# SPECIFICATION FOR

# PREFABRICATED VACUUM AND CLASS 100 AIR PIPING

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington


R. D. Ciatto 7/21/97

EXPIRES 8/5/98

**INSTALLATION MANAGER:** _____

**STRUCTURAL ENGINEER:** R. D. Ciatto

**TECHNICAL DIRECTOR:** D. A. McWilliams

**PROJECT MANAGER:** _____



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| 1 | REG 9/5/97 | RES 9/5/97 | REISSUED FOR CONSTRUCTION DEO# 0548 ADDED SECTION 3.2 |
| Ø | MJE/16JUL97 | REG 7/24/97 | RELEASED FOR CONSTRUCTION PER DEO# 0525 |
| P1 | REG 12/20/96 | 12/20/96 | ISSUED FOR QUOTES DEO 0393 |

**PROCESS SYSTEMS INTERNATIONAL, INC.** | **SPECIFICATION**

| INITIAL APPROVALS | PREPARED DATE | APPROVED DATE | Number V049-2-178 | Rev. |
|---|---|---|---|---|
| | REG, 12/20/96 | RES 12/20/96 | LIGO-E970134-01-V | 1 |

Title: FABRICATED CLASS 100 VACUUM AND AIR PIPING-LIGO WASHINGTON SITE

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ATTACHMENTS:



C960117/E960008 already in sys in, Rev. 5

needs new #'s

| SPECIFICATION | | |
|---|---|---|
| Number: | A V049-2-178 | Rev. 1 |

## 1.0 PURPOSE

This specification defines the scope of work to be provided by the contractor for the supply of the prefabricated Vacuum and Class 100 Air piping for the LIGO Vacuum Equipment. All requirements of V049-2-021 "Specification for Installation/Commissioning for LIGO Vacuum Equipment " applicable to this work.

## 2.0 SCOPE

2.1 The contractor is to provide all material and labor to detail design, procure, fabricate, test, clean and deliver to the site Vacuum and Class 100 Air piping and pipe supports as shown on the piping arrangement drawings and P&I Diagrams listed in Attachment A.

2.2 The Vacuum piping is comprised of the following:

Roughing Header (Corner Station only)

Turbo Headers

Annulus Piping

## 3.0 MATERIALS

3.1 All materials shall be in accordance with V049-2-037 "Specification for Piping Design and Materials".

3.2 All flex sections are to meet the following requirements:

Note: Flex sections are intended to act as vibration/sound isolators.

### 3.2.1 Vacuum and Class 100 Air Headers

Flex sections are to be vacuum compatible stainless steel, with full penetration welds, low stiffness bellows without metal braids.

All flex sections are to be cleaned, tested and packaged for UHV service, as manufactured by A&N Corp., Varian Vacuum Products or approved equal.

### 3.2.2 Cooling Water Supply / Return and Instrument Air Headers

Flex sections are to be Safeflex SFU-CT as manufactured by Mason Industries or approved equal.

## 4.0 FABRICATION AND TESTING

4.1 Pipe spool sections shall be prefabricated using only approved welding procedures in lengths appropriate to allow installation in the vacuum equipment area without requiring welding. Fabrication shall be done in accordance with specified codes.

4.2 Each spool section run shall have one fixed and one rotatable CF flange to permit easy assembly of the piping system. Flex sections shall be provided as shown on the piping drawings. Branches shall terminate in fittings as designated on the P&I Diagrams. Blind flanges shall be provided as indicated including gaskets and hardware. Where ISO Quick flanges are designated on piping drawings, use 304 stainless steel centering rings with Viton o-rings. Spool drawings shall be submitted to PSI for approval prior to fabrication.

4.3 Each spool section is to be helium leak checked after welding by evacuating and spraying with helium, and show no detectable leaks with a helium mass spectrometer at a sensitivity of 1x10-9 torr l/s. Spools shall be given unique serial numbers (1 to xx) to control testing documentation.

4.4 Each spool section shall be pressure washed with hot water using approved detergent (Oakite Inpro-Clean 1300)* and then rinsed with de-ionized water to remove all dirt and hydrocarbons. After drying with clean, filtered hydrocarbon free air or nitrogen, the section shall be checked for contamination using a white glove. Any discoloration or visable particles shall be cause for rejection and the piece shall be rewashed. If contamination is localized, the area may be cleaned using isopropyl alcohol and lint free cloths.

* Per manufacturer's specifications and not to exceed 5% Inpro-Clean 1300 in solution.

NOTE: This cleaning requirement also applies to contractor provided spools of piping, materials used between Class 100 Air Compressors and stainless steel O.D. tubing air headers.

4.5 After drying the section shall be properly labeled and capped to provide an airtight seal. The seal shall be maintained up to the time the section is to be installed.

## 5.0 DOCUMENTATION

The following documentation shall be provided.

- Material certification of all materials on pipe and fittings
- Leak Test Report
- Cleaning Report
- As built drawings

# ATTACHMENT "A" SPEC. V049-2-178
## DOCUMENT LIST

**Washington**

For Drawing Revision level see Gen. Doc. List

| Dwg. V049-0-000 | DRAWING SIZE | DOCUMENT NUMBER |
|---|---|---|
| **P&ID's** | D | |
| Legend/Station Diagrams (3 Shts.) | D | V049-0-001 |
| Beam Splitter Chamber All But Corner Vertex Arms | D | V049-0-002 |
| Beam Splitter Chamber Corner Vertex Arms | D | V049-0-003 |
| Horizontal Access Module | D | V049-0-004 |
| 112cm & 122cm Gate Valves | D | V049-0-005 |
| 80K Cryopump | D | V049-0-006 |
| Chamber Pressurization System | D | V049-0-007 |
| WA Left End Station | D | V049-0-010 |
| WA Left Mid Station | D | V049-0-011 |
| WA Left Beam Manifold | D | V049-0-012 |
| WA Vertex Section | D | V049-0-013 |
| WA Diagonal Section | D | V049-0-014 |
| WA Right Beam Manifold | D | V049-0-015 |
| WA Right Mid Station | D | V049-0-016 |
| WA Right End Station | D | V049-0-017 |
| WA Corner Station Mechanical Room | D | V049-0-018 |

| QTY | Washington | | |
|---|---|---|---|
| | For Drawing Revision level see Gen. Doc. List Dwg. V049-0-000 | **DRAWING SIZE** | **DOCUMENT NUMBER** |
| | **MECHANICAL DRAWINGS** | | |
| 6 | 25 L/S Annulus Tubing-44" G.V. Type III | C | V049-4-106 |
| 2 | 25 L/S Annulus Tubing 48" G.V. Type 1 | C | V049-4-108 |
| 8 | Annulus Tubing & Ion Pump Assembly. 44" G.V. | D | V049-4-109 |
| 2 | 25 L/S Annulus Tubing 48"G.V. Type II | C | V049-4-110 |
| 2 | 25 L/S Annulus Tubing - 44" G.V. Type I | C | V049-4-164 |
| 4 | Annulus Tubing & Ion Pump Assy 48" G.V. | D | V049-4-165 |
| 8 | 25 L/S Annulus Tubing - 44" G.V. Type II | C | V049-4-166 |
| - | Left & Right Beam Manifold Annulus Headers | D | V049-5-012 |
| 1 | Right Beam Manifold Annulus Header Per Line No. 2 1/2-PV-1174-T3 | | |
| 1 | Left Beam Manifold Header Per Line No. 2 1/2-PV-1158-T3 | | |

**Washington**

For Drawing Revision level see Gen. Doc. List

Dwg. V049-0-000

| | DRAWING SIZE | DOCUMENT NUMBER |
|---|---|---|
| **MECHANICAL DRAWINGS** | | |
| Equipment Arr't. Plan, Corner Station WA Sht 1 of 2 | D | V049-5-001 |
| Equipment Arr't. Elevation, Sht 2 of 2 | D | V049-5-001 |
| Equipment Arr't ISO, Corner Station, WA | D | V049-5-002 |
| Equipment Arr't , Right Mid Station, WA | D | V049-5-004 |
| Equipment Arr't , Right End Station, WA | D | V049-5-005 |
| Equipment Arr't , Left Mid Station, WA | D | V049-5-006 |
| Equipment Arr't , Left End Station, WA | D | V049-5-007 |
| Equipment Arr't ISO, Right Mid Station, WA | D | V049-5-010 |
| Equipment Arr't ISO, Right End Station, WA | D | V049-5-011 |
| Piping Arr't, Plan Corner Station/WA (4 Shts) | D | V049-5-012 |
| Piping Arr't, Elevation, Corner Station/WA | D | V049-5-013 |
| Piping Arr't, Sections, Corner Station/WA | D | V049-5-014 |
| Piping Arr't, Plan, Right Mid Station/WA (4 Shts) | D | V049-5-017 |
| Piping Arr't, Elevation, Right Mid Station/WA (2 Shts) | D | V049-5-018 |
| Piping Arr't, Sections, Right Mid Station/WA | D | V049-5-019 |
| Piping Arr't, Plan, Right End Station/WA (2 Shts) | D | V049-5-021 |
| Piping Arr't, Elevation, Right End Station/WA | D | V049-5-022 |
| Piping Arr't, Sections, Right End Station/WA | D | V049-5-023 |
| Piping Arr't. Plan Left Mid Station/WA (4 Sheets) | D | V049-5-026 |
| Piping Arr't Elevation Left Mid Station/WA (2 Sheets) | D | V049-5-027 |
| Piping Arr't, Sections, Left Mid Station/WA | D | V049-5-028 |
| Piping Arr't. Plan Left End Station/WA (2 Sheets) | D | V049-5-030 |
| Piping Arr't Elevation Left End Station/WA | D | V049-5-031 |
| Piping Arr't, Sections, Left End Station/WA | D | V049-5-032 |
| Overall Flange Arr't, Corner Station, WA | D | V049-5-033 |
| Overall Flange Arr't, Mid Station, WA | D | V049-5-035 |
| Overall Flange Arr't, Type End Station | D | V049-5-036 |

Title: FABRICATED CLASS 100 VACUUM AND AIR PIPING- WASHINGTON SITE

# ATTACHMENT "B"

# TO

# V049-2-178

## SPECIFICATION FOR PIPING AND MATERIAL FOR LIGO VACUUM EQUIPMENT

**V049-2-037**
(LIGO-E960008-05-V)

| ATTACHMENT | |
|---|---|
| Number: A V049-2-178 | Rev. 0 |

**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

STATE OF LOUISIANA RAYMOND D. CIATTO REG. No. 26750 REGISTERED PROFESSIONAL ENGINEER IN CIVIL ENGINEERING

**PROCESS ENGINEER:** Robert Tam

**PROJECT ENGINEER:** S. Motew

**CIVIL/STRUC. ENGINEER:** R. D. Ciatto

**MANUFACTURING ENGINEER:** Phillip Fisher

**QUALITY ASSURANCE ENGINEER:** Alan L Braddock

**PROJECT MANAGER:**

| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| 5 | RTM 1/14/97 | D.M.W 1-18-97 | 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 | RTM 10/16/96 | D.M.W 10-17-96 | Added "C1", Spec. sht for cryogenic coffer 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 7/26/96 | 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 | 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

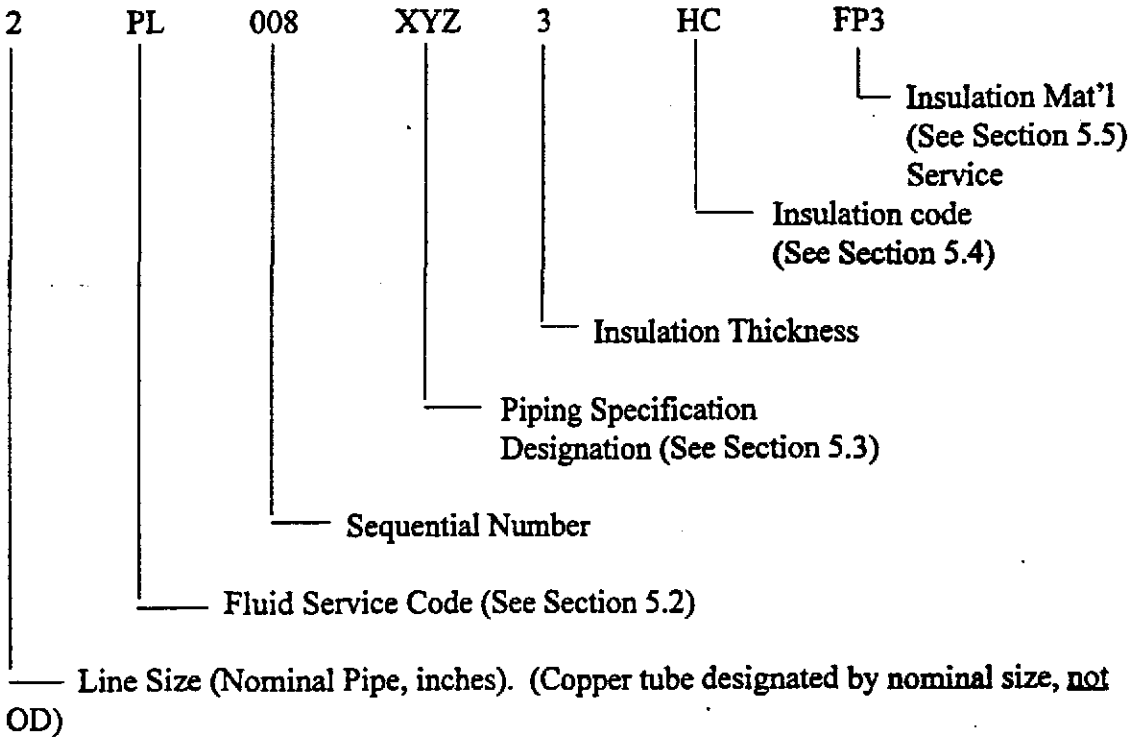
3.1 All materials used to manufacture the piping, tubing, flanges or fittings, as designated per this specification, are to be of U.S.A. origin and manufacture.

## 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 |

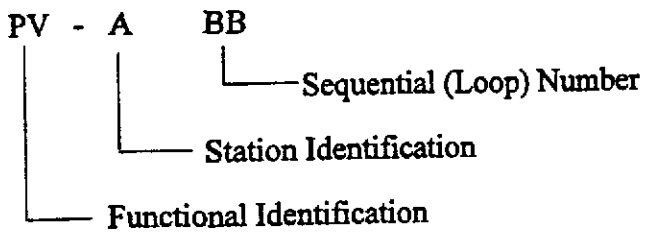
### 5.5 Insulation Material Codes

| | | |
|---|---|---|
| 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<br>ASTM A403 WP304 WPS, WPW<br>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.

Continued on Next Page

## 1B1

Branch Connections:

| Run Size " | Branch Size ½ | ¾ | 1 | 1½ | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 04 | | | | | | | | | | |
| ¾ | 06 | 04 | | | | | | | | | |
| 1 | 12 | 06 | 04 | | | | | | | | |
| 1½ | 05 | 05 | 06 | 04 | | | | | | | |
| 2 | 05 | 05 | 06 | 06 | 04 | | | | | | |
| 3 | 05 | 05 | 05 | 05 | 06 | 04 | | | | | |
| 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 |

04 - Tee
05 - Sockolet
06 - Tee Then Reducer or Reducing Tee
12 - BW O'let

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<br>ASTM A403 WP304 WPS, WPW<br>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.

Branch Connections:

| Run Size " | Branch Size ½ | ¾ | 1 | 1½ | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 04 | | | | | | | | | | |
| ¾ | 06 | 04 | | | | | | | | | |
| 1 | 12 | 06 | 04 | | | | | | | | |
| 1½ | 05 | 05 | 06 | 04 | | | | | | | |
| 2 | 05 | 05 | 06 | 06 | 04 | | | | | | |
| 3 | 05 | 05 | 05 | 05 | 06 | 04 | | | | | |
| 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 |

04 - Tee
05 - Sockolet
06 - Tee Then Reducer or Reducing Tee
12 - BW O'let

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.

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## 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<br>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<br>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<br>ASTM B88, B280, copper tube designated by its nominal sizes, not OD (UON). |
| Fittings: | |
| All sizes | Wrought copper<br>ASTM B75<br>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 | | |
| | | | | | | | |
| | | | | | | | |
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Pg. 20 SPEC V049-2-037

# ATTACHMENT "C"

# TO

# V049-2-178

## SPECIFICATION FOR CLEAN QUARTER TURN VALVES

## V049-2-060

(LIGO-E970136-02-V)

| ATTACHMENT | |
|---|---|
| Number: A V049-2-178 | Rev. |

# SPECIFICATION FOR

# CLEAN QUARTER-TURN VALVES

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

**PREPARED BY:** Thomas M. Stan

**PROCESS ENGINEER:** Patrick Thom

**QUALITY ASSURANCE:** Alan L Bradbrook

**TECHNICAL DIRECTOR:** D. C. McWilliams

**PROJECT MANAGER:** Rick Bayless



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| 2 | REL 07/10/97 | D.M.W 7-10-97 | REVISED FOR PURCHASE TO ADD QTY. 12 - 1½" VALVES. DEO 0520 |
| 1 | TMS 9-25-96 | D.M.W 9.26.96 | REVISED FOR PURCHASE PER DEO 0274 |
| 0 | TMS 3-1-96 | D.M.W 9-5-96 | RELEASED FOR QUOTE PER DEO 077 |

**PROCESS SYSTEMS INTERNATIONAL, INC.** — **SPECIFICATION**

| INITIAL APPROVALS | PREPARED | DATE | APPROVED | DATE | Number | V049-2-060 | Rev. |
|---|---|---|---|---|---|---|---|
| | T.M. Stan | 3-1-96 | RES | | A | | 2 |

## SPECIFICATION TABLE OF CONTENTS



## 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of 2" clean quarter-turn valves for the LIGO vacuum system. These valves will be used in Federal Standard 209 Class 100 air service.

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 in an L shape with 4 km arms, a vacuum system for the sensitive interferometer 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:

| | Quantity | Date | PSI Part No. |
|---|---|---|---|
| PSI, Westboro, MA: | 21 | 11/29/96 | V049BVCA20 |
| PSI, Westboro, MA. | 12 | 07/30/97 | V049BVCA15 (80K purge) |

2.2 Deleted

## 3.0 DESIGN REQUIREMENTS

3.1 The valves shall be either butterfly style, MDC Model No. BFV-200, MDC Part No. 360002.

3.2 The valves shall be 304 stainless steel.

3.3 End connections shall be CF flanges.

3.4 The valves shall be designed to seal in both directions.

3.5 The internal valve mechanisms shall be non-lubricated.

3.6 The valves shall be cleaned in accordance with the Vendor's standard procedure for valves intended for use in Federal Standard 209 Class 100 clean air service..

3.7 Valves shall be manually actuated.

## 4.0 REQUIRED DOCUMENTATION

Engineering drawings shall be submitted for approval prior to fabrication. Manufacturer's standard QA reports shall be provided prior to shipment:

## 5.0 SHOP TESTING

Manufacturer's standard testing shall be performed.

## 6.0 INSPECTION

The Vendor's standard inspections shall be performed. Also, each valve shall be visually inspected for cleanliness prior to shipment. Valves shall be recleaned if any contamination is found.

ATTACHMENT A
TO V049-2-060

PG 101 OF 20

## Butterfly Valves

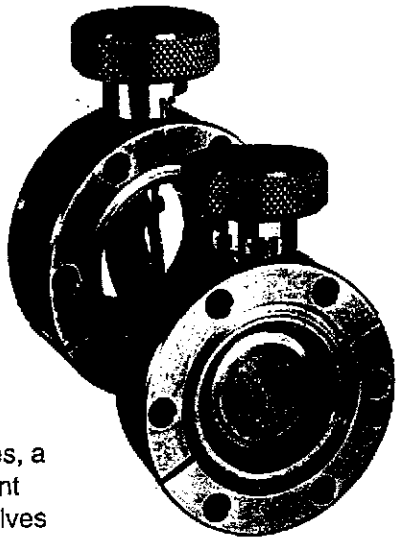
***Del•Seal*** Metal Seal Flange

***Kwik•Flange*** ISO O-Ring Flange

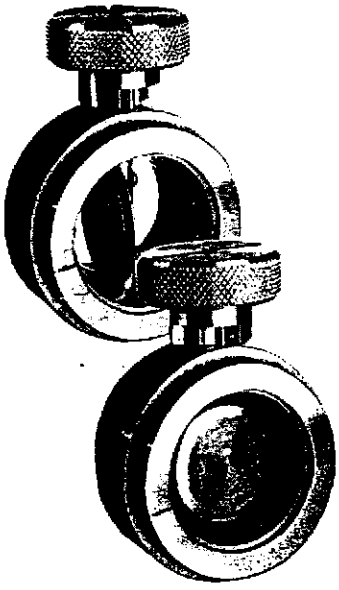


### FEATURES

- Quick open/Quick close
- Positive lock both positions
- Positive Viton® O-Ring vacuum seal
- High conductance
- Choice of *Del-Seal* or *Kwik-Flange*



*Del-Seal* Flange
BFV-150



*Kwik-Flange* Flange
KBFV-150

### DESCRIPTION

MDC Butterfly Valves require only one-quarter turn rotation of the handle to go from fully open to the fully closed position. In the 1-1/3 Mini *Del-Seal* flange series, a spring loaded ball bearing becomes seated in an indent providing a positive mechanical stop. All other size valves employ a roll pin stop method.

These quick-acting Butterfly Valves feature an improved sealing action. The opening in the body of the valve has been machined at a slight angle to the plane of the flapper. The flapper is set to rotate slightly off-center. On closure, this causes the sealing pressure to be applied more uniformly all around the O-ring. A reliable, positive seal is made and the tendency of previous designs to roughen the surface of the O-ring and eject it from its groove is eliminated.

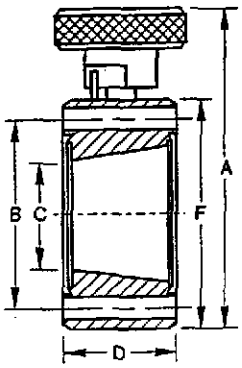
MDC Butterfly Valves are low outgassing. All internal surfaces are machined from solid stainless steel bar stock. The handle is made of aluminum. A small O-ring on the stem prevents shaft leakage.

The valves are offered with a choice of *Del-Seal* ultra-high vacuum metal-seal flanges or ISO *Kwik-Flange* O-ring seal flanges.

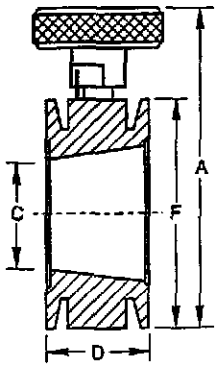
# Butterfly Valves








*Del-Seal* Flange




*Kwik-Flange* Flange

## ORDERING INFORMATION

***Please order by Part Number***

| Valve Nom I.D. Size | Reference | Part Number | Flange F | Flange O.D. | Bolt Holes No. | Ref ISO | Height A | Bolt Circle B | C | Thickness D | Wt Lbs | Unit Price |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/4 | BFV-075 | 360000 | *Del-Seal* 1-1/3 | 1.33 | 6 | - | 1.96 | 1.062 | .60 | .75 | 1 | $250 |
| 3/4 | KBFV-075 | 360010 | *Kwik-Flange* | 1.18 | - | NW16 | 1.81 | - | .56 | 1.25 | 1 | $250 |
| 1 | KBFV-100 | 360011 | *Kwik-Flange* | 1.57 | - | NW25 | 2.32 | - | .87 | 1.25 | 1 | $255 |
| 1-1/2 | BFV-150 | 360001 | *Del-Seal* 2-3/4 | 2.73 | 6 | - | 3.81 | 2.312 | 1.33 | 1.00 | 1 | $260 |
| 1-1/2 | KBFV-150 | 360012 | *Kwik-Flange* | 2.16 | - | NW40 | 3.81 | - | 1.31 | 1.34 | 1 | $260 |
| 2 | BFV-200 | 360002 | *Del-Seal* 3-3/8 | 3.37 | 8 | - | 4.46 | 2.850 | 1.84 | 1.00 | 2-1/2 | $360 |
| 2 | KBFV-200 | 360013 | *Kwik-Flange* | 2.95 | - | NW50 | 4.46 | - | 1.87 | 1.68 | 2-1/2 | $360 |

*Dimensions are in inches*

# ATTACHMENT "D"

# TO

# V049-2-178

## SPECIFICATION FOR SMALL VACUUM VALVES

## V049-2-059

(LIGO-E970137-01-V)

**ATTACHMENT**

| Number: | Rev. |
|---|---|
| A V049-2-178 | |

# SPECIFICATION FOR

# SMALL VACUUM VALVES

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

**PREPARED BY:** Thomas M. Stan

**PROCESS ENGINEER:** Roberto Thom.

**QUALITY ASSURANCE:** Alan H Bradbook

**TECHNICAL DIRECTOR:** D. O. McCW Allen

**PROJECT MANAGER:** Richard Boyle



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| 1 | TMS 7-19-96 | D McCW | REVISED FOR PURCHASE PER DEO 0224 |
| 0 | TMS 2-29-96 | D. McCW | RELEASED FOR QUOTE PER DEO 0075 |

**PROCESS SYSTEMS INTERNATIONAL, INC.** | **SPECIFICATION**

| INITIAL APPROVALS | PREPARED | DATE | APPROVED | DATE | Number | Rev. |
|---|---|---|---|---|---|---|
| | T. Stan | 2-29-96 | K&S | 2/21/96 | V049-2-059 | 1 |

## SPECIFICATION TABLE OF CONTENTS



## 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of small (1 1/2" and 2 1/2") high vacuum and ultra high vacuum angle valves for the LIGO vacuum system.

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 in an L shape with 4 km arms, a vacuum system for the sensitive interferometer 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:

| | Quantity | Date | PSI Part No. |
|---|---|---|---|
| 1 1/2" High Vac | 137 | 9/30/96 | V049AVHV15 |
| 2 1/2" High Vac | 70 | 9/30/96 | V049AVHV25 |
| 1 1/2" Ultra High Vac | 77 | 9/30/96 | V049AVUV15 |
| 2 1/2" Ultra High Vac | 26 | 9/30/96 | V049AVUV25 |

2.2 All valves shall be delivered to Process Systems International, Inc. at 20 Walkup Drive, Westboro, Massachusetts, 01581.

2.3 Acceptances at the sites are expected to occur on a staggered basis, with final acceptance at Washington expected to occur about May 31, 1998, and about November 30, 1998 in Louisiana.

## 3.0 DESIGN REQUIREMENTS

3.1 Angle valves shall be 304L or 316L stainless steel (304 or 316 stainless steel is acceptable if the valves are unavailable in L grade SS).

3.2 End connections shall be CF flanges.

3.3 The valves shall have stainless steel metal bellows stem feedthroughs.

3.4 Neither the body leakage not the seat leakage shall exceed $1 \times 10^{-9}$ torr liters/sec of helium.

3.5 The valves shall be designed to seal in both directions.

3.6 The internal valve mechanisms shall be non-lubricated.

3.7 Valves shall be manually actuated by a handwheel.

3.8 Valves shall be bakeable to 150 C +/-20 C (170 C maximum).

3.9 The valves shall be cleaned in accordance with the Vendor's standard procedures applicable to the valve service.

## 4.0 REQUIRED DOCUMENTATION

Engineering drawings shall be submitted for approval prior to fabrication. Manufacturer's standard QA reports shall be provided prior to shipment:

## 5.0 SHOP TESTING

Each valve shall be tested for leakage (using oil-free pumping equipment and leak detector) prior to shipment from the manufacturer

## 6.0 INSPECTION

The Vendor's standard inspections shall be performed. Also, each valve shall be inspected for cleanliness by black light prior to shipment. Valves shall be recleaned if any contamination is found.

Title: SPECIFICATION FOR PREFABRICATED VACUUM AND CLASS 100 AIR PIPING

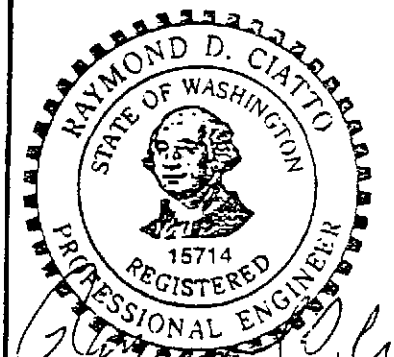
# SPECIFICATION FOR

# PREFABRICATED VACUUM AND CLASS 100 AIR PIPING

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington




7/21/97

EXPIRES 8/5/98

INSTALLATION MANAGER:

STRUCTURAL ENGINEER:

TECHNICAL DIRECTOR:

PROJECT MANAGER:



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| Ø | MJE/16JUL97 | REB 7/21/97 | RELEASED FOR CONSTRUCTION PER NEO # 0525 |
| P1 | REB 12/20/96 | 12/20/96 | ISSUED FOR QUOTES DEO 0393 |

PROCESS SYSTEMS INTERNATIONAL, INC. | SPECIFICATION

| INITIAL APPROVALS | PREPARED DATE | APPROVED DATE | Number V049-2-178 | Rev. |
|---|---|---|---|---|
| | REB, 12/20/96 | 12/20/96 | LIGO-E970134-00-V | Ø |

TABLE OF CONTENTS



ATTACHMENTS:

## 1.0 PURPOSE

This specification defines the scope of work to be provided by the contractor for the supply of the optional prefabricated Vacuum and Class 100 Air piping for the LIGO Vacuum Equipment. All requirements of V049-2-021 "Specification for Installation/Commissioning for LIGO Vacuum Equipment " applicable to this work.

## 2.0 SCOPE

2.1 The contractor is to provide all material and labor to detail design, procure, fabricate, test, and deliver to the site Vacuum and Class 100 Air piping and pipe supports as shown on the piping arrangement drawings and P&I Diagrams listed in Attachment A.

2.2 The Vacuum piping is comprised of the following:

Roughing Header (Corner Station only)

Turbo Headers

Annulus Piping

## 3.0 MATERIALS

All materials shall be in accordance with V049-2-037 "Specification for Piping Design and Materials"

## 4.0 FABRICATION AND TESTING

4.1 Pipe spool sections shall be prefabricated using only approved welding procedures in lengths appropriate to allow installation in the vacuum equipment area without requiring welding. Fabrication shall be done in accordance with specified codes.

4.2 Each spool section run shall have one fixed and one rotatable CF flange to permit easy assembly of the piping system. Flex sections shall be provided as necessary. Branches shall terminate in fittings as designated on the P&I Diagrams. Blind flanges shall be provided as indicated including gaskets and hardware. Spool drawings shall be submitted to PSI for approval prior to fabrication.

4.3 Each spool section is to be helium leak checked after welding by evacuating and spraying with helium, and show no detectable with a helium mass spectrometer at a sensitivity of 1x10-9 torr l/s. Spools shall be given unique serial numbers (1 to ___) to control testing documentation.

4.4 Each spool section shall be pressure washed with hot water using approved detergent (Oakite Inpro-Clean 1300)* and then rinsed with dionized water to remove all dirt and hydrocarbons. After drying with clean, filtered hydrocarbon free air or nitrogen, the section shall be checked for contamination using a white glove. Any discoloration shall be cause for rejection and the piece shall be rewashed. If contamination is localized, the area may be cleaned using isopropyl alcohol and lint free cloths.

* Per manufacturer's specifications and not to exceed 5% inpro-clean in solution.

4.5 After drying the section shall be properly labeled and capped to provide an airtight seal. The seal shall be maintained up to the time the section is to be installed.

## 5.0 DOCUMENTATION

The following documentation shall be provided.

- Material certification of all materials on pipe and fittings
- Leak Test Report
- Cleaning Report
- As built drawings

# ATTACHMENT "A" SPEC. V049-2-178

## DOCUMENT LIST

| *TITLE* | *DRAWING SIZE* | *DOCUMENT NUMBER* | *REV.* |
|---|---|---|---|
| **P&ID's** | D | | |
| Legend/Station Diagrams (3 Shts.) | D | V049-0-001 | 2 |
| Beam Splitter Chamber All But Corner Vertex Arms | D | V049-0-002 | 2 |
| Beam Splitter Chamber Corner Vertex Arms | D | V049-0-003 | 2 |
| Horizontal Access Module | D | V049-0-004 | 2 |
| 112cm & 122cm Gate Valves | D | V049-0-005 | 2 |
| 80K Cryopump | D | V049-0-006 | 3 |
| Chamber Pressurization System | D | V049-0-007 | 0 |
| WA Left End Station | D | V049-0-010 | 2 |
| WA Left Mid Station | D | V049-0-011 | 2 |
| WA Left Beam Manifold | D | V049-0-012 | 2 |
| WA Vertex Section | D | V049-0-013 | 2 |
| WA Diagonal Section | D | V049-0-014 | 2 |
| WA Right Beam Manifold | D | V049-0-015 | 2 |
| WA Right Mid Station | D | V049-0-016 | 2 |
| WA Right End Station | D | V049-0-017 | 2 |
| WA Corner Station Mechanical Room | D | V049-0-018 | 2 |

Number

Rev.

| *QTY* | *TITLE* | *DRAWING SIZE* | *DOCUMENT NUMBER* | *REV.* |
|---|---|---|---|---|
| | **MECHANICAL DRAWINGS** | | | |
| 6 | 25 L/S Annulus Tubing-44" G.V. Type III | C | V049-4-106 | 0 |
| 2 | 25 L/S Annulus Tubing 48" G.V. Type 1 | C | V049-4-108 | 0 |
| 8 | Annulus Tubing & Ion Pump Assembly. 44" G.V. | D | V049-4-109 | 0 |
| 2 | 25 L/S Annulus Tubing 48"G.V. Type II | C | V049-4-110 | 0 |
| 2 | 25 L/S Annulus Tubing - 44" G.V. Type I | C | V049-4-164 | 0 |
| 4 | Annulus Tubing & Ion Pump Assy 48" G.V. | D | V049-4-165 | 0 |
| 8 | 25 L/S Annulus Tubing - 44" G.V. Type II | C | V049-4-166 | 0 |
| - | Left & Right Beam Manifold Annulus Headers | D | V049-5-012 | Sht 1 |
| 1 | Right Beam Manifold Annulus Header Per Line No. 2 1/2-PV-1174-T3 | | | |
| 1 | Left Beam Manifold Header Per Line No. 2 1/2-PV-1158-T3 | | | |

| *TITLE* | *DRAWING SIZE* | *DOCUMENT NUMBER* | *REV.* |
|---|---|---|---|
| MECHANICAL DRAWINGS | | | |
| Equipment Arr't. Plan, Corner Station WA Sht 1 of 2 | D | V049-5-001 | 1 |
| Equipment Arr't. Elevation, Sht 2 of 2 | D | V049-5-001 | 1 |
| Equipment Arr't ISO, Corner Station, WA | D | V049-5-002 | 1 |
| Equipment Arr't , Right Mid Station, WA | D | V049-5-004 | 1 |
| Equipment Arr't , Right End Station, WA | D | V049-5-005 | 1 |
| Equipment Arr't , Left Mid Station, WA | D | V049-5-006 | 1 |
| Equipment Arr't , Left End Station, WA | D | V049-5-007 | 1 |
| Equipment Arr't ISO, Right Mid Station, WA | D | V049-5-010 | 1 |
| Equipment Arr't ISO, Right End Station, WA | D | V049-5-011 | 1 |
| Piping Arr't, Plan Corner Station/WA (4 Shts) | D | V049-5-012 | 1 |
| Piping Arr't, Elevation, Corner Station/WA | D | V049-5-013 | 1 |
| Piping Arr't, Sections, Corner Station/WA | D | V049-5-014 | 1 |
| Piping Arr't, Plan, Right Mid Station/WA (4 Shts) | D | V049-5-017 | 1 |
| Piping Arr't, Elevation, Right Mid Station/WA (2 Shts) | D | V049-5-018 | 1 |
| Piping Arr't, Sections, Right Mid Station/WA | D | V049-5-019 | 1 |
| Piping Arr't, Plan, Right End Station/WA (2 Shts) | D | V049-5-021 | 1 |
| Piping Arr't, Elevation, Right End Station/WA | D | V049-5-022 | 1 |
| Piping Arr't, Sections, Right End Station/WA | D | V049-5-023 | 1 |
| Piping Arr't. Plan Left Mid Station/WA (4 Sheets) | D | V049-5-026 | 1 |
| Piping Arr't Elevation Left Mid Station/WA (2 Sheets) | D | V049-5-027 | 1 |
| Piping Arr't, Sections, Left Mid Station/WA | D | V049-5-028 | 1 |
| Piping Arr't. Plan Left End Station/WA (2 Sheets) | D | V049-5-030 | 1 |
| Piping Arr't Elevation Left End Station/WA | D | V049-5-031 | 1 |
| Piping Arr't, Sections, Left End Station/WA | D | V049-5-032 | 1 |
| Overall Flange Arr't, Corner Station, WA | D | V049-5-033 | 0 |
| Overall Flange Arr't, Mid Station, WA | D | V049-5-035 | 0 |
| Overall Flange Arr't, Type End Station | D | V049-5-036 | 0 |

Title: PREFABRICATED CLASS 100 VACUUM AND AIR PIPING - WASHINGTON SITE

# ATTACHMENT "B"

# TO

# V049-2-178

## SPECIFICATION FOR PIPING AND MATERIAL FOR LIGO VACUUM EQUIPMENT

## V049-2-037

| ATTACHMENT | |
|---|---|
| Number: A V049-2-178 | Rev. 0 |

**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 15714 REGISTERED PROFESSIONAL ENGINEER STATE OF WASHINGTON

EXPIRES 8/5/99

7/21/97

STATE OF LOUISIANA
RAYMOND D. CIATTO
REG. No. 26750
REGISTERED
PROFESSIONAL
ENGINEER
IN
CIVIL ENGINEERING

PROCESS ENGINEER: Robert Tam

PROJECT ENGINEER: S. Motar

CIVIL/STRUC. ENGINEER: R. D. Ciatto

MANUFACTURING ENGINEER: Phillip Fabel

QUALITY ASSURANCE ENGINEER: Alan L Budlong

PROJECT MANAGER:

| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| 5 | RM 1/14/97 | D.M.W 1-15-97 | Clarified 18i flange/gasket requirements DEO # 0411 |
| 4 | REE 11/27/96 | D.M.W 11-28 | Revised T3 Class, MAT'L To BE 304S/S, IT WAS 304L. DEO 0369 |
| 3 | RM 10/16/96 | D.M.W 10-17-96 | Added "C1" Spec. sht for cryogenic copper lines. Revised 181-Flanges DEO # 0317 |
| 2 | REE, 8/24/96 | PTH/PEB 8/28/96 | Revised "T4" SPEC SHT. 17, ITEM 5. Released For Purchase DEO. 249 |
| 1 | REE 7/26/96 | PEB 8/13/96 | Revised "T4" SPEC. SHT. 17 Released For Purchase DEO #0236 |
| 0 | REE. 1-19-96 | D.M.W | Released For Design & Quotes DEO #0044 |

PROCESS SYSTEMS INTERNATIONAL, INC. | SPECIFICATION

| INITIAL APPROVALS | PREPARED | DATE | APPROVED | DATE | Number | Rev. |
|---|---|---|---|---|---|---|
| | R. Ciatto | 1-11-96 | D.M.W | 1-18-96 | A V049-2-037 | 5 |

## TABLE OF CONTENTS

## 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

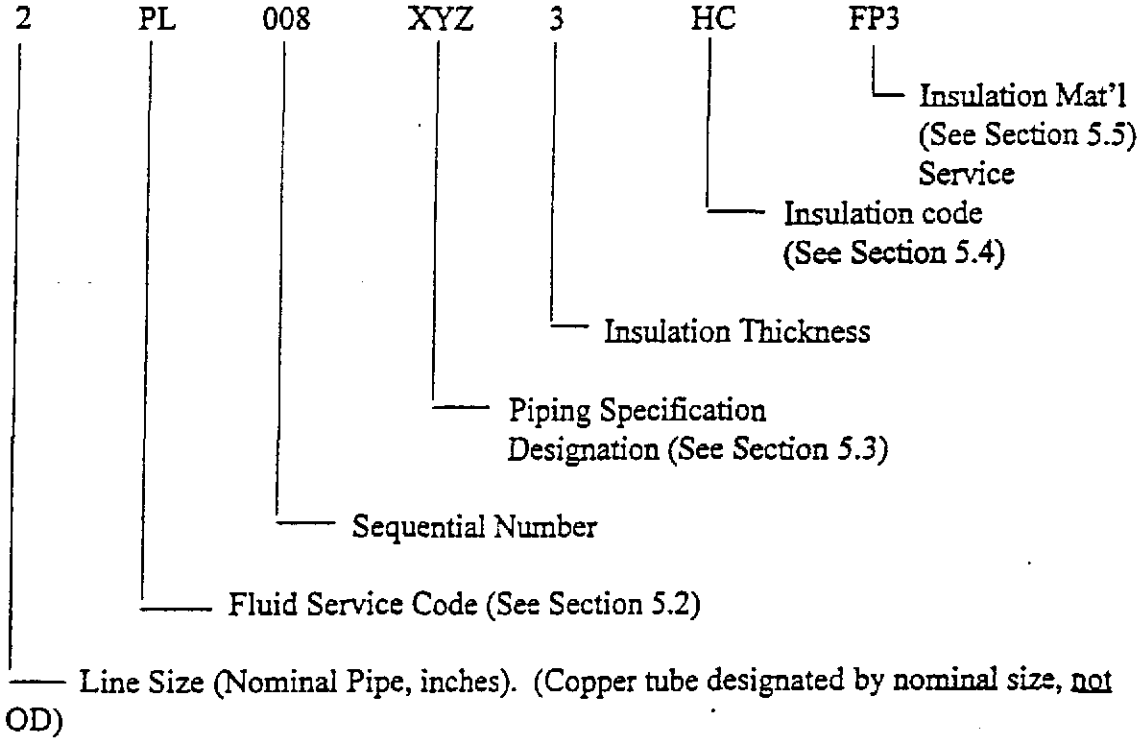
3.1 All materials used to manufacture the piping, tubing, flanges or fittings, as designated per this specification, are to be of U.S.A. origin and manufacture.

## 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 |

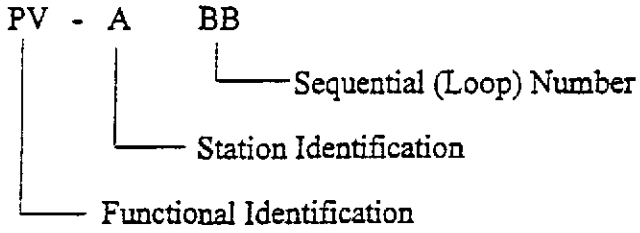
### 5.5 Insulation Material Codes

| | | |
|---|---|---|
| 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<br>ASTM A403 WP304 WPS, WPW<br>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.

Continued on Next Page

## 1B1

Branch Connections:

| Run Size " | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 04 | | | | | | | | | | |
| ¾ | 06 | 04 | | | | | | | | | |
| 1 | 12 | 06 | 04 | | | | | | | | |
| 1½ | 05 | 05 | 06 | 04 | | | | | | | |
| 2 | 05 | 05 | 06 | 06 | 04 | | | | | | |
| 3 | 05 | 05 | 05 | 05 | 06 | 04 | | | | | |
| 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 |

04 - Tee
05 - Sockolet
06 - Tee Then Reducer or Reducing Tee
12 - BW O'let

## 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<br>ASTM A403 WP304 WPS, WPW<br>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" | Branch Size ½ | ¾ | 1 | 1½ | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ | 04 | | | | | | | | | | |
| ¾ | 06 | 04 | | | | | | | | | |
| 1 | 12 | 06 | 04 | | | | | | | | |
| 1½ | 05 | 05 | 06 | 04 | | | | | | | |
| 2 | 05 | 05 | 06 | 06 | 04 | | | | | | |
| 3 | 05 | 05 | 05 | 05 | 06 | 04 | | | | | |
| 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 |

04 - Tee
05 - Sockolet
06 - Tee Then Reducer or Reducing Tee
12 - BW O'let

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.

## 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.

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<br>*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.

**SPECIFICATION**

Number A V049-2-037 Rev. 5

# 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<br>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.

Title **SPECIFICATION FOR PIPING DESIGN AND MATERIAL**

## 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.

Number

Rev.

**SPECIFICATION**

Number A V049-2-037 Rev.

## 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<br>ASTM B88, B280, copper tube designated by its nominal sizes, not OD (UON). |
| Fittings: | |
| All sizes | Wrought copper<br>ASTM B75<br>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 | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |

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Title: PREFABRICATED CLASS 100 VACUUM AND AIR PIPING - WASHINGTON SITE

# ATTACHMENT "C"

# TO

# V049-2-178

## SPECIFICATION FOR CLEAN QUARTER TURN VALVES

## V049-2-060

| ATTACHMENT | |
|---|---|
| Number: A V049-2-178 | Rev. 2 |

# SPECIFICATION FOR

# CLEAN QUARTER-TURN VALVES

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

PREPARED BY: Thomas M. Stan

PROCESS ENGINEER: Roberto Thom

QUALITY ASSURANCE: Alan L Bullock

TECHNICAL DIRECTOR: D C. McWilliams

PROJECT MANAGER: Rick Bayless



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| 2 | REG 07/10/97 | D.McW 7-10-97 | REVISED FOR PURCHASE TO ADD QTY. 12 – 1½" VALVES. DEO 0520 |
| 1 | TMS 9-25-96 | D.McW 9.26.96 | REVISED FOR PURCHASE PER DEO 0274 |
| 0 | TMS 3-1-96 | D.McW 3-5-96 | RELEASED FOR QUOTE PER DEO 077 |

PROCESS SYSTEMS INTERNATIONAL, INC. | SPECIFICATION

| INITIAL APPROVALS | PREPARED | DATE | APPROVED | DATE | Number | V049-2-060 | Rev. |
|---|---|---|---|---|---|---|---|
| | T.M.Stan | 3-1-96 | RES | | A | | 2 |

## SPECIFICATION TABLE OF CONTENTS



## 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of 2" clean quarter-turn valves for the LIGO vacuum system. These valves will be used in Federal Standard 209 Class 100 air service.

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 in an L shape with 4 km arms, a vacuum system for the sensitive interferometer 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:

| | Quantity | Date | PSI Part No. |
|---|---|---|---|
| PSI, Westboro, MA: | 21 | 11/29/96 | V049BVCA20 |
| PSI, Westboro, MA. | 12 | 07/30/97 | V049BVCA15 (80K purge) |

2.2 Deleted

## 3.0 DESIGN REQUIREMENTS

3.1 The valves shall be either butterfly style, MDC Model No. BFV-200, MDC Part No. 360002.

3.2 The valves shall be 304 stainless steel.

3.3 End connections shall be CF flanges.

3.4 The valves shall be designed to seal in both directions.

3.5 The internal valve mechanisms shall be non-lubricated.

3.6 The valves shall be cleaned in accordance with the Vendor's standard procedure for valves intended for use in Federal Standard 209 Class 100 clean air service..

3.7 Valves shall be manually actuated.

## 4.0 REQUIRED DOCUMENTATION

Engineering drawings shall be submitted for approval prior to fabrication. Manufacturer's standard QA reports shall be provided prior to shipment:

## 5.0 SHOP TESTING

Manufacturer's standard testing shall be performed.

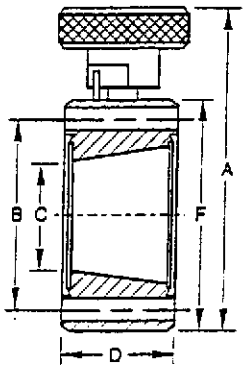
## 6.0 INSPECTION

The Vendor's standard inspections shall be performed. Also, each valve shall be visually inspected for cleanliness prior to shipment. Valves shall be recleaned if any contamination is found.

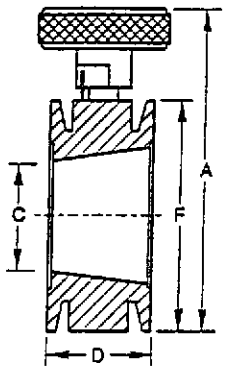
ATTACHMENT "A"
TO V045-3-060

PG 2 OF 2






*Del-Seal* Flange




*Kwik-Flange* Flange

## ORDERING INFORMATION

*Please order by Part Number*

| Valve Nom I.D. Size | Reference | Part Number | Flange F | Flange O.D. | Bolt Holes No. | Ref ISO | Height A | Bolt Circle B | C | Thickness D | Wt Lbs | Unit Price |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/4 | BFV-075 | 360000 | *Del-Seal* 1-1/3 | 1.33 | 6 | - | 1.96 | 1.062 | .60 | .75 | 1 | $250 |
| 3/4 | KBFV-075 | 360010 | *Kwik-Flange* | 1.18 | - | NW16 | 1.81 | - | .56 | 1.25 | 1 | $250 |
| 1 | KBFV-100 | 360011 | *Kwik-Flange* | 1.57 | - | NW25 | 2.32 | - | .87 | 1.25 | 1 | $255 |
| 1-1/2 | BFV-150 | 360001 | *Del-Seal* 2-3/4 | 2.73 | 6 | - | 3.81 | 2.312 | 1.33 | 1.00 | 1 | $260 |
| 1-1/2 | KBFV-150 | 360012 | *Kwik-Flange* | 2.16 | - | NW40 | 3.81 | - | 1.31 | 1.34 | 1 | $260 |
| 2 | BFV-200 | 360002 | *Del-Seal* 3-3/8 | 3.37 | 8 | - | 4.46 | 2.850 | 1.84 | 1.00 | 2-1/2 | $360 |
| 2 | KBFV-200 | 360013 | *Kwik-Flange* | 2.95 | - | NW50 | 4.46 | - | 1.87 | 1.68 | 2-1/2 | $360 |

*Dimensions are in inches*

ATTACHMENT "A"
TO V049-2-060

Pg 1 of 2

## Butterfly Valves

*Del•Seal* Metal Seal Flange

*Kwik•Flange* ISO O-Ring Flange



### FEATURES

- Quick open/Quick close
- Positive lock both positions
- Positive Viton® O-Ring vacuum seal
- High conductance
- Choice of *Del-Seal* or *Kwik-Flange*

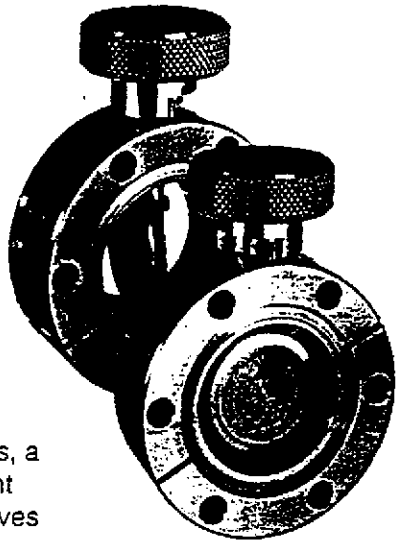
### DESCRIPTION

MDC Butterfly Valves require only one-quarter turn rotation of the handle to go from fully open to the fully closed position. In the 1-1/3 Mini *Del-Seal* flange series, a spring loaded ball bearing becomes seated in an indent providing a positive mechanical stop. All other size valves employ a roll pin stop method.

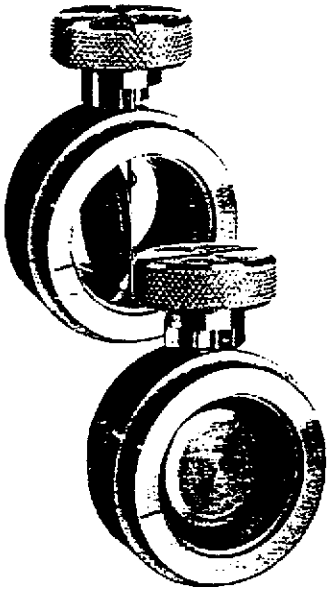
These quick-acting Butterfly Valves feature an improved sealing action. The opening in the body of the valve has been machined at a slight angle to the plane of the flapper. The flapper is set to rotate slightly off-center. On closure, this causes the sealing pressure to be applied more uniformly all around the O-ring. A reliable, positive seal is made and the tendency of previous designs to roughen the surface of the O-ring and eject it from its groove is eliminated.

MDC Butterfly Valves are low outgassing. All internal surfaces are machined from solid stainless steel bar stock. The handle is made of aluminum. A small O-ring on the stem prevents shaft leakage.

The valves are offered with a choice of *Del-Seal* ultra-high vacuum metal-seal flanges or ISO *Kwik-Flange* O-ring seal flanges.



*Del-Seal* Flange
BFV-150



*Kwik-Flange* Flange
KBFV-150

Title: PREFABRICATED CLASS 100 VACUUM AND AIR PIPING - WASHINGTON SITE

# ATTACHMENT "D"

# TO

# V049-2-178

## SPECIFICATION FOR SMALL VACUUM VALVES

## V049-2-059

| ATTACHMENT | |
|---|---|
| Number: A V049-2-178 | Rev. 1 |

# SPECIFICATION FOR

# SMALL VACUUM VALVES

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

PREPARED BY: Thomas M. Stan

PROCESS ENGINEER: Roberto Thom.

QUALITY ASSURANCE: Alan L Bradbrook

TECHNICAL DIRECTOR: D. O. McCoy

PROJECT MANAGER: Richard Bagley



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| 1 | TMS 7-19-96 | D McCoy | REVISED FOR PURCHASE PER DEO 0224 |
| 0 | TMS 2-29-96 | D McCoy | RELEASED FOR QUOTE PER DEO 0075 |

| PROCESS SYSTEMS INTERNATIONAL, INC. | | | | SPECIFICATION | |
|---|---|---|---|---|---|
| INITIAL APPROVALS | PREPARED T. Stan | DATE 2-29-96 | APPROVED K&B | DATE 2/21/96 | Number V049-2-059 | Rev. 1 |

## SPECIFICATION TABLE OF CONTENTS



## 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of small (1 1/2" and 2 1/2") high vacuum and ultra high vacuum angle valves for the LIGO vacuum system.

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 in an L shape with 4 km arms, a vacuum system for the sensitive interferometer 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:

| | Quantity | Date | PSI Part No. |
|---|---|---|---|
| 1 1/2" High Vac | 137 | 9/30/96 | V049AVHV15 |
| 2 1/2" High Vac | 70 | 9/30/96 | V049AVHV25 |
| 1 1/2" Ultra High Vac | 77 | 9/30/96 | V049AVUV15 |
| 2 1/2" Ultra High Vac | 26 | 9/30/96 | V049AVUV25 |

2.2 All valves shall be delivered to Process Systems International, Inc. at 20 Walkup Drive, Westboro, Massachusetts, 01581.

2.3 Acceptances at the sites are expected to occur on a staggered basis, with final acceptance at Washington expected to occur about May 31, 1998, and about November 30, 1998 in Louisiana.

## 3.0 DESIGN REQUIREMENTS

3.1 Angle valves shall be 304L or 316L stainless steel (304 or 316 stainless steel is acceptable if the valves are unavailable in L grade SS).

3.2 End connections shall be CF flanges.

3.3 The valves shall have stainless steel metal bellows stem feedthroughs.

3.4 Neither the body leakage not the seat leakage shall exceed 1 x $10^{-9}$ torr liters/sec of helium.

3.5 The valves shall be designed to seal in both directions.

3.6 The internal valve mechanisms shall be non-lubricated.

3.7 Valves shall be manually actuated by a handwheel.

3.8 Valves shall be bakeable to 150 C +/-20 C (170 C maximum).

3.9 The valves shall be cleaned in accordance with the Vendor's standard procedures applicable to the valve service.

## 4.0 REQUIRED DOCUMENTATION

Engineering drawings shall be submitted for approval prior to fabrication. Manufacturer's standard QA reports shall be provided prior to shipment:

## 5.0 SHOP TESTING

Each valve shall be tested for leakage (using oil-free pumping equipment and leak detector) prior to shipment from the manufacturer

## 6.0 INSPECTION

The Vendor's standard inspections shall be performed. Also, each valve shall be inspected for cleanliness by black light prior to shipment. Valves shall be recleaned if any contamination is found.