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|  <b>LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY</b><br><b>SPECIFICATION</b> | E1000083 -v6          |
|   | Document No      Rev. |
| Sheet 1 of 2  |                       |
| <b>Specification for Enameled Steel to be used in the LIGO Ultra-High Vacuum System</b>   |                       |

| APPROVALS   | DATE        |
|---|-------------|
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| APPROVED: <a href="#">(refer to associated DCC file card to confirm approval)</a> |             |

## 1 Scope

This process specification is for the application of enamel (porcelain) coating, primarily for use on sheet steel baffles for Advanced LIGO. It includes material requirements and the process and preparation for applying porcelain onto the baffle. These baffles are for use in an Ultra-High Vacuum (UHV) system.

## 2 Manufacturing Process

### 2.1 Material

The substrate shall be 304, 304L, or enameling steel ASTM A424 Types I or III (not Type II)

### 2.2 Shaping

The requirements of LIGO document E0900364 for machining, allowable machining fluids, and standard cleaning practices (post machining/stamping and forming) should have been followed prior to enameling.


Sheet metal edges must be fully rounded and R.025 applied to machined part edges to facilitate proper application and adhesion of the porcelain coating.

Only for parts to be porcelain coated, an exception to E0900364 can be granted allowing the use of Scotch-Brite, gray wheel, or similar abrasive removal techniques to fully round the edges of sheet metal and other parts. (Note: This exception is allowed because of the firing temperature of the porcelain and because the surfaces will be fully encapsulated by the porcelain.) Surfaces rounded with abrasive means should be wiped with acetone on a clean cloth.

### 2.3 Surface Preparation and Cleaning

#### 2.3.1 ASTM A424 Type I or III Enameling Steel

Use a multiple bath high-alkaline aqueous degreasing solution heated to approximately 160°F. Soak for 10 minutes then rinse and dry. A light film of oxidation is acceptable but moderate to heavy rust with pitting must be removed. Contact LIGO if such a condition exists.

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### 2.3.2 304 and 304L Stainless Steel

Sandblasting of all surfaces must be performed to produce a surface to which the porcelain will adhere. Use only new Fused Silica grade G-36. A minimal blast should be used, just sufficient to produce a light etch on the stainless steel surface.

Use a multiple bath high-alkaline aqueous degreasing solution heated to approximately 160°F. Soak for 10 minutes then rinse and dry.

## 2.4 Porcelain Process

### 2.4.1 Masking around designated holes

The part drawings will indicate which holes, if any, have masking requirements. The method of masking should be discussed and agreed upon with a LIGO representative prior to beginning work.

### 2.4.2 Frit application

Unless otherwise specified, the frit material used shall be Ferro Corp. Part #RM108, gloss black for wet application and Pemco #GP-2077 for electrostatic application. No substitutions shall be allowed without prior approval from LIGO. LIGO prefers electrostatically applied frit because of the flatter porcelain surface after firing (lower BRDF). The porcelain vendor should coordinate with LIGO in advance of processing production parts to agree on the process to be used. The porcelain vendor shall provide copies of material conformance specification certificates upon request by LIGO. Apply frit to achieve a final enamel thickness of .003" min - .008" max.

### 2.4.3 Firing

The parts can be fired in a continuous or batch furnace depending on the size of the part. Parts should be either hung or placed on horizontal tooling to minimize warpage during the firing process. Please discuss the workholding method with a LIGO representative prior to beginning work. Follow the Ferro Corporation's guidelines but generally 1510°F for 4 minutes or 1430°F for 6-10 minutes will be acceptable.

## 2.4.4 Testing

### 2.4.4.1 Thickness

Inspect the coating thickness by means of a magnetic or eddy current thickness meter to ensure a minimum of .003" and a maximum of .008".

### 2.4.4.2 Adhesion

An adherence check must be performed on test coupons to ensure the enamel is fired correctly and the sheet has been prepared properly. The vendor is to perform ASTM B916-01, "Standard Test Method for Adherence of Porcelain Enamel Coatings to Sheet Metal", or

a similar/equivalent test with prior approval from a LIGO Laboratory representative. The porcelain enamel must achieve a rating of “very good adherence”, or better, by this test method.

### **3 Packaging for shipment**

#### **3.1.1 LIGO Class A cleanliness level (only if specified)**

Immediately after firing, all LIGO parts must be transferred into a Class 100 cleanroom adjacent to the firing furnace for cooling and packaging. Personnel must be dressed according to Class 100.

Tables in the cleanroom must be covered with UHV grade aluminum foil.

The newly enameled parts are to be completely wrapped in UHV grade aluminum foil and then double wrapped in Ameristat and sealed with Kapton tape.

#### **3.1.2 Standard**

Package parts for protection during shipment. Care must be taken to prevent chipping of the porcelain from handling and shipping damage.