LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

- LIGO -

CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Specification	LIGO-E950092-00 -E		1/2/96
Document Type	*Doc Number*	*Group-Id*	*Date*

Interface Control Document (ICD): Beam Tube (BT) - Vacuum Equipment (VE)

Title

D. Coyne, A. Lazzarini

Authors(s

Distribution of this draft:

W. Althouse	J. Heefner	R. Spero
F. Asiri	A. Lazzarini	G. Stapfer
R. Bork	O. Matherny	R. Vogt
M. Coles	G. Sanders	R. Weiss

This is an internal working note of the LIGO Project

DRAFT

California Institute of Technology
LIGO Project - MS 102-33
Pasadena CA 91125
Phone (818) 395-2966
Fax (818) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project - MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW: http://www.ligo.caltech.edu/

ICD CHANGE RECORD

REVISION	AUTHORITY	PAGES AFFECTED	ITEM(S) AFFECTED

Organization/Group	*Name*	*Signature*	*Date*
Program Manager	Gary Sanders		
Integration and Systems Engineering	Albert Lazzarini		
Facilities	Mark Coles		
Beam Tube	Larry Jones		
Vacuum Equipment	John Worden		

TBDs to be resolved by BT

Section	Subject	Due Date
3.2.2.1 3.2.2.1.4	Provide pump port flange set details (1.5" & 10"), LIGO-D95**TBD-LIGO**-1	1/31/96
3.2.2.1.2	Provide allowable pump port hardware loads at Portable Pump Stand interfaces	1/31/96
3.2.1.1.4	Complete LIGO-D95**TBD-LIGO**-2, showing BT/VE interface details and allowable loads	1/31/96

TBDs to be resolved by VE

Section	Subject	Due Date
3.2.1.1.4	Provide soft support design for large gate valves.	1/31/96
3.2.1.1.2	Adopt for configurational control (envelope dimensions) and number with LIGO DCC number the PSI/GNB large gate valve drawings: LIGO-D**TBD-LIGO**-3,-4	1/31/96

1 SCOPE

This document defines the interfaces between the Beam Tube (BT) and the Vacuum Equipment (VE). 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 Vacuum Equipment (VE) 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 (DET) 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 VE. As a consequence, the complete interface definition for any system is the ensemble of (at most) three ICDs.

The interfaces between the Beam Tube (BT) and the Vacuum Equipment (VE) involve mechanical and structural elements.

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 separately for 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
Beam Tube Detailed Design	LIGO-E950020
Beam Tube Modules Detailed Design	LIGO-C950496
LIGO Master Schedule	Latest Revision
Interface Control Document (ICD): Detector - Beam Tube	LIGO-E950093
Interface Control Document (ICD): Detector - Vacuum Equipment	LIGO-E950091
Interface Control Document (ICD): Detector - Civil Construction	LIGO-E950090
Interface Control Document (ICD): Vacuum Equipment - Civil Construction	LIGO-E950088
Interface Control Document (ICD): Beam Tube - Civil Construction	LIGO-E950089

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 interface drawings in this document 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 BT large aperture to VE termination.

3.2.1.1 Mechanical Interfaces

Each 2km beam tube (BT) module has two termination interfaces with the vacuum equipment system (VE). The interface consists of a large-aperture gate valve. The gate valve, along with any required mounting hardware, shall be provided by the VE Contractor to the BT Contractor. The date of required delivery is defined in the LIGO Facilities Master Schedule. LIGO-D950021 shows these interfaces along the arms.

3.2.1.1.1 Alignment and Clear Aperture

The alignment requirements for the gate valves are called out in drawings LIGO D950028, D950093,and D950140. The valves shall be mounted vertically with the actuators on top. The gate valve, in its open position, shall provide a minimum circular clear aperture as specified in Table 3.2-1.

Table 3.2-1: BT Termination Gate Valve Minimum Clear Apertures

Site	*Location (Same for both arms)*	*Clear Aperture (Nominal, Minimum)*
Hanford WA	All valves at BT-VE interfaces	44.125" (1120 mm)
Livingston LA	Vertex, End	44.125" (1120 mm)
Livingston LA	Mid Station, Both Sides	48.750" (1220 mm)

3.2.1.1.2 Interface Critical Dimensions

The gate valves shall be outfitted with tube stub sections on the interface side. These tube stubs shall be 49.12" +/- .020" (1247.7 mm +/- .5 mm) ID with a 0.127"+/- .007" (3.2 mm +/- .2 mm) wall thickness. Ends of the butt shall be perpendicular to the tube axis and flat to within .010" (.25 mm). The outside surface shall be cylindrical and unobstructed for 6" (152 mm) from the end. The inside surface shall be cylindrical and unobstructed for 2" (51 mm) from the end.

The LA midstation valves require tube stub sections on both sides. The stub lengths shall be sized to provide a total length (stub-valve-stub) of 39.4" (1000 mm).

The gate valve envelopes are depicted in LIGO-DTBD-LIGO-3,-4.

3.2.1.1.3 Material

The interface side of every valve shall be oufitted with a 304L SS tube stub having 0.010% < sulfur content < 0.020%.

3.2.1.1.4 Mounting/Loads

The valves shall be butt welded onto the ends of the 2km BT modules by the BT contractor. The BT Contractor shall be responsible for the mechanical and vacuum integrity of the weld. Provision shall be made to support the valves from below using a soft support. This support shall be designed and provided by **TBD-VE**. Refer to LIGO-D95**TBD-LIGO**-2 for additional details.

The valves shall be capable of withstanding a 1 atmosphere pressure differential acting in either direction when the valve gate is in the closed position. Refer to DWG LIGO-D**TBD-LIGO**-2 for further loading details.

3.2.1.2 Thermal Interfaces

The gate valve shall have be able to withstand an elevated temperature of 170C for indefinite periods of time.

3.2.1.3 Electrical Interfaces

None.

3.2.2 BT Pump Ports to VE interface.

3.2.2.1 Mechanical Interfaces

BT modules have nine (9) pumping ports. The ports adjacent to vertex station terminations are denoted as "inboard", while all others are denoted "outboard". Pump port details are depicted in drawing LIGO D950027, D950029.

All ports are terminated by a 10" (254 mm) gate valve (manual, with a locking device) provided by the BT Contractor. The outboard sides of these valves shall be fitted with 10" (254mm) Conflat type flanges. The flange details are to be provided by the BT Contractor and are shown in LIGO-D**TBD-LIGO**-1. The VE Portable Pump Stands shall have a provision to connect to these Conflat flanges directly for rough pumping of the BT.

There are two types of pump port hardware: type "B", for use during BT bakeout, and type "H" for hold after BT acceptance and before operations begin. This hardware shall be provided by the BT Contractor and mounts to the gate valves. These hardware "trees" provide for hookup to the BT module of miscellaneous pumping and sensing instruments. In addition, the trees are outfitted with 1.5" (38 mm), and 10" (254 mm) Conflat type flanges. The 10" flanges shall be identical to the ones called out above in this section. The flange details for the 1.5" (38 mm) ports shall be provided by the BT contractor and are shown in LIGO D**TBD-LIGO**-1. The Portable Pump Stands provided by the VE contractor shall be designed so that the auxiliary turbomolecular pumps shall be able to connect to the 1.5" flanges.

3.2.2.1.1 Mounting/Loads

Adequate stress relief shall be provided by the Portable Pump Stand design to permit coupling to the 10" and 1.5" ports on the BT hardware without exceeding the allowable loads on these ports. These allowable loads are **TBD-BT**.

3.2.2.1.2 Alignment

The BT pump ports have centerlines 42.125" (1070 mm) above the BTE foundation slab. The arrangement of the BT pump ports with respect to the BT are indicated in drawing LIGO D950027. The Portable Pump Stands shall be designed for this nominal pump port centerline height.

3.2.2.1.3 Connectors and Fasteners

The number and types of fasteners required to mount the VE Portable Pump Stand pumping hardware to the flanges on the BT port hardware are specified in drawing LIGO D95TBD-LIGO-1.

3.2.3 Thermal Interfaces

The pump port hardware and the connected VE Pump Stand hardware shall be able to withstand an elevated temperature of 170C for indefinite periods of time.

3.2.4 Electrical Interfaces

None.

4 INTERFACE VERIFICATION

Verification of the interface is to be performed by one or more of 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*
3.2.1.1.1	Gate Valve minimum clear aperture		X			
3.2.1.1.2	Gate Valve stub critical dimensions and overall valve envelope		X			
3.2.1.1.3	Gate Valve stub material		X			
3.2.1.1.4	Gate Valve mounting loads at interface			X		
3.2.1.2	Thermal compatibility for bakeout		X	X	X	
3.2.2.1	Pump Port flange set compatibility		X		X	
3.2.2.1.1	Portable Pump Stand envelope dimensions		X		X	

Table 4-1: Verification Matrix

Para.	*Requirement Title*	*Test*	*Inspection*	*Analysis*	*Demonstration*	*Similarity*
3.2.2.1.2	Maximum allowable stress on pump port hardware by Portable Pump Stands			X		
3.2.2.1.3	Portable Pump Stand centerline height		X			
3.2.2.1.4	Pump Port/Portable Pump Stand flange set compatibility		X			
3.2.3	Thermal compatibility of Portable Pump Stand hardware during BT bakeout		X	X	X	

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 constitute 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.

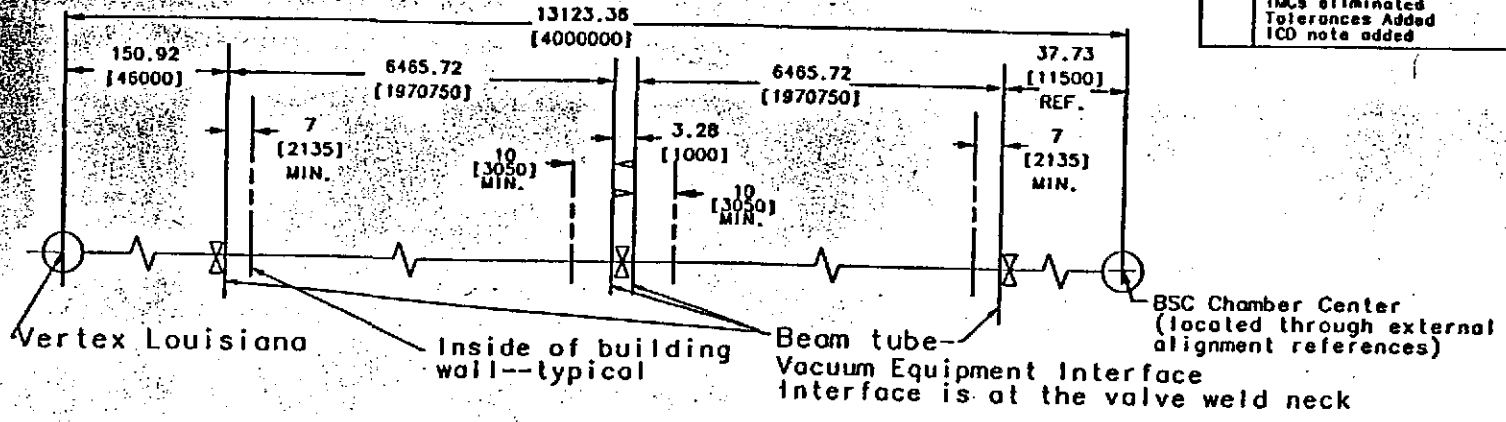
6 DRAWINGS:

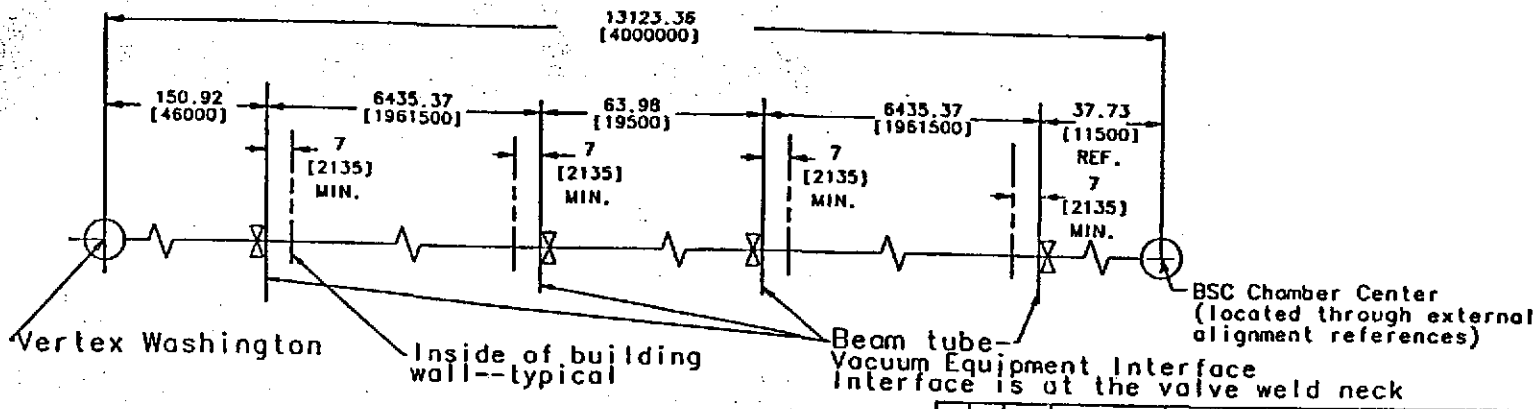
Drawing No.	Title	Sheets	Complete
D950021	LIGO Arm Layouts	1	Y
D950027	Beam Tube Pump Port Hardware	1	Y
D950028	Beam Tube Terminations	1	Y
D950029	General Details and Fixed Support Details	2	Y
D950093	Beam Tube Termination Foundations	1	Y
D950140	BTE Foundation Orientation	2	Y
D95**TBD-LIGO**-1	Pump Port flange set details	2	N
D95**TBD-LIGO**-2	Beam Tube/VE Termination Details	1	Sketch
D95**TBD-LIGO**-3	44 1/8" (1.212m) Gate Valve Dimensions (PSI/GNB Drawing)	1	Y
D95**TBD-LIGO**-4	48 1/4" (1.22m) Gate Valve Dimensions (PSI/GNB Drawing)	1	Y

NOTES: (UNLESS OTHERWISE SPECIFIED)

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

REV	DESCRIPTION OF CHANGE	APPROVAL
A	Original	
B	Lengths changed English units added TMCs eliminated Tolerances Added ICD note added	





Legend:

Gate Valve

BSC

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

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN ft [mm] TOLERANCES ARE:	APPROVALS	DATE
ft ± 0.5 in mm ± 12 mm DO NOT SCALE DRAWING	DRAWN D. Coyne	10/16/95
	CHECKED E. Jones	10/17/95
	F. Asiri	10/17/95
	J. Worden	10/17/95
MATERIAL NA	M. Coles	10/17/95
FINISH NA	A. Lazzarini	10/17/95

LIGO — CALIFORNIA INSTITUTE OF TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

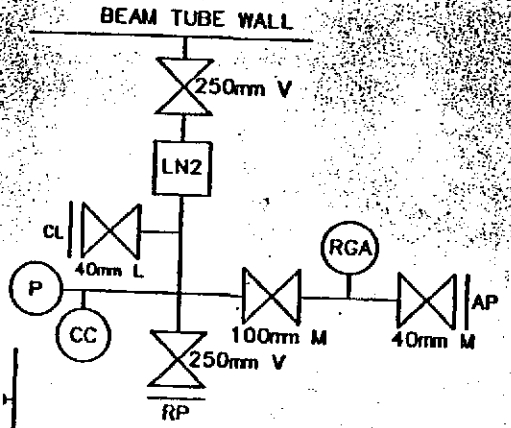
TITLE: LIGO ARM LAYOUTS

SIZE A3 | DWG NO. D950021

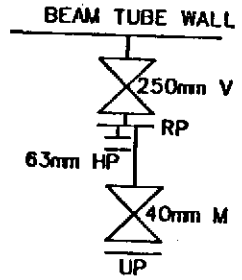
SCALE NTS | SHEET 1 of 1

PUMP PORT HARDWARE

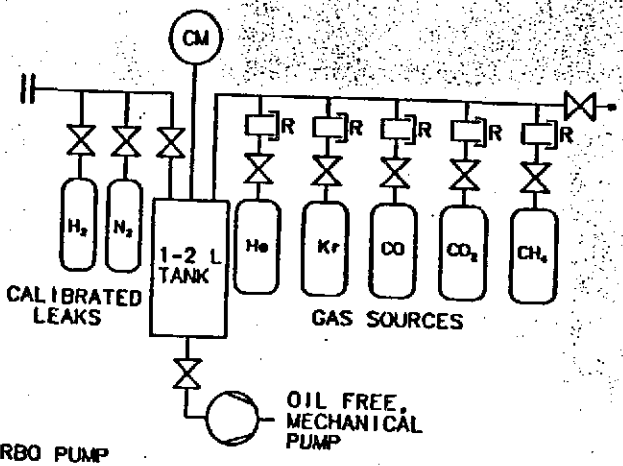
TYPE B: FOR PORTS DURING BAKE & LEAK CHECK
10 UNITS REQUIRED, INCLUDING 1 SPARE



TYPE H: FOR PORTS DURING HOLD (AFTER ACCEPTANCE, BEFORE OPERATION)
75 UNITS REQUIRED: 36 PER SITE, PLUS 3 SPARES



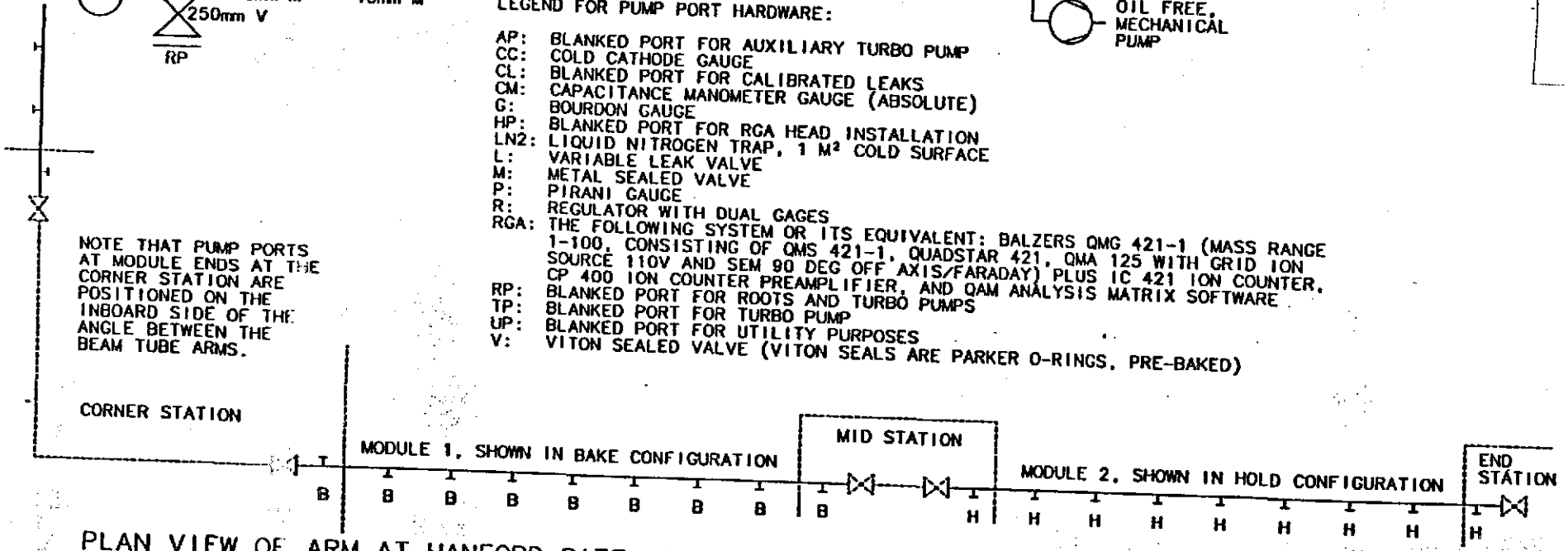
PORTABLE CALIBRATION MODULE



LEGEND FOR PUMP PORT HARDWARE:

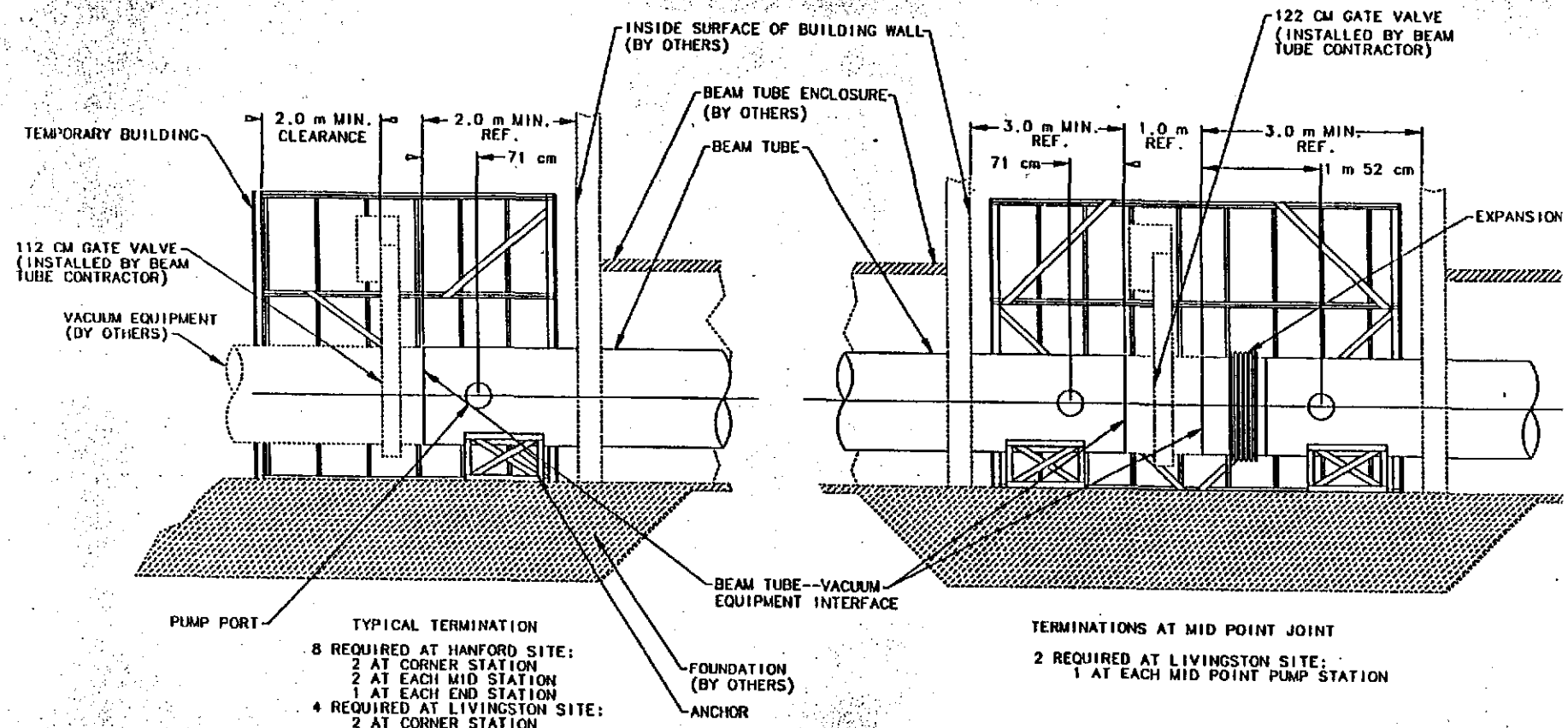
AP: BLANKED PORT FOR AUXILIARY TURBO PUMP
CC: COLD CATHODE GAUGE
CL: BLANKED PORT FOR CALIBRATED LEAKS
CM: CAPACITANCE MANOMETER GAUGE (ABSOLUTE)
G: BOURDON GAUGE
HP: BLANKED PORT FOR RGA HEAD INSTALLATION
LN2: LIQUID NITROGEN TRAP, 1 M^2 COLD SURFACE
L: VARIABLE LEAK VALVE
M: METAL SEALED VALVE
P: PIRANI GAUGE
R: REGULATOR WITH DUAL GAGES
RGA: THE FOLLOWING SYSTEM OR ITS EQUIVALENT: BALZERS QMG 421-1 (MASS RANGE 1-100, CONSISTING OF QMS 421-1, QUADSTAR 421, QMA 125 WITH GRID ION SOURCE 110V AND SEM 90 DEG OFF AXIS/FARADAY) PLUS IC 421 ION COUNTER, CP 400 ION COUNTER PREAMPLIFIER, AND QAM ANALYSIS MATRIX SOFTWARE
RP: BLANKED PORT FOR ROOTS AND TURBO PUMPS
TP: BLANKED PORT FOR TURBO PUMP
UP: BLANKED PORT FOR UTILITY PURPOSES
V: VITON SEALED VALVE (VITON SEALS ARE PARKER O-RINGS, PRE-BAKED)

NOTE THAT PUMP PORTS AT MODULE ENDS AT THE CORNER STATION ARE POSITIONED ON THE INBOARD SIDE OF THE ANGLE BETWEEN THE BEAM TUBE ARMS.



PLAN VIEW OF ARM AT HANFORD SITE, SHOWING TYPES OF HARDWARE AT EACH PUMP PORT

LIGO PROJECT
BEAM TUBE PUMP PORT HARDWARE
D950027-C-B
EDITION: 11/3/95


INSIDE SURFACE OF BUILDING WALL (BY OTHERS)
122 CM GATE VALVE (INSTALLED BY BEAM TUBE CONTRACTOR)
BEAM TUBE ENCLOSURE (BY OTHERS)
TEMPORARY BUILDING
2.0 m MIN. CLEARANCE
2.0 m MIN. REF.
71 cm
BEAM TUBE
3.0 m MIN. REF.
1.0 m REF.
3.0 m MIN. REF.
71 cm
1 m 52 cm
EXPANSION
112 CM GATE VALVE (INSTALLED BY BEAM TUBE CONTRACTOR)
VACUUM EQUIPMENT (BY OTHERS)
BEAM TUBE--VACUUM EQUIPMENT INTERFACE
PUMP PORT
FOUNDATION (BY OTHERS)
ANCHOR
TYPICAL TERMINATION
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
TERMINATIONS AT MID POINT JOINT
2 REQUIRED AT LIVINGSTON SITE:
1 AT EACH MID POINT PUMP STATION

EDITION 1

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.

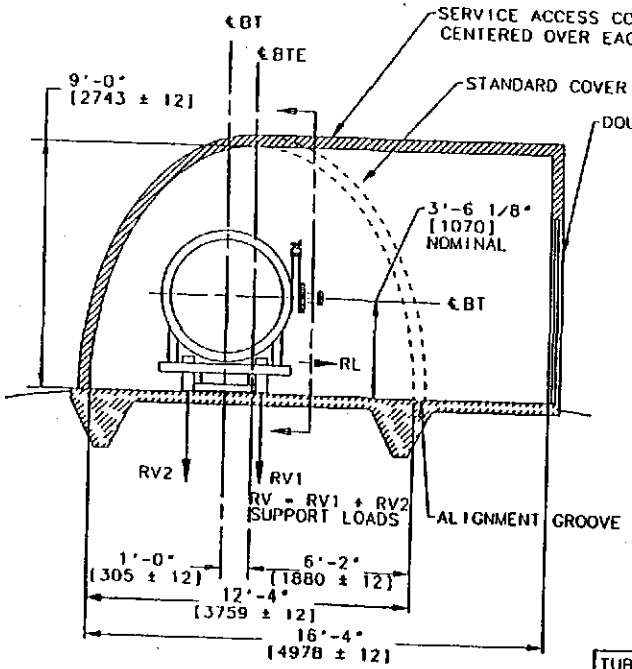
REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	Original		
B	English units, ICD note and tolerances added; Clarified loading point; Clarified loading point; Minor load corrections.		
C	Revised construction loads note. only effects sheet 1.		11/15/05

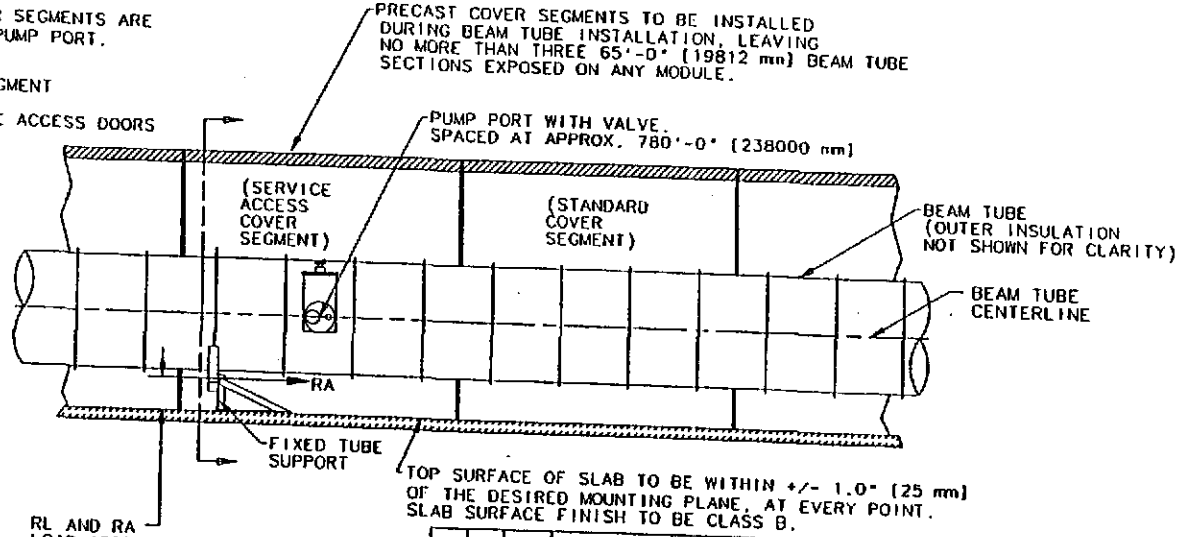
CATEGORIZATION OF ELEMENTS OF TUBE SUPPORT LOADS (kgf)

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	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN (in-lbs [mm]) TOLERANCES ARE: FRACTIONS DECIMALS X.X ± 0.5 X.XX ± 0.05 X.XXX ± 0.005 fi-le ± 0.5° DO NOT SCALE DRAWING

MATERIAL NA

FINISH NA

APPROVALS	DATE
DRAW D. Coyne	11/15/05
CHECKED L. Jones	11/15/05
F. Asiri	
M. Coles	
A. Lazzarini	
J. Worden	

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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.

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.

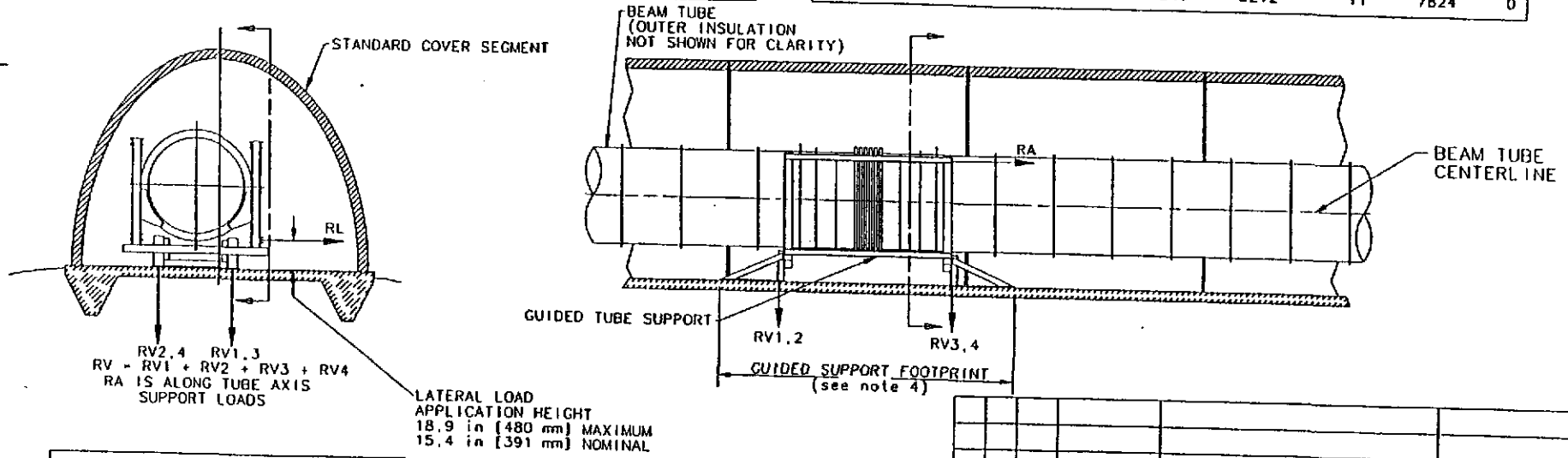
REV	DESCRIPTION OF CHANGE	SHEETS EFFECTED	APPROVAL	DATE
A	Original	ALL		
B	English units, ICD note and tolerances added; Clarified loading point; Clarified loading point; Minor load corrections.	ALL		
C	Revised construction loads note.	1		

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]

PARTS LIST

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

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	11/15/95
CHECKED	

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY

TITLE: GENERAL DETAILS AND FIXED SUPPORT DETAILS

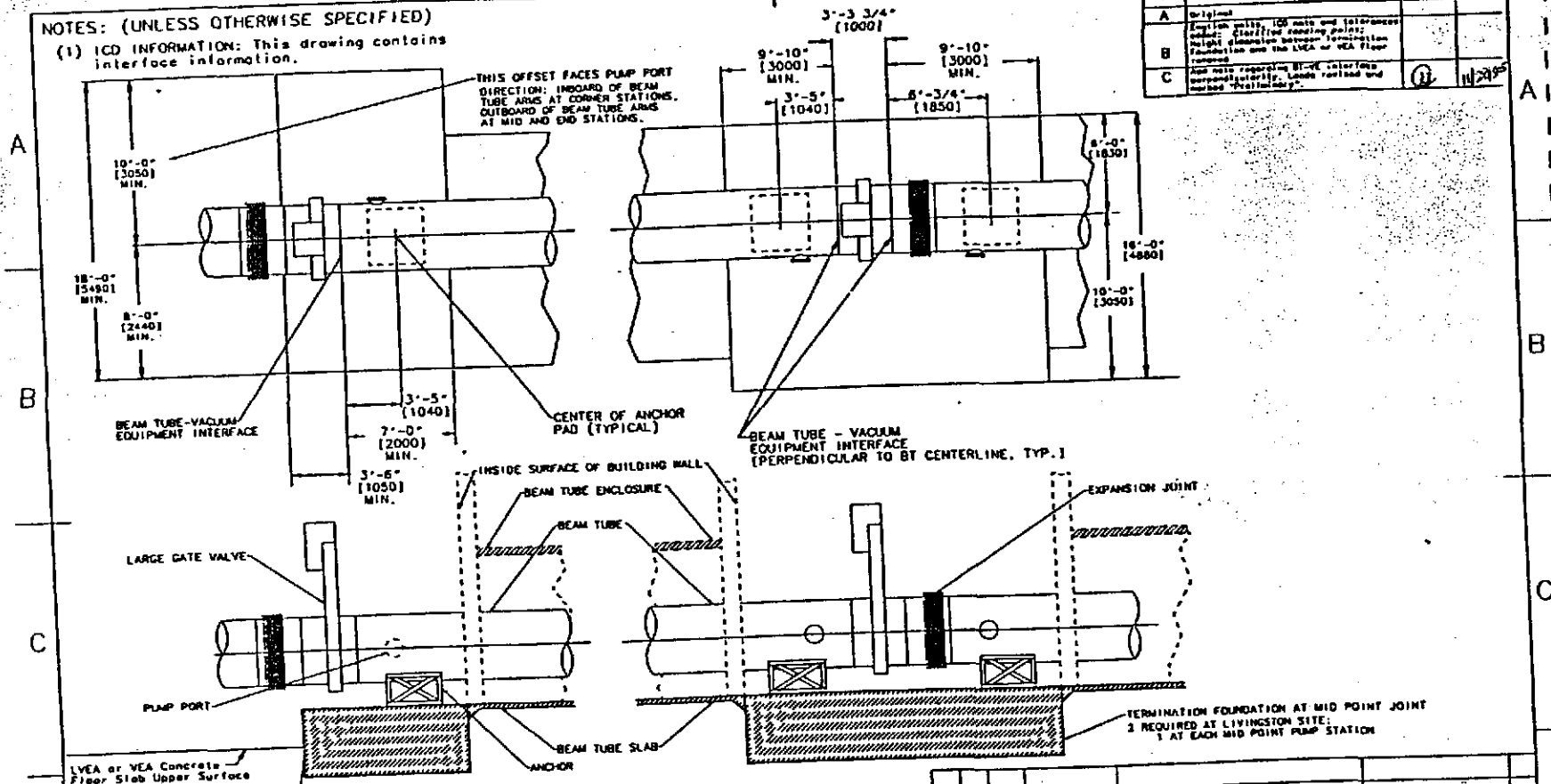
DWG NO. D950029 REV C

SCALE NTS SHEET 2 of 2

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	Original		
B	Equation using ICD main and interfaces added; Clarified coupling points; Height dimension between termination foundation and the LVEA or VEA floor removed.		
C	Add note requiring BT-VE interface personnel notify, Leads realized and marked "Preliminary".	(1)	11/29/95

NOTES: (UNLESS OTHERWISE SPECIFIED)

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



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	704
LATERAL	1400	0	0	694	0	0

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	3088	0	0	1534	0	1552

PARTS LIST

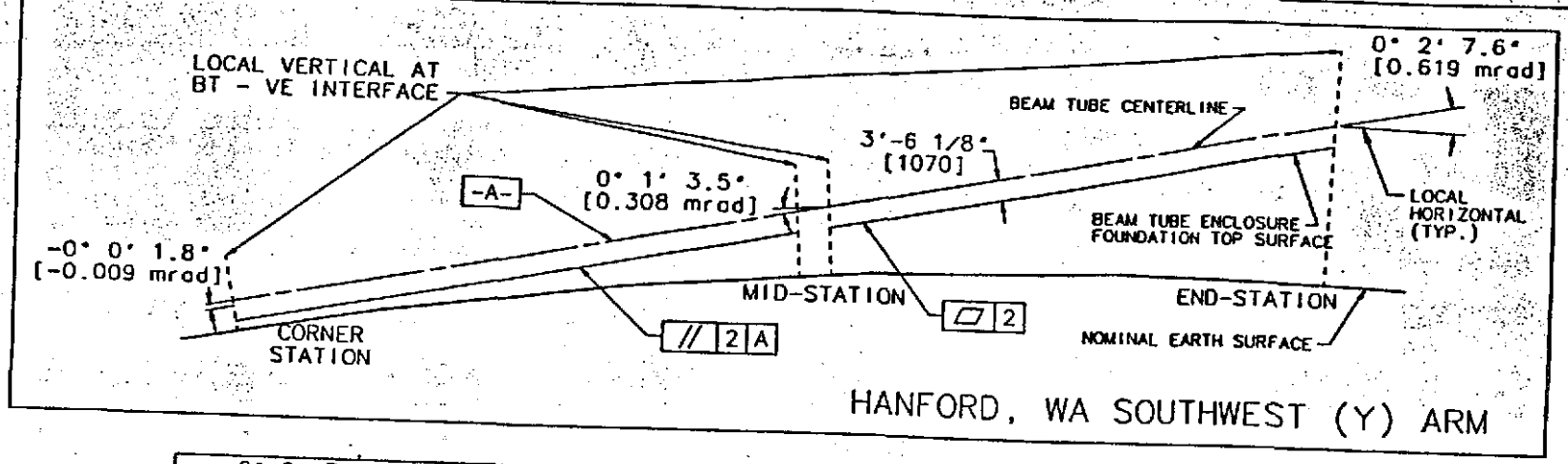
UNLESS OTHERWISE SPECIFIED	APPROVALS	DATE
DIMENSIONS ARE IN INCHES TOLERANCES ARE:	DRAWN C. Conley	11/27/95
fr. in. ± 0.5 in	CHECKED L. Jones	11/28/95
mm ± 13 mm	ENG APPR. F. Asiri	11/28/95
DO NOT SCALE DRAWING	MFG APPR. J. Worden	11/28/95
MATERIAL NA	PROJ SCI M. Coles	11/28/95
FINISH NA	QA A. Lamerial	11/28/95

TITLE	BEAM TUBE TERMINATION FOUNDATIONS
SIZE	D
DWG NO.	D950093
REV	C
SCALE	NTS
SHEET	1 of 1

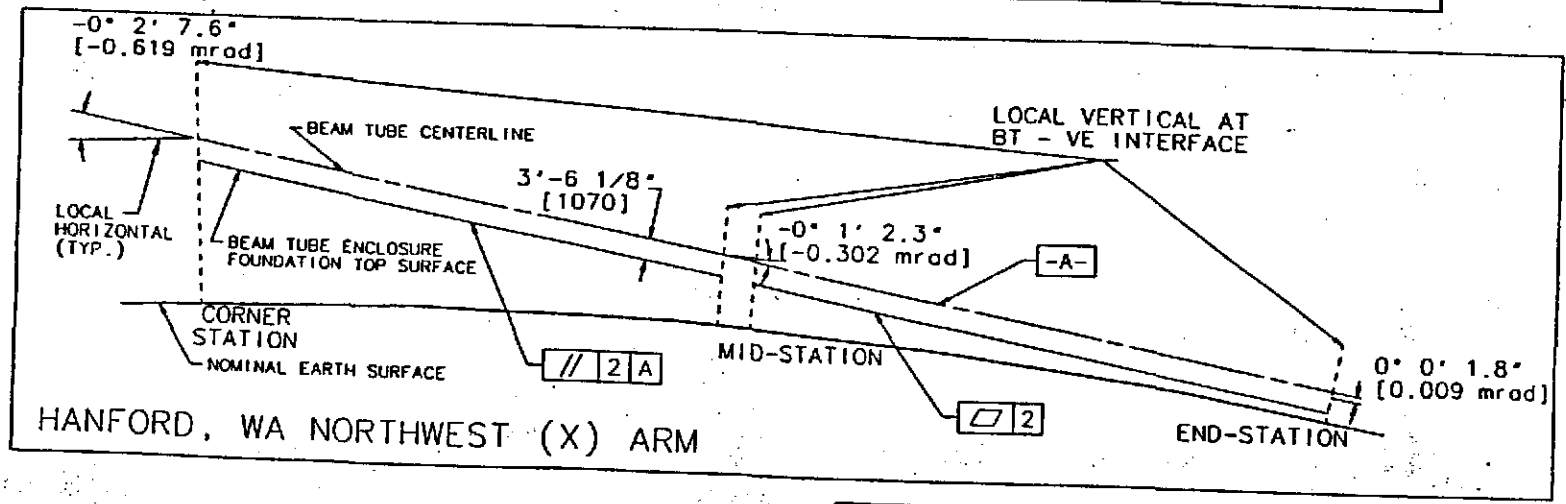
LIGO — CALIFORNIA INSTITUTE OF TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	ORIGINAL		



HANFORD, WA SOUTHWEST (Y) ARM



HANFORD, WA NORTHWEST (X) ARM

PARTS LIST

MATERIAL	NA
FINISH	NA
DO NOT SCALE DRAWING	

APPROVALS	DATE
DRAWN B. Corey	11/15/95
CHECKED K. Thorne	11/15/95
L. Jones	11/27/95
P. Adair	11/27/95
W. Cahn	11/28/95

LIGO — CALIFORNIA INSTITUTE OF TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

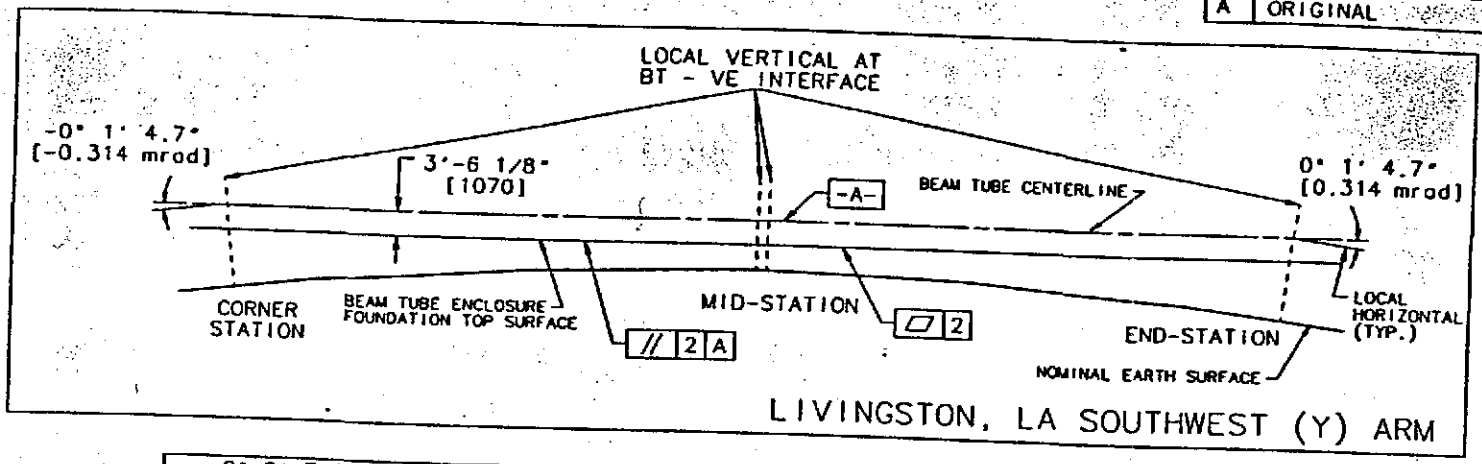
TITLE: ORIENTATION OF THE BEAM TUBE ENCLOSURE FOUNDATION WITH RESPECT TO THE LOCAL HORIZONTAL

DWG NO. D950140 REV A

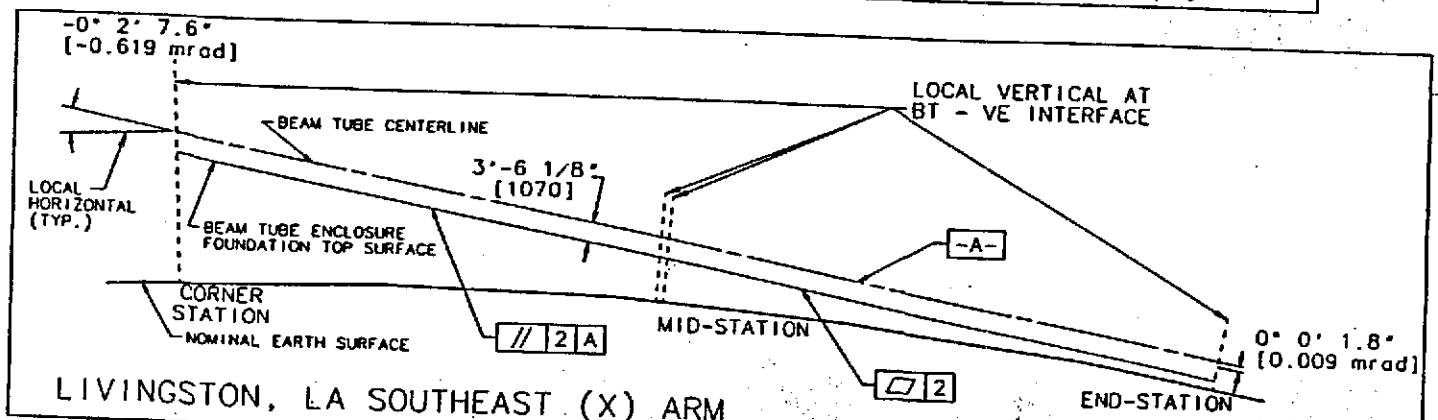
SCALE NTS SHEET 1 OF 2

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

REV	DESCRIPTION OF CHANGE	APPROVAL	DATE
A	ORIGINAL		11/25/95



LIVINGSTON, LA SOUTHWEST (Y) ARM



LIVINGSTON, LA SOUTHEAST (X) ARM

PARTS LIST

APPROVALS	DATE
C. Cantley	11/27/95
G. Labarrial	11/27/95
L. James	11/27/95
P. Astell	11/27/95
M. Coles	11/27/95

NA
NA

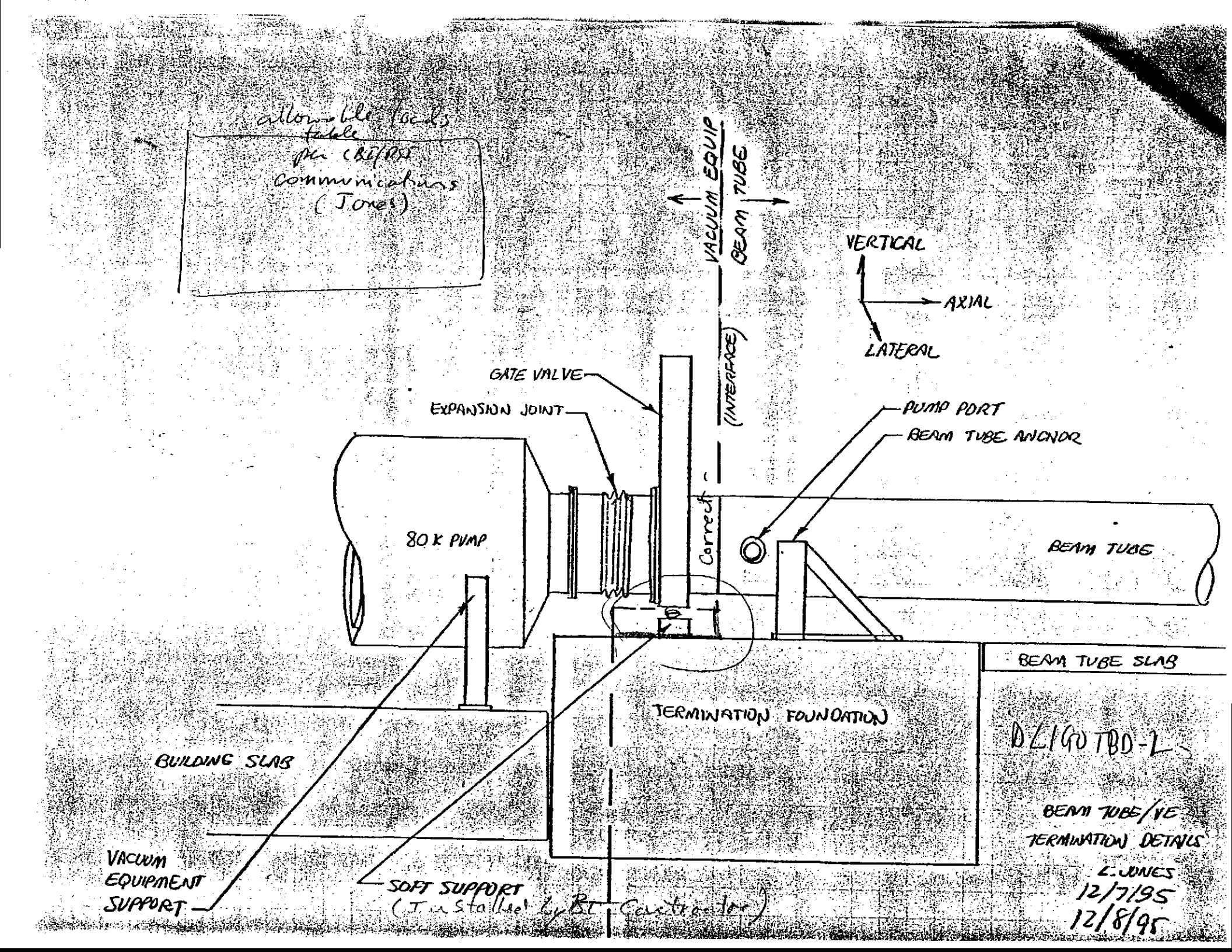
LIGO — CALIFORNIA INSTITUTE OF TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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

D950140 | REV A

SCALE NTS | SHEET 2 OF 2

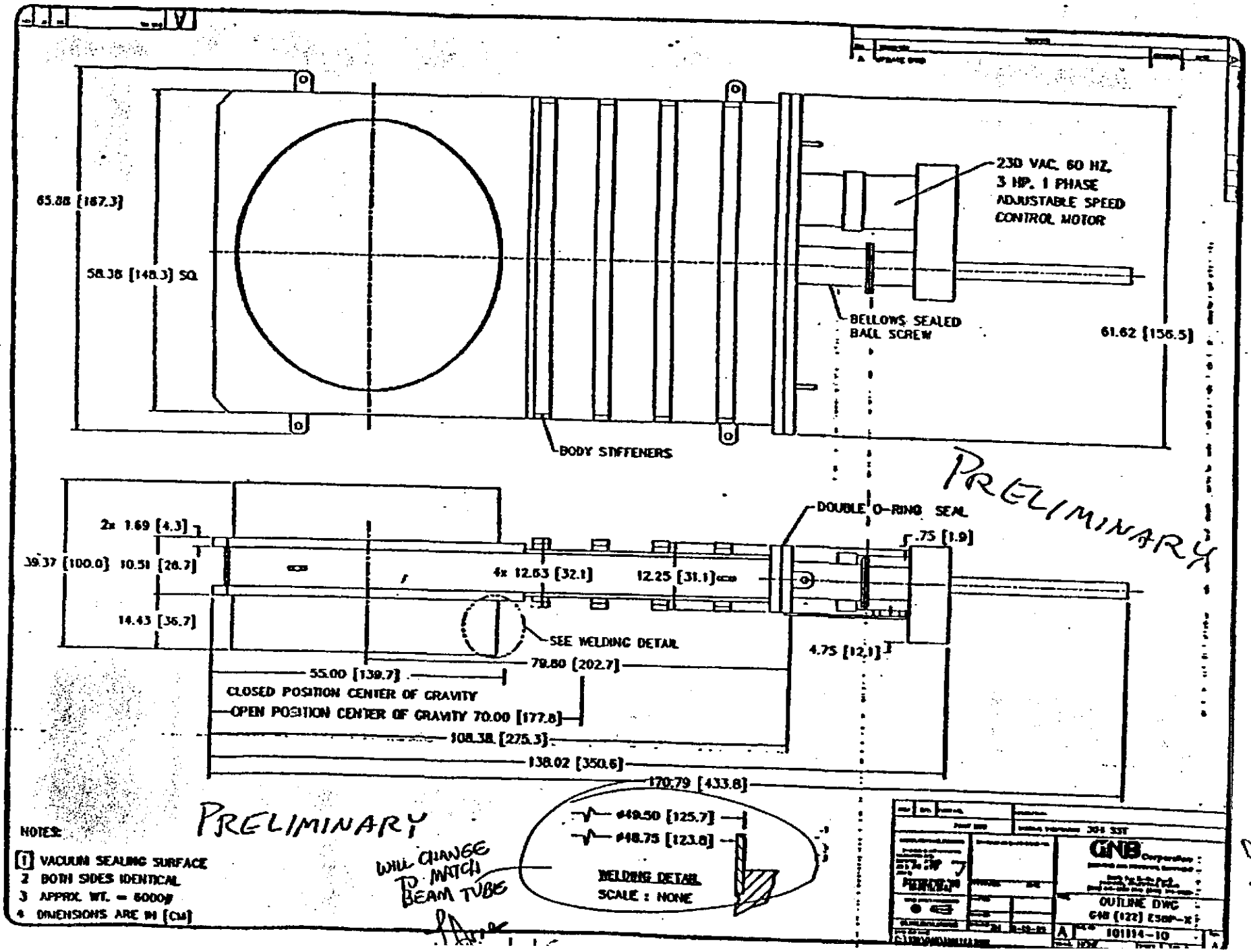
allowable loads table per (BE/RE) communications (Jones)

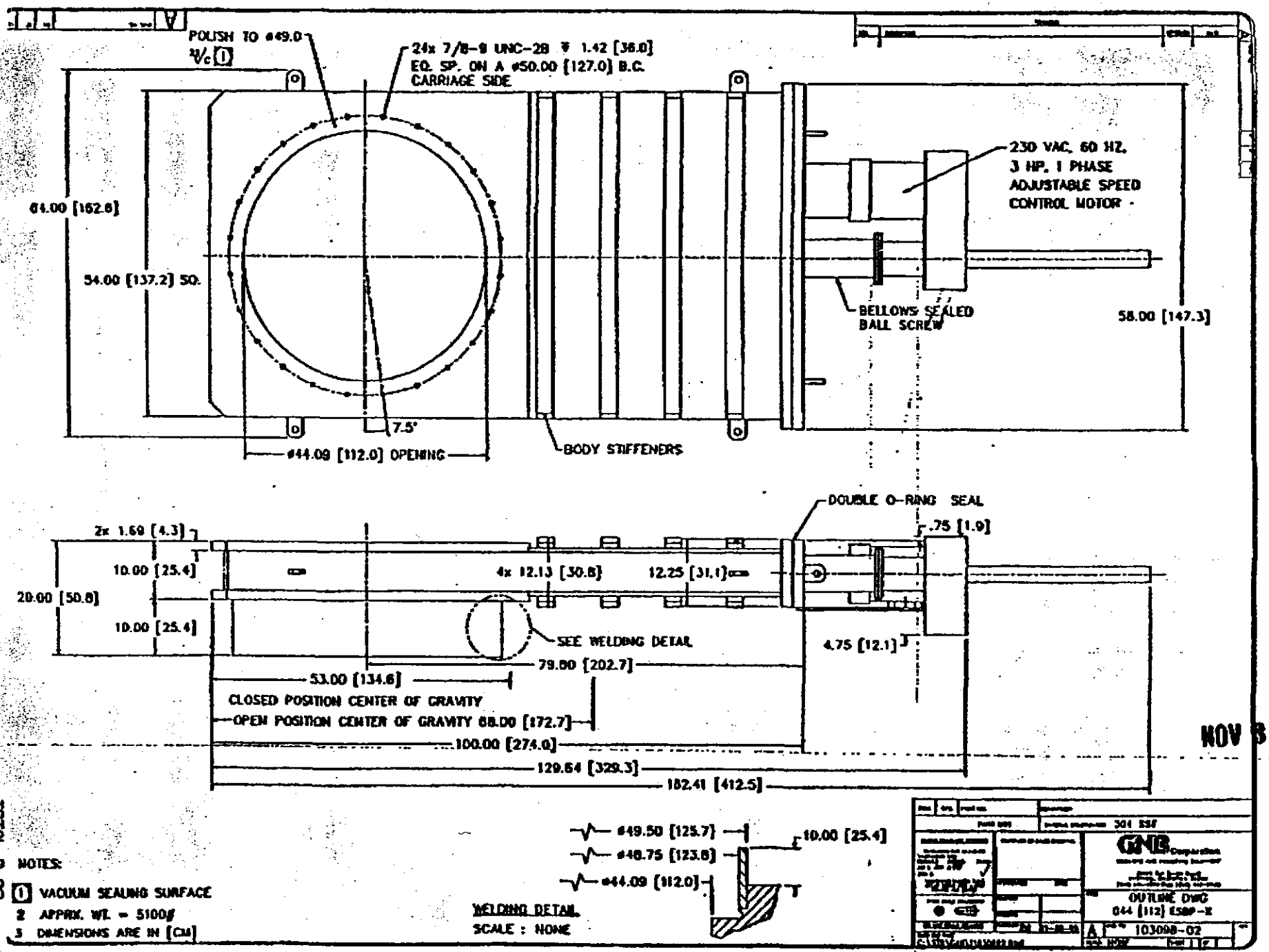


DLIGOTBD-L

BEAM TUBE/VE TERMINATION DETAILS

L. JONES
12/7/95
12/8/95


65.88 [167.3]
58.38 [148.3] SQ.
230 VAC, 60 HZ,
3 HP, 1 PHASE
ADJUSTABLE SPEED
CONTROL MOTOR
BELLOWS SEALED
BALL SCREW
61.62 [156.5]
BODY STIFFENERS
PRELIMINARY
2x 1.69 [4.3]
39.37 [100.0]
10.51 [26.7]
14.43 [36.7]
4x 12.63 [32.1]
12.25 [31.1]
DOUBLE O-RING SEAL
.75 [1.9]
4.75 [12.1]
SEE WELDING DETAIL
55.00 [139.7]
79.80 [202.7]
CLOSED POSITION CENTER OF GRAVITY
OPEN POSITION CENTER OF GRAVITY 70.00 [177.8]
108.38 [275.3]
138.02 [350.6]
170.79 [433.8]
PRELIMINARY
NOTES:
1 VACUUM SEALING SURFACE
2 BOTH SIDES IDENTICAL
3 APPROX WT. = 6000#
4 DIMENSIONS ARE IN [CM]
WILL CHANGE TO MATCH BEAM TUBE
ø49.50 [125.7]
ø48.75 [123.8]
WELDING DETAIL
SCALE : NONE
GNB Corporation
OUTLINE DWG
A
101114-10



NOV 8

TOTAL P.02

D-LIGO TBD-3