



SPECIFICATION

SPECIFICATION FOR S. S. BELLOWS

APPROVALS	DATE	REV	DCN NO.	BY	CHECK	DCC	DATE
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SPECIFICATION FOR S. S. BELLOWS

1.0 Scope

This specification covers the minimum requirements for the design, materials, fabrication, inspection, testing, preparation for shipping, and shipment of bellows expansion joints for the LIGO vacuum system. The Seller shall include these requirements in their procedures and purchase orders.

2.0 The Material Requirements

2.1 All bellows material provided by the vendor shall conform to the requirements of ASME Specification SA-240 Type 304L with the additional supplementary requirements described in this specification. Other vendor supplied materials shall be provided as required by the drawings and bills of material. The stainless steel bellows material used shall be hot rolled, annealed and pickled. Bright H₂ annealed material is not permitted. If the bellows material is supplied dual certified to grade 304/304L, this will be acceptable.

2.2 Applicable Codes

2.2.1 ASME Boiler & Pressure Vessel Code, Section II, "Materials", 2007 Edition and all published Addenda.

2.2.2 ASTM A-480, "Standard Specification for General Requirements for Flat-Roll Stainless and Heat-Resisting Steel Plate, Sheet, and Strip".

2.3 Any apparent conflicts between the requirements given herein and the applicable ASME Specification shall be brought to the attention of buyer for clarification.

3.0 Schedule

As requested in the purchase order.

4.0 Equipment Requirements

4.1 All Bellows and assemblies shall be designed and fabricated to comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels, latest edition and subsequent addenda, even though vacuum vessels are beyond the scope of this code. Furnished components need not be code "U" stamped.

4.2 Bellows will to be designed to be retracted 3" maximum or extended 1" maximum from the shipping length. Also, bellows will be retracted 3" maximum from the installed position for equipment maintenance and "O-Ring" replacement for approximately 200 cycles (total plant life).

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- 4.3 The bellows spring rate shall be such that the total load (spring rate x maximum displacement) shall not exceed 100 #/inch of circumference at the flange I.D.
- 4.4 The bellows ends shall have 3 inches of straight material to allow welding the bellows into rolled up SS sections.

5.0 Design Requirements

- 5.1 Expansion joints shall withstand Ultra-high Vacuum (10E-09 Torr.) at 400 Deg F, bakeout and 2 PSIG internal pressure at room temperature during the purging operation.
- 5.2 In addition to the dimensional requirements, the bellows must be capable of permitting a maximum of 1/2 degree of angular offset (bending) while in the installed position.
- 5.3 Multi-ply bellows are not acceptable for Hi-Vacuum service.
- 5.4 Circumferential welds in bellows are not permitted under any circumstance.

6.0 Material Testing

- 6.1 One material coupon, 2" x 2" min., from each heat number, lot and thickness of bellows material provided by the vendor must be supplied to the buyer for information prior to release for shipment. Each coupon shall be permanently marked/stamped with heat number, lot, etc., for positive identification.

7.0 Fabrication

- 7.1 The SS bellows shall be prevented from coming in contact with carbon steel contamination of any kind.

8.0 WELDING

- 8.1 All welding if required by the purchase order, shall be performed in accordance with the ASME Boiler & Pressure Vessel Code, Section IX, Welding and Brazing Qualification, latest edition and other applicable code sections referenced herein.
- 8.2 All welders shall be certified to ASME Section IX Procedures.
- 8.3 Grinding is not permitted; welds shall be smooth but NOT FLUSH & NOT GROUND. Carbide cutting is permitted.
- 8.4 All welds at vacuum boundaries shall be vacuum tight with a helium leak rate equivalent to a total of 1×10^{-9} torr liters/sec/chamber. The Seller shall leak test all



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bellows with a helium mass spectrometer. Vendor shall repair all leak areas identified.

8.5 All weld joint preparation shall be done by tungsten carbide tooling. Backing strips or rings shall not be used

8.6 Welding Process

8.6.1. Vacuum boundary and attachment welds shall be gas tungsten arc welds (GTAW) or plasma arc welds (PAW) (see sample Attachment C). The vendor shall submit weld procedures to the Buyer for review and approval prior to fabrication.

8.6.2. All weld repairs shall be performed in accordance with procedures approved by the Buyer.

8.6.3. All weld wire and weld joint preparation areas shall be cleaned with CO₂ scrubbing prior to welding . Weld wire shall be packaged after cleaning to prevent contamination. Weld wire shall be handled only with clean gloves after CO₂ cleaning.

8.7 Welding shall be done in an area that is separate from dirty processes (MIG welding, grinding, blasting, painting, etc.).

9.0 CLEANLINESS

9.1 This material is intended for use in a high vacuum application. Potential hydrocarbon contamination shall be prevented. Also, the material shall be wrapped and covered at all times the material is not being processed to minimize possible exposure to contaminants.

9.2 No iron, carbon steel or other contaminants (such as grease, oil or hydrocarbons) are to come in contact with the shells. Machining fluids shall be water soluble and free of oil and sulfur. All fluids that come in contact with bellow shall not exceed the contaminant levels permitted as stated below.

Maximum Concentration Limits

<u>Contaminant</u>	<u>Limit</u>
Water Leachable Chlorides	100 ppm
Total Halogens (including Water Leachable Chlorides)	1000 ppm
Total Sulfur	1000 ppm

9.3 Bellows shall be steam cleaned with detergent (Inpro-clean 1300) and dried (air dried) prior to wrapping. The bellows shall be free of all surface contaminants, forming lubricants, free from residue from forming rolls, tools etc. and standing water. The Seller shall submit all cleaning procedures and methods for Buyers approval.

**SPECIFICATION FOR S. S. BELLOWS****10.0 Shop Testing**

The Seller shall submit all test methods and procedures that are to be used to verify the leak tightness of the expansion bellows for the buyer's approval. The Seller shall submit the documented results of the tests to the Buyer for his records. The Buyer reserves the right to witness the tests on-site. The vendor shall notify the buyer 5 working days before each lot is leak tested.

Bellows shall be helium leak checked per ASTM E498 to less than 1×10^{-9} Torr l/sec. Liquid penetrant testing shall not be used for testing.

11.0 Inspection

- 11.1 The responsibility for all inspections rests with the Seller; however, the Buyer reserves the right to inspect the components at any time during or after fabrication to assure that the workmanship and materials are in compliance with this specification.
- 11.2 The purchaser shall have the right to witness all manufacturing processes.
- 11.3 The purchaser shall be informed 5 working days before the scheduled ship date of each lot. A signed release for ship form is required from the purchaser to release each shipment.

12.0 Repair of Defects

Welding is not permitted to repair the formed bellows.

13.0 Identification

- 13.1 Identification of the bellows material shall be maintained and documented through all manufacturing processes (i.e. re-stamping material heat numbers after each cut).
- 13.2 If material identity of the bellows or nipples is lost, they shall be re-qualified by making all tests that were required for the material or as indicated in this specification.
- 13.3 Marking the finished bellows with marking fluids, die stamps, and/or electro-etching is not permitted. A vibratory tool with a minimum tip radius of .005" is acceptable for marking only the outside of the bellows.
- 13.4 All bellows and bellows assemblies shall be marked with the Buyer's part number.

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14.0 Documentation

- 14.1 The Certified Material Test Reports (CMTRs) for vendor purchased material shall be provided to the purchaser with the shipment of the bellows and shall be available for review during inspection visits prior to shipment.
- 14.2 Design calculations and fabrication drawings shall be submitted to the purchaser for approval prior to fabrication.

15.0 Packaging, Storage and Shipping

- 15.1 Temporary shipping supports, as required, shall be provided if necessary.
- 15.2 All material and parts shall be covered with a tarp immediately after each processing operation has been completed to minimize contamination. The material shall remain packaged and covered until it is necessary to remove the covering and packaging material for further processing.
- 15.3 After final cleaning, bellows/assemblies shall be packaged for shipping. All bellows/assemblies shall be wrapped in polyethylene and placed in closed wooden crates with proper supports to prevent shipping damage.
- 15.4 The bellows shall be shipped as specified in the purchase order.
- 15.5 The purchaser shall approve each lot of bellows/bellows assemblies prior to shipment.

16.0 Non-Escort Privileges and Inspection Right

Non-escort privileges for Buyer, Owner, and Government and Owner representatives to all areas of the facilities where the work is being performed shall be arranged. This will include access to fabrication, assembly, cleaning and test areas for the purpose of monitoring activities.



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ATTACHMENT A

BELLOWS REQUIRED

<u>BELLOWS TAG NO</u>	<u>QUANTITY</u>	<u>I. D.</u>	<u>LENGTH</u>
TAG 1 TO TAG 12	12	60.5 IN.	BY VENDOR
TAG 13 AND 14	2	44.62 IN.	BY VENDOR