TITLE

LOS ALIGNMENT FIXTURE DESIGN SPECIFICATION

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
DRAWN:				n/a	n/a	n/a	n/a
CHECKED:							
APPROVED:							
DCC RELEASE:							

1 Introduction

1.1 Objectives and Scope

The scope of this document is to define the requirements for the alignment fixtures and auxiliary transport/ holding fixtures for the three Large Optics Suspension configurations defined herein and in the applicable documentation. This document will include and/or identify suspension and ASC/LSC (Alignment Sensing and Control/Length Sensing and Control) interface information and documentation to accomplish this task.

1.2 Applicable Documents

LIGO-D960132 Large Optic Suspension Assembly (LOS1a), End Test Mass
LIGO-D970505 Large Optic Suspension Assembly (LOS2a), Beamsplitter, 4k,pending
LIGO-D970539 Large Optic Suspension Assembly (LOS2b), Beamsplitter 2k,pending
LIGO-D970564 Large Optic Suspension Assembly (LOS1c), Recycling Mirror 4k,pending
LIGO-D970577 Large Optic Suspension Assembly (LOS1e), Recycling Mirror 2k,pending
LIGO-D970310 Equipment Arrangement, Hanford Site, Laser Vacuum Equipment Area (LVEA)

LIGO-T970151 ASC Initial Alignment
LIGO-T950011 Suspension Design Requirements
LIGO-T970158 Large Optics Suspension Final Design (Mechanical System)
LIGO-L970196 Part Numbers and Serialization of Detector Hardware
LIGO-E960050 LIGO Vacuum Compatible Materials List
LIGO-E960022 LIGO Vacuum Compatibility, Cleaning Methods and Qualification Procedures

2 Overview

2.1 Suspensions and Alignment Sensing and Control

The suspension assemblies support large, cylindrical, wedged pieces of glass with a loop of wire. Suspension design is defined in the following documents: LIGO-T950011 and LIGO-T970158.

The three LIGO interferometers, two at the Hanford, Washington observatory and one at the Louisiana observatory, will utilize 23 large optic suspensions which must be aligned to each other at each site. Alignment of the optics' suspensions will be accomplished by surveying techniques and equipment, autocollimation and electronic distance measurement (EDM) equipment, as defined in the ASC Initial Alignment document, LIGO-T970151. The fixtures whose requirements are outlined in this document will be used to

move the optics into the vacuum chamber, position the suspension assemblies within the vacuum chambers, onto their appropriate optical tables and into their proper orientations.

The fixtures include:

(1) A transport table (or tables) for moving the LOS from a comfortable working table height onto a lifting fixture on the floor of a BSC or onto a HAM optical table.

(2) A lifting fixture to move an LOS from the floor of a BSC to the inverted optical table.

(3) An alignment fixture which is temporarily clamped to a HAM or BSC optics table and used to translate and rotate an LOS into proper orientation.

2.2 Suspension Configurations

There are a number of different suspension assemblies, some of which are listed above under Applicable Documents. The alignment fixture must support three main suspension configurations.

LOS1: Structure 15.5” wide, 8.5” deep and 24.25” high with a height adapter bolted above it that is 5.71” high and the same width and depth of the LOS1 structure. It’s interface to the BSC optical table is the top of the height adapter. Assembly P/N D960132.

LOS2: Structure 20.5” wide, 9.0” deep and 24.25” high with two different height adapters bolted above it - one is 2.5” high and the other is 4.2” high, both with the same width and depth of the LOS2 structure. It’s interface to the BSC optical table is the top of the height adapter. Assembly P/Ns, D970505 and D970539.

LOS1 RM (Recycling Mirror): Structure is the same size as LOS1 but the height adapter is bolted below the structure. There are two different height adapters - one is 2.3” high and the other is 3.0” high with the same width and depth of the LOS1 structure. It’s interface to the HAM optical table is the bottom of the height adapter. Assembly P/N D970577.

3 Requirements

3.1 Alignment requirements:

- The LOS Alignment Fixtures will be used to position and adjust the large optic suspension assemblies in X,Y, Z and Yaw (vertical axis), relative to the global coordinate system identified on the interface layout drawing (ILD), LIGO-D970310.
- The fixture should be placed either over or around the suspension assembly and provide coarse adjustments for linear translations and ultrafine adjustments for angular adjustment.
- Coarse linear adjustment may be attained with UNF adjustment screws/micrometer, in both X and Y orientation, with a range of +/- .75 inches. The sensitivity should be less than or equal to 1mm (0.04”) per turn. The resolution (1/8 turn) should be less than or equal to 0.13mm (0.005”). (Thirty-two or forty threads per inch screws are consistent with these requirements.) The backlash should not exceed the resolution.
- Precise angular adjustment about the vertical axis requires a gimbal-type adjustment. It is recommended that a pin locate to a hole in the top plate of the height adapter at the face of the optic to provide rotation about the center of the reflecting surface. Resolution requirement is 1.0 arc second; 1/8 turn = 1 arc second. An 80 tpi adjustment screw, or similar, may be used to provide movement. The adjustment range required is +/- 2 degrees. (Position of the face of the optic for the different suspension configurations will be provided

by the LIGO cognizant engineer; however a single pin/hole is judged to be sufficient since the position of the face of the optic doesn't change significantly.)

- After alignment has been achieved, the suspension assembly is to be clamped to the optical table and the alignment fixture must be removed.
- Clamps to hold the optic support assemblies are to be included within the scope of this work. The clamps may have integral shims. An average LOS1 assembly with optic and height adapter weighs about 170 lbs with an LOS2 weighing a bit more. Clamps must mate with 1/4-20 threaded holes in the optical table in an arbitrary 2.0" x 2.0" array, with approx. 6 clamps/long side and 3 clamps/short side of the height adapter assembly. Stiffness of clamp should be limited by the 1/4-20 attaching bolt rather than the clamp design itself.
- Include in the design of the fixture a prism with part no.7261-35AP01, manuf. by Sokkia. The prism to be mounted at a fixed distance in front of the center of the suspended optic. If this is not feasible, define the vertical offset of the prism from the nominal center of the optic. The prism and its support must have the ability to be removable (for a clear view of the optic) and reattached with a repeatability of .005" of the initial position. The prism shall fit on either side of the fixture.These prisms will be used to provide targets for axial and transverse EDM position measurements.
- Include provisions in the design to mount a 10" optical tooling scale on the prism mount. The scale to be used is a Brunson model #564-10 and will be supplied by LIGO.

3.2 Transport Requirements

- A transfer device will be required to transfer the alignment fixture and the suspension assembly as a unit into a BSC and a HAM chamber.
- A universal table design may be used to accommodate for the different heights of the optical tables in the BSC and HAM chambers or different table designs may be utilized.
- The transport tables are not to be mounted to the optical tables but preferably to the floor within the BSC or HAM chambers.
- Lift table to allow for smooth movement, in all directions.
- Adjustable height of the lift table is required to raise or lower the fixture in close proximity to the table tops such that positioning can occur on the rollers prior to clamping the fixture in place.

3.3 Clearance/Safety Requirements

- All alignment fixture components and transport tables to clear seismic and chamber parts while in use. LIGO to provide documentation that defines dimensions and layout of seismic and chamber components.
- Lift and transport tables to include provisions which would prevent the fixture and suspension assembly from rolling off of the table.
- After aligning the suspension assembly and bolting it to the optical table, removal of the alignment fixture must be accomplished without disturbing the suspension assembly or other components on the optical table.

3.4 Documentation Requirements

- LIGO will provide AutoCAD 13 drawing formats for size A,B,C,D and E documents.
- Any and all changes to the LIGO suspension drawings required to interface with the alignment fixtures, including but not limited to mounting holes, dowel pins, reference points, and tolerancing need to be supplied to the LIGO cognizant engineer in a timely manner as the procurement of the suspension components will be in parallel to the design/documentation of the alignment fixture.
- Include a written procedure for using all components of the alignment fixture, lift and transport assemblies.

3.5 Materials

Materials used to fabricate the fixtures and associated tables should comply with LIGO Vacuum Compatible Materials List, LIGO-E960050. Deviation from this list must be approved by LIGO. Off-the-shelf items may be incorporated in the design as long as care is taken to choose items with little or no grease, lubrication or contaminants. All questions concerning materials and vacuum contaminants should be addressed to LIGO personnel. Also, LIGO document titled LIGO Vacuum Compatibility, Cleaning Methods and Qualification Procedures, LIGO-E960022 may be used as a measure of the effort to which materials cleanliness is an issue for the LIGO observatories. No painted components may enter the vacuum chamber.

3.6 Identification

Fixture assemblies, lift tables, transport tables and transport dollies shall be marked with laser marking or acid etch techniques. Also, a vibratory tool with a minimum tip radius of 0.0005” is acceptable for marking on surfaces which are not hidden from view. Engraving is also permitted.

Assemblies to be serialized according to the document titled Part Numbers and Serialization of Detector Hardware, LIGO-L970196. This document allows for “bag-and-tag” type of identification for small parts.

The Serial number shall be of the format:
Dxxxxxx-y S/N *nnn* Where

Dxxxxxx-y is the LIGO piece part or assembly drawing number, Dxxxxxx, including the revision letter, -y, to which the hardware item was built, and

nnn is the sequential serial number, 001 through 999, in the order produced.