



**COMPONENT SPECIFICATION**

**TITLE**  
**LARGE OPTICS SUSPENSION (LOS)  
 STRUCTURAL FABRICATION SPECIFICATION**

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
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DCC RELEASE:							

**1 INTRODUCTION**

**1.1. Objectives and Scope**

The scope of this document is limited to the specifications for the fabrication of the LOS (Large Optics Suspension) Structure Assemblies and the LOS Height Adapters.

**1.2. Applicable Documents**

- LIGO-D960132: Large Optic Suspension Assembly, LOS1;Reference only - not required for fabrication
- LIGO-D960133: LOS Structure Assembly, LOS1
- LIGO-D970551 Recycling Mirror LOS Structure Assembly
- LIGO-D960145: LOS Height Adapter Assembly
  
- LIGO-L970196: Part Numbers and Serialization of Detector Hardware
- LIGO-E970132: Large Optic Suspension Assembly Quality Conformance Worksheet

**2 SPECIFICATION FOR FABRICATION**

**2.1. Physical Configuration**

Build in accordance with:

- LIGO-D960132: Large Optics Suspension Assembly; Ref. only - not required for fabrication
- LIGO-D960133: LOS Structure Assembly
- LIGO-D970551 Recycling Mirror LOS Structure Assembly
- LIGO-D960145: LOS Height Adapter Assembly

**2.2. Fabrication**

**2.2.1. Process Sequence**

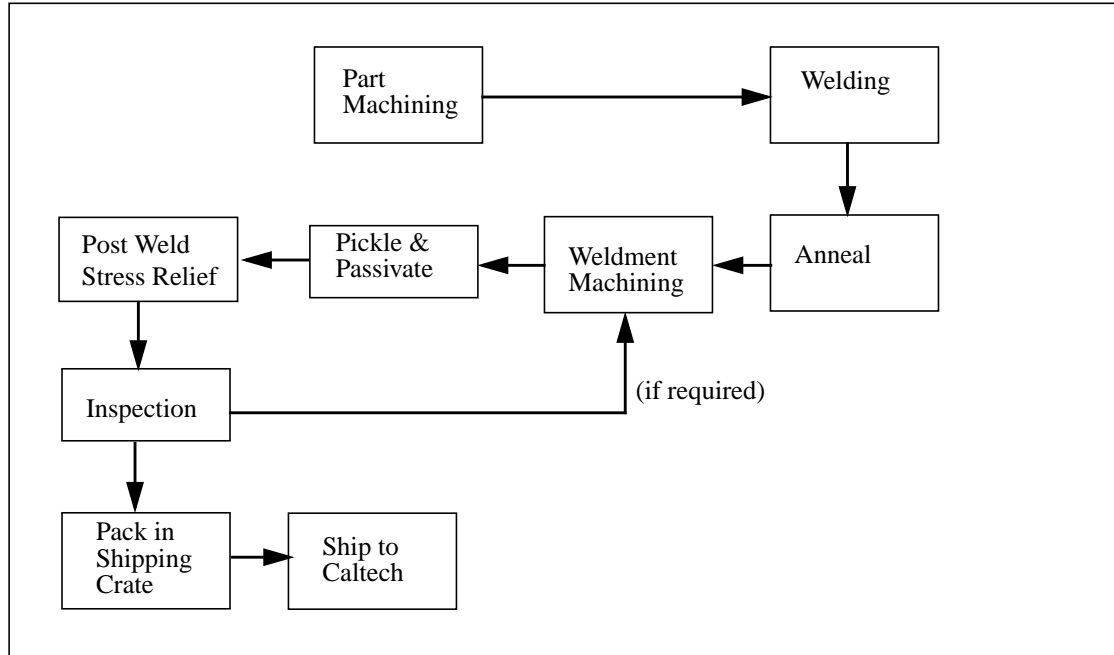
The sequence of process steps for the fabrication of the LOS Structure Assemblies and LOS Height Adapters required by this specification is as indicated in Figure 1.



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**Figure 1: Process Sequence**

### 2.2.2. Protection from Contamination

The LOS Structure Assemblies and the LOS Height Adapters are made of stainless steel (see drawings). No carbon steel hooks, fork lift forks, grapples or chains shall be allowed to contact the stainless steel.

Stored materials (raw materials or work-in-process) shall be protected from the shop atmosphere when not being handled (or worked on) by plastic sheets or similar protective covers. Polyethylene plastic sheet is acceptable. Raw materials shall be protected from contamination throughout the fabrication process. Smoking is not allowed in any suspension storage or manufacturing area.

### 2.2.3. Part Machining

#### • Liquid contaminants/Machining Lubricants

Liquids containing hydrocarbons or other contaminants, other than the machining fluids specified herein, shall not be allowed to come into contact with suspension material at any time. All machining fluids shall be water soluble and free of sulfur, chlorine and silicone; such as Cincinnati Milacron's Cimtech 410 (stainless steel) or Hangsterfer's S-500CF (all metals).

#### • Grinding & Abrasive Cloth/Paper

Grinding (with abrasive wheels, cloth, or stones), or use of abrasive cloth or paper, is permitted on suspension components, except where noted, if the ground or impacted surface is subsequently skimmed with a carbide tool to remove any residual contaminants. The use of oil free Arkansas stones are also approved to remove slight imperfections in the machined surfaces.



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#### 2.2.4. Welding

Welders must be certified to American Welding Society (AWS) or American Society of Mechanical Engineering (ASME) standards. All welds for suspension components are full penetration. Grinding shall comply with the requirements outlined under Grinding & Abrasive Cloth/Paper. An inert shield gas (e.g. Argon) must be used in all suspension welding. A 308 welding wire shall be used. All welding and fitting shall be done in clean manufacturing space.

#### 2.2.5. Annealing

The Large Optic Suspension Structure Assemblies and LOS Height Adapter shall be annealed at 2000 degrees F. for TBD (to be determined) hours and then allowed to slowly cool in air. Prospective heat treatment companies shall propose the annealing duration. The purpose of the annealing is to fully stress relieve and fully demagnetize the stainless steel (strength is not a concern).

#### 2.2.6. Carbon Steel Contamination

Careful control of the pickled assemblies shall be imposed so that carbon steel contamination is prohibited. In the event of carbon steel contamination, skim with a carbide tool to remove any residual contaminant.

#### 2.2.7. Post-Weld Stress Relief

There are a number of post-weld, post-anneal machining operations called out on the LOS Structure Assembly drawing, including flatness to .002" for the top and bottom plates. A post machining stress relief operation is required. The structure shall be held at 488C (900F) for 4 hours per inch of thickness and slow cooled in air.

#### 2.2.8. Pickle and Passivate

After annealing, final machining and post-weld stress relief, pickle and passivate the LOS Structure Assemblies and the LOS Height Adapter, at room temperature, with special attention paid to sufficiently agitate the solution or flush the inside of the legs of both assemblies in the acid bath. In subsequent water rinse, special care must be made to thoroughly rinse the inside of the legs of both assemblies. Minimize hydrocarbon exposure to the pickled parts in all subsequent fabrication steps.

#### 2.2.9. Handling and Shipping Procedures

Weldments should be inspected before the pickling process. After pickling and passivation, Nitrilite gloves should be worn when wrapping the parts for shipment. Nitrilite 100% nitril gloves are from Ansell Edmont Industrial. Once the parts are pickled, the parts should be handled as little as possible.

Processed parts awaiting shipping will be wrapped as follows:

- (a) wrap the part(s) with UHV quality aluminum foil
- (b) Place each part(s) in an anti-static bag fabricated from "CP Stat 100(TM) ESD poly sheet cleaned to



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Class 100"

(d) Compress the bag tightly around the part. Tie wrap the bag for closure, or use a bag with a zipper.

(e) Place "UHV CLEAN PART..." and identification labels outside bag.

(f) Place the bagged part(s) in an appropriate shipping container, using care to not puncture or cut the bag. Seal the shipping container closed. Attach a label with the LIGO part number (drawing number(s), including revision letter) and serial number(s) to the outside of the container.

The shipping containers must be such that they insure that the double bags do not get punctured and that the parts are properly supported during transit.

The CP Stat material is ordered as follows:

CP Stat 100 ESD sheeting cleaned to Class 100 with CFC certification that it passes JPL specifications. At the time of this writing, it is available in various sheet and bag sizes from:

Caltex Plastics, Inc.  
P.O. Box 58546  
2380 E. 51st Street  
Vernon, CA 90058  
(213) 583-4140

At the time of this writing, one source for UHV Quality Aluminum Foil is:

ASTM B-479 Dry Annealed A Allfoil  
4597 Vanepps Rd.  
Brooklyn, OH 44131  
(216) 661-0211

## 2.3. Quality Assurance/Control

### 2.3.1. Identification

Separate (non-welded) parts and assemblies shall be marked with laser marking or acid etch techniques. A vibratory tool with a minimum tip radius of 0.0005" is acceptable for marking on surfaces which are not hidden from view. Engraving is also permitted.

Separate (non-welded) parts and assemblies to be serialized according to the document titled Part Numbers and Serialization of Detector Hardware, LIGO-L970196. This document allows for "bag-and-tag" type of identification for small parts.



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#### 2.3.2. Serial Number

The Serial number shall be of the format:

Dxxxxxx-y S/N *nnn* Where

Dxxxxxx-y is the LIGO piece part or assembly drawing number, Dxxxxxx, including the revision letter, -y, to which the hardware item was built, and

*nnn* is the sequential serial number, 001 through 999, in the order produced.

#### 2.3.3. Quality Assurance Provisions

A first article shall be produced and inspected for form, dimensions and workmanship. Caltech will approve the first articles before committing to production fabrication for both the LOS Structure Assemblies and the LOS Height Adapter. All assemblies shall be inspected per the Large Optic Suspension Structure Quality Conformance Worksheet, LIGO-E970132.

#### 2.3.4. Purchaser Access

Non-escort privileges for the buyer, owner, government and owner representatives to all areas of the facilities where work is being performed shall be arranged. This will include access to all areas where material is being processed and stored. The purchaser shall have the right to witness all manufacturing processes.

#### 2.3.5. QA Approval

LIGO QA reserves the right to inspect and approve vendor/fabricator QA plan and processes.

#### 2.3.6. Travelers

QA travelers shall accompany all material from delivered raw stock to final components and assemblies.

#### 2.3.7. Welding QC

A QC procedure for 100% inspection of all welded joints shall be developed and submitted for approval. This QC procedure shall be used to verify that all welds called out on the drawings have been accomplished and that the weld penetration is complete and that the weld quality is acceptable.