



# LIGO Laboratory

Date:	20 Feb 2014
Refer to:	E1400073-v3
Subject:	<b>Directive regarding preparation of aLIGO Third Interferometer Viewports</b>
To:	All aLIGO Technical Staff Involved with Viewports: Joe DeRenzis, Jodi Fauver, Chris Guido, Jeff Lewis
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The viewports for the third interferometer should be prepared as follows prior to placing them into long term storage:

### Commercial Viewports:

1. Visually inspect the windows and the knife edges of the conflat flanges and replace or repair as necessary.
2. Clean and bake the commercial viewports
3. Do not leak test or proof test the commercial viewports
4. Wrap/bag/tag the commercial viewports for storage using materials and methods suitable for maintaining the Class A cleanliness of these parts.
5. Place the commercial viewports into long term storage using suitable packaging to protect the knife edges and the windows. In particular, if the viewports are to be stacked the packaging must be able to sustain the weight without risking damage to the viewports.

### Custom (high optical quality) Viewports:

1. Visually inspect the high optical quality windows and replace if necessary
2. After visual inspection of the high quality windows put them back into the packaging used for shipping by the manufacturer and place them into long term storage.
3. Inspect the knife edges of the conflat flanges and replace or repair as necessary.
4. Clean and bake the custom viewport non-optical parts (machined parts, fasteners, Viton o-rings, Kapton shims), but not the high quality windows for these custom viewports.
5. Do not assemble the custom (high optical quality) viewports
6. Wrap/bag/tag the custom viewport parts for storage using materials and methods suitable for maintaining the Class A cleanliness of these parts.
7. Place the custom viewport parts into long term storage using suitable packaging to protect the knife edges and the fastener threads. In particular, if the flanges are to be stacked the packaging must be able to sustain the weight without risking damage to the knife edges.

The rationale for the above directive follows.

The current documentation<sup>1,2</sup> regarding long term storage of viewports for the third interferometer does not explicitly specify the condition of the viewports and any requirements with regard to their preparation prior to storage. The general guidance defined in section 3 of the Long Term Storage Plan (E1300001) stipulates that:

- The components will be cleaned (and presumably baked if intended for in-vacuum service, as is the case for the viewports), and
- All assembly and testing will be performed to the point which best serves the needs to demonstrate that the assembly is functional, but allows storage with minimal disassembly.

Since the viewports form part of the vacuum boundary, and they are comprised of brittle (fracture sensitive) materials, they are safety critical elements. As a consequence, what is of paramount importance is that the integrity of the viewports be preserved. For this reason it is prudent to consider whether the default guidance (above) should apply, or whether other considerations dictate a different approach for the viewports.

The normal basic sequence of processing steps for the viewports is as follows<sup>3</sup>:

1. Inspect the window and the conflat seal of the flange
2. Clean for UHV service
3. Assemble the viewport (for custom viewport units only)
4. Leak and proof test the viewport (and final inspection of the window element)

Let's consider each step in the sequence.

1) Inspect: We should certainly inspect the windows of both our custom (high optical quality) and commercial viewports. Any windows/viewports which fail the inspection<sup>3</sup> must be replaced. Likewise, all conflat seals should be inspected and either repaired or replaced if damaged.

2) Clean: Cleaning for UHV service (cleaning and baking to the LIGO Class A<sup>4</sup> standard) requires that the parts be removed from the packing/shipping containers provided by the manufacturers. Once Class A cleaned parts must be wrapped in ultra-clean, low particulate shedding materials. As a consequence alternate containers must be provided for storing, with care to protect the parts, for example from damage due to stacking. In addition alternate containers suitable for shipping must be designed and/or procured. (Note that shipping containers are beyond aLIGO project scope).

3) Assemble: The custom (high optical quality) viewports require assembly. The commercial units (with windows brazed onto the flange) do not require assembly. Once assembled, the entire surface of the fracture critical window elements cannot be inspected fully. However the assembly does protect the window element reasonably well, since it is sandwiched between

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<sup>1</sup> [E1300001-v11](#), "Long Term Storage Plan for the Components of the Third Advanced LIGO Interferometer"

<sup>2</sup> [T1300006-v3](#), "Stray Light Control (SLC) Long Term Storage for the 3rd aLIGO Interferometer"

<sup>3</sup> [E1100948-v6](#), "Specification: Viewport Inspection and Testing Procedure"

<sup>4</sup> [E0900047](#), "LIGO Contamination Control Plan"

o-ring elements and contact to the stainless steel flange parts is prevented by PEEK shims. Once the custom viewports have been assembled storage containers must be designed or procured (to prevent damage due to stacking for example). The manufacturer's containers will not serve. Since assembly of the viewports does not require much effort or time, limits the capability for subsequent window inspection, and prevents use of the shipping containers provided by the manufacturer for the windows, there seems to be little benefit in performing this assembly prior to arrival at the third interferometer location.

4) Test: Proof testing is required<sup>3</sup> for all viewports, commercial or custom. However proof testing must be performed after all transportation and handling has been completed. As a consequence proof testing must be performed at the 3<sup>rd</sup> interferometer site. Furthermore it is detrimental to the life of the viewport to proof test repeatedly; Each application of the over-stress condition in a proof test reduces the life of the window element. Consequently we should plan to perform the proof test only once, and so only at the third interferometer location.

Leak testing is also required<sup>3</sup> for all viewports, commercial or custom. Leak testing is performed with the same tooling/setup as the proof testing and so is best performed at the same time. Since no aLIGO viewport has failed the leak test, and the third interferometer viewport components were manufactured or purchased in the same lots, there is very little risk that any of the third interferometer custom viewports will fail to seal. Furthermore the manufacturer of the commercial viewport units will have already performed a leak test. The LIGO performed test is a verification. As a consequence there is little risk that the commercial viewport units will be found to leak.