Title: **SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

SPECIFICATION FOR
PIPING DESIGN AND MATERIAL
FOR
LIGO VACUUM EQUIPMENT

Hanford, Washington
And
Livingston, Louisiana

RAYMOND D. CIATTO
STATE OF WASHINGTON
15714
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 8/5/99
7/21/97

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CIVIL ENGINEERING

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REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
5	DM 1/14/97	D.M.W 1-15-97	Clarified 181 flange/gasket requirements DEO # 0411
4	REC 11/27/96	D. M.W 11-27	REVISED T3 CLASS, MAT'L TO BE 304S/S, IT WAS 304L. DEO 0369
3	DM 10/16/96	D.M.W 10-17-96	Added "C1", spec. sht for cryogenic copper lines. REVISED 181-FLANGES DEO # 0317
2	REC 8/24/96	PTH/REB 8/28/96	REVISED "T4" SPEC SHT. 17, ITEM 5. RELEASED FOR PURCHASE. DEO 249
1	REC 7/25/96	REB 8/13/96	REVISED "T4" SPEC. SHT. 17 RELEASED FOR PURCHASE DEO #0236
0	REC 1-19-96	D.M.W	RELEASED FOR DESIGN & QUOTES DEO #0044

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED R. Ciatto	DATE 1-11-96	APPROVED D.M.W	DATE 1-18-96	Number A V049-2-037 LIGO-E960008-05-V	Rev. 5

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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

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

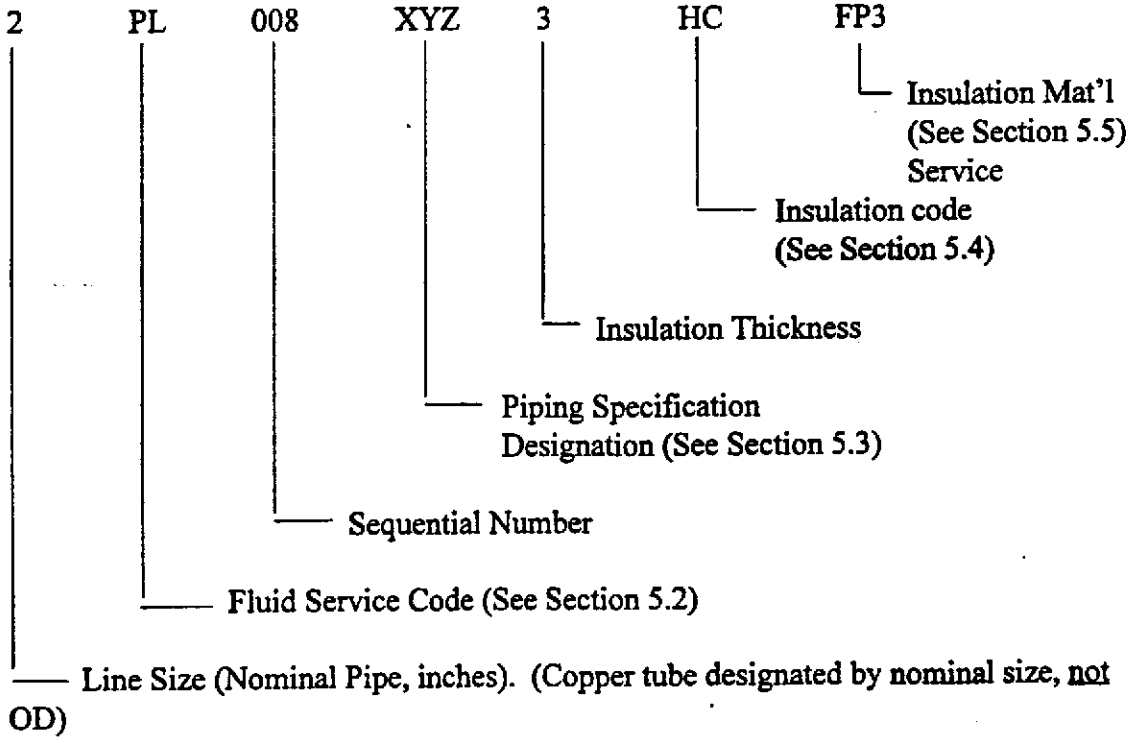
3.1 All materials used to manufacture the piping, tubing, flanges or fittings, as designated per this specification, are to be of U.S.A. origin and manufacture.

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:



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5.2 Fluid Codes

Code	Fluid
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

Insulation Symbol	Insulation Service
HC	Hot and Cold
C	Cold Conservation
PC	Personnel Protection COLD
PH	Personnel Protection HOT
VJ	Vacuum Jacketed

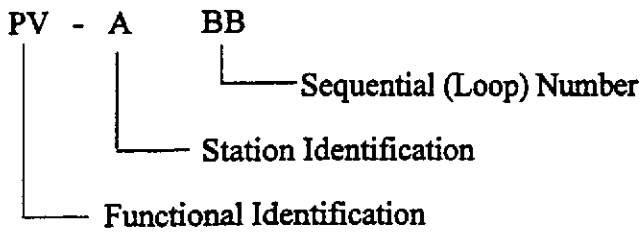
5.5 Insulation Material Codes

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, preceeded 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

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. Flanges on the vent line, (which mate to a flat faced flange on the vacuum equipment) shall be stainless steel raised-face design. Flanged joints shall have spiral wound, stainless steel gaskets, Flexitallic or equal.

Valves: Valves shall be furnished under their own unique specification.

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1B1

Branch Connections:

Run Size "											
½	04							04 - Tee			
¾	06	04						05 - Sockolet			
1	12	06	04					06 - Tee Then			
1½	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	½	¾	1	1½	2	3	4	6	8	10	12

1B2

PIPING DESIGN AND MATERIAL SPECIFICATION

Service:	Non-Cryogenic - Clean
Primary Rating:	150# ANSI 304 SSTL
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.

1B2

Branch Connections:

Run Size "											
½	04							04 - Tee			
¾	06	04						05 - Sockolet			
1	12	06	04					06 - Tee Then			
1½	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	½	¾	1	1½	2	3	4	6	8	10	12

Note:

1. Piping and fittings to be internally cleaned, dryed 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.

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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.

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, dryed 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.

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.

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 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, dryed and ends sealed during shiping, 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.

T3

PIPING DESIGN AND MATERIAL SPECIFICATION

Service: Process Vacuum

Design 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 TP304 SMLS
1 1/2" and larger	ASTM A26 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"

Flanges: All Flanges to be Conflat, ISO Large Flange or KF tube fittings 304 Stainless Steel.

Continued on next page.

T3

Fittings: All fittings to be 304 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, dryed 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.

T4

PIPING DESIGN AND MATERIAL SPECIFICATION

Service: Process Ultra High Vacuum

Design 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"	ASTM A269 GR TP304L SMLS
1 1/2" and larger	ASTM A269 GRTP304L 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.

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, dryed 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.

T5

PIPING DESIGN AND MATERIAL SPECIFICATION

Service: Class 100 Clean Air

Design 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.

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, dryed and ends sealed during shiping, 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.

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.

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:	SPEC NO: 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		

SPEC V049-2-037

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