LIGO - C951392-00 - B

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Reference: Caltech Contract No. PC181520
LIGO Beam Tube Modules
Fabrication and Installation

Subject: Foundation Loads and Valve Support at the Terminations
CBI-CT-2.2 / 0019

CBI's concept for the Termination Support presented in CBI's fax dated September 8, 1995 has been modified based on the loads presented on Caltech drawing D950093 presented in the November 1 Draft of Contract PC181520. The termination foundation loads presented in this drawing have been used with the exception of the axial load which has been increased due to the presence of higher axial bake out loads than those stated on the Drawing D950093. CBI has not checked the loads provided by Caltech which include the contribution of the valve and vacuum system. However, the design of the termination support is governed largely by the axial loads imposed by vacuum and bake out conditions. The loads imposed by the valve and vacuum system will not significantly affect the termination design and foundation loads provided that the basic configuration of the terminations is unchanged. A foundation load summary and new termination details are attached. Please note that these items have not been checked internally by CBI and are issued prior to checking at your request.

In addition to identifying the termination concept, CBI's September 8, 1995 raised a number of questions concerning the valve configuration and the interface between the vacuum system, valve, and beam tube. Typically, large vacuum valves are mounted to vacuum chambers and are supported exclusively through the flanged attachment of the valve to the chamber. CBI's fax of September 8th requested information on the allowable loads on the valve and how could these loads be applied. In addition, CBI suggested that a "soft support for the valve may be required".

Caltech's December 8th fax provides a response to CBI's questions and provides some information on the valve configuration and allowable loading and now shows a soft support under the valve. The attached sketch also shows the soft support to be within CBI's scope of work. CBI's scope of work does not include an independent permanent soft support for the valve. CBI expects to temporarily support the valve as required prior to installation of the vacuum system. The permanent termination support will support the end of the tube and some or all of the weight of the valve. If proper operation of the valve requires special support conditions, these special support conditions should be provided with the vacuum system.

Regards,

L. C. Buboltz
Project Manager

Foundation Loads Summary

Foundation Loads at Terminations

The loads used in the design of the terminations are based on the "Foundation Loads at Anchor" shown on Caltech drawing D950093, Revision B, with the exception of the Axial Load. The axial load due to bake out has been increased from the value of 5639 pounds stated by Caltech to 24,000 pounds. The axial bake out load is based on an expansion joint maximum spring rate of 8,000 pounds per inch and a 3 inch compression of the expansion joint due to thermal growth of the tube. This increase in axial bake out load has resulted in a increase in the total axial load from the value of 40,124 pounds stated by Caltech to 58,485 pounds. The Foundation Loads used in the termination design are as follows:

Vertical	7937 lb.
Axial	58485 lb.
Lateral	3086 lb.

The specified axial load is a combination of the axial load due to bakeout, the axial load due to vacuum on the outside of the gate valve with full atmospheric pressure inside the tube and axial load due to earthquake. These loads are considered to act simultaneously and in the same direction. The axial loads due to vacuum and bakeout would not normally act in the same direction but could if the vacuum in the beam tube was accidentally lost during bakeout.

The axial load will be supported by a pinned connection at the vertical centerline of the beam tube. The centerline of the tube is assumed to be 42.1 in above the top of the foundation when the tube is in its nominal position. The maximum height of the connection point is 45.6 in above the foundation.

The support frame will be clamped down to the foundation using 1" diameter Hilti Adhesive Anchors. These anchors are installed by gluing threaded rods into holes drilled into the concrete foundation. The axial shear loads at the foundation connection will be resisted by rectangular plates up against the frame to lock the frame in place. The plates will be slotted to allow their position to be adjusted to fit the frame. The plates will be anchored to the foundation using the 1" diameter adhesive anchors or by using structural bolts threaded into plates that are embedded into the foundation.

Foundation Loads at the Fixed Supports Nearest the Terminations

The axial load at the fixed supports includes a component for axial load generated through compression of the expansion joint between fixed supports. In the interior of the modules, the beam tube length on each side of the expansion joints are equal and thus the axial load at the fixed support is based solely on the variation of the expansion joint spring rates on each side of the fixed support. At the first fixed support away from the terminations, the beam tube lengths on each side of the expansion joint are unequal resulting in unequal amounts of compression in the expansion joints which in turn results in an additional axial

load. The axial load shown below is based on the use of expansion joints with equal spring rates on each side of the first fixed support from the terminations. The resulting axial load is only slightly larger than the axial load present at the other fixed supports. The fabrication plan will be revised to include the selection of equal spring rates for the two expansion joints at the end of each beam tube module. The foundation loads at the fixed supports nearest to the termination are as follows:

RL	2607 lb.
RV1 MAX	7895 lb.
RV2 MIN	-377 lb.
RV MAX	8948 lb.
RA	9862 lb.

See LIGO Drawing D950029 Sht 1 of 2 Rev B for the definition of the load labels. The configuration of this support will be similar to that shown on D950029 for the intermediate fixed supports. The fixed support brackets will be attached to the slab with 5/8" anchor bolts in drilled holes located during support installation.

Foundation loads at the Intermediate Fixed Supports

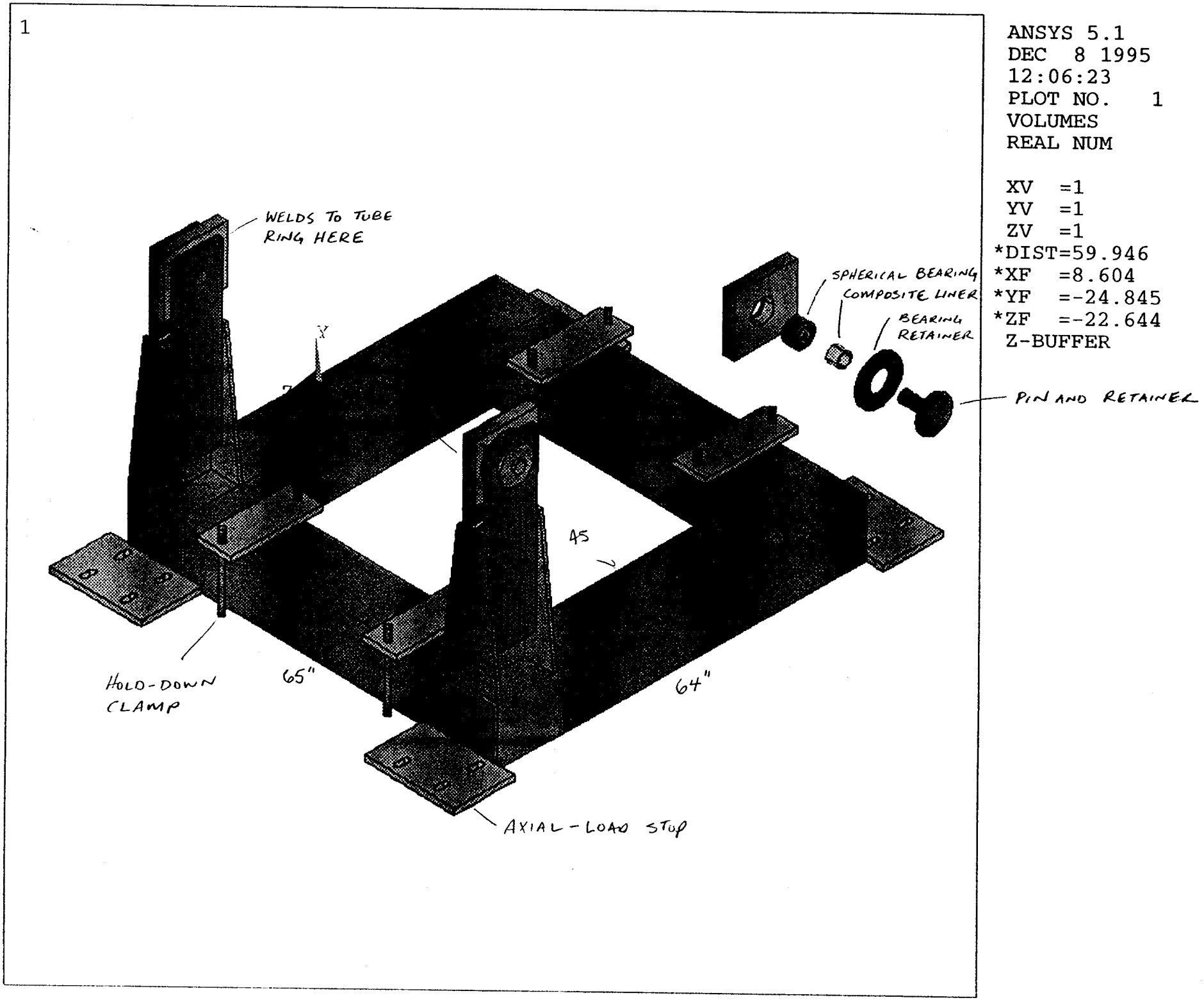
The foundation loads at the intermediate fixed supports are based on the loads reported by CBI in support of the Detailed Design and presented by Caltech on drawing D950029, Sheet 1 of 2, Revision B, except for the axial load. The axial load due to bake out has been increased from the value of 5,188 pounds shown on Caltech drawing D950029 to 5,566 pounds based on the current bellows spring rate specification. These loads are as follows:

RL	2607 lb.
RV1 MAX	7895 lb.
RV2 MIN	-377 lb.
RV MAX	8948 lb.
RA	8506 lb.

See LIGO Drawing D950029 Sht 1 of 2 Rev B for the definition of the load labels and the configuration of these supports. The fixed support brackets will be attached to the slab with 5/8" anchor bolts in drilled holes located during support installation.

Foundation Loads at the Guided Supports

There are no changes to the loads specified on LIGO Drawing D950029 Sht 2 of 2 Rev B. These loads remain as originally reported by CBI in support of the Detailed Design. The guided support brackets will be attached to the slab with 5/8" anchor bolts in drilled holes located during support installation.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WELDS TO TUBE RING HERE
SPHERICAL BEARING
COMPOSITE LINER
BEARING RETAINER
PIN AND RETAINER
45
HOLD-DOWN CLAMP
65"
64"
AXIAL-LOAD STOP
ANSYS 5.1
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