



**Statement of Work  
 Fabrication of Vacuum Cables  
 for aLIGO HAM-ISI, ISC and SUS Subsystems**

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 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.

**2.0 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 type="checkbox"/> 3.2 Supplier In Process Quality Control	<input checked="" type="checkbox"/> 3.10 Quality Records
<input type="checkbox"/> 3.3 In Process Inspection	<input type="checkbox"/> 3.11 Drawing and Specification Change Control
<input 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 checked="" type="checkbox"/> 4.2 Raw Material Procurement
<input 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 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.

LIGO prefers to utilize the vendors existing QA/QC programs to the fullest extent possible consistent with the LIGO QA and QC requirements. All bidders are requested to submit a written description/plan of their existing QA/QC system with their quotes. The bidder must also submit QA/QC plans for managing subcontractor work and materials.

In the event that a prospective contractor lacks an existing quality system, the contractor/vendor shall develop and implement a quality assurance program in compliance with requirements negotiated at contract/PO award.

### 3.0 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
- Dimensional & QC inspection reports—this shall include a report showing that parts have been inspected and fall within specified tolerances.
- Certificate or statement of compliance with all contract and drawing process restrictions.

### 4.0 Included Documents:

The drawings cited below are only partially dimensioned. In addition to the drawings, the contractor will be provided with CAD solid models of the parts (SolidWorks Professional 2009, SP5.0)

<i>DCC #</i>	<i>Description</i>
<a href="#">D1000220-v4</a>	25 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000221-v4</a>	25 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000222-v4</a>	25 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000225-v2</a>	25 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000227-v4</a>	25 PIN-to-two 9 PINs CUSTOM IN-VACUUM CABLE
<a href="#">D1000218-v4</a>	3 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000918-v2</a>	3 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000919-v1</a>	3 PIN CUSTOM IN-VACUUM CABLE
<a href="#">D1000920-v1</a>	3 PIN CUSTOM IN-VACUUM CABLE

### 5.0 Scope:

This SOW is for the fabrication of various individual parts detailed in the nine (9) unique drawings included in this package. These parts will be used by aLIGO to connect vacuum parts for use in the Advanced LIGO HAM-ISI, ISC and SUS subsystems. These parts will be in contact with an ultra-high vacuum environment. **A sample of each type of cable is required before full production commences.**

### 6.0 Quantity Required:

D1000220-v4	25 PIN CUSTOM IN-VACUUM CABLE 40"	total qty: 27
D1000221-v4	25 PIN CUSTOM IN-VACUUM CABLE 100"	total qty: 27
D1000222-v4	25 PIN CUSTOM IN-VACUUM CABLE 120"	total qty: 27
D1000225-v2	25 PIN CUSTOM IN-VACUUM CABLE 156"	total qty: 306
D1000227-v4	25 PIN to 2 9-PIN CUSTOM IN-VACUUM CABLE	total qty: 15
D1000218-v4	3 PIN CUSTOM IN-VACUUM CABLE 25"	total qty: 21
D1000918-v2	3 PIN CUSTOM IN-VACUUM CABLE 70"	total qty: 36
D1000919-v1	3 PIN CUSTOM IN-VACUUM CABLE 95"	total qty: 36
D1000920-v1	3 PIN CUSTOM IN-VACUUM CABLE 135"	total qty: 21

## 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.

### Shipping Location:

The samples will be shipped to:

California Institute of Technology  
Attn: Ben Abbott  
391 S. Holliston Ave.  
M/S 18-34  
Pasadena, CA 91125

The remaining items will be shipped to:

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

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

### Shipping Containers:

The contractor is responsible for providing shipping containers and transportation which protects these parts from damage from the transportation environment (weather, handling, accidents, etc.).

## 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.

### 8.2 Restrictions

#### Cleanliness Requirements for Cable Assembly/Manufacture:

- These cables will be used in an Ultra-High Vacuum (UHV) system. Cleanliness must be carefully controlled at all stages of fabrication and handling. All machines, tools, fixtures and storage containers which come into contact with the cable parts or cable assemblies are to be cleaned, and kept clean from oxides, oils, fingerprints, etc. This is to avoid cross contamination before any winding/assembly takes place.
- All parts/components of the cable assembly must be clean before assembly. If parts are in need of cleaning, use lint- free tissue and analytical reagent grade isopropyl alcohol and/or de-ionized water.
- The backshells are machined parts. Water soluble (not just water miscible) cutting fluid (lubrication) is to be used for all machining operations. The use of cutting fluids or lubricants,

which contain sulfur, chlorine or silicone compounds is prohibited. Machine all backshell surfaces to remove any oxides and mill finish. No grinding or lapping with abrasive wheels, cloth or stones is permitted. Abrasive removal techniques are not acceptable.

- Latex gloves and a face mask must be worn for handling cleaned parts and the cable assemblies. Assembly in an ISO 5 (Class 100) cleanroom with full cleanroom garb is preferred.
- Cable parts and cable assemblies are to be stored in clean, closed containers when not involved in active assembly. The material used for covering can be UHV quality aluminum foil, clean stainless steel covers/boxes, or cleanroom grade sheeting materials (low lint, low shedding), such as DuPont™ Tyvek®.
- Completed cable assemblies are to be wrapped/bagged and stored in a clean, controlled area prior to shipment. The wrapping, or bag, should be Ameristat® or similar class 100 cleanroom grade packaging material. No tape (adhesive) should be used to attach or close the inner wrapping. Heat sealing can only be performed on an outer bag with the part in the inner wrapping/bag.
- All electrical pin connections on the cables must be crimped and not soldered.

### **8.3 Materials**

The wire to be used to manufacture the cables, the copper braided shield and PEEK overbraid material will be supplied by LIGO. All other materials are specified on the drawings. All materials specified by drawings or SOW have been approved for use in the UHV environment in LIGO. No materials may be substituted or added without prior knowledge and testing by LIGO. Cast tooling plate is not permitted.

### **8.4 Finishing**

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

### **8.5 Testing**

Each cable should be tested by the manufacturer for correct continuity, and to ensure that no incorrect shorting has occurred. The added ability to perform an insulation resistance test, and/or a dielectric breakdown test would be beneficial.

## Delivery Schedule:

<b>Part Number</b>	<b>Part Name</b>	<b>Please quote samples lead time to Caltech</b>	<b>Please quote remainders lead time to Livingston</b>	<b>Please quote remainders lead time to Hanford</b>
D1000220-v4	25 Pin Custom In-Vacuum Cable 40"	qty: 1	qty: 8	qty: 18
D1000221-v4	25 Pin Custom In-Vacuum Cable 100"	qty: 1	qty: 8	qty: 18
D1000222-v4	25 Pin Custom In-Vacuum Cable 120"	qty: 1	qty: 8	qty: 18
D1000225-v2	25 Pin Custom In-Vacuum Cable 156"	qty: 1	qty: 101	qty: 204
D1000227-v4	25-to two 9 Pin Custom In-Vacuum Cable 36"	qty: 1	qty: 4	qty: 10
D1000218-v3	3 Pin Custom In-Vacuum Cable 25"	qty: 1	qty: 6	qty: 14
D1000918-v1	3 Pin Custom In-Vacuum Cable 70"	qty: 1	qty: 11	qty: 24
D1000919-v1	3 Pin Custom In-Vacuum Cable 95"	qty: 1	qty: 11	qty: 24
D0900920-v1	3 Pin Custom In-Vacuum Cable 135"	qty: 1	qty: 6	qty: 14