

Advanced LIGO Quad Installation Fixtures – Design Requirements

APPROVALS	DATE	REV	DCN NO.	BY	CHECK	DCC	DATE
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1. INTRODUCTION

1.1 Objectives and Scope

The scope of this document is to define the design requirements for the installation fixtures for the Advanced LIGO Quad Suspensions needed for the ETM, ITM, BS and FM BSC chambers at LLO, LHO and LASTI. This document will include and/or identify requirements regarding load capacity, material, clearance, functionality and safety.

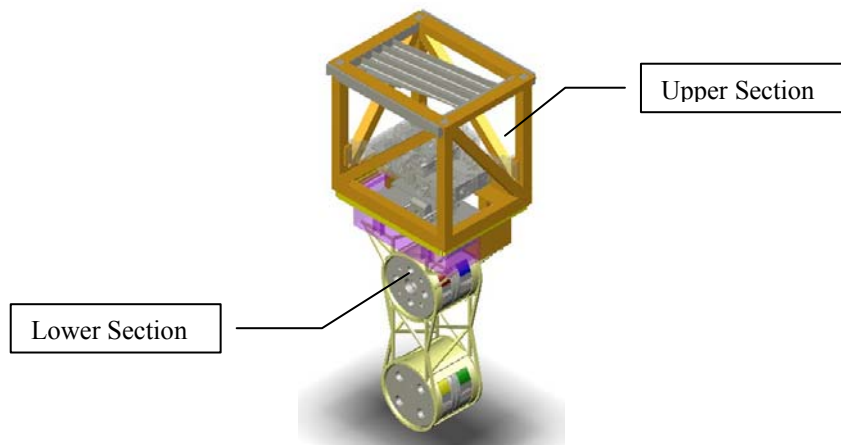
1.2 Applicable Documents

- LIGO-T040151-02-D Advanced LIGO Quad Installation & Alignment Fixtures Product Design Specification
- LIGO-T030137-05 ETM Controls Prototype: - Mass estimate of an ETM suspension layout
- LIGO-T040141-02 ETM Upper Structure Product Design Specification
- LIGO-T040080-02 Advanced LIGO ETM (Quad) Controls Prototype Catcher Jig Design Specification

2. OVERVIEW

2.1 Suspension Structure

The Advanced LIGO Quadruple Pendulum Suspension Structure is composed of an upper and a lower section. The upper section will be lifted into place by crane through the top of each BSC chamber upon removal of the dome, and the lower section will be brought into place through the door of the BSC chamber by utilizing the installation fixtures. The fixtures must also provide adequate possibility for alignment of the structure, once transferred into the chamber. The total estimated weight of the structure is approx. 550 lbs for the upper section including non-suspended mass and suspended components and approx. 500 lbs for the lower section. The lower section is approx. 51 inches high and max. 22.5 inches wide.



Model by Calum Torrie



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2.2 Installation Fixtures

The installation fixtures have three functions:

- (1) Safely transport the lower quad suspension section into the BSC through the chamber door.
- (2) Position the section correctly so that the lower section may be mounted to the upper section.
- (3) Align the suspension assembly to the optics table.

In order to meet the requirements for functionality, the installation fixtures must be capable of secure and clean horizontal load transfer of the lower section into the BSC chamber. Rotational and horizontal positioning inside the chamber must also be provided, in addition to vertical lift and tilt possibilities and fine alignment in X and Y directions once positioned. Removal of the fixtures through the BSC chamber door after installation, without disturbance of the structure, optic table, chamber or other seismic components, is an additional requirement.

3. REQUIREMENTS

3.1 Load Capacity

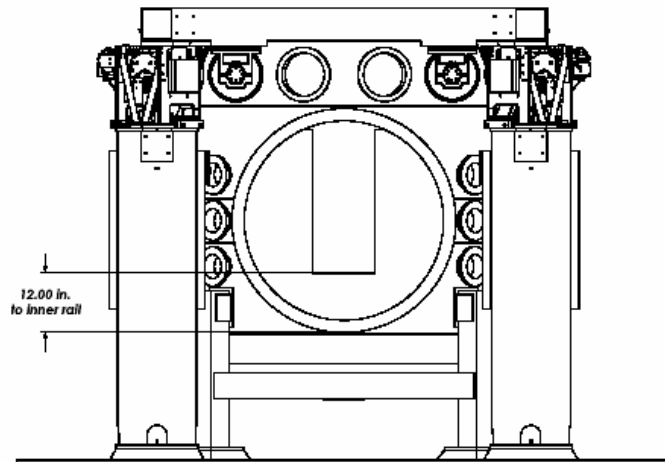
The supporting structures of the installation fixtures must have a load capacity of minimum 2,750 lbs with a maximum vertical deflection of .0005 in. and maximum stress of less than half of the tensile yield strength of the fixture material.

3.2 Material

All material utilized for the installation fixture components must be in compliance with the LIGO Vacuum Compatible Materials List (E960050-B-E). The fixtures should be minimized in weight.

3.3 Clearance

The clearance between the inner rails of the BSC chamber and the bottom of the lower suspension section, defines the maximum allowable height of the installation fixtures, including components for load support, linear translation, lift and fine alignment. The fixtures must also fit through the chamber door before and after the lower suspension section has been installed. All fixtures are to clear seismic and chamber parts while in use.



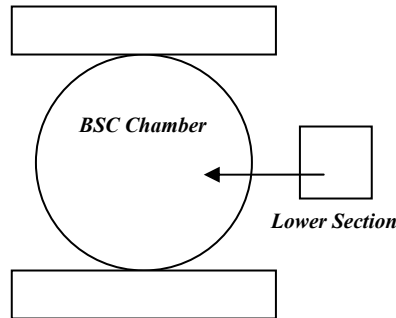


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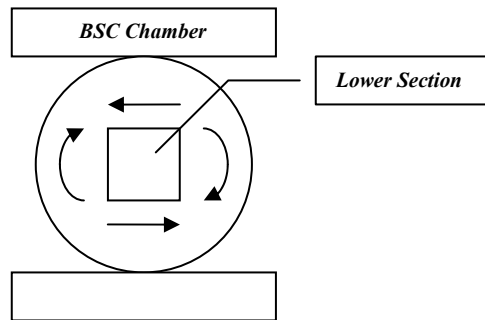
3.4 Functionality

The installation fixtures will be used for the following tasks:

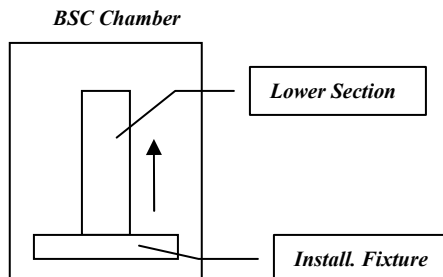
- Secure transportation of the lower section of the quad suspension into the BSC through the chamber door by means of linear translation. Due to the high mass of the section, a brake or clamping mechanism should be included in this component. The section should be transferred into the chamber in the horizontal plane.



- Course positioning of the lower section below the upper section inside the chamber by means of horizontal linear and angular translation. The range of horizontal linear motion required is approx. 120 inches maximum and the range of horizontal angular translation +/- 30 degrees.



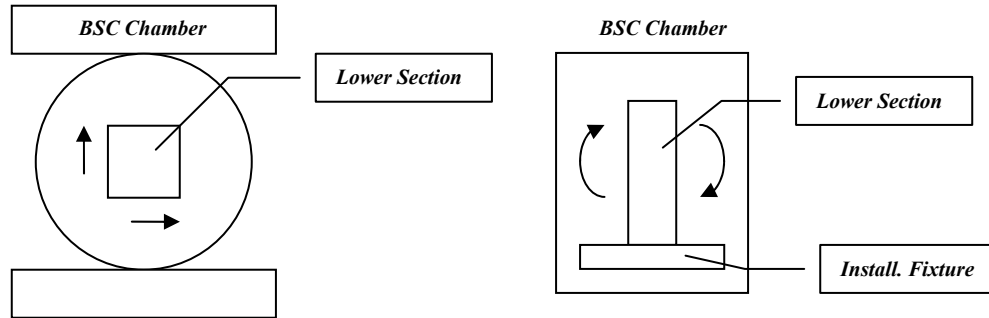
- Lifting the lower section so that it may be mounted to the upper section by means of vertical linear translation. The range of vertical linear motion required should be 2-4 inches depending on the height of the installation fixture, with a sensitivity of .005 inches or less. The backlash should not exceed this resolution.





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- Fine alignment of the suspension structure to the optical table by means of precise angular adjustment about the vertical axis and horizontal linear adjustment. The angular adjustment range required is +/- 2 degrees with a resolution of 1.0 arc second. The horizontal linear adjustment range required is +/- 2 inches with a sensitivity of .005 inches or less.



NOTE: The installation fixtures are not to be mounted to the optical tables but preferably to the floor or other supporting structure within the BSC chamber.

3.5 Safety Requirements

Lift and transport/transfer components must include provisions which would prevent the fixture and suspension assembly from undesired motion, such as the fixtures sliding off supporting chamber structures or suspension section rolling off transport unit.

All components of the installation fixtures supporting the load of the suspension assembly must be designed with a safety factor of two above the desired load capacity of 1,100 lbs and with a safety factor of minimum two above the tensile yield strength of the material for the weakest load supporting component.