



**Statement of Work
 Fabrication of Machined Parts
 for Advanced LIGO HAM Large Triple Suspensions (HLTS)**

The following documents are incorporated into and made a part of this purchase order. Click on the following LIGO Document Control Center (DCC) links to access these documents or go on line to the LIGO Public DCC at <https://dcc.ligo.org/> to access the DCC#.

1.0 Scope:

This Statement of Work (SOW) is for the fabrication of machined parts per the unique drawings included in this package for the Advanced LIGO HAM Large Triple Suspensions (HLTS).

2.0 Terms:

<u>DCC #</u>	<u>Description</u>
C080185-v1	Laser Interferometer Gravitational Wave Observatory (LIGO) Commercial Items or Services Contract General Provisions California Institute of Technology "Institute", LIGO Rev 11/12/08

[F0810001-v4](#) Technical Direction Memorandum

3.0 Quality Control:

<u>DCC #</u>	<u>Description</u>
Q0900001-v4	Advanced LIGO Supplier Quality Requirements, dated 2/10/10, describes following contractor/supplier QA/QC actions for this procurement:
<input checked="" type="checkbox"/> 3.1 Pre-Award Inspection	<input checked="" type="checkbox"/> 3.9 Discrepant Material Storage
<input checked="" type="checkbox"/> 3.2 Supplier In Process Quality Control	<input checked="" type="checkbox"/> 3.10 Quality Records
<input checked="" type="checkbox"/> 3.3 In Process Inspection	<input checked="" type="checkbox"/> 3.11 Drawing and Specification Change Control
<input checked="" type="checkbox"/> 3.4 Pre-Ship Inspection	<input type="checkbox"/> 3.12 Welding Certification
<input checked="" type="checkbox"/> 3.5 Receiving Inspection	<input checked="" type="checkbox"/> 3.13 End Item Data Package (including Certifications of Compliance)
<input checked="" type="checkbox"/> 3.6 Discrepant Material	<input checked="" type="checkbox"/> 4.1 Design Verification
<input type="checkbox"/> 3.7 Material Review Action	<input checked="" type="checkbox"/> 4.2 Raw Material Procurement
<input checked="" type="checkbox"/> 3.8 Material Review Actions at Contractor	<input checked="" type="checkbox"/> 4.3 Traceability of Materials
	<input checked="" type="checkbox"/> 4.4 Calibration Program
	<input type="checkbox"/> 4.5 Critical Interface
	<input checked="" type="checkbox"/> 4.6 Cleanliness
	<input checked="" type="checkbox"/> 4.7 Packaging
	<input checked="" type="checkbox"/> 4.8 Storage
	<input checked="" type="checkbox"/> 4.9 Transport
	<input type="checkbox"/> 4.10 Customs

For the above list, the Supplier shall: 1) Identify the corresponding sections/paragraphs in their existing QA/QC system 2) meet or exceed the design requirements contained in the attached engineering documents for each area called out.

4.0 End Item Data Package:

At the time of delivery of the parts, the Supplier shall also provide the following data, as a minimum:

- Any as-built modifications (with approval of the LIGO Contracting Officer) as mark-ups to the drawings
- Material certifications
- Certificate or statement of compliance with all contract and drawing process restrictions
- Dimensional & QC inspection reports—this shall include a report showing that parts have been inspected and fall within specified tolerances

4.1 Dimensional & QC Inspections:

The drawing list is categorized by the level of inspection that is required. The color coded key is found in Table 1. The complete color coded drawing list can be found in Table 2 of E1000363 (see link in Section 5.0 below).

Table 1. Inspection Criteria for Machined Parts

Quantity	Non Critical Parts	Critical Parts
10 or fewer	Level 2	Level 1
11 or more	Level 4	Level 3

Level 1: Inspect all parts, provide inspection report by serial number prior to shipping to LIGO.

Level 2: Inspect all parts, provide inspection report on first and last only prior to shipment to LIGO.

Level 3: Inspect first and last parts and random 30%, provide inspection report by serial number prior to shipment to LIGO.

Level 4: Inspect first and last parts and random 10%, provide inspection report on first and last item only prior to shipment to LIGO.

If any setup changes are made to the tooling, treat the next item out of the unit as a “first item.”

All threaded holes for Helicoils must be 100% gaged with appropriate gage tools according to [Emhart Helicoil Product Catalog, HC2000, Rev. 4](#).

5.0 Included Document Hyperlinks:

[E1000363-v2](#) **Table 2**

Drawing list including: part number, revisions, descriptions, ship-to points, quantities, and inspection levels.

[E1000364-v2](#) **Drawing Package**

PDF package containing all drawings associated with this fabrication effort.

[E0900364-v7](#) **Engineering Specification**

Specification covering metal components intended for use in the Advanced LIGO Vacuum System.

3D CAD files are available upon request and are provided as reference only. All parts are to be manufactured to the referenced 2D drawings. If there are any discrepancies between the drawings and the CAD files, the drawings take precedence with the following two exceptions:

- A significant number of the drawings specify a required surface roughness (finish) of 32 micro inches Ra. This requirement is no longer valid: all of these parts can be produced with a required surface roughness (finish) of 63 micro inches Ra. See Section 8.5 (Finishing) for further details.
- Although not called out on the drawings, laser etching is the preferred method of marking parts. See Section 8.6 (Marking) for further details.

6.0 Quantity Required:

The total quantity required for each part by drawing number, and (if appropriate) type number, is indicated in E1000363.

7.0 Delivery Requirements:

The deliveries are FOB at these destinations, i.e. the contractor has responsibility for shipping title and control of goods until they are delivered and the transportation has been completed. The contractor selects the carrier and is responsible for the risk of transportation and for filing claims for loss or damage.

7.1 Shipping Locations:

All parts are to be shipped to these locations in the quantities listed in E1000363.

LIGO Livingston Observatory (LLO)
Attn: Derek Bridges and Tom Gentry
19100 LIGO Lane
Livingston, LA 70754

LIGO Hanford Observatory (LHO)
Attn: Betsy Bland and Jodi Fauver
127124 North Route 10
Richland, WA 99354

7.2 Shipping Containers:

The contractor is responsible for providing shipping containers and transportation which protect these parts from damage from the transportation environment (weather, handling, accidents, etc.). Edges of parts should be especially protected from damage during shipping.

7.3 Delivery Schedule:

All deliveries are to be completed **12 weeks ARO**. If this cannot be accommodated, please provide an alternative delivery schedule for consideration with your bid package. Early and/or partial deliveries are welcome.

8.0 Manufacturing:

8.1 Precedence:

The Statement of Work (SOW) sections below regarding processing or fabrication of the parts are meant to convey the scope and nature of the requested work. If there is a conflict between this SOW and the drawing, the drawing has precedence.

8.2 Materials:

Parts are mainly aluminum alloy (6061-T6, 2024-T351, 1100-H14) or stainless steel (302, 304, 316). The specific material alloys and/or grades are called out on the drawings. (If aluminum is called out, but a specific grade or temper is not specified, use 6061-T6 aluminum.) No materials may be substituted or added without prior knowledge and testing by LIGO. Material certifications are required for all parts.

All material is to be virgin material. **No weld repairs or plugs are permitted** unless approved in advance in writing by LIGO.

8.3 Machining for Use in Ultra-High Vacuum (Clean):

- All surfaces of all parts are to be machined. (No as received, as rolled, as milled surfaces will be accepted.) No grinding or lapping with abrasive wheels, cloth or stones is permitted. No sanding of any type is permitted. No parts shall be cast or molded.
- All machining fluids must be fully synthetic, water soluble (not simply water miscible) and free of sulfur, chlorine, and silicone. All machining fluids shall be approved in writing by LIGO prior to machining.
- Thoroughly clean each part to remove all oil, grease, dirt, and chips with soap and water. Follow with solvent (acetone) wipe. Pay close attention to tapped holes. The use of Scotch-Brite is not allowed.
- The contractor is NOT responsible for cleaning or insertion of helicoils.
- The contractor is NOT responsible for "Post-Machining Notes" on the drawings, i.e. special cleaning, etc.

8.4 Repairs:

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

8.5 Finishing:

The required surface roughness (finish) is defined in the drawings. If no call-out is on the drawing, the surface finishes should be 63 micro inches Ra. If finish is called out on the drawing, it is assumed to be the arithmetic average (Ra). As already indicated in section 5.0, a significant number of the drawings specify a required surface roughness (finish) of 32 micro inches Ra. This requirement is no longer valid: all of these parts can be produced with a required surface roughness (finish) of 63 micro inches Ra. No coatings or applied finishes are to be used. Localized scratches, digs and blemishes should be minimized and addressed through visual inspection and quality assurance (QA).

8.6 Marking:

The majority of parts are to be serialized. All necessary part identification requirements are found on the drawings. Mechanically scribe, stamp, or engrave (no dyes or inks), or laser etch, these markings. Laser etching is the preferred method of marking parts.

8.7 Helicoils:

All helicoil holes are to be machined according to the steps specified in the Emhart Helicoil Product Catalog, HC2000 Rev 4, page 17. These steps include drilling, countersinking, tapping and gaging the holes to the sizes specified on the LIGO part drawings. It is important that all holes are gaged after tapping to ensure they were prepared properly.

Procurement and installation of helicoils is NOT the responsibility of the contractor and will be done by LIGO.