



## Statement of Work Fabrication of Maraging Steel Blades for Advanced LIGO HAM Suspensions

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 maraging steel spring blades for the HAM suspensions per the unique drawings included in this package. Details of the scope of this procurement are covered in section 8, part 4.

### 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"/> 3.9 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 type="checkbox"/> 4.1 Design Verification
<input type="checkbox"/> 3.7 Material Review Action	<input type="checkbox"/> 4.2 Raw Material Procurement
<input checked="" type="checkbox"/> 3.8 Material Review Actions at Contractor	<input 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 checked="" 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.

First Article Inspection: LIGO requires a first article inspection of the first 6 of each blade configuration. The inspection will involve LIGO characterizing the blades, either at your site or at one of the LIGO sites, and delay in delivery due to this characterization will be our responsibility to bear.

It is assumed that the first articles that will be characterized will all have passed dimensional inspection. If one of these blades does not pass characterization, the blade will need to be re-annealed, have its bend radius corrected (and maybe a new form machined, if required), and then re-age hardened. We understand that this may require an additional or adjusted comb jig. It is not expected that a large number of blades will need this correction, however we would like the vendor to quote a cost for the re-work of a single blade once, (including tooling, etc.) and an indication of the expected turnaround for this operation.

#### 4.0 Included Documents:

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

<u>DCC #</u>	<u>Description</u>
<a href="#">E090023-v10</a>	Manufacturing Process for Cantilever Spring Blades for Advanced LIGO
<a href="#">D080018-v1</a>	OMC Upper Blade
<a href="#">D080019-v1</a>	OMC Lower Blade
<a href="#">D1001812-v1</a>	HSTS Upper Blade
<a href="#">D080761-v3</a>	HSTS Lower Blade
<a href="#">D020617-v2</a>	HLTS Upper Blade
<a href="#">D020615-v2</a>	HLTS Lower Blade

#### 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
- Dimensional & QC inspection reports—this shall include a report showing that parts have been inspected and fall within specified tolerances. **Dimensional inspection reports for thickness, radius and height for all blades. Full dimensional inspection reports for first, last and an additional 3 blades, for each type of blade.**
- Certificate or statement of compliance with all contract and drawing process restrictions

#### 6.0 Quantity Required:

Document No.	Revision	Description	Quantity
D080018	v1	OMC Upper Blade	20
D080019	v1	OMC Lower Blade	40
D1001812	v1	HSTS Upper Blade	96
D080761	v3	HSTS Lower Blade	192
D020617	v2	HLTS Upper Blade	32
D020615	v2	HLTS Lower Blade	64

## 7.0 Delivery Requirements:

### 1. Packaging and Shipping Requirements

Take care that the blades are completely dry before bagging in plastic. Double bag each blade individually. Bags should be made from polyethylene. Heat sealed or zip lock is preferred. Insert small desiccant package in between the bag layers, not in contact with the blades. It is our preference that the blades be bagged and then put back into the age hardening comb fixture for shipment. This allows the blades to stay on their sides, so as to avoid undo sag or stresses. However, if an alternative packing approach will meet these requirements, please contact LIGO Engineering for review and approval at procurement kick-off meeting. Add additional desiccant packages to the shipping container. Shipping container should be stiff enough so as to avoid any damage to the blades during shipment. LIGO Engineering can provide guidance on successful packaging and shipping procedures.

### 2. Delivery Schedule

All deliveries must be shipped within **10 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. It is our preference to receive the HSTS blades (D1001812 & D080761) first and then the HLTS blades (D020617 & D020615) and then the OMC blades (D080018 & D080019).

## 8.0 Manufacturing:

### 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 blade springs 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.

### 2. Machining

Machine all surfaces to remove oxides and mill finish. Abrasive removal techniques other than Blanchard grinding, surface grinding or double disk grinding, are not acceptable. The methods mentioned are acceptable only if all surfaces are subsequently electropolished to remove a minimum of 0.0002 in. Any additional methods must first be approved by the LIGO Contracts Technical Representative. A surface finish of 32 microinches is required. The vendor will need to confirm this surface finish in the inspection report.

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 manufacturing process specification, section 2.4.

### 3. Materials

Material is specified on the drawings. All blade springs are made from Maraging C-250. LIGO will provide the Maraging C-250 sheet material for this fabrication. The material is in the annealed state. Material certifications are available. There are 18 pieces of 0.063"/0.071" thick x 24.0" x 60.0" (+0.125/-0.00) width & length) and 4 pieces of 0.095"/0.105" x 24.0" x 60.0" (+0.125/-0.00) width & length).

### 4. Scope of the Procurement

It is assumed that the fabrication method for this procurement will follow the Alternative process, Section 3, of the Manufacturing Process for Cantilever Spring Blades for Advanced LIGO, E0900023-v10. This Procurement covers the material cutting, shaping, dimensional check, cleanliness requirements and age hardening steps along with dimensional check after age hardening, outlined in Sections 2.1, 2.2 2.3, 2.4 and 2.7 (2.7.1 in particular) and 2.8.

This procurement does not include the nickel plating, Section 2.5, or the after-plating heat treatment Section 2.6, or the alternative heat treatment called out in Section 3.

Although the blade drawings show the blades in their fabricated configuration, we ultimately care about the shape each blade forms when mass is suspended from the free end of the blade. Should a vendor be willing to undertake this testing, we would be interested in this and willing to pay for this service. For this RFQ, please indicate willingness to take on this work, and should your company win this contract, LIGO will discuss this extra cost and details at a later date.

### 5. Marking

Each blade 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, laser etching 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 500 for the first part and incrementing thereafter>

As an example:

D080018-V1 S/N – 500

The serial number must be a sequential 3-digit number, **starting with 500**, for each part. Also where indicated, mechanically scribe, stamp, or engrave (no dyes or inks) any additional markings called out on drawing sheets.

### 6. Finishing

Any required surface finish is defined in the drawings. Localized scratches, digs and blemishes should be minimized.