LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -

CALIFORNIA INSTITUTE OF TECHNOLOGY
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Document Type	*Doc Number*	*Group-Id*	*Date*

Interface Control Document (ICD): Beam Tube (BT) - Civil Construction (CC)

Title

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ICD CHANGE RECORD			
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TBDs to be resolved by BT

Section	Subject	Due Date
3.2.1.5	Provide details of loads and load locations on BTE slab	12.15.95
3.2.1.8	Obtain back-up (to initial LIGO estimates) of interface loads and load locations for anchor supports	12.15.95
3.2.1.10	Provide positioning accuracy tolerances for location of pump ports along the BT	12.15.95

TBDs to be resolved by CC

Section	Subject	Due Date
3.2.1.11	Provide details of survey monuments being provided by BTE contractor and available to BT contractor later.	TBD
3.2.2.1.2	Priovde details of high voltage power distribution system for Livingston, LA	1.31.96
6	Provide details of BTE/BT Portals inside the station buildings	1.31.96

1 SCOPE

This document defines the interfaces between the Beam Tube (BT) and the Civil Construction (CC). This ICD takes precedence over previous interface definitions between these systems.

1.1 Purpose

The purpose of this document is to define the interfaces required to insure compatibility between the Beam Tube (BT) and the Civil Construction (CC) and compliance with the LIGO System Specification.

1.2 Content

This document contains interface descriptions, definitions, drawings and requirements. The content is intended to be as concise as possible so as to convey requirements and not duplicate design information.

The intent is that this document be self-contained with little or no requirements included by reference to other documents or drawings. If it is necessary to include information by reference to another document or drawing, then that source must be:

- an approved document
- under configuration control
- cited by document number, date, and revision number

1.3 Interface Overview

There are four major subsystems involved in the design and construction of the LIGO project; the detector system, the Civil Construction (CC) package, the Vacuum Equipment (VE) and the Beam Tube (BT). Since a quadripartite ICD is impractical, the interfaces have been approached in a pairwise fashion. This ICD addresses only the interfaces between the BT and the CC. As a consequence, the complete interface definition for any system is the ensemble of (at most) three ICDs.

The interfaces between the Civil Construction (CC) and the Beam Tube (BT) involve:

- mechanical and structural
- electrical power

For each of these areas, the detailed requirements are delineated in text supported with drawings as required; these drawings (each marked with a note indicating that they are part of an ICD) are an integral part of the ICD and subject to the same control procedures as the overall interface control document.

When an interface is site-specific, then the definition is provided for both the Hanford, WA and the Livingston, LA sites; unless otherwise noted information applies to both sites.

2 APPLICABLE DOCUMENTS

The documents cited in Table 2-1 specifically relate to the interface defined and controlled in this ICD. In the event of discrepancies, this ICD takes precedence; Any conflicts should be pointed out to LIGO systems engineering.

Table 2-1: Relevant Documents

DOCUMENT TITLE	DATE AND ID NUMBER
LIGO System Specification	LIGO-E950084-00 -E
Design Configuration Control Document (DCCD)	August 7, 1995; PAR-FDCM010AB1B03
Beam Tube Detailed Design	LIGO-E950020-01-B
Beam Tube Modules Detailed Design	LIGO-C950496-02-B
LIGO Master Schedule	Latest Revision
Interface Control Document (ICD): Detector - Beam Tube	LIGO-E950093-00-E
Interface Control Document (ICD): Vacuum Equipment - Beam Tube	LIGO-E950092-00-E
Interface Control Document (ICD): Detector - Civil Construction	LIGO-E950090-00-E
Interface Control Document (ICD): Vacuum Equipment - Civil Construction	LIGO-E950088-00-E

3 REQUIREMENTS FOR INTERFACE

3.1 General Requirements

3.1.1 Responsibilities

The LIGO Integration and Systems Engineering group is responsible for maintaining this ICD and for resolving interface conflicts which may arise between the involved subsystems. The forum for interface conflict resolution is the Interface Control Working Group (ICWG). Members of the ICWG consist of Caltech and MIT personnel; representation of LIGO contractor interests is through the subsystem task managers. It is the responsibility of the subsystem task leaders to insure that they and their contractors design and implement in accordance with this interface specification.

3.1.2 Schedules

The LIGO program office is responsible for maintaining the master project schedule. Schedules often have significant interface impacts. Recognizing the often volatile and certainly evolving nature of project schedules, they are included only by reference.

3.1.3 Dimensioning

All interfaces in this document drawings shall be dimensioned in english units with metric units in parentheses.

3.1.4 Coordinate System

The common coordinate system to be used in global dimensioning for interfaces is a cartesian system with its origin located at the corner station vertex (intersection of the projected beam tube centerlines) and with its:

- x-axis aligned along the northwest beam tube centerline in Hanford, WA and along the southwest beam tube centerline in Livingston, LA. These arms are also denoted "Right Arm" or "X-Arm".
- y-axis aligned along the southwest beam tube centerline in Hanford, WA and along the southeast beam tube centerline in Livingston, LA. These arms are also denoted "Left Arm" or "Y-Arm".
- z-axis aligned upwards along the normal to the x-y plane.

3.2 Specific Requirements

3.2.1 Mechanical Interfaces

3.2.1.1 Arm Layouts and Minimum Clearances to Walls

The dimensions of the BT modules for each arm and the minimum clearance distances from the ends of the BT to the CC interior walls are indicated in drawing D950021.

3.2.1.2 BTE Floor Surface Flatness & Parallelism

The BTE concrete slab shall equal or exceed a class B surface. Deviations of the slab from a plane defined by the global x-y axes and located at grade shall not exceed ±1 in. [±25 mm] over the entire extent of the BTE (refer to definitions in drawing D950140). The BTE foundation slab shall be free of all obstructions and objects (such as drains, trenches, grooves, conduit openings, etc.) with the exception of expansion joints which shall not occur within the expansion support footprint (which is defined in drawing D950029, sheet 2).

3.2.1.3 BT Support Mounting ands Adjustments

The anchoring system (designed and provided by the BT contractor) for the BT supports requires 2 3/4" [70 mm] embedment depth free and clear of any obstructions other than re-bar, in regions every 65 ft.[19812 mm] along the BTE arms as indicated section 3.2.1.7 for fixed supports, section 3.2.1.8 for guided supports and section 3.2.1.9 for anchor supports.

The BT supports will provide +/- 3" [75mm] of horizontal adjustment and +/- 2" [50 mm] of vertical adjustment after the initial BT installation and alignment.

3.2.1.4 Maximum BTE foundation drift

The maximum allowable BTE foundation drifts over a 20 year period are as follows:
[i] subsidence: +/- 2.0 in. [+/- 50 mm],
[ii] long term lateral drift is not specified.

3.2.1.5 Maximum Load during Installation on the BTE foundation

Refer to drawing LIGO-D950029, sheet 1.

3.2.1.6 Fixed Supports: Dimensions and Loads

Refer to drawing D950029, sheet 1.

N.B.: The interface loads for the fixed support are defined at a height above the foundation slab (as indicated in drawing D950029), not at the interface with the slab.

3.2.1.7 Guided Supports: Dimensions and Loads

Refer to drawing D950029, sheet 2.

N.B.: The interface loads for the guided support are defined the support BT interface (as indicated in drawing D950029), not at the interface with the slab.

3.2.1.8 Anchor Supports: Dimensions and Loads

Refer to drawing D950093.

*N.B.: The interface loads for the guided support indicated in drawing D950093, are an internal estimate made by LIGO and applied at the centerline of the BT, not at the interface with the foundation slab. BT Task Leader has an action to revise and re-specify the interface loads at the foundation surface. [***TBD-BT***]*

3.2.1.9 BT Portal Through Building Walls

Portals through the corner station, mid-station and end-station buildings shall be designed and prepared by the CC contractor to accommodate the BT. The BT interface requirements on the portal are:

- centered on the projected BT centerline and permit alignment freedom of the BT radially up to 4 in. [102 mm] and longitudinally up to 0.5 in. [12 mm]
- seal the opening around the BT
- permit arbitrary placement of the stiffening rings of the BT relative to the wall
- allow for dynamic motion (peak amplitude less than 1/16 in. [2 mm]) of the BT relative to the wall without significant structural coupling
- be capable of sustaining a temperature of 356F [180C] or be removable
- be centered at the BT axis penetrations through the walls, as defined in drawing D95xxx1.
- be installed after beam tube installation or be readily removed and re-installed.

3.2.1.10 Pump Ports Centered on BTE Service Access Doors

BTE service access module doors shall be co-located with and centered on the BT pump ports to an accuracy of ±4 in. [±100 mm] over the entire length of each arm (see drawing D950139). Table 3-1 provides the allocation of this tolerance to each of the elements of the interface.

Table 3-1: Allocation of BTE-BT co-location alignment tolerances

BT Pump Ports Spacing [Nominally 780 ft. (238 m])	*BTE Service Entrance Modules*	*Total Alignment Tolernace*
+/- 2 in. [50 mm]	+/- 2 in. [50 mm]	+/- 4 in. [100 mm]

3.2.1.11 Alignment monuments

The CC contractor will install survey monuments for initial site development. These are located per drawing D950090-01-0 and surveyed to an accuracy of **TBD-CC**. These site benchmarks are available to the BT contractor.

3.2.2 Electrical Interfaces

3.2.2.1 Power Distribution for BT Installation and Bakeout

3.2.2.1.1 Hanford, WA

Buried vaults with 13.8 kV power terminals will be provided at 17 locations along each arm. The arrangement of vaults is symmetric, having 8 on either side of the midstation, and one located at the midstation. The arrangement is indicated in Table 3-1.

Table 3-1: Typical locations of buried HV vaults along a 2km BT module in Hanford, WA.

Distance From Mid-Station	*Distance From Previous Vault*	*Required Power (@ 13.8 kV)*
Mid-Station	-	75 KVA
1027 ft. [313030 mm]	1027 ft. [313030 mm]	400 KVA
1807 ft. [550774 mm]	780 ft. [237744 mm]	75 KVA
2587 ft. [788518 mm]	780 ft. [237744 mm]	400 KVA
3367 ft. [1026262 mm]	780 ft. [237744 mm]	75 KVA
4147 ft. [1264006 mm]	780 ft. [237744 mm]	400 KVA
4927 ft. [1501750 mm]	780 ft. [237744 mm]	75 KVA
5707 ft. [1739494 mm]	780 ft. [237744 mm]	400 KVA
End or Corner Station 6451ft. [1966265 mm]	744 ft. [226771 mm]	75 KVA

Vaults are centered on the 14 service entrances into the BTE along each arm. Vaults are also located in the vicinity of the BT ends at the corner station, mid-stations and end-stations. Access to the terminals is via a removable cover flush with the ground. Each 13.8 kV line along a beam tube arm can be switched off at switch-gear located in the vicinity of the corner station.

3.2.2.1.2 Livingston, LA

Details of power distribution for Livingston are **TBD-CC** at present. The high voltage power in LA will be at13.2 kV.

3.2.2.2 Power Capacity Available for BT Operations

3.2.2.2.1 Hanford, WA

The total site demand by the BT contractor (during both installation and bakeout) on the 13.8 kV lines shall not exceed the values listed in Table 3-2.

3.2.2.2.2 Livingston, LA

The total site demand by the BT contractor (during both installation and bakeout) on the 13.2 kV lines shall not exceed the values listed in Table 3-2.

Table 3-2: Estimated total power requirements for BT operations

Step	*kVA [Max]*
BT Installation	**TBD-BT**
BT Bakeout, 2km Module	1100 kVA
Total Site BT Operations Power [needed at one time]	**TBD-BT**

4 INTERFACE VERIFICATION

Verification of the interface is to be performed the following methods:

- Test
  A test (wherein the specific test is to be specified) is conducted to insure compliance with the ICD requirements. In some cases this test may be part of a planned component or subsystem test program and not required specifically for verification of the interface.
- Inspection
  In some cases verification may be accomplished by an inspection of the physical article (e.g. measurement of critical dimensions).
- Analysis
  Verification by analysis (wherein the specific analysis is to be specified) may be appropriate in instances where verification by test is expensive or impractical.
- Demonstration
  Demonstration may be used for qualitative determination of properties and performance of an item. Demonstration is accomplished by observation of the item in the performance of its function.
- Similarity
  Arguments of similarity of design may be invoked to verify compliance with interface requirements (e.g. lifetime of a component based upon demonstrated lifetime of similar component designs).

The specific verification method is called out for each of the requirements in the following table.

Table 4-1: Verification Matrix

Para.	*Requirement Title*	*Test*	*Inspection*	*Analysis*	*Demonstration*	*Similarity*
3.2.1.1	Arm Layout Dimensions & Minimum Clearances to Walls		✓			
3.2.1.2	BTE Floor Flatness and Levelness		✓			
3.2.1.3	BT Support Mounting		✓			
3.2.1.4	Maximum BTE Foundation Settlement			✓		
3.2.1.5	Maximum Load During Installation Over the BTE Slab			✓		
3.2.1.6	Fixed Supports: Dimensions & Loads			✓		
3.2.1.7	Guided Supports: Dimensions & Loads			✓		

Table 4-1: Verification Matrix

Para.	*Requirement Title*	*Test*	*Inspection*	*Analysis*	*Demonstration*	*Similarity*
3.2.1.8	Anchor Supports: Dimensions & Loads			✓		
3.2.1.9	BT Portal Through Building Walls		✓	✓		
3.2.1.10	Pump Ports Co-located with BTE Service Access Module Centers		✓			
3.2.2.1	Power Distribution		✓			
3.2.2.2	Power Capacity		✓	✓		✓

5 NOMENCLATURE AND ACRONYMS

Table 5-1: Nomenclature and Acronyms

Acronym	*Meaning*
Anchor Support	A structure for supporting the end of a Beam Tube Module off of the foundation slab of the Beam Tube Enclosure which acts as fixed (translational) support and supports atmospheric pressure loads and bakeout thermal loads.
Arm	One of the two perpendicular beam lines which consititute the LIGO interferometer vacuum envelope between stations.
Caltech	California Institute of Technology
CC	Civil Construction
DCCD	Design Configuration Control Document -- the requirements document for the Civil Construction design
BT	Beam Tube
BT module	An approximately 2 km length of Beam Tube extending between terminus valves, from corner station to mid station and from midstation to endstation
BTE	Beam Tube Enclosure
BTE Service Access Module	A segment of the Beam Tube Enclosure which has double doors and a vestibule for service access to the Beam Tube
Endstation	The 4 km termini of the LIGO arms. There are buildings situated at these points at both sites.
Fixed Support	A structure for supporting the Beam Tube off of the foundation slab of the Beam Tube Enclosure which acts as fixed (translational) support and provides support to the beam tube vertically, axially, and laterally.
Guided Support	A structure for supporting the Beam Tube off of the foundation slab of the Beam Tube Enclosure which acts as guided (translational) support and provides support to the beam tube vertically and laterally.
ICD	Interface Control Document
ICWG	Interface Control Working Group
LIGO	Laser Interferometer Gravitational Wave Observatory
Midstation	The 2km mid points along the LIGO arms. In Hanford there are stations at this location; in Livingston, there is a minor expansion of the BTE.
MIT	Massachusetts Institute of Technology

Table 5-1: Nomenclature and Acronyms

Acronym	*Meaning*
N.B.	Nota bene:, note:
Pump Ports	Access ports/gate valves used to connect vacuum pumps and instrumentation to the Beam Tube
Termination Foundation	The Beam Tube Enclosure foundation segment which interfaces to the anchor support
Terminus Valves	Gate Valves at the ends of each Beam Tube Module
Vault	A buried chamber used to provide access to the high voltage power lines
VE	Vacuum Equipment
Vertex	The point of intersection of the two LIGO arms. Also may refer to the facilities (buildings) erected around this point. It is also called the corner or corner station.

6 DRAWINGS:

LIGO Dwg	*Title*	*No. of Sheets*	*Approved/ Released?*
D950021	LIGO Arm Layouts	1	Y
D950029	General Details and Fixed Support Details	2	Y
D950090	Hanford, WA GPS Monument Locations (J.U.B. drawing)	1	Y
D950093	Beam Tube Termination Foundations	1	Y
D950140	BTE Foundation Orientation	2	Y
D950139	BTE Service Access Module and BT Pump Port Locations	1	Y
D95xxx1	Beam Tube Portals in Building Walls	3	**TBD-CC**

REV	DESCRIPTION OF CHANGE	SHEETS EFFECTED	APPROVAL	DATE
A	Original	ALL		
B	English units, ICD note and tolerances added; Clarified loading point; Clarified loading point; Minor load corrections.	ALL		
C	Revised construction loads note. *Only affects Sheet 1*	1		

NOTES: (UNLESS OTHERWISE SPECIFIED)

1) ICD INFORMATION: This drawing contains interface information.

2) SUPPORTS ARE FASTENED WITH 5/8" [16 mm] DIA. EXPANSION ANCHORS

3) GUIDED SUPPORTS ARE SPACED MIDWAY BETWEEN FIXED SUPPORTS.

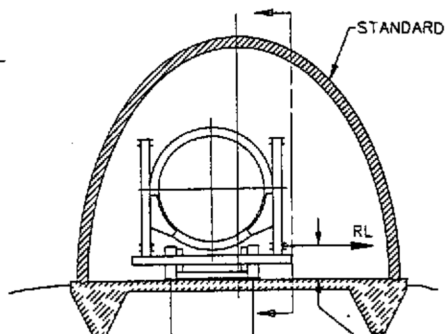
4) DO NOT LOCATE SLAB EXPANSION JOINT WITHIN GUIDED SUPPORT FOOTPRINT.

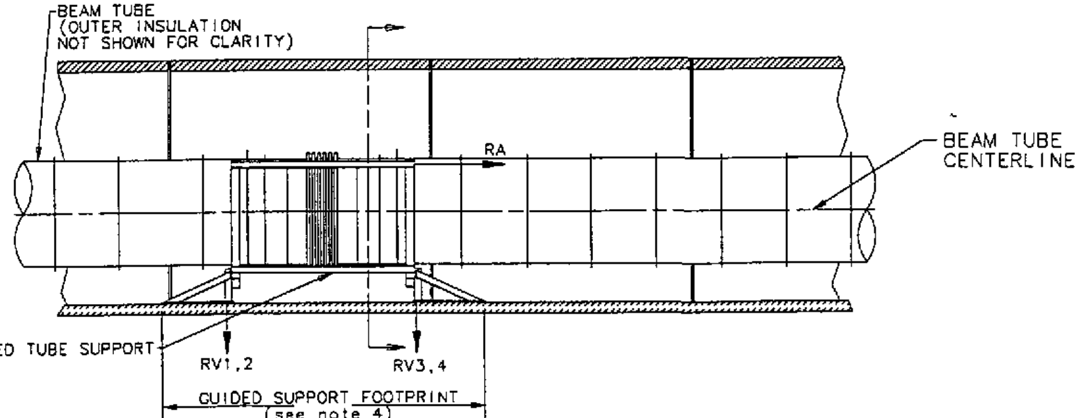
CATEGORIZATION OF ELEMENTS OF TUBE SUPPORT LOADS (kgf)

TYPE LOAD	RL	RV1 MAX.	RV2 MIN.	RV3 MAX.	RV4 MIN.	RV MAX.	RA
SEISMIC	400	263	-263	263	-263	0	0
DEAD LOAD & VAC.	39	756	706	756	706	2925	0
THERMAL	298	272	-272	272	-272	305	0
SETTLEMENT	0	325	-325	166	-166	319	0
TOTAL	737	1616	-154	1457	5	3549	0

CATEGORIZATION OF ELEMENTS OF TUBE SUPPORT LOADS (lbf)

TYPE LOAD	RL	RV1 MAX.	RV2 MIN.	RV3 MAX.	RV4 MIN.	RV MAX.	RA
SEISMIC	882	580	-579	579	-579	0	0
DEAD LOAD & VAC.	86	1667	1556	1667	1556	6449	0
THERMAL	657	600	-600	600	-600	672	0
SETTLEMENT	0	716	-716	366	-366	703	0
TOTAL	1625	3563	-340	3212	11	7824	0





TUBE SUPPORT LOADS:

MAXIMUM RL = 1625 lbf [737 kgf]
MAXIMUM RV1 = 3563 lbf [1616 kgf]
MINIMUM RV2 = -340 lbf [-154 kgf]
MAXIMUM RV3 = 3212 lbf [1457 kgf]
MINIMUM RV4 = 11 lbf [5 kgf]
MAXIMUM RV = 7824 lbf [3549 kgf]
MAXIMUM RA = 0 lbf [0 kgf]

QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN ft-in [mm]
TOLERANCES ARE:
FRACTIONS DECIMALS
X.X ± 0.5
X.XX ± 0.05
X.XXX ± 0.005
ft-in ± 0.5"
DO NOT SCALE DRAWING

MATERIAL NA
FINISH NA

APPROVALS		DATE
DRAWN D. Coyne	DC	11/15/95
CHECKED		

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TITLE GENERAL DETAILS AND FIXED SUPPORT DETAILS

DWG NO. D950029 REV C

SCALE NTS SHEET 2 of 2

NOTES: (UNLESS OTHERWISE SPECIFIED)

1) ICD INFORMATION: This drawing contains interface information.

2) SLAB LOADS DURING CONSTRUCTION OF THE BEAM TUBE SHALL NOT EXCEED 3600 LB. [1633 kgf] APPLIED ON A 6"x6"x3/4" [152x152x19 mm] STEEL PADS SPACED ON 36" [914 mm] MINIMUM CENTERS.

3) BEAM TUBE FIXED SUPPORTS ARE EQUALLY SPACED AT 130'-0" [39624 mm] ALONG TUBE AXIS

4) BEAM TUBE SUPPORTS ARE FASTENED WITH 5/8" [16 mm] EXPANSION ANCHORS

5) SLAB TO BE DESIGNED FOR A MAXIMUM SETTLEMENT OF NO MORE THAN 2.0" [50 mm] OVER 20 YEARS.

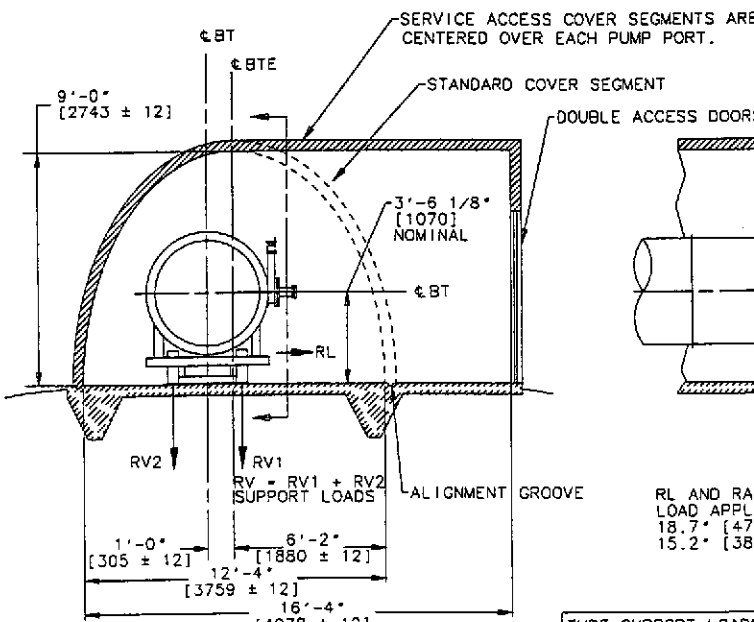
REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	Original		
B	English units, ICD note and tolerances added; Clarified loading point; Clarified loading point; Minor load corrections.		
C	Revised construction loads note. Only affects sheet 1.	(signature)	11/15/95

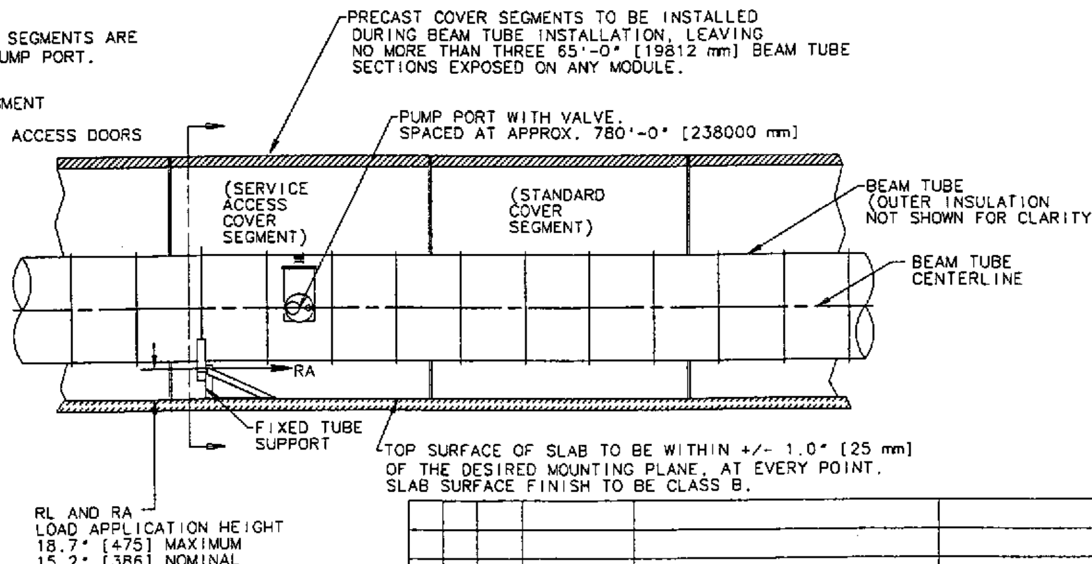
CATEGORIZATION OF ELEMENTS OF TUBE SUPPORT LOADS (kgf)

TYPE LOAD	RL	RV1 MAX.	RV2 MIN.	RV MAX.	RA
SEISMIC	584	766	-766	0	984
DEAD LOAD & VAC.	39	1755	1655	3410	350
THERMAL	0	0	0	0	2353
SETTLEMENT	0	324	-324	649	0
HORIZ. ALIGN.	560	735	-735	0	0
TOTAL	1183	3581	-171	4059	3687

CATEGORIZATION OF ELEMENTS OF TUBE SUPPORT LOADS (lbf)

TYPE LOAD	RL	RV1 MAX.	RV2 MIN.	RV MAX.	RA
SEISMIC	1287	1689	-1689	0	2169
DEAD LOAD & VAC.	85	3870	3648	7518	771
THERMAL	0	0	0	0	5188
SETTLEMENT	0	715	-715	1430	0
HORIZ. ALIGN.	1235	1621	-1621	0	0
TOTAL	2607	7895	-377	8948	8128





TUBE SUPPORT LOADS:

MAXIMUM RL = 2607 lbf [1183 kgf]
MAXIMUM RV1 = 7895 lbf [3581 kgf]
MINIMUM RV2 = -377 lbf [-171 kgf]
MAXIMUM RV = 8948 lbf [4059 kgf]
MAXIMUM RA = 8128 lbf [3687 kgf]

QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN ft-in (mm) TOLERANCES ARE:
FRACTIONS DECIMALS
X.X ± 0.5
X.XX ± 0.05
X.XXX ± 0.005
ft-in ± 0.5"
DO NOT SCALE DRAWING

MATERIAL NA
FINISH NA

APPROVALS		DATE
DRAWN D. Coyne	(signature)	11/15/95
CHECKED L. Jones	(signature)	11/15/95
F. Asiri	(signature)	11/15/95
M. Coles	(signature)	11/15/95
A. Lazzarini	(signature)	
J. Worden	(signature)	

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TITLE GENERAL DETAILS AND FIXED SUPPORT DETAILS

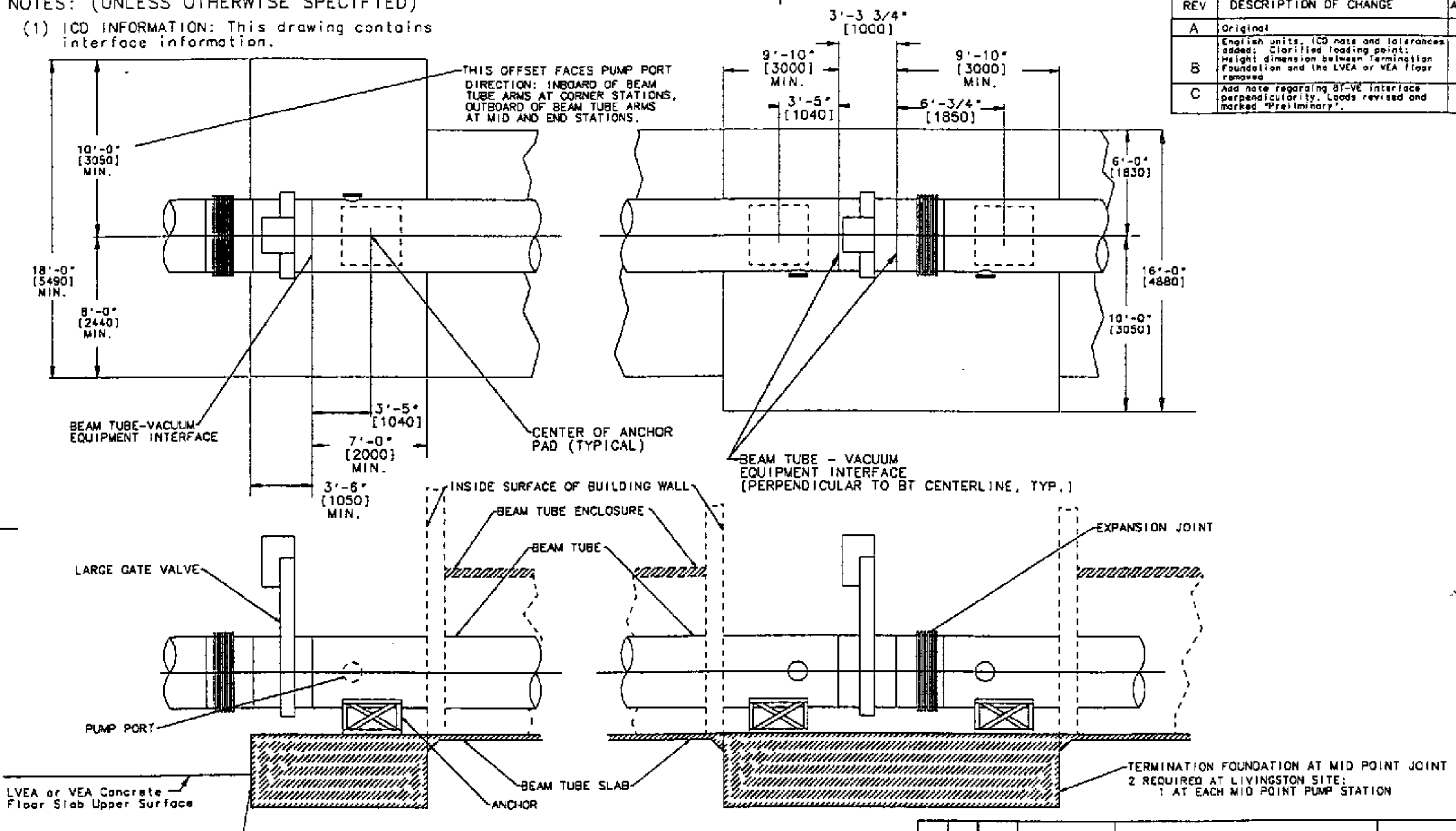
DWG NO. D950029 REV C

SCALE NTS SHEET 1 of 2

NOTES: (UNLESS OTHERWISE SPECIFIED)

(1) ICD INFORMATION: This drawing contains interface information.

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	Original		
B	English units, ICD note and tolerances added; Clarified loading point; Height dimension between Termination foundation and the LVEA or VEA floor removed		
C	Add note regarding BT-VE interface perpendicularity. Loads revised and marked "Preliminary".	[signature]	11/27/95



TYPICAL TERMINATION FOUNDATION
8 REQUIRED AT HANFORD SITE:
2 AT CORNER STATION
2 AT EACH MID STATION
1 AT EACH END STATION
4 REQUIRED AT LIVINGSTON SITE:
2 AT CORNER STATION
1 AT EACH END STATION

FOUNDATION LOADS AT ANCHORS (kgf) (Preliminary)

DIRECTION	TOTAL	DEAD	VACUUM	SEISMIC	THERMAL	WIND
VERTICAL	3600	3600	0	0	0	0
AXIAL	26530	0	14788	854	10887	0
LATERAL	1400	0	0	696	0	704

FOUNDATION LOADS AT ANCHORS (lbf) (Preliminary)

DIRECTION	TOTAL	DEAD	VACUUM	SEISMIC	THERMAL	WIND
VERTICAL	7937	7937	0	0	0	0
AXIAL	58485	0	32602	1883	24000	0
LATERAL	3086	0	0	1534	0	1552

PARTS LIST

QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN ft-in [mm] TOLERANCES ARE:
ft,-in. ± 0.5 in
mm ± 12 mm
DO NOT SCALE DRAWING
MATERIAL NA
FINISH NA

APPROVALS		DATE
DRAWN C. Conley		11/27/95
CHECKED L. Jones	[signature]	11/28/95
F. Asiri	[signature]	11/27/95
J. Worden	[signature]	11/25/95
M. Coles	[signature]	11/28/95
A. Lazzarini	[signature]	11/23/95

LIGO — CALIFORNIA INSTITUTE OF TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

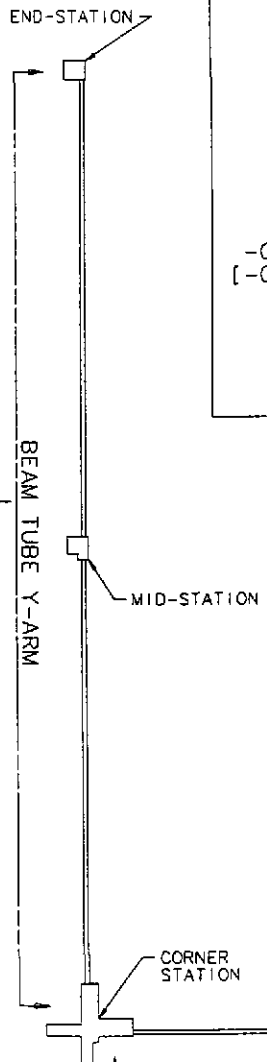
TITLE: BEAM TUBE TERMINATION FOUNDATIONS

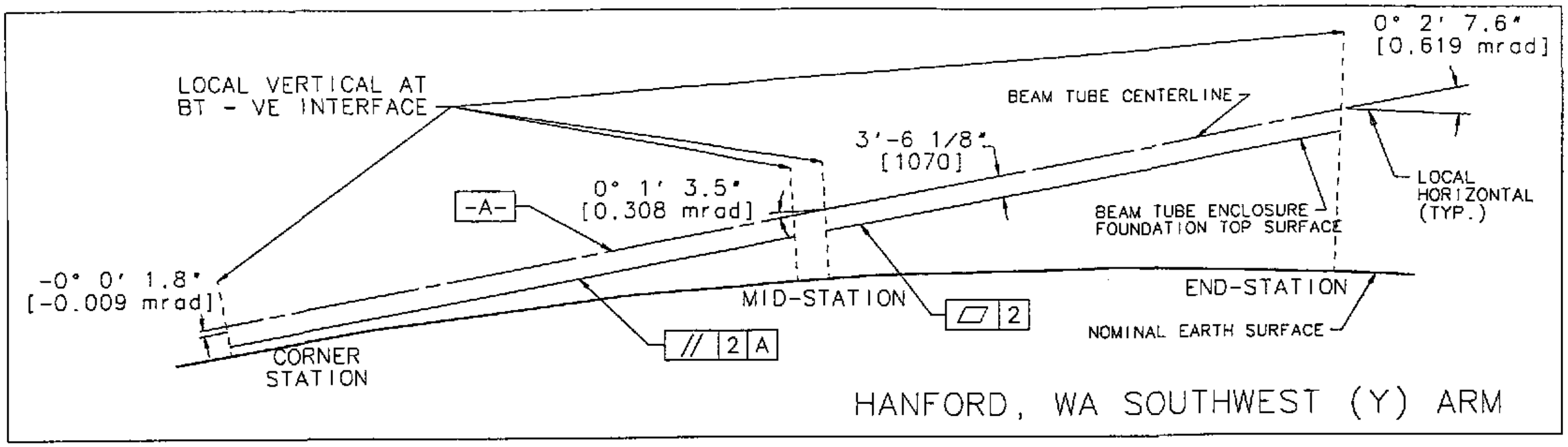
DWG NO. D950093 — REV C

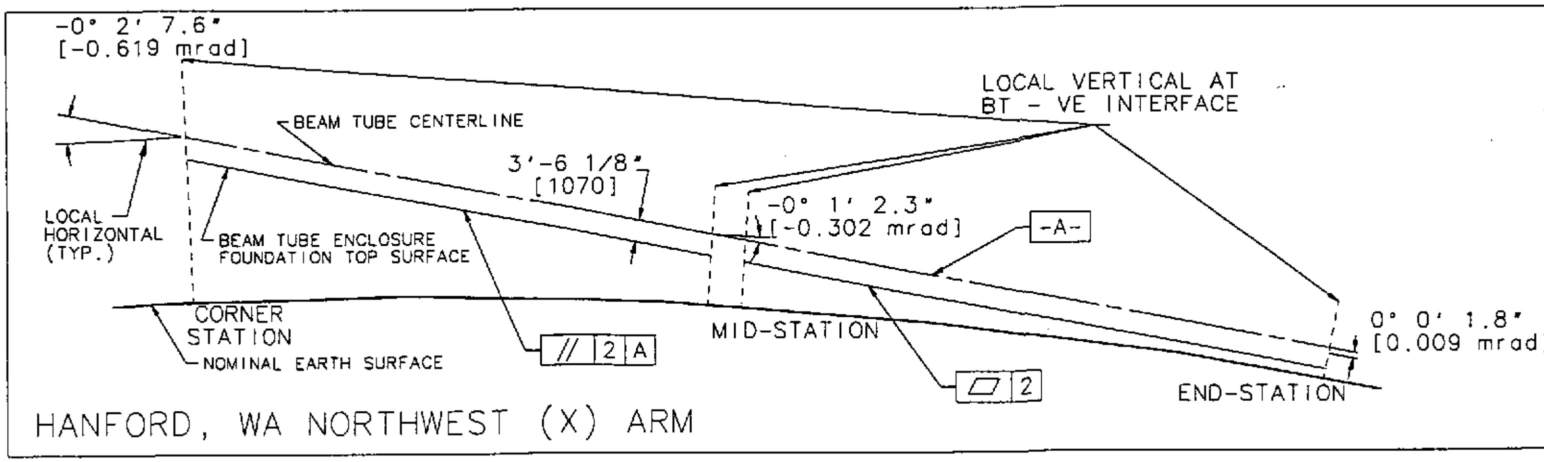
SCALE NTS — SHEET 1 of 1

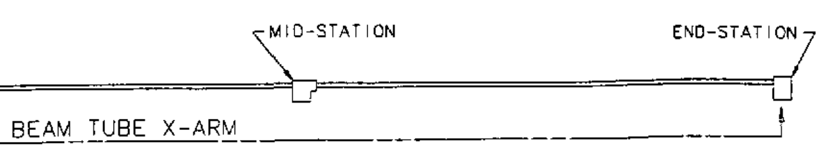
NOTES:
1) ICD INFORMATION: This drawing contains interface information.

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	ORIGINAL		11/28/95









QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FT-IN (mm) TOLERANCES ARE:
FRACTIONS DECIMALS

FLATNESS TOL. IS IN inches
PARALLELISM TOL. IS IN inches

DO NOT SCALE DRAWING

MATERIAL: NA
FINISH: NA

APPROVALS		DATE
DRAWN D. Coyne		11/13/95
CHECKED A. Lazzarini		11/27/95
L. Jones		11/27/95
F. Asiri		11/27/95
W. Coles		11/28/95

LIGO — CALIFORNIA INSTITUTE OF TECHNOLOGY — MASSACHUSETTS INSTITUTE OF TECHNOLOGY

TITLE: ORIENTATION OF THE BEAM TUBE ENCLOSURE FOUNDATION WITH RESPECT TO THE LOCAL HORIZONTAL

DWG NO. D950140 — REV A

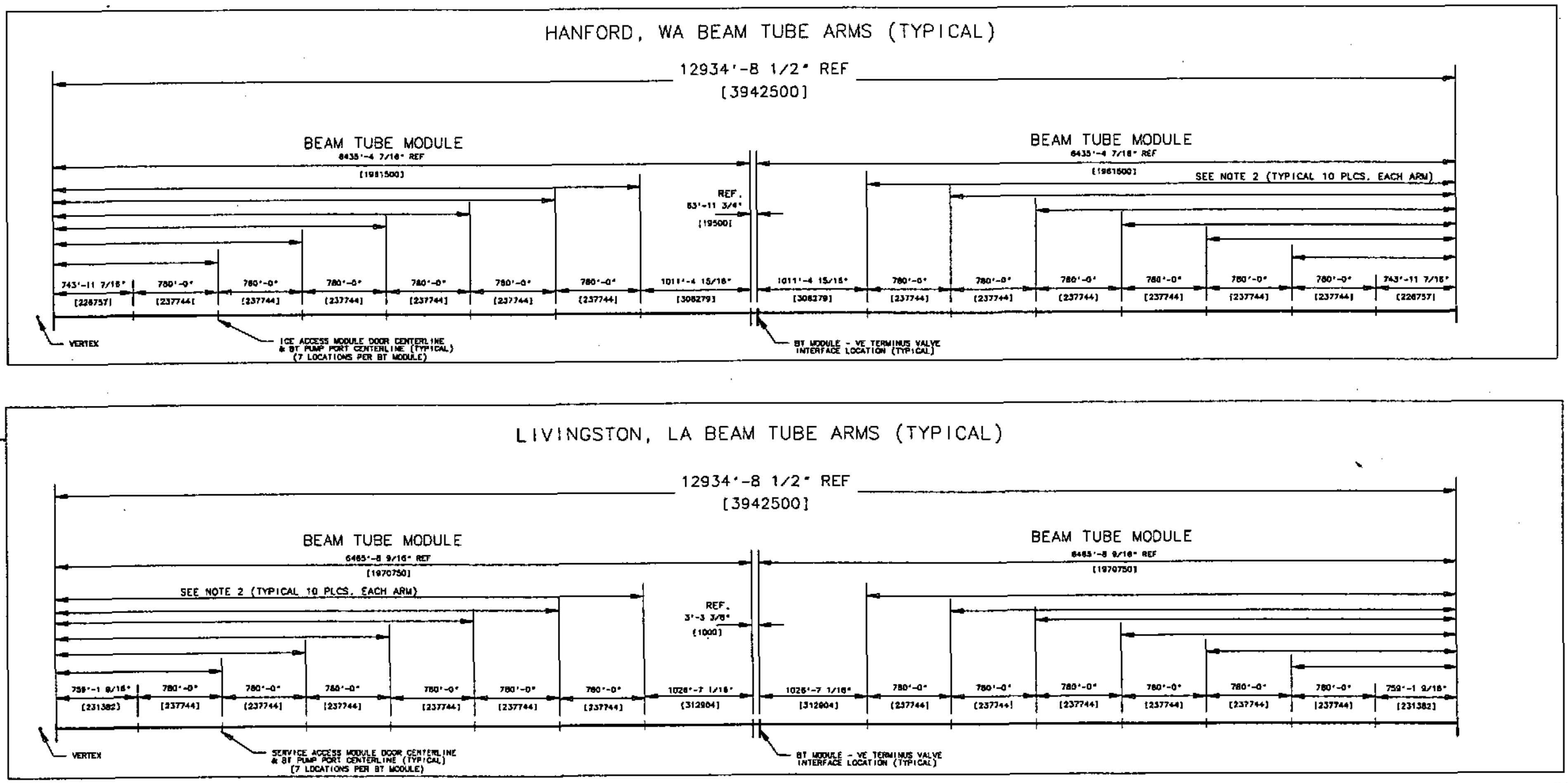
SCALE NTS! — SHEET 1 OF 2

NOTES: (UNLESS OTHERWISE SPECIFIED)

1) ICD INFORMATION: This drawing contains interface information.

2) End-to-end tolerances to be maintained to ±2" [±50 mm]

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	ORIGINAL		11/29/95



QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN ft-in [mm] TOLERANCES ARE:
±2" [±50 mm]
Subject to constraint in NOTE 2 above.

DO NOT SCALE DRAWING

MATERIAL NA

FINISH NA

APPROVALS		DATE
DRAWN D. Coyne	DCC	11/13/95
CHECKED		
A. Lazzarini	AL	11/28/95
L. Jones		11/29/95
F. Asiri		11/29/95
W. Coles		11/28/95

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY

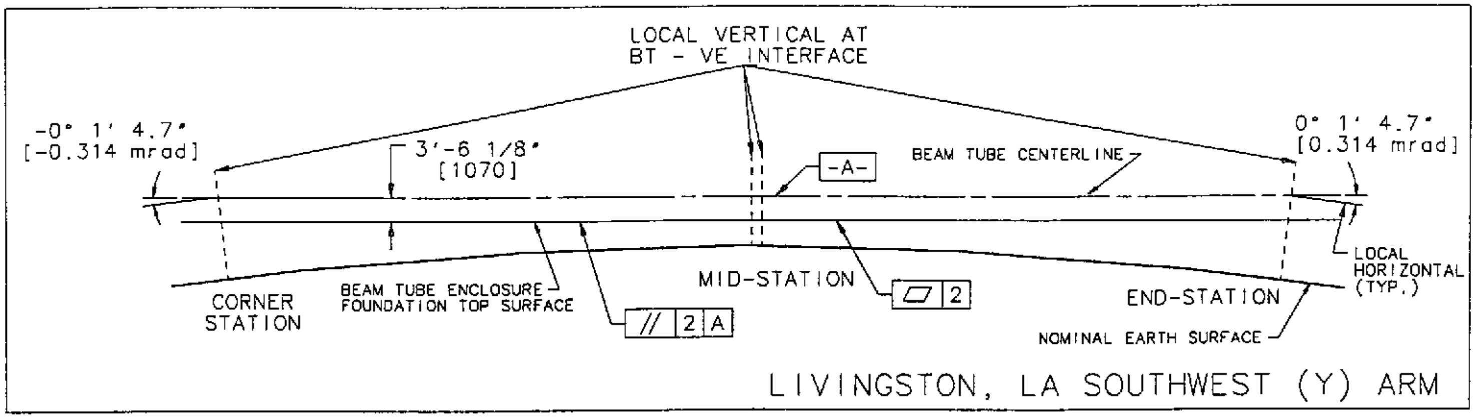
TITLE BTE SERVICE ACCESS AND BT PUMP PORT LOCATIONS

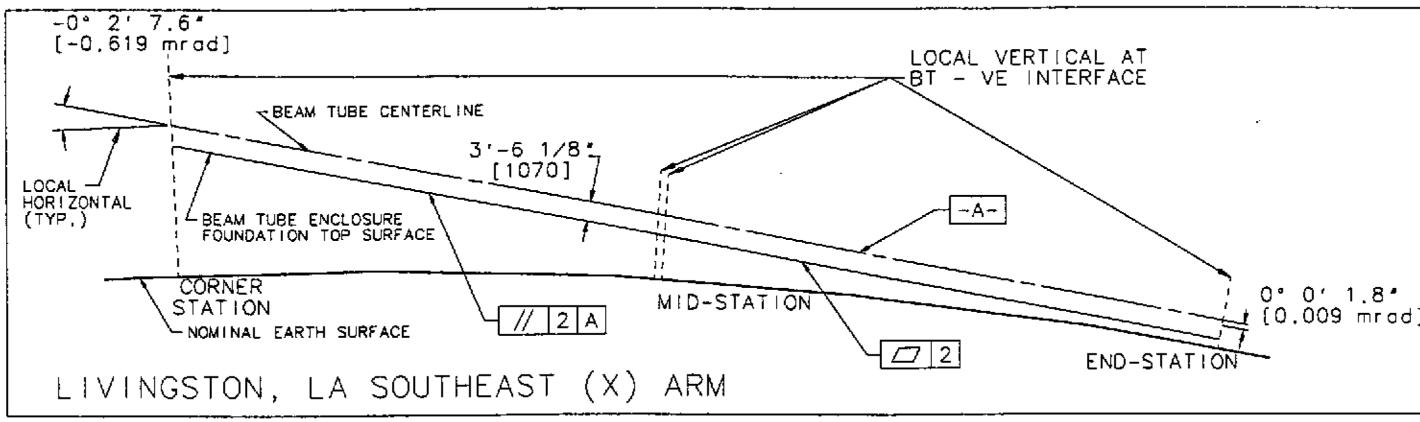
DWG NO. D950139 REV A

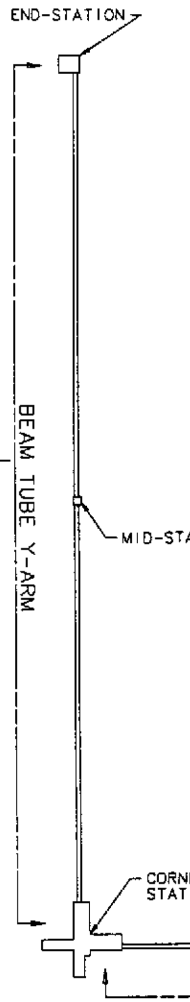
SCALE NTS SHEET 1 OF 1

NOTES:
1) ICD INFORMATION: This drawings contains interface information.

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	ORIGINAL	[signature]	11/29/95







QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN Ft-In [mm] TOLERANCES ARE: FRACTIONS DECIMALS	APPROVALS	DATE	LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY
	DRAWN C. Conley	11/27/95	
FLATNESS TOL. IS IN inches PARALLELISM TOL. IS IN inches	CHECKED A. Lazzarini	11/28/95	TITLE ORIENTATION OF THE BEAM TUBE ENCLOSURE FOUNDATION WITH RESPECT TO THE LOCAL HORIZONTAL
DO NOT SCALE DRAWING	L. Jones	11/28/95	
MATERIAL NA	F. Asiri	11/28/95	DWG NO. D950140 REV A
FINISH NA	M. Coles	11/28/95	SCALE NTS SHEET 2 OF 2