEL VESSEL HEADS

SPECIFICATION FOR  
STAINLESS STEEL VESSEL HEADS  
FOR  
LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY: D. Curtis  
 STRUCTURAL ENGINEER: R. D. Liato  
 QUALITY ASSURANCE: Alan J. Bealbrock  
 TECHNICAL DIRECTOR: D. A. McWilliams  
 PROJECT MANAGER: Richard Bagley

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
4	R.E.S. 6/20/96	D.M.W.	ADDED P/N V049m260-1 ADDED ATTACHMENT "B" DEO# 0209
3	R.E.S. 5/24/96	D.M.W.	REVISED SECTIONS 4.3, 4.5, 4.7, 4.8, 10.1 & 10.2 DEO# 0183
2	R.E.S. 4/8/96	D.M.W.	ADDED DELIVERY SCHEDULE DEO# 0115
1	R.E.S. 12/28/95	D.M.W.	REVISED SECT. 3.7 & 8.1 DEO# 0037.
0	D.M.W.		ISSUE PER DEO 0021 (MAT'L. PROCUREMENT)

ROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-039
	R.E.S.	11/21/95	R.E.S.	11/27/95	Rev. 4



## SPECIFICATION TABLE OF CONTENTS

- 1.0 Scope
- 2.0 Schedule
- 3.0 Material Requirements
- 4.0 Manufacture Requirements
- 5.0 Material Testing
- 6.0 Inspection/Witness
- 7.0 Rejections and Repair of Defects
- 8.0 Identification
- 9.0 Documentation
- 10.0 Packaging, Storing and Shipping
- 11.0 Non-escort Privileges and Inspection Right

Attachment A LIGO Quality Assurance Requirements  
Summary

Attachment B Head End Prep. Details

## SPECIFICATION

Number

A

Rev.

4

V049-2-039  
Page 2 of 8

Number

Rev.

## 1.0 SCOPE

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the heads to be used for manufacturing ultra-high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

## 2.0 SCHEDULE

2.1 Head delivery shall be as follows:

<u>ITEM NO.</u>	<u>PART NO.</u>	<u>I.D.</u>	<u>QTY.</u>	<u>DELIVERY SITE</u>	<u>DATE</u>
1	V049M001-1	104.5	6	PSI, Westborough	19 July 1996
2	V049M001-1	104.5	6	PSI, Westborough	1 Nov. 1996
3	V049M001-1	104.5	3	PSI, Westborough	1 Feb. 1997
4	V049M010-1	104.5	6	PSI, Westborough	19 July 1996
5	V049M010-1	104.5	6	PSI, Westborough	1 Nov. 1996
6	V049M010-1	104.5	3	PSI, Westborough	1 Feb. 1997
7	V049M132-1	84.25	12	PSI, Westborough	19 July 1996
8	V049M132-1	84.25	12	PSI, Westborough	1 Nov. 1996
9	V049M132-1	84.25	12	PSI, Westborough	1 Feb. 1997
10	V049M002-1	60.5	14	PSI, Westborough	19 July 1996
11	V049M002-1	60.5	8	PSI, Westborough	1 Nov. 1996
12	V049M002-1	60.5	6	PSI, Westborough	1 Feb. 1997
13	V049M138-1	79.5	3	PSI, Westborough	19 July 1996
14	V049M260-1	79.5	3	PSI, Westborough	19 July 1996
15	V049M138-1	79.5	3	PSI, Westborough	1 Nov. 1996
16	V049M260-1	79.5	3	PSI, Westborough	1 Nov. 1996
17	V049M138-1	79.5	3	PSI, Westborough	1 Feb. 1997
18	V049M260-1	79.5	3	PSI, Westborough	1 Feb. 1997
19	V049M138-1	79.5	3	PSI, Westborough	15 Apr. 1997
20	V049M260-1	79.5	3	PSI, Westborough	15 Apr. 1997

## SPECIFICATION

Number

A

Rev.

4

V049-2-039

Page

3

of

8

**3.0 MATERIAL REQUIREMENTS**

3.1 This material shall conform to the requirements of ASME Specification SA-240 Type 304L with the additional supplementary requirements described in this specification. The material used shall be hot rolled, annealed and pickled. If the material is supplied dual certified to grade 304/304L, this will be acceptable to PSI.

**3.2 Applicable Codes**

3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", the 1992 Edition through the 1994 Addenda.

3.2.2 ASTM A-480, "Standard Specification for General Requirements for Flat-Roll Stainless and Heat-Resisting Steel Plate, Sheet, and Strip".

3.2.3 ASTM A-700, "Standard Packages for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment".

3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

Number

Rev.

**SPECIFICATION**

Number

**A**

Rev.

**4**V049-2-039  
Page**4**of **8**

**4.0 MANUFACTURE****4.1 Thickness Tolerance**

The heads shall be furnished in the minimum thickness(es) specified in the purchase order.

**4.2 Circumference Tolerance  $\pm 1/8$ "****4.3 Out-of-Round Tolerance = within 1/2% of head I.D.****4.4 Heads to be square trimmed by manufacturer to a flatness tolerance of  $\pm 1/8$ ".****4.5 Heads to be manufactured with or without center holes as specified in P.O.****4.6 Surface Finish.**

Cold rolled and pickled surface finish is acceptable.

**4.7 No grinding with abrasive wheels, cloth or stones is permitted after final cleaning. No iron, carbon steel or other contaminants (such as grease, oil, hydrocarbons or chlorides) to come in contact with the heads after the pickle process. Machining fluids shall be water soluble and free of oil and sulfur.****4.8 Cleanliness - After Pickling**

The heads are intended for use in a high vacuum application. Potential hydrocarbon or chloride contamination shall be eliminated. Also, the material shall be wrapped and covered at all times with polyethylene sheet, for protection.

**5.0 MATERIAL TESTING****5.1 2" x 2" material coupons must be supplied to PSI with shipment. The coupons are to be cut from the same heat number, lot and thickness of material to be supplied.****6.0 INSPECTION/WITNESS****6.1 The purchaser shall have the right to witness all manufacturing processes.****6.2 The purchaser shall be informed 5 working days before the head material is formed.**

Number

Rev.

**SPECIFICATION**

Number

**A**

Rev.

**4**V049-2-039  
Page**5**of **8**

**7.0 REJECTIONS AND REPAIR OF DEFECTS**

7.1 No weld splices or repair welding is permitted to the material or formed heads.

**8.0 IDENTIFICATION**

8.1 Identification of the material shall be maintained through all manufacturing processes.

8.2 If material identity of the heads is lost, they shall be requalified by making all tests that were required for the material or as indicated in this specification.

8.3 Marking the finished heads with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking the outside only of the finished materials. All other marking methods must be approved by the purchaser prior to use. All heads shall be marked in the straight flange area 2" up from the edge.

**9.0 DOCUMENTATION**

9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser with the shipment of the material and available for review during inspection visits prior to shipment.

9.2 A record of the material thickness for each head is required. Thickness shall be measured and recorded at both the knuckle and the center of the head.

**10.0 PACKAGING, STORING AND SHIPPING**

10.1 The head material shall be wrapped in waterproof polyethylene and covered with a tarp immediately after pickle processing operations have been completed to minimize contamination.

10.2 The heads shall be shipped wrapped in waterproof polyethylene and covered with tarps to prevent any roadway contamination.

**11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT**

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to fabrication, assembly, cleaning and test areas for the purpose of monitoring activities.

**SPECIFICATION**

Number

**A**

Rev.

**4**

VII49-2-039  
Page 6 of 8

Number

Rev.

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049	
EQUIPMENT: Vacuum Vessel Heads	VENDOR ENG. OFFICE:					DWG. NO.:	
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-039	
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:	
						Inspector:	
						Date:	
	MILESTONE SCHEDULE			X	2	X	
	VENDOR Q.A. PLAN			X	2	X	
	CLEANING PROCEDURE			X	2	X	
	PREP FOR SHIPMENT PROCEDURE			X	2	X	
	WELDING PROCEDURES						
	ASSEMBLY DRAWINGS						
	DESIGN REVIEW						
	CERTIFIED MATERIAL TEST REPORTS				2	X	
	IN-PROCESS INSPECTIONS		X		2	X	
	OPERATION & MAINTENANCE MANUALS						
	SHOP TEST PLAN						
SHOP TEST (WITH REPORT)							
SHOP DIMENSIONAL INSPECTION		X		2	X		

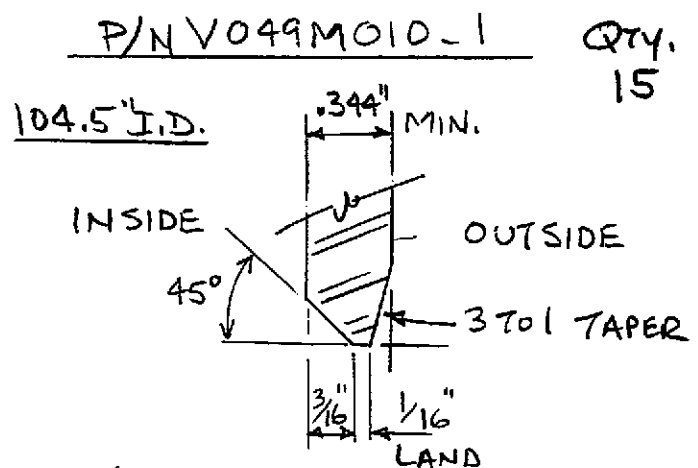
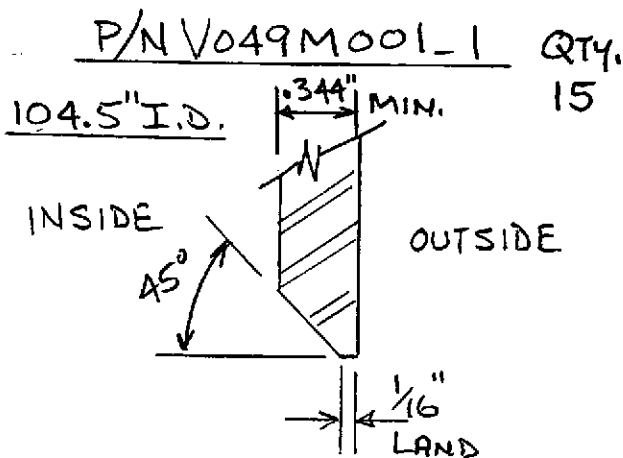
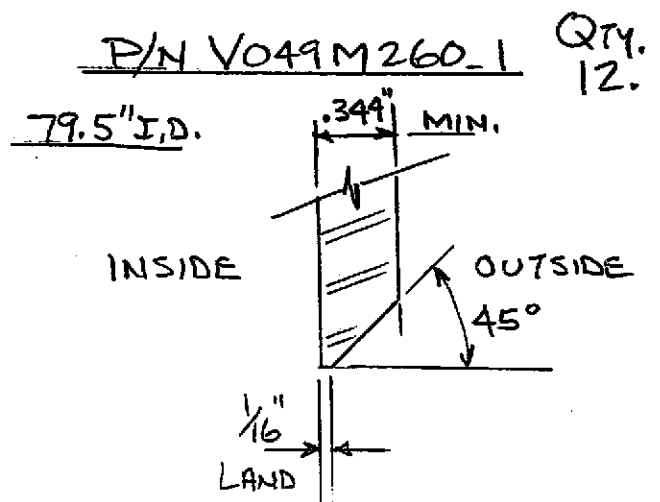
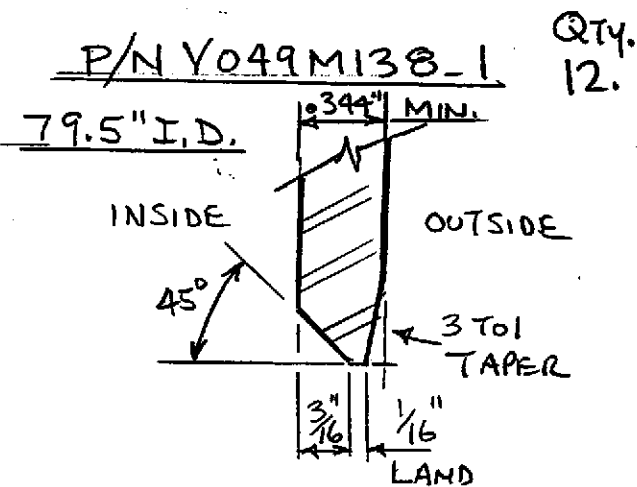
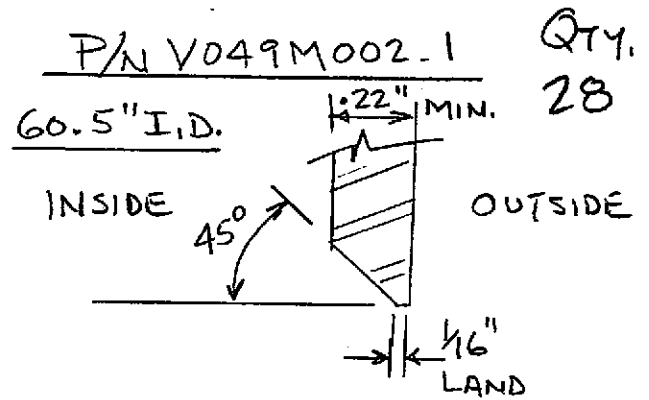
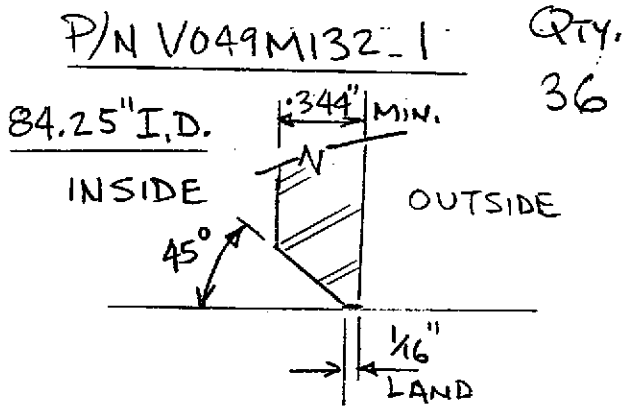
Pg 7 of 8

SPEC. V049-2-039 REV. 4.

# ATTACHMENT "B"

By: D. CURTIS 21 JUNE 96

## HEAD WELD PREP BEVELS BY HEAD MANUFACTURER



SPECIFICATION FOR  
STAINLESS STEEL FLANGE FORGINGS  
FOR  
LIGO VACUUM EQUIPMENT

Hanford, Washington  
and  
Livingston, Louisiana

PREPARED BY: D. Curtis *D. Curtis*

STRUCTURAL ENGINEER: R. O. Wirth *R. O. Wirth*

QUALITY ASSURANCE: A. R. Bradburn *A. R. Bradburn*

TECHNICAL DIRECTOR: D. A. McWilliam *D. A. McWilliam*

PROJECT MANAGER: Bruce Bagby *Bruce Bagby*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
6	REC 6/17/96	D.M.W.	DELETED P/N V049M248-1 & V049M249-1 FROM SHTS. 70E10 & 90E10. DEO #0201
5	REC 6/14/96	PH/REB 6/14/96	ADDED 1.97" OFFSET TO P/N V049M248-1 & V049M249-1 DEO #0197
4	REC 5/29/96	REB 5/30/96	ADDED ATTACHMENT "B" SIZE & QUANTITIES REVISED FOR PURCHASE DEO #0189
3	REC 9/11/96	REB 9/11/96	REVISED TOLERANCES IN SECTION 4.0. ADDED SCHEDULE SECTION 2.0 DEO #0117
2	D.M.W. 3-15-96	REC FOR RB	REV SECT 3.5 (MAX SULFUR CONEN) PER DEO #0096
1	REC 12/22/95	D.M.W.	REVISED SECT. 3.4, 3.5 & 9.1 DEO #0037
0	D.M.W.		ISSUER PER DEO 0021 (MATERIAL PROCUREMENT)

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number <b>A V049-2-040</b>
	<i>REC</i>	11/21/95	<i>REB</i>	11/27/95	Rev. <b>6</b>



## SPECIFICATION TABLE OF CONTENTS

- 1.0 Scope
- 2.0 Schedule of Deliveries
- 3.0 Material Requirements
- 4.0 Manufacture Requirements
- 5.0 Material Testing
- 6.0 Inspection/Witness
- 7.0 Rejections and Repair of Defects
- 8.0 Identification
- 9.0 Documentation
- 10.0 Packaging, Storing and Shipping
- 11.0 Non-escort Privileges and Inspection Right

Attachment A LIGO Quality Assurance Requirements Summary

Attachment B Schedule of Deliveries in Lots With Sizes and Quantities

Number  
Rev.

## SPECIFICATION

Number	V049-2-040	Rev.
<b>A</b>		<b>6</b>

Page 2 of 10

**1.0 SCOPE**

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the flange forgings to be used for manufacturing ultra high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

**2.0 SCHEDULE OF DELIVERIES**

2.1 Flange rings shall be delivered in lots with sizes and quantities as specified in Attachment "B".

**3.0 MATERIAL REQUIREMENTS**

3.1 This material shall conform to the requirements of ASME Specification SA-182 Grade F Type 304L as given in the ASME Code 1992 Edition through 1994 Addenda with the additional supplementary requirements described in this specification.

**3.2 Applicable Codes**

3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", 1992 Edition through 1994 Addenda.

3.2.2 ASTM A-700, "Standard Packages for Packaging, marking, and Loading Methods for Steel Products for Domestic Shipment".

3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**Page 3 of 10

## 4.0 MANUFACTURE

## 4.1 Thickness Tolerance, + .06 - 0

The forgings shall be rough machined to the thickness(es) specified in the purchase order.

## 4.2 ID/OD Tolerance, ID -.06+0, OD + .06-0

The forgings shall be furnished in the diameters as specified in the purchase order.

4.2.1 The ID/OD are to be concentric within  $\pm 1/32$ ".

## 4.3 Flatness Tolerance

The machined forgings shall be flat to  $\pm 1/32$ " across the diameter.

## 4.4 Surface Finish

The surface finish of the forgings shall be 250/500 RMS on four sides.

## 4.5 Chemistry and Mechanical Properties

The material shall meet the chemistry and mechanical requirements as specified in SA 182 Grade F, 304L material specification. The final content of sulfur is to be limited to 0.006%.

## 4.6 No grinding with abrasive wheels, cloths or stones is permitted. No iron carbon steel or other contaminants (such as grease, oil or hydrocarbons) to come in contact with the forging after the cleaning process. Machining fluids shall be water soluble and free of oil, sulfur, and chlorides.

## 4.7 Cleanliness

The forgings are intended for use in a high vacuum application. Potential hydrocarbon contamination shall be eliminated.

## 5.0 MATERIAL TESTING

## 5.1 2" x 2" material coupons for each heat of material, must be supplied to PSI for approval prior to release for shipment. The coupons are to be cut from the same heat number, lot and thickness of material to be supplied.

Number

Rev.

## SPECIFICATION

Number

A

V049-2-040

Rev.

6

Page 4 of 10

# SPECIFICATION FOR STAINLESS STEEL FLANGE FORGINGS

Title

## 6.0 INSPECTION/WITNESS

- 6.1 The purchaser shall have the right to witness all manufacturing processes.
- 6.2 The purchaser shall be informed 5 working days before the forging material is formed.

## 7.0 REJECTIONS AND REPAIR OF DEFECTS

- 7.1 No weld splices or repair welding is permitted to the material and forgings.

## 8.0 IDENTIFICATION

- 8.1 Identification of the material shall be maintained through all manufacturing processes.
- 8.2 If material identity is lost, the forging shall be requalified by making all tests that were required for the material or as indicated in this specification.
- 8.3 Marking the finished materials with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking the outside only of the finished materials. All other marking methods must be approved by the purchaser prior to use.

## 9.0 DOCUMENTATION

- 9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser with the shipment of the material, and available for review during inspection visits prior to shipment.
- 9.2 A record of the material thickness for each flange forging is required.

## 10.0 PACKAGING, STORING AND SHIPPING

- 10.1 The material shall be cleaned and protected from contamination prior to shipment. The material shall be shipped covered in a closed trailer or tightly wrapped with a waterproof covering if shipped on an open bed.

## 11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to fabrication, assembly, cleaning and test areas for the purpose of monitoring activities.

### SPECIFICATION

Number

**A**

V049-2-040

Rev.

**6**

Page 5 of 10

Number

Rev.

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049
EQUIPMENT: Flange Forgings	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-040
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:
						Date:
MILESTONE SCHEDULE			X	2	X	
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
WELDING PROCEDURES						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
CERTIFIED MATERIAL TEST REPORTS			X	2	X	
IN-PROCESS INSPECTIONS		X		2	X	
OPERATION & MAINTENANCE MANUALS						
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION		X		2	X	

Rev 6  
Pg 6 of 10

ATTACHMENT "B"Schedule of Deliveries in Lots with Sizes and Quantities

Flange rings shall be delivered in lots as follows:

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	1	104.25 x 112.5 x 1.5	4	PSI Westboro	1 July 1996
V049M004-1	1	104.25 x 112.5 x 1.25	4	PSI Westboro	1 July 1996
V049M133-1	1	84.0 x 92.25 x 1.63	12	PSI Westboro	1 July 1996
V049M136-1	1	83.75 x 92.25 x 1.38	12	PSI Westboro	1 July 1996
V049M135-1	1	60.0 x 68.5 x 1.63	30	PSI Westboro	1 July 1996
V049M243-1	1	60.0 x 68.5 x 1.25	26	PSI Westboro	1 July 1996
V049M244-1	1	44.0 x 52.25 x 1.5	14	PSI Westboro	1 July 1996
V049M245-1	1	44.0 x 52.25 x 1.25	6	PSI Westboro	1 July 1996
V049M242-1	1	48.0 x 56.25 x 1.5	12	PSI Westboro	1 July 1996
V049M241-1	1	48.0 x 56.25 x 1.25	4	PSI Westboro	1 July 1996
V049M250-1	1	56.3 x 72.5 x 1.25	2	PSI Westboro	1 July 1996
V049M246-1	1	72.00 x 80.25 x 1.63	10	PSI Westboro	1 July 1996
V049M247-1	1	72.00 x 80.25 x 1.25	6	PSI Westboro	1 July 1996
Total			142		

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-040

Rev.

**6**Page 7 of 10

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	2	104.25 x 112.5 x 1.5	4	PSI Westboro	1 Nov. 1996
V049M004-1	2	104.25 x 112.5 x 1.25	4	PSI Westboro	1 Nov. 1996
V049M133-1	2	84.0 x 92.25 x 1.63	10	PSI Westboro	1 Nov. 1996
V049M136-1	2	83.75 x 92.25 x 1.38	10	PSI Westboro	1 Nov. 1996
V049M135-1	2	60.0 x 68.5 x 1.63	24	PSI Westboro	1 Nov. 1996
V049M243-1	2	60.0 x 68.5 x 1.25	26	PSI Westboro	1 Nov. 1996
V049M244-1	2	44.0 x 52.25 x 1.5	14	PSI Westboro	1 Nov. 1996
V049M245-1	2	44.0 x 52.25 x 1.25	4	PSI Westboro	1 Nov. 1996
V049M246-1	2	72.0 x 80.25 x 1.63	4	PSI Westboro	1 Nov. 1996
Total			100		

Number

Rev.

## SPECIFICATION

Number	V049-2-040	Rev.
A		6

Page 8 of 10

**SPECIFICATION FOR STAINLESS STEEL FLANGE FORGINGS**

Title

Sheet 3 of 4

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	3	104.25 x 112.5 x 1.5	4	PSI Westboro	1 Feb. 1997
V049M004-1	3	104.25 x 112.5 x 1.25	4	PSI Westboro	1 Feb. 1997
V049M133-1	3	84.0 x 92.25 x 1.63	8	PSI Westboro	1 Feb. 1997
V049M136-1	3	83.75 x 92.25 x 1.38	8	PSI Westboro	1 Feb. 1997
V049M135-1	3	60.0 x 68.5 x 1.63	21	PSI Westboro	1 Feb. 1997
V049M243-1	3	60.0 x 68.5 x 1.25	11	PSI Westboro	1 Feb. 1997
V049M244-1	3	44.0 x 52.25 x 1.5	10	PSI Westboro	1 Feb. 1997
V049M245-1	3	44.0 x 52.25 x 1.25	2	PSI Westboro	1 Feb. 1997
V049M242-1	3	48.0 x 56.25 x 1.5	4	PSI Westboro	1 Feb. 1997
V049M250-1	3	56.3 x 72.5 x 1.25	1	PSI Westboro	1 Feb. 1997
V049M246-1	3	72.00 x 80.25 x 1.63	12	PSI Westboro	1 Feb. 1997
V049M247-1	3	72.00 x 80.25 x 1.25	8	PSI Westboro	1 Feb. 1997
Total			93		

Number  
Rev.

**SPECIFICATION**

Number	V049-2-040	Rev.
<b>A</b>		<b>6</b>



<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> (Dimensions in Inches)	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M003-1	4	104.25 x 112.5 x 1.5	3	PSI Westboro	15 Apr. 1997
V049M004-1	4	104.25 x 112.5 x 1.25	3	PSI Westboro	15 Apr. 1997
V049M133-1	4	84.0 x 92.25 x 1.63	6	PSI Westboro	15 Apr. 1997
V049M136-1	4	83.75 x 92.25 x 1.38	6	PSI Westboro	15 Apr. 1997
V049M135-1	4	60.0 x 68.5 x 1.63	10	PSI Westboro	15 Apr. 1997
V049M244-1	4	44.0 x 52.25 x 1.5	10	PSI Westboro	15 Apr. 1997
V049M245-1	4	44.0 x 52.25 x 1.25	2	PSI Westboro	15 Apr. 1997
V049M246-1	4	72.00 x 80.25 x 1.63	2	PSI Westboro	15 Apr. 1997
Total			42		

Number

Rev.

## SPECIFICATION

Number	V049-2-040	Rev.
<b>A</b>		<b>6</b>

Page 10 of 10

**SPECIFICATION FOR  
STAINLESS STEEL VESSEL PLATE  
FOR  
LIGO VACUUM EQUIPMENT**

Hanford, Washington  
and  
Livingston, Louisiana

**PREPARED BY:** D. Curtis *D. Curtis*

**STRUCTURAL ENGINEER:** R. D. Ciatto *R. D. Ciatto*

**QUALITY ASSURANCE:** A. R. Bradbrook *A. R. Bradbrook*

**TECHNICAL DIRECTOR:** D. A. McWilleen *D. A. McWilleen*

**PROJECT MANAGER:** Bradbrook Bagley *Bradbrook Bagley*

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
3	REL 7/30/96	RB	pg. 4 & 5 REVISED SIZE OF P/N V049M174, WAS 1/4" X 54 X 192
2	REL 5/7/96		REVISED SIZE OF P/N V049M155, WAS 1/4" X 72 X 229. DEO REVISED QTY. OF P/N V049M166, WAS QTY. 4 #0193
1	REL 4/26/96	D.M.W.	RELEASED FOR FDR AND MAT'L PURCHASE 0142 DEO
0	D.M.W.		RELEASE PER DEO 0021 (MAT'L PROCUREMENT)

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION		
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number	Rev.
	REL.	11/21/95	RB	11/27/95	V049-2-041	3

## SPECIFICATION TABLE OF CONTENTS

- 1.0 Scope
- 2.0 Schedule and Delivery
- 3.0 Material Requirements
- 4.0 Manufacture Requirements
- 5.0 Material Testing
- 6.0 Inspection/Witness
- 7.0 Rejections and Repair of Defects
- 8.0 Identification
- 9.0 Documentation
- 10.0 Packaging, Storing and Shipping
- 11.0 Non-escort Privileges and Inspection Right

Attachment A LIGO Quality Assurance Requirements  
Summary

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

Page 2 of 9

## 1.0 SCOPE

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the plate to be used for manufacturing ultra high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

## 2.0 SCHEDULE AND DELIVERY

Plate shall be delivered in lots as follows:

PSI Part No.	Lot No.	Plate Size	Qty	Destination	Date
V049M149	1	1/4 x 84 x 254	2	PSI, Westborough	1 July 1996
V049M150	1	1/4 x 63 x 254	2	PSI, Westborough	1 July 1996
V049M151	1	1/4 x 80 x 144	2	PSI, Westborough	1 July 1996
V049M152	1	1/4 x 49 x 254	2	PSI, Westborough	1 July 1996
V049M153	1	1/4 x 62 x 192	2	PSI, Westborough	1 July 1996
V049M154	1	1/4 x 120 x 229	13	PSI, Westborough	1 July 1996
V049M155	1	3/8 x 96 x 230	1	PSI, Westborough	1 July 1996
V049M156	1	1/4 x 99 x 120	6	PSI, Westborough	1 July 1996
V049M157	1	1/4 x 90 x 98	4	PSI, Westborough	1 July 1996
V049M158	1	1/4 x 66 x 142	2	PSI, Westborough	1 July 1996
V049M159	1	1/4 x 96 x 142	1	PSI, Westborough	1 July 1996
V049P7815	14	1/2 x 76 x 270	7	PSI, Westborough	1 July 1996
V049P7817	14	1/2 x 62 x 195	6	PSI, Westborough	1 July 1996
V049M163	1	1/4 x 72 x 154	4	PSI, Westborough	1 July 1996
V049M164	1	1/4 x 96 x 229	1	PSI, Westborough	1 July 1996
V049M166	1	1/4 x 88 x 154	2	PSI, Westborough	1 July 1996
V049P7801	14	1/2 x 91 1/2 x 333	5	PSI, Westborough	1 July 1996
V049P7802	14	1/4 x 60 x 332	5	PSI, Westborough	1 July 1996
V049P7803	14	1/2 x 72 x 195	5	PSI, Westborough	1 July 1996

## SPECIFICATION

Number

**A**

V049-2-041

Rev.

**3**Page 3 of 9

Title

## SPECIFICATION FOR STAINLESS STEEL VESSEL PLATE

PSI Part No.	Lot No.	Plate Size	Qty	Destination	Date
V049M170 1	2.	1/4 x 40 x 144	2	PSI, Westborough	1 November 1996
V049M171 1	2.	1/4 x 84 x 229	2	PSI, Westborough	1 November 1996
V049M154 1	2.	1/4 x 120 x 229	2	PSI, Westborough	1 November 1996
V049M156 1	2.	1/4 x 99 x 120	6	PSI, Westborough	1 November 1996
V049M174 1	2.	1/4 x 57 x 192	2	PSI, Westborough	1 November 1996
V049M175 1	2.	1/4 x 70 x 229	8	PSI, Westborough	1 November 1996
V049M158 1	2.	1/4 x 66 x 142	2	PSI, Westborough	1 November 1996
V049M177 1	2.	3/8 x 96 x 192	2	PSI, Westborough	1 November 1996
V049M178 1	2.	1/4 x 88 x 142	2	PSI, Westborough	1 November 1996
V049M159 1	2.	1/4 x 96 x 142	2	PSI, Westborough	1 November 1996
V049M166 1	2.	1/4 x 88 x 154	2	PSI, Westborough	1 November 1996
V049P7815 14	2.	1/2 x 76 x 270	6	PSI, Westborough	1 November 1996
V049P7817 14	2.	1/2 x 62 x 195	6	PSI, Westborough	1 November 1996
V049P7801 14	2.	1/2 x 91 1/2 x 333	5	PSI, Westborough	1 November 1996
V049P7802 14	2.	1/4 x 60 x 332	5	PSI, Westborough	1 November 1996
V049P7803 14	2.	1/2 x 72 x 195	5	PSI, Westborough	1 November 1996
V049M152 1	2.	1/4 x 49 x 254	3	PSI, Westborough	1 November 1996

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

Page 4 of 9

Title

## SPECIFICATION FOR STAINLESS STEEL VESSEL PLATE

PSI Part No.	Lot No.	Plate Size	Qty.	Destination	Date
V049M174 1	3.	1/4 x 57 x 192	1	PSI, Westborough	1 February 1997
V049M175 1	3.	1/4 x 70 x 229	4	PSI, Westborough	1 February 1997
V049M149 1	3.	1/4 x 84 x 254	2	PSI, Westborough	1 February 1997
V049M150 1	3.	1/4 x 63 x 254	2	PSI, Westborough	1 February 1997
V049M152 1	3.	1/4 x 49 x 254	4	PSI, Westborough	1 February 1997
V049M170 1	3.	1/4 x 40 x 144	6	PSI, Westborough	1 February 1997
V049M157 1	3.	1/4 x 90 x 98	2	PSI, Westborough	1 February 1997
V049M156 1	3.	1/4 x 99 x 120	6	PSI, Westborough	1 February 1997
V049M154 1	3.	1/4 x 120 x 229	16	PSI, Westborough	1 February 1997
V049M159 1	3.	1/4 x 96 x 142	2	PSI, Westborough	1 February 1997
V049M198 1	3.	1/4 x 55 x 154	2	PSI, Westborough	1 February 1997
V049M164 1	3.	1/4 x 96 x 229	1	PSI, Westborough	1 February 1997
V049M153 1	3.	1/4 x 62 x 192	2	PSI, Westborough	1 February 1997
V049M177 1	3.	3/8 x 96 x 192	1	PSI, Westborough	1 February 1997
V049M158 1	3.	1/4 x 66 x 142	2	PSI, Westborough	1 February 1997
V049M155 1	3.	3/8 x 96 x 230	1	PSI, Westborough	1 February 1997
V049P7801 14	3.	1/2 x 91 1/2 x 333	5	PSI, Westborough	1 February 1997
V049P7802 14	3.	1/4 x 60 x 332	5	PSI, Westborough	1 February 1997
V049P7803 14	3.	1/2 x 72 x 195	5	PSI, Westborough	1 February 1997
V049P7817 14	3.	1/2 x 62 x 195	7	PSI, Westborough	1 February 1997
V049P7815 14	3.	1/2 x 76 x 270	7	PSI, Westborough	1 February 1997

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

Page 5 of 9

**3.0 MATERIAL REQUIREMENTS**

- 3.1 This material shall conform to the requirements of ASME Specification SA-240 Type 304/304L with the additional supplementary requirements described in this specification. The material is to be dual certified to meet the material grade of 304 and 304L.
- 3.2 Applicable Codes
- 3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", the 1992 Edition with the 1994 Addenda.
- 3.2.2 ASTM A-480, "Standard Specification for General Requirements for Flat-Roll Stainless and Heat-Resisting Steel Plate, Sheet, and Strip".
- 3.2.3 ASTM A-700, "Standard Packages for Packaging, marking, and Loading Methods for Steel Products for Domestic Shipment".
- 3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

**4.0 MANUFACTURE**

- 4.1 Thickness Tolerance
- The material shall be furnished in the thickness(es) specified in the purchase order. The thickness tolerance shall meet ASTM A-480 requirements.
- 4.2 Width and Length Tolerance
- The plate material shall be cut to the minimum size specified in the purchase order. The width and length plus tolerance of the finished material shall not exceed the tolerances specified in ASME SA-480 specification, the minus tolerance is 0.0 in..
- 4.3 Surface Finish
- Hot rolled, Annealed, and Pickled (HRAP) mill finish is acceptable.
- 4.4 Chemistry and Mechanical Properties
- The material shall meet the chemistry requirements as specified in SA 240 Type 304L, and the mechanical requirement of SA240 Type 304 material specification.

**SPECIFICATION**

Number	A	V049-2-041	Rev.	3
--------	---	------------	------	---

Page 6 of 9

4.4.1 The material shall be dual certified as type 304/304L.

4.5-- After final cleaning and pickling, no grinding with abrasive wheels, cloth or stones is permitted. No iron, carbon steel or other contaminants (such as grease, chloride compounds, oil hydrocarbons) to come in contact with the plate.

4.6 Cleanliness

This material is intended for use in a high vacuum application. Potential hydrocarbon contamination shall be eliminated. Also, the material shall be wrapped and covered at all times the material is not being processed to minimize possible exposure to contaminants. The plate shall be cleaned prior to shipment.

## 5.0 MATERIAL TESTING

5.1 A 2" wide coupon, the width of one plate is to be supplied for each heat number supplied. The coupon must be pickled the same as the plate.

## 6.0 INSPECTION/WITNESS

6.1 The purchaser shall have the right to witness all manufacturing processes.

## 7.0 REJECTIONS AND REPAIR OF DEFECTS

7.1 No weld splices or repair welding is permitted to the material.

## 8.0 IDENTIFICATION

8.1 Identification of the material shall be maintained through all manufacturing processes.

8.2 If material identity is lost, the plate shall be requalified by making all tests that were required for the material or as indicated in this specification.

8.3 Marking the finished materials with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking one side only of the finished plate. All other marking methods must be approved by the purchaser prior to use. All plates shall be marked 6" in from both edges in one corner. When stacked for shipment, all markings shall be in the same corner for easy identification upon receipt at PSI. The minimum marking is to be the heat/lot number.

Number

Rev.

## SPECIFICATION

Number

A

V049-2-041

Rev.

3

Page 7 of 9



**9.0 DOCUMENTATION**

- 9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser a minimum of 48 hours prior to shipment of the material.
- 9.2 A record of the material thickness for each group of materials is required. Thickness shall be measured and recorded at both edges and the center of the plates.

**10.0 PACKAGING, STORING AND SHIPPING**

- 10.1 The material shall be packaged for shipment as described in ASTM A700-94, Section 11.3.3 and Figure 56 (wrapped package on skids) with the additional supplementary requirements as described herein.
- 10.2 The plate material shall be wrapped in waterproof polyethylene and covered with a tarp immediately after all steel processing operations have been completed to minimize contamination. The material shall remain packaged and covered until it is necessary to remove the covering and packaging material for further processing.
- 10.2 The material shall be shipped as specified in the purchase order.

**11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT**

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to all areas where material is being processed and stored.

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-041

Rev.

**3**Page 8 of 9

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049
EQUIPMENT: Vacuum Vessel Plate	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-041
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:
						Inspector:
						Date:
MILESTONE SCHEDULE			X	2	X	
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
WELDING PROCEDURES						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
CERTIFIED MATERIAL TEST REPORTS			X	2	X	
IN-PROCESS INSPECTIONS		X		2	X	
OPERATION & MAINTENANCE MANUALS						
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION		X		2	X	

Title:

LIGO VACUUM EQUIPMENT; V59049

O RING SPECIFICATION

PROJECT ENGINEER A. Moten

TECHNICAL DIRECTOR D.A. McWilliam

QUALITY ASSURANCE A. R. Beallock

PROJECT MANAGER Paul R. Ray

Number

5	Sm 11/24/96	D.A. McWilliam	Released per DEU 0367
4	Sm 10/9/96	D.A. McWilliam	Released per DEU 0297
3	Sm 9/17/96	D.A. McWilliam	Released per DEU 0268
2	Sm 8/21/96	D.A. McWilliam	Released per DEU 0247
1	Sm 7/16/96	D.A. McWilliam	RELEASED PER DEU 0223
φ	Sm 12/27/95	D.A. McWilliam	RELEASED PER DEU 0035

Rev

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
----------	---------	------------	-----------------------

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION			
-------------------------------------	--	--	--	---------------	--	--	--

INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number	Rev
	Sm	12/27/95	DEB	12/27/95	A V049-2-045	5

Title

O RING SPEC. V049-2-045

SM LIGOV7.WB1

SERVICE : ULTRA HIGH VACUUM SEALS

MATERIAL: EXTRUDED CORD STOCK; CERTIFIED DUPONT VITON A-500

DUROMETER : 70-75

JOINTS : VULCANIZED SPLICE

CROSS-SECTION DIAMETER : 0.275 + - 0.006 INCHES

DEVELOPED LENGTH : SEE TABLE 1

SPECIAL REQUIREMENTS:

1. O RINGS SHALL BE SUPPLIED SUITABLE FOR ULTRA HIGH VACUUM SERVICE. ORINGS MUST BE SUPPLIED CONSISTENT WITH CLASS 100 CLEAN ROOM STANDARDS. HANDLING AND PACKAGING TO PREVENT CONTAMINATION FROM DIRT, HYDROCARBONS (OILS, GREASES, FINGERPRINTS ETC.), GRIT, CHIPS, MANUFACTURING RESIDUES, PARTICULATES (DUST, HAIR, LINT ETC.) IS REQUIRED. SUPPLIER MUST SUBMIT HANDLING AND PACKAGING PROCEDURES TO PSI, FOR APPROVAL, PRIOR TO MANUFACTURING O RINGS.

2. O RINGS SHALL BE INDIVIDUALLY PACKAGED IN SEALED PROTECTIVE POLYETHYLENE PLASTIC BAGS. BAGS SHALL BE PUNCTURE RESISTANT AND AIR TIGHT. BAGS SHALL BE MARKED WITH PART NO., FLANGE SIZE, CORD LENGTH, AND LOT NO.

3. O RINGS WILL BE VACUUM BAKED BY PSI TO REMOVE (OFF-GAS) WATER, VOLATILE COMPOUNDS, AND GASSES, REMAINING IN THE BULK VITON. BAKING WILL BE DONE AT 170 C (338 F) IN A PURE N2 ATMOSPHERE, AT A PRESSURE = 1 TORR, FOR A 12 HOUR DURATION. AFTER BAKING, THE O-RING PART NO. WILL HAVE THE SUFFIX "V" REMOVED. (SEE TABLE 1)

4. PRIOR TO OBTAINING A RELEASE FOR SHIPMENT, VENDOR MUST CERTIFY THAT ALL SPLICED JOINTS HAVE BEEN VISUALLY INSPECTED AND TESTED IN ACCORDANCE WITH ASTM STANDARD D2527-83 (REAPPROVED 1992). JOINT CLASSIFICATION IS CLASS 3.

5. THE O-RING VENDOR WILL SUPPLY UNBAKED O-RINGS WITH THE SUFFIX "V" ADDED TO THE PART NUMBER. (SEE TABLE 1)

Number  
Rev.

**SPECIFICATION**

Number **A V049-2-045** Rev. **5**

Title

O RING SPEC. V049-2-045

SM LG0V7.WB1

TABLE 1

PART NO. UNBAKED	PART NO. BAKED	FLANGE SIZE	CROSS SECT. INCHES	CORD LENGTH INCHES	REF. DWG.
V049M016V	V049M016	104	0.275 + - 0.006	337.5	V049-4-022
V049M017V	V049M017	104	0.275 + - 0.006	328.125	V049-4-022
V049M018V	V049M018	84	0.275 + - 0.006	274.375	V049-4-021
V049M019V	V049M019	84	0.275 + - 0.006	265.125	V049-4-021
V049M020V	V049M020	72	0.275 + - 0.006	237.125	V049-4-020
V049M021V	V049M021	72	0.275 + - 0.006	227.75	V049-4-020
V049M022V	V049M022	60	0.275 + - 0.006	200.625	V049-4-019
V049M023V	V049M023	60	0.275 + - 0.006	191.25	V049-4-019
V049M024V	V049M024	48	0.275 + - 0.006	162.5	V049-4-018
V049M025V	V049M025	48	0.275 + - 0.006	153.125	V049-4-018
V049M026V	V049M026	44.25	0.275 + - 0.006	150	V049-4-017
V049M027V	V049M027	44.25	0.275 + - 0.006	140.75	V049-4-017
V049M030V *	V049M030 *	60	0.275 + - 0.006	213	V049-4-067
V049M031V *	V049M031 *	60	0.275 + - 0.006	203.75	V049-4-067
V049M032V	V049M032	44.625	0.275 + - 0.006	151.25	V049-4-132
V049M033V	V049M033	44.625	0.275 + - 0.006	203.75	V049-4-132

\* BE-3A'S ONLY

Number

Rev.

**SPECIFICATION**

Number

**A** V049-2-045

Rev.

**5**

Title: SPECIFICATION FOR STAINLESS STEEL RINGS CUT OUT OF PLATE

SPECIFICATION FOR  
 STAINLESS STEEL RINGS CUT OUT OF PLATE  
 FOR  
 LIGO VACUUM EQUIPMENT

Hanford, Washington  
 and  
 Livingston, Louisiana

PREPARED BY:

R.E. Carter 6/9/96

STRUCTURAL ENGINEER:

A.D. Watts 6/7/96

QUALITY ASSURANCE:

Alvin R. Bradbrook

TECHNICAL DIRECTOR:

D.A. McWilliams

PROJECT MANAGER:

P.F. Hendry for R.E.B.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

REV	LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1		REC, 6/17/96	D. McW	ATTACHMENT "B" REVISED TO L. SECT. 4.2 ADDED P/N V049M248-1 & P/N V049M249-1
0		REC, 6/12/96	D.W. (A) Alvin	RELEASED FOR PURCHASE
				DEO # 0193

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-134
	REC	6/12/96	REB/PFH	6/12/96	Rev. 1

**SPECIFICATION TABLE OF CONTENTS**

- 1.0 Scope
- 2.0 Schedule and Delivery
- 3.0 Material Requirements
- 4.0 Manufacture Requirements
- 5.0 Material Testing
- 6.0 Inspection/Witness
- 7.0 Rejections and Repair of Defects
- 8.0 Identification
- 9.0 Documentation
- 10.0 Packaging, Storing and Shipping
- 11.0 Non-escort Privileges and Inspection Right

Attachment A LIGO Quality Assurance Requirements Summary

Attachment B Schedule of Deliveries in Lots with Sizes and Quantities

Number

Rev.

**SPECIFICATION**

Number	<b>A</b>	V049-2-134	Rev.	1
--------	----------	------------	------	---

**1.0 SCOPE**

This specification covers the minimum technical requirements for the materials, fabrication, inspection, testing, preparation for shipping, shipment and delivery of the plate to be used for manufacturing ultra high vacuum boundary equipment.

All attachments are incorporated herein by reference and made a part of this specification.

Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements, and shall not be disclosed to any other party.

**2.0 SCHEDULE AND DELIVERY**

Rings shall be delivered in lots with sizes and quantities as specified in Attachment "B".

**3.0 MATERIAL REQUIREMENTS**

3.1 This material shall conform to the requirements of ASME Specification SA-240 Type 304/304L with the additional supplementary requirements described in this specification. The material is to be dual certified to meet the material grade of 304 and 304L.

**3.2 Applicable Codes**

3.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", the 1992 Edition with the 1994 Addenda.

3.2.2 ASTM A-480, "Standard Specification for General Requirements for Flat-Roll Stainless and Heat-Resisting Steel Plate, Sheet, and Strip".

3.2.3 ASTM A-700, "Standard Packages for Packaging, marking, and Loading Methods for Steel Products for Domestic Shipment".

3.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of PSI for clarification.

**4.0 MANUFACTURE****4.1 Thickness Tolerance**

The material shall be furnished in the thickness(es) specified in the purchase order. The thickness tolerance shall meet ASTM A-480 requirements.

**SPECIFICATION**

Number

**A**

V049-2-134

Rev.

/

Page 3 of 8

Number

Rev.



## 4.2 Diameter Tolerance

The rings to be flame cut to the following tolerances:

ID  $-1/4'' + 0$ , OD  $+ 1/4'' - 0$

## 4.2.1 Surface flatness per ASTM A480.

## 4.3 Surface Finish

Hot rolled, Annealed, and Pickled (HRAP) mill finish is acceptable.

## 4.4 Chemistry and Mechanical Properties

The material shall meet the chemistry requirements as specified in SA 240 Type 304L, and the mechanical requirement of SA240 Type 304 material specification.

## 4.4.1 The material shall be dual certified as type 304/304L.

4.5 After final cleaning, no grinding with abrasive wheels, cloth or stones is permitted. No iron, carbon steel or other contaminants (such as grease, chloride compounds, oils, hydrocarbons) to come in contact with the plate.

## 4.6 Cleanliness

This material is intended for use in a high vacuum application. Potential hydrocarbon contamination shall be eliminated. The plate shall be cleaned prior to shipment.

## 5.0 MATERIAL TESTING

5.1 A 2" x 2" wide coupon, is to be supplied for each heat number supplied. The coupon must be pickled the same as the plate.

## 6.0 INSPECTION/WITNESS

6.1 The purchaser shall have the right to witness all manufacturing processes.

## 7.0 REJECTIONS AND REPAIR OF DEFECTS

7.1 No weld splices or repair welding is permitted to the material.

## SPECIFICATION

Number

A

V049.2-134

Rev.

1

Page 4 of 8

Number

Rev.

**SPECIFICATION FOR STAINLESS STEEL RINGS CUT OUT OF PLATE**

**8.0 IDENTIFICATION**

- 8.1 Identification of the material shall be maintained through all manufacturing processes.
- 8.2 If material identity is lost, the plate shall be requalified by making all tests that were required for the material or as indicated in this specification.
- 8.3 Marking the finished materials with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking one side only of the finished plate. All other marking methods must be approved by the purchaser prior to use. All plates shall be marked 2" in from the O.D. When stacked for shipment, all markings shall be in the same corner for easy identification upon receipt at PSI. The minimum marking is to be the heat/lot number.

**9.0 DOCUMENTATION**

- 9.1 The Certified Material Test Report (CMTR) shall be provided to the purchaser shipment of the material.
- 9.2 A record of the material thickness for each group of materials is required.

**10.0 PACKAGING, STORING AND SHIPPING**

- 10.1 The material shall be cleaned and protected from contamination prior to shipment. The material shall be shipped covered in a closed trailer or tightly wrapped with tarps if shipped on an open bed.

**11.0 NON-ESCORT PRIVILEGES AND INSPECTION RIGHT**

Non-escort privileges for Buyer, Owner, Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to all areas where material is being processed and stored.

Number  
Rev.

<b>SPECIFICATION</b>	
<b>Number</b> <b>A</b>	<b>Rev.</b> <b>/</b>
V049-2-134	

ATTACHMENT "A"  
LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY

LIGO VACUUM EQUIPMENT	VENDOR: V59049					JOB NO.: V59049
EQUIPMENT: Stainless Steel Rings Cut Out Of Plate	VENDOR ENG. OFFICE:					DWG. NO.:
PSI P.O. NO:	VENDOR FACTORY:					SPECNO: V049-2-134
TESTING INSPECTION AND DOCUMENTATION RECORD	Submittal After P.O.	Witnessed by PSI	Approval by PSI	Copies Req'd for PSI Files	Record in Mfr's File	Remarks:  Inspector:  Date:
MILESTONE SCHEDULE			X	2	X	
VENDOR Q.A. PLAN			X	2	X	
CLEANING PROCEDURE			X	2	X	
PREP FOR SHIPMENT PROCEDURE			X	2	X	
WELDING PROCEDURES						
ASSEMBLY DRAWINGS						
DESIGN REVIEW						
CERTIFIED MATERIAL TEST REPORTS			X	2	X	
IN-PROCESS INSPECTIONS		X		2	X	
OPERATION & MAINTENANCE MANUALS						
SHOP TEST PLAN						
SHOP TEST (WITH REPORT)						
SHOP DIMENSIONAL INSPECTION		X		2	X	

ATTACHMENT "B"Schedule of Deliveries in Lots with Sizes and Quantities

Rings are to be delivered in lots as follows:

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> <u>(Dimensions in Inches)</u>	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M251-1	1	44.9 x 80.3 x 1.25	6	PSI Westboro	15 July 1996
V049M252-1	1	48.5 x 68.5 x 1.25	6	PSI Westboro	15 July 1996
V049M253-1	1	48.5 x 68.5 x 1.25 with 48.5 hole offset from O.D. center line by 5.88 in.	2	PSI Westboro	15 July 1996
V049M254-1	1	30.8 x 68.5 x 1.25	4	PSI Westboro	15 July 1996
V049M255-1	1	60.8 x 72.5 x 1.25	4	PSI Westboro	15 July 1996
V049M256-1	1	60.8 x 80.3 x 1.25	2	PSI Westboro	15 July 1996
V049M257-1	1	44.9 x 68.5 x 1.25	2	PSI Westboro	15 July 1996
V049M258-1	1	30.8 x 68.5 x 1.63	4	PSI Westboro	15 July 1996
V049M248-1	1	60.25 x 72.5 x 1.63 with 60.25 hole offset from O.D. center line by 1.97 in.	2	PSI Westboro	15 July 1996
V049M249-1	1	60.25 x 72.5 x 1.25 with 60.25 hole offset from O.D. center line by 1.97 in.	2	PSI Westboro	15 July 1996

Number

Rev.

**SPECIFICATION**

Number

**A**

V049-2-134

Rev.

/

Page 7 of 8

ATTACHMENT "B"Schedule of Deliveries in Lots with Sizes and Quantities

Rings are to be delivered in lots as follows:

<u>PSI Part No.</u>	<u>Lot No.</u>	<u>I.D. x O.D. x Thk</u> <u>(Dimensions in Inches)</u>	<u>Qty.</u>	<u>Destination</u>	<u>Date</u>
V049M251-1	2	44.9 x 80.3 x 1.25	4	PSI Westboro	1 Feb. 1997
V049M252-1	2	48.5 x 68.5 x 1.25	2	PSI Westboro	1 Feb. 1997
V049M254-1	2	30.8 x 68.5 x 1.25	2	PSI Westboro	1 Feb. 1997
V049M255-1	2	60.8 x 72.5 x 1.25	2	PSI Westboro	1 Feb. 1997
V049M259-1	2	48.5 x 80.3 x 1.25	2	PSI Westboro	1 Feb. 1997
V049M258-1	2	30.8 x 68.5 x 1.63	2	PSI Westboro	1 Feb. 1997
V049M248-1	2	60.25 x 72.5 x 1.63 with 60.25 hole offset from O.D. centerline by 1.97 in.	1	PSI Westboro	1 Feb. 1997
V049M249-1	2	60.25 x 72.5 x 1.25 with 60.25 hole offset from O.D. centerline by 1.97 in.	1	PSI Westboro	1 Feb. 1997

**SPECIFICATION**

Number

**A**

V049-2-134

Rev.

1

Page 8 of 8

Number

Rev.