



## Statement of Work Fabrication of HAM LARGE TRIPLE SUSPENSION (HLTS) STRUCTURES

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 SOW is for the fabrication of the structure per the unique drawings included in this package as part of the Advanced LIGO HAM Large Triple Suspension (HLTS) Structure. This fabrication includes:

- Fabrication of stainless steel and aluminum parts
- Welding of stainless steel parts (including tubing)
- Drilling, tapping and gaging of through holes and tapped holes (including tapped holes for Helicoils)
- Temporary assembly of parts using provided fasteners
- Flycutting of parts to achieve required dimensions and tolerances

### 2.0 Terms:

<u>DCC #</u>	<u>Description</u>
<a href="#">C080185-v1</a>	Laser Interferometer Gravitational Wave Observatory (LIGO) Commercial Items or Services Contract General Provisions California Institute of Technology “Institute”, LIGO Rev 11/12/08
<a href="#">F0810001-v4</a>	Technical Direction Memorandum

### 3.0 Quality Control:

<u>DCC #</u>	<u>Description</u>
<a href="#">Q0900001-v4</a>	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"/> 3.2 Supplier In Process Quality Control <input checked="" type="checkbox"/> 3.3 In Process Inspection <input checked="" type="checkbox"/> 3.4 Pre-Ship Inspection <input checked="" type="checkbox"/> 3.5 Receiving Inspection <input checked="" type="checkbox"/> 3.6 Discrepant Material <input type="checkbox"/> 3.7 Material Review Action <input checked="" type="checkbox"/> 3.8 Material Review Actions at Contractor	<input checked="" type="checkbox"/> 3.9 Discrepant Material Storage <input checked="" type="checkbox"/> 3.10 Quality Records <input checked="" type="checkbox"/> 3.11 Drawing and Specification Change Control <input checked="" type="checkbox"/> 3.12 Welding Certification <input checked="" type="checkbox"/> 3.13 End Item Data Package (including Certifications of Compliance) <input type="checkbox"/> 4.1 Design Verification <input checked="" type="checkbox"/> 4.2 Raw Material Procurement <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 Included Documents:

The drawings cited below are fully dimensioned. In addition to the drawings, the contractor will be provided with CAD solid models of the parts (SolidWorks Professional 2010, SP4.0).

<i>DCC #</i>	<i>Description</i>
<a href="#">D070537-v2</a>	Structure, HLTS
<a href="#">D070442-v5</a>	Structural Weldment, HLTS
<a href="#">D070575-v2</a>	Base Plate, Structural Weldment, HLTS
<a href="#">D070580-v2</a>	Top Gusset, Structural Weldment, HLTS
<a href="#">D070579-v2</a>	Upper Front Gusset, Structural Weldment, HLTS
<a href="#">D070576-v2</a>	Lower Front Gusset, Structural Weldment, HLTS
<a href="#">D070578-v2</a>	Side Strut, Structural Weldment, HLTS
<a href="#">D070577-v2</a>	Side Gusset, Structural Weldment, HLTS
<a href="#">D070374-v2</a>	Mounting Pad Body, HLTS
<a href="#">E0900048-v8</a>	Welding Specification for Weldments Used Within the Advanced LIGO Vacuum System
<a href="#">E0900364-v6</a>	Metal Components Intended for Use in the Advanced LIGO Vacuum System

#### 5.0 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 (including inspection reports on stainless steel seamed tubing as described in Section 2 of E0900048 – link given in Section 4.0 above)
- Welding and welding personnel certifications (see requirements in Section 2 of E0900048 – link given in Section 4.0 above)
- Heat treatment certifications
- Dimensional & QC inspection reports—this shall include a report showing that parts have been inspected and fall within specified tolerances
  - **Complete dimensional inspection reports for the first, last, and one (1) additional structure are required**
  - **All tapped holes for Helicoils are to be 100% gaged using appropriate gage tools according to the [Emhart Helicoil Systems Catalog HC2000, Rev 4](#)**
  - **Dimensional inspection reports of the overall structure height and flatness and parallelism of fly cut surfaces (see note 5 of D070537-v2) of ALL structures are also required**
- Certificate or statement of compliance with all contract and drawing process restrictions

#### 6.0 Quantity Required:

D070537-v2	Structure, HLTS	Total quantity: 8
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All other drawings listed in Section 4.0 are for parts or subassemblies which should be made in sufficient quantities to produce the total quantity of structures given above.

## 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 structures are to be shipped to these locations in the following quantities: three (3), with serial numbers 001, 002 and 003, to LIGO Livingston Observatory (LLO) and five (5), with serial numbers 004, 005, 006, 007 and 008, to LIGO Hanford Observatory (LHO).

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 to 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 **10 weeks ARO**. If this cannot be accomplished, 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 the SOW and the drawing, the drawing has precedence.

3D CAD files are available upon request and are provided as reference only. The structures are to be manufactured to the linked 2D drawings. If there are any discrepancies between the drawings and the CAD files, the drawings take precedence.

### 8.2 Machining:

**Please note** that the structure has machining requirements after welding, and post-weld stress relief heat treatment, to mate with other components.

All surfaces of all parts are to be machined, except the inner surfaces and outer radii of the tubing. Abrasive removal techniques are not acceptable. 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. Blanchard grinding is acceptable if all ground surfaces are machined afterwards.

All machining fluids must be fully synthetic, fully water soluble and free of sulfur, silicone, and chlorine. Upon award of contract, vendor will be required to supply MSDS sheets for all proposed machining fluids for approval prior to starting work.

Treatment of raw materials and work-in-process materials with respect to cleanliness is covered in the welding specification, E0900048.

All tapped holes for Helicoils are to be machined according to the [Emhart Helicoil Systems Catalog HC2000, Rev 4](#), page 17. These steps include drilling, countersinking, tapping and gaging the holes to the sizes specified on the LIGO drawings. All tapped holes for Helicoils are to be gaged after tapping to ensure that they are prepared properly (see Section 5 for additional information regarding the inspection of tapped holes for Helicoils). The contractor is NOT responsible for procurement, cleaning or insertion of Helicoils.

### **8.3 Materials:**

Material is specified on the drawings. For the square stainless steel tubing called out as having a wall thickness of 0.188", a wall thickness of 7 gauge (0.180") is permissible depending on availability. Vendor should indicate in their quote which wall thickness they plan to use. All materials specified by drawings or SOW have been approved for use in the ultra-high vacuum (UHV) environment in LIGO. No materials may be substituted or added without prior knowledge and testing by LIGO. Cast tooling plate is not permitted.

**Note** that if seamed tubing is used, the weld seam and any weld flash must meet the requirements listed in E0900048. If the weld flash does not meet the requirements, then it must be removed. Details, including fixtures required to remove this flash and a method for removal should be included in this quote. The flash removal process must be inspected 100% visually and certified by the vendor and approved by LIGO.

### **8.4 Hardware:**

Fasteners required to assemble the parts of structure (washers and silver-plated socket head cap screws) in order to perform flycutting will be provided by LIGO.

### **8.5 Welding:**

All welds are to be per E0900048 referenced in the "Included Documents" section of this SOW. All dimensions apply after heat treatments.

**Note** that E0900048 calls for the structures to undergo a post-weld stress relief heat treatment and to be pickled and passivated. Please make sure to list sub-contractor information with the bid package.

### **8.6 Marking:**

Each structure must be marked with a part number, revision code and serial number at the location indicated on the drawing. Marking is to be accomplished by mechanically scribing, stamping or engraving (no dyes or inks).

If not indicated in the drawing, mechanically scribe, stamp or engrave as follows:  
<drawing number> - <revision code>, <type number if applicable>

<unique 3 digit serial number starting at 001 for the first part and incrementing thereafter>

As an example:

D070442-V5

S/N – 001

The serial number must be a sequential 3-digit number, **starting with 001**, for each part. Also where indicated, mechanically scribe, stamp, or engrave (no dyes or inks) any additional markings called out on drawing sheets.

### **8.7 Finishing:**

Any required surface finish is defined in the drawings.

Localized scratches, digs and blemishes should be minimized.