



REQUIREMENTS

Metal components intended for use in the Adv LIGO Vacuum System

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AUTHOR(S): Calum Torrie, Dennis Coyne, Ken Mailand	27-Oct-2010	see DCC record Status:

1 Introduction

All metal components intended for vacuum service shall have quality finishes on all surfaces, suitable for service in an Ultra-High Vacuum (UHV) system. These requirements define the restrictions and practices which must be followed for parts to be used in the LIGO UHV system.

Exceptions, additions or clarifications should be obtained from the LIGO Contractual officer or the Contracting Officer's Technical Representative.

2 Scope

These requirements only apply to metal components intended for in-vacuum service; If the parts are not intended for in vacuum, then these requirements do not apply.

In addition these requirements do not apply to cantilever blade springs, all weldments and porcelain steel. For these applications, see the following references:

LIGO-E0900023, Process for Manufacturing Cantilever Spring Blades

LIGO-E0900048, Welding Specification for Weldments used within the Advanced LIGO Vacuum System

LIGO-E1000083, Specification for Enameled Steel Sheet to be used in the LIGO Ultra-High Vacuum System

3 Purchase Order Specific Requirements

In addition to the requirements defined in this specification, additional requirements, specific to a particular procurement or part, may be defined in the Statement Of Work (SOW) or Request for Quotation (RFQ).

4 General Requirements for Metal parts in vacuum

4.1 Materials

Only materials (specific alloys) approved for use in the LIGO UHV system may be used. All materials should be specified on the drawing. No substitutions may be made without prior approval by the Contracting Officer or the Contracting Officer's Technical Representative.

Tooling plate material is not permitted.

All material is to be virgin material (i.e. no weld repairs or plugs unless approved in advance in writing by LIGO (see also section 4.8)



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4.2 Castings, Moldings

No cast or molded parts are permitted.

4.3 Machining

All final surfaces of all parts are to be machined; No as received, as rolled, as milled surfaces will be accepted, unless otherwise noted on the drawing.

All machining, and tapping, fluids must be fully synthetic, water soluble (not simply water miscible) and free of sulfur, chlorine, and silicone. If this is difficult or expensive please talk to LIGO staff about an exemption.

4.4 Abrasive Removal Techniques

4.4.1 Grinding

No grinding or lapping with abrasive wheels, cloth or stones is permitted for the final surface, unless otherwise noted on the drawing. Grinding (e.g. Blanchard grinding) is acceptable if all ground surfaces are machined afterwards.

4.4.2 Sanding

No parts are to be sanded with abrasive techniques e.g. sanding, grinding. Scotch-Brite™ or similar products are not permitted. Stainless steel wool can be used if sanding is required.

4.4.3 Scotch-Brite™

The use of Scotch-Brite™ or similar products is not permitted at any time.

4.5 Finishing (Surface roughness)

The required surface roughness (finish) is defined in the drawing block entitled "finish". Please note if finish is called out on the drawing it is in Ra. If no call-out is included in this block, then the surface finish should default to: -

- 63 micro-inch (Ra) for stainless all surfaces
- 63 micro-inch (Ra) for aluminum all surfaces
- large thin sheet should have a surface 32 micro-inch (Ra)

Refer to section 4.9 for exceptions.

Localized scratches, digs and blemishes should be minimized and addressed though visual inspection and QA. If such blemishes compromise the function or performance of the part (e.g. a stray light control baffle), then limits on acceptable scratches and digs should be defined in the drawing or associated process specification.



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In general no coatings or finishes shall be applied to any metal parts, with the exception of silver or other approved coatings for tribology or thermal control reasons. If any coatings or finishes are required they will be defined in the drawing or associated process specification. In particular no aluminum parts are to be anodized.

4.6 Cleaning requirements

Thoroughly clean part to remove all ink, oil, grease, dirt, and chips with soap and water. Solvents may be used.

4.7 De-burring

All sharp edges and corners shall be rounded. You can de-burr with de-burring tools, filing and / or stainless steel wire brushes. Tumbling or use of steel wool is not acceptable for de-burring. All deburring tools, files and stainless wire brushes must be clean and free of contaminants.

4.8 Repairs

No repairs shall be made unless approved in advance, and in writing, by LIGO Laboratory. In general weld repairs and press fit insert repairs are never acceptable; The material should be virgin material. Special circumstances can be reviewed if/when brought to the attention of LIGO Contracting Officer's Technical Representative (COTR), through a Material Review Board (MRB) process.

4.9 Exceptions

When it is not practical to machine all surfaces, e.g.

1) if extruded tubular sections (or angles or other stock shapes) are to be used, then machining the interior surfaces is not practical and machining the outer radius on the corners is prohibitive. In this case either

- a) all surfaces of all parts are to be machined, except those not practical to machine. In this case the inner surface and outer radius will be accepted "as extruded" or "as rolled", or
- b) the part is electropolished to remove all surface oxides and potentially embedded contaminants refer to section 5.1 or 5.2, or
- c) (for aluminum) the part is chemically cleaned / etched by acid or caustic process, refer to section 5.1

2) if large thin sheet is used with a surface finish higher than the standard 32 micro-inch (Ra) is delivered from the supplier either

- a) the surface finish should be discussed with LIGO Contractual office prior to acceptance, or
- b) the sheet should be electropolished as per section 5.1 or 5.2
- c) the sheet should be chemically cleaned / etched by acid and / or caustic process, refer to section 5.1



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Further questions related to machining all surfaces can be discussed with the LIGO Contractual officer or the Contracting Officer's Technical Representative. Under no circumstances should the parts be anodized.

5 Further Cleaning (only if specified)

These cleaning steps only apply if called out in the individual SOW/RFQ and/or drawing. Additional questions related to this section on further cleaning can be discussed with the LIGO Contractual officer or the Contracting Officer's Technical Representative.

5.1 Aluminum

5.1.1 Chemical clean

1. First the parts or assemblies are de-burred, and cleaned, removing all possible machining residue.
2. The part(s) are then washed with Alkaline Soak Cleaner and inspected for cleanliness using the water break test.
3. The part(s) are then to be chemically cleaned / etched by acid and / or caustic process. At this step in the process Scotch-Brite™ or similar mildly abrasive pads can be used. This is the only step where Scotch-Brite™ is permitted.
4. The acid formulation, time and temperature should be chosen to achieve slight chemical etching (<0.0005 inch).
5. Under no circumstances should the parts be anodized.
6. The part(s) are then thoroughly rinsed with clean water. After rinsing, a full visual inspection is performed, to assure a satisfactory surface finish has been achieved uniformly, over the entire part(s).
7. The parts are then dried, re-inspected and packaged for shipment.

5.1.2 Electropolish

Electropolishing Aluminum parts is also allowed. If using electropolishing on a part follow similar steps to those outlined in section 5.2.1 Pickling. The use of Scotch-Brite™ or similar products is not permitted.

5.2 Stainless Steel

5.2.1 Pickling & Passivation

1. First the parts or assemblies are de-burred, and cleaned, removing all possible machining residue and inspected for cleanliness using the water break test..
2. Stainless steel parts are to be pickled and passivated at room temperature, with special attention paid to sufficiently agitate the solution or flush the inside of the box section used in the particular design. The pickling and passivation process formulation, time and temperature should be chosen to achieve slight chemical etching (<0.0005 inch).



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3. The part(s) are then thoroughly rinsed with clean water. After rinsing, a full visual inspection is performed, to assure a satisfactory surface finish has been achieved uniformly, over the entire part(s).
4. The parts are then dried, re-inspected and packaged for shipment.

5.2.2 Electropolish

Electropolishing stainless steel parts is also allowed. If using electropolishing on a part follow similar steps to those outlined in section 5.2.1 Pickling. The use of Scotch-Brite™ or similar products is not permitted.