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# LIGO LABORATORY

California Institute of Technology

1200 E. California Blvd.

Pasadena, CA 91125

**Statement of Work**

**End Test Mass Re-Polishing**

**C1900175-v3**

Note to LIGO users: all red text in this template is font type ‘hidden’ and comprises instructions to complete the SOW. Easier than deleting them, you can hide all red text before saving. In Word 2010, click File, Options (on the left side), Display (on the left side), and then unclick “Hidden Text”.

The “TEMPLATE” watermark can be removed by clicking Page Layout, Watermark, and then Remove Watermark.

1. **End Test Mass Polishing Scope**

The polisher must provide all facilities, tooling, services, materials and staff to take the existing fused silica test mass optic, provided by Caltech, remove existing ears and HR coating and re-polish according to the polishing specifications and drawings. The polisher must provide inspection and certification data as called out in the polishing specifications. The contractor is not responsible for applying dielectric coatings.

Briefly describe the work. For example: Fabrication of Vacuum Pod components for Advanced LIGO BSC-ISI Seismometers.

1. **Document Access**

Many supplemental documents and specifications are incorporated into and made a part this Statement of Work. Click on the document links to access these documents from the LIGO Document Control Center (DCC) or go on line to the LIGO Public DCC at <https://dcc.ligo.org/> to access the DCC#.

1. **Commercial Terms and Applicable LIGO Specifications:**

**Note: The documents listed below are invoked for this Statement of Work and comprise additional requirements which are integral to this Statement of Work.**

Important: C080185 and Q0900001 apply to all SOWs. Add/delete others as appropriate.

Check to be sure the latest revisions are specified below (please notify QAME or Systems if this template needs to be updated).

* [LIGO-C080185-v2](https://dcc.ligo.org/LIGO-C080185/public) LIGO Commercial Items or Services Contract General Provisions
* [LIGO-Q0900001-v5](https://dcc.ligo.org/LIGO-Q0900001/public) Advanced LIGO Supplier Quality Requirements

1. **Quality System:**

Referring to the above referenced LIGO Specification Q0900001, Suppliers should include a copy of their current ISO 9001, AS9100, or TS16949 certification in their bid package. Suppliers lacking current certification should send a copy of their Quality Manual with their bid package.

1. **Parts/Assemblies to be manufactured, Quantity Required, and Inspection requirements:**

Note: refer to Section 8.0 for delivery schedule and location

List all parts to be made, including the **public** hyperlink to the latest revision, and the total quantity required. If you have more than ten parts, create a separate drawing document posted to the DCC as a public document, and link here.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Part Description** | **Drawing #** | **Specification #** | **Material Supplied** | **Total Qty:** |
| End Test Mass | [LIGO-D1900269-v1](https://dcc.ligo.org/D1900269/public) | [LIGO-E1900199-v1](https://dcc.ligo.org/LIGO-E1900199/public) | [LIGO-D0902455-v3](https://dcc.ligo.org/LIGO-D0902455-v3/public) | 4  +2 optional |

Note 1: Care should be given to the selection of the AQL number. Consider the amount of time (which equals cost) required to 100% inspect a given number of parts. Contact QAME for advice.

Note 2: Additional inspection instructions beyond the AQL number can be given – such as 100% inspection of all threaded holes.

1. **Manufacturing:** 
   1. **Precedence:**

The drawings typically represent the finished part as needed for use in service. There may be requirements on the drawing (such as coatings) which are specifically defined as not the responsibility of the supplier in this SOW. Suppliers should always contact a LIGO representative to resolve any discrepancies uncertainties in the documentation or instructions.

* 1. **Special Instructions:**

1. Removal of the “production ear,” item 2 on assembly D0902455, 2 places, is required.
2. Re-polish of the flats “S3” and “S4” and placement of reference grooves is required. Add special manufacturing notes
3. “S2” coating must be protected during rework.
4. Do not change serial number.
5. Please propose minimal tolerance increase on thickness and horizontal width at locations C8 and B5 of LIGO-D1900269. The current dimensions of each optic are shown in Appendix A.
6. Option Item to add a custom S1 figure per Appendix B.
7. Option item to include two (2) additional ETMs for a total of six (6).
   1. **Exclusions:** Add/delete as appropriate
8. The contractor is not responsible for supplying dielectric coatings.
9. The contractor is not responsible for modification of etched serial numbers or top and bottom fiducial markings.
10. The contractor is not responsible for supplying shipping containers, these are supplied by Caltech.
11. Caltech will supply at least one dummy test mass with ears for use in process testing.
12. **End Item Data Package:** Add/delete lines as necessary

Before delivery of the parts, the Supplier must provide the following data, as a minimum:

* All items named in the polishing specification LIGO-E1900199, version noted in section 5.

1. **Delivery Requirements:**
   1. **Shipping Containers and Packaging:**

Caltech will supply clean containers and transit cases for each polished substrate. Optics are to be shipped clean, and packaged per [LIGO-E0900394-v6](https://dcc.ligo.org/LIGO-E0900394/public).

Note any special packaging requirements here (i.e., wrap in UHV foil and Ameristat).

* 1. **Shipping Destination(s):**

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

Delete shipping destinations that don’t apply to this SOW. Be sure to reference the shipping abbreviations (i.e., LLO) in the Delivery Schedule if there is more than one shipping destination.

These items will be shipped to:

**GariLynn Billingsley**

**California Institute of Technology (CIT)**

LIGO Project MS 100-36

391 S. Holliston Ave.

Pasadena, CA 91125

* 1. **Delivery Schedule:**

The first ETM is to be delivered on or before November 1, 2019, followed by at least one optic per month until completion. Material for four (4) ETMs is available immediately. Material for two (2) optional ETMs will become available November 18, 2019.

1. **POINTS OF CONTACT**

Technical POC: GariLynn Billingsley, 626-395-2184, [Billingsley\_G@ligo.caltech.edu](mailto:Billingsley_G@ligo.caltech.edu)

Contractual POC: Eric Garcia, 509-372-8134, [elgarcia@caltech.edu](mailto:elgarcia@caltech.edu)

Invoice POC: Caltech Procurement Hotline, 626-395-8900, [procurementhotline@caltech.edu](mailto:procurementhotline@caltech.edu)

**Appendix A. Description of optics to be reworked**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SN** | **Thick.(mm)** | **Dia. (mm)** | **Mass (g)** | **Wedge** | **Vendor polish report** |
| ETM07 | 199.75 | 340.18 | 39620 | 0.08 | C1000485 |
| ETM08 | 199.75 | 340.13 | 39603 | 0.08 | C1000486 |
| ETM09 | 199.59 | 340.13 | 39564 | 0.07 | C1000487 |
| ETM12 | 199.725 | 340.156 | 39597 | 0.076 | C1106292 |

Vendor polish reports may be furnished upon request.

**HR Coating**: Ti:Ta2O5 and SiO2 total thickness 6 µm

**AR Coating:** Ti:Ta2O5 and SiO2, final layer SiO2

**Ear/Optic interface material**: sodium silicate

**Optic material:** fused silica

**Ear material**: fused silica

**Appendix B. Custom S1 Figure**

An aspheric coating and thermal stress pre-compensation may be added to the S1 optical surface.  The pre-compensation shall be provided by Caltech.  The vendor would apply the correction to the S1 surface, but would not be responsible for its overall effectiveness as they do not control the coating process.  A software null would be used to subtract the pre-compensation from the optical surface data.  Surface RMS specifications will apply to the corrected data.  Only features with spatial frequencies > 0.166mm-1 will be corrected.  The slope of the correction file will be less than 2.5 nm / mm with a 6mm baseline, and a maximum deviation of less than 100nm PTV error.

Insert a list or table detailing the delivery requirements (by P/N, as necessary). Delivery should be specified in weeks ARO (after receipt of order). Please also specify the shipping destination (i.e. LLO).

Note any first article requirements. If applicable, the SOW must state upfront that LIGO wants to assemble the first articles for fit check before the rest of the order is completed.