LIGO-E980315-00-V

PROCESS SYSTEMS INTERNATIONAL, INC.					ENGINEERING	NO: V049-1-190
WESTBOROUGH, MA					CALCULATIONS	PAGE 1 OF 10
REV	DEO#	DATE	BY:	CHECK	TITLE:	
0	631	10/23/98	JFC	ROC	**Design of LA Beam Tube Manway**	
					BY: F. J. Cordella	DEPT: 744
PROJECT: LIGO Vacuum Equipment					PROJECT NO: V59049	

PURPOSE: Perform design/analysis of proposed manway penetration in beam tube of the Louisiana right arm.

METHOD: Finite element analysis using the IMAGES computer program.

ASSUMPTIONS: All assumptions of linear elasticity are included.

INPUTS: 1. Design sketch, Dwg. V049-4-306 (Attachment 1).
2. Internal vacuum = 14.7 psi.

OCT 27 1998

REFERENCES: 1. V049-1-066 LIGO, Vacuum Equipment Structural Design Criteria.
2. V049-PL-594, Repair of LA Right Mid Beam Tube Valve.
3. R. L. Cloud & Assoc., IMAGES-3D, Ver. 3.0.
4. ASME B&PV Code, Section VIII, Pressure Vessels, Div. 2, Alternative Rules.

CALCULATIONS:

see Attachments

CONCLUSIONS:

The manway meets the requirements of References 1 & 4.

NOTES: IMAGES FILES
F:\HV\LIGO\IN\1\LIGO.* (7 FILES)

TABLE OF CONTENTS

REVISION HISTORY

Rev. 0	Original Issue – Oct. 1998

MANWAY CONFIGURATION

Attachment 1 (PSI Dwg. V049-4-306) shows the configuration of the proposed manway that will be installed in the beam tube.

MATERIALS

The manway nozzle and repad will be constructed of A240 Type 304L stainless steel plate. Stainless steel, SA403 WP304L, will be used for the nozzle cap. The design stress intensity for both of these materials is:

$$S_m = 15{,}800 \text{ psi at } 400\ ^\circ\text{F}$$

Ref. ASME Code, Section II, Part D, Table 2A.

FE MODEL

A finite element model was constructed using the IMAGES program. Plate elements with both bending and membrane capability were used. The model consisted of the 0.12 inch thick beam tube shell, the ½ inch thick repad, nozzle, cap, and stiffeners. The model was sufficiently long to exclude the boundary condition effects at the areas of interest.

Model Boundary Conditions

The ends of the model are at circular sections of the beam tube. Nodes at the end near the adjacent gate valve were unrestrained while the other end of the model was fixed.

LOAD

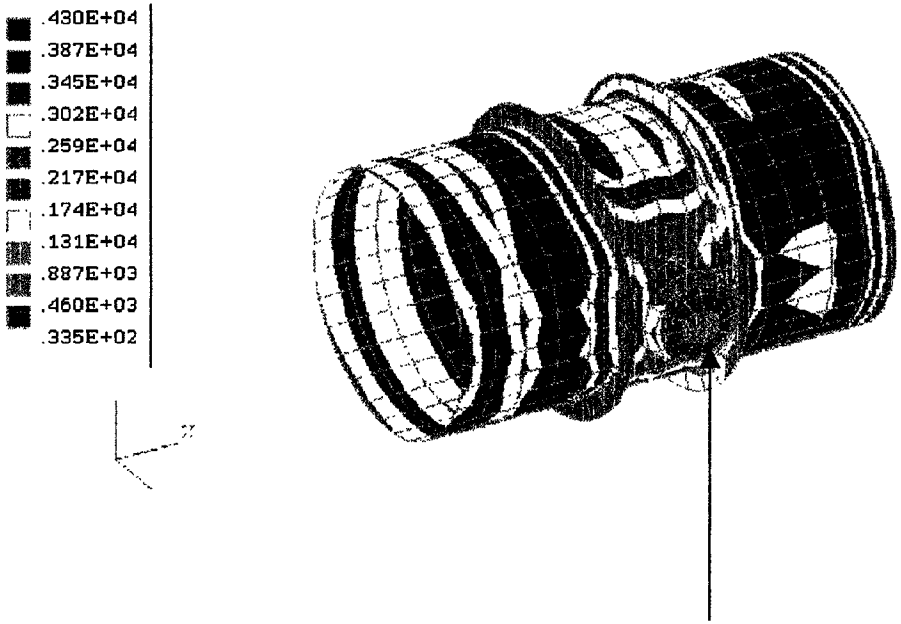
Full vacuum (15 psi external pressure) was applied to the model. Nodal forces were applied to the circular end of the model near the adjacent gate valve to simulate the unbalanced vacuum load that results when the adjacent valve is closed and the other side is vented to atmosphere.

RESULTS

The contour plots on the following 2 sheets show resulting stress intensities for the vacuum load described above.

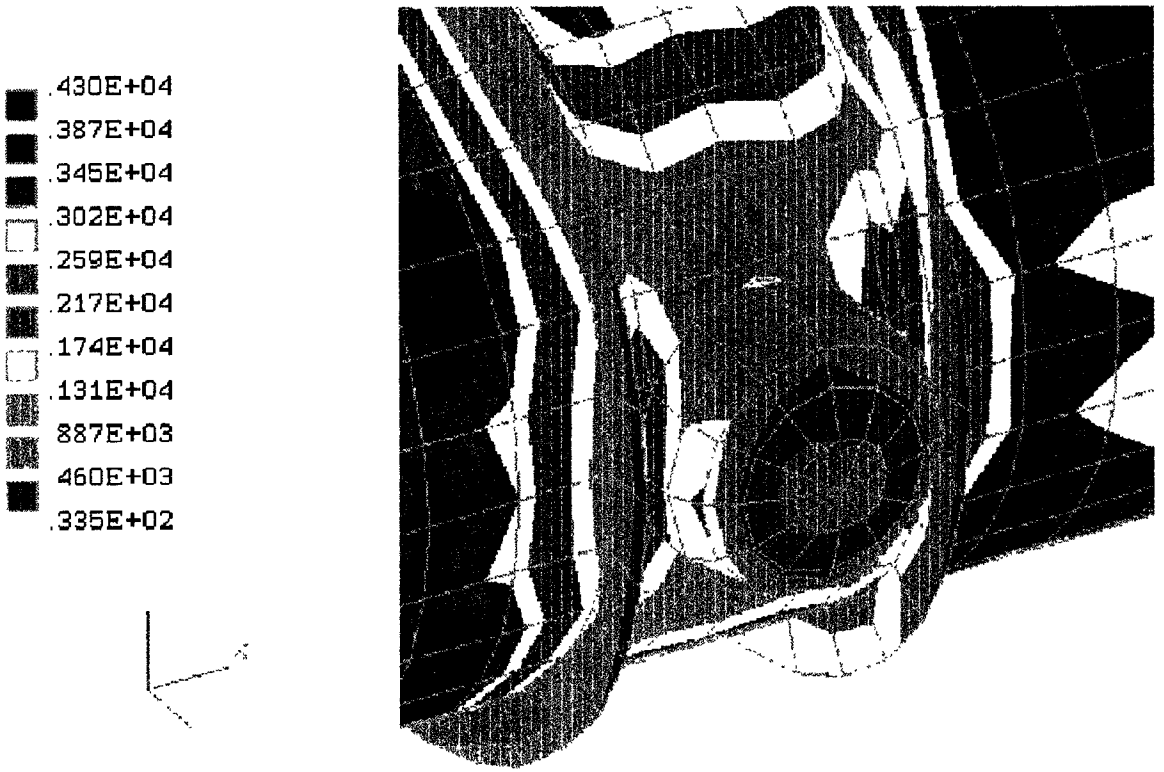
LIGO BEAM TUBE
PROPOSED MANWAY @ LA MID-POINT
FINITE ELEMENT ANALYSIS

- **Max. Stress Intensity = 4,300 psi for combined vacuum + un-balanced pressure loading.**
- **Allowable stress intensity (Sm) = 15,800 psi @ 400 deg. F.**



Proposed Manway with Reinforcing

LIGO BEAM TUBE
PROPOSED MANWAY @ LA MID-POINT
FINITE ELEMENT ANALYSIS



Enlarged view of Manway area.

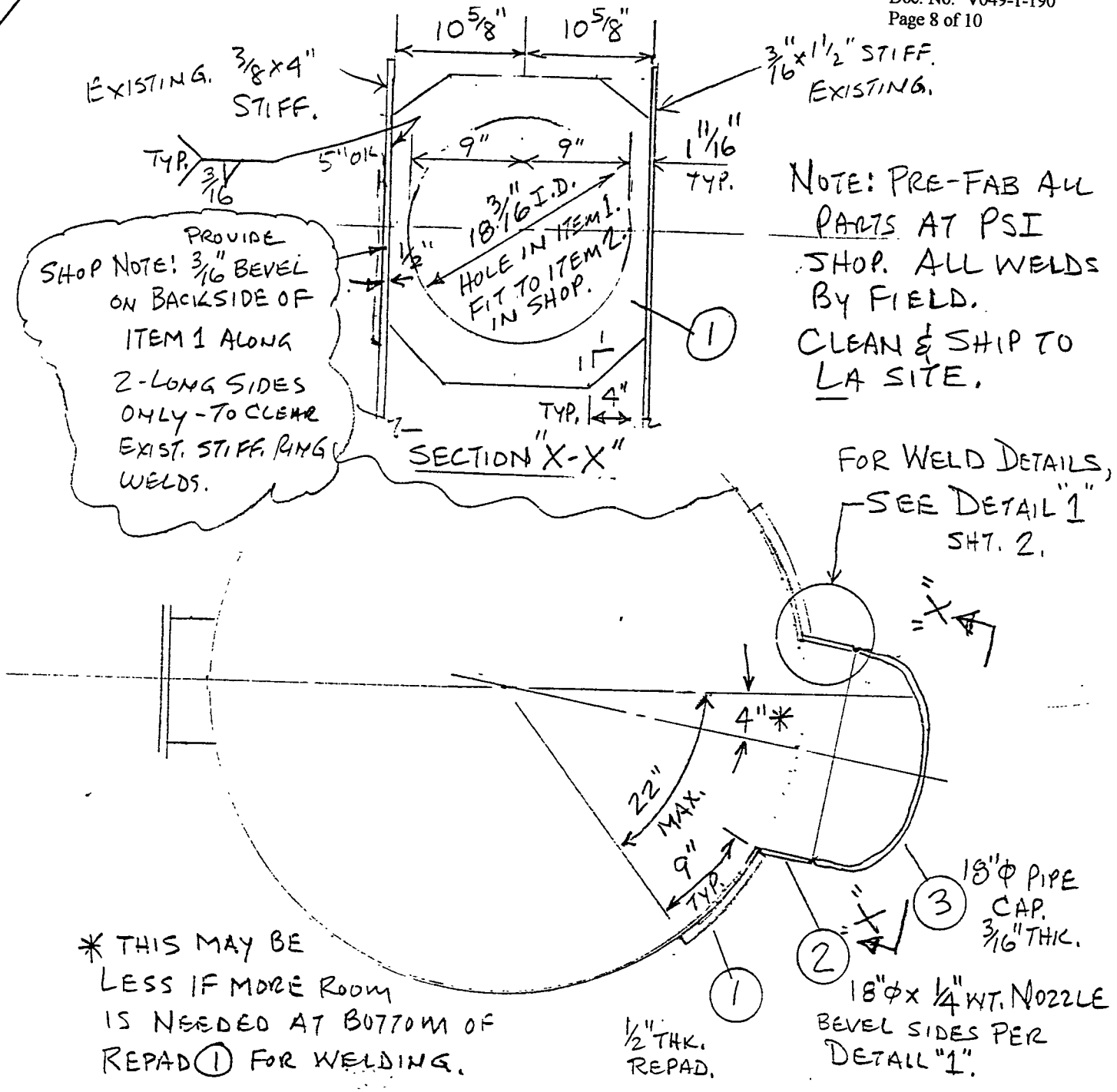
EVALUATION

The maximum stress intensity from the FE model is very low, 4300 psi. It includes secondary membrane plus bending stress and it would be compared to $3S_m$. To be conservative, this stress intensity will be compared to the allowable stress intensity for primary general membrane stress, Sm.

$$P_m = 4300 < S_m = 15800 \text{ psi @ } 400\ ^\circ F$$

$\therefore$ The manway meets the code design requirements.

Ref. ASME Code, Section VIII, Div. 2, Appendix 4, Fig. 4-130.1.

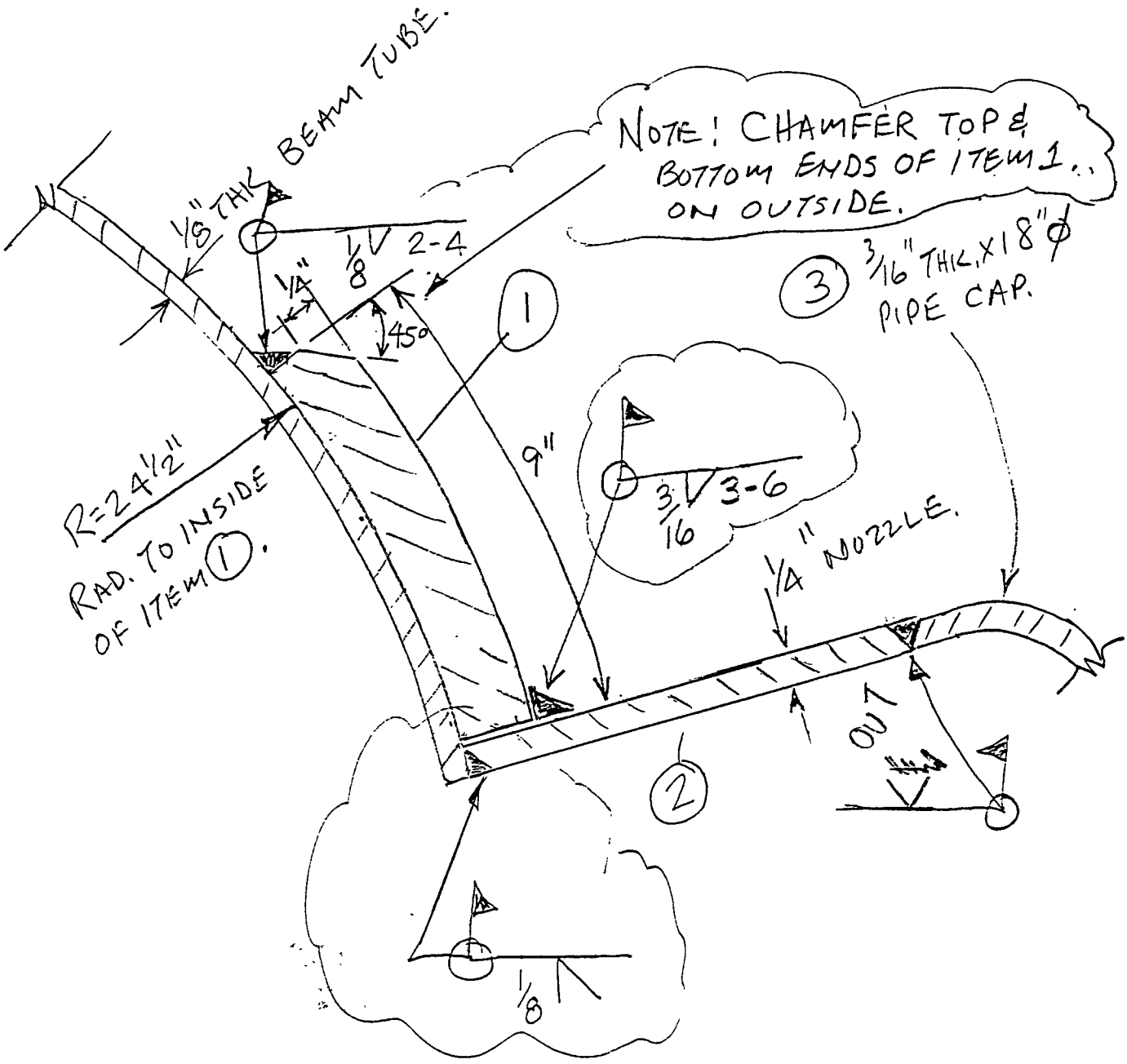


ELEV. LOOKING TOWARD VERTEX.

ITEM	PART NO.	QTY.	DESCRIPTION.
1	V049P7801-1	1EA.	PLATE, SST, A240 TP304L, 1/2" x 21 1/4" x 37" CMTRS. ROLL LONG DIM. TO 24 1/2" INSIDE RADIUS.
2.	V049P7802-1	1EA.	SHELL, SST, A240 TP304L, 1/4" x 56 3/16" CMTRS ROLL TO 175/8 "I.D., BEVEL SEAM ENDS.
3.	C132001-18-1	1EA.	CAP, SST. A403 WP304L, 18" DIA, SCH. 10S (3/16") CMTRS.

LIGO LA SITE 18" BEAMTUBE MANWAY - RIGHT. MID JT.

DRN. R. Curtis 2SEPT.98 PSI DWG. V049-4-306 SHT. 1 OF 2 REV. 0



DETAIL "1"

2 SEPT. 98 PSI DWG. V049-4-306 REV.=0 SHT. 2 OF 2

BILL OF MATERIALS

Attachment 1 cont.

PROCESS SYSTEMS INTERNATIONAL, INC.
20 WALKUP DRIVE, WESTBORO, MA 01581

PREP. R.E.C. CHK'D R.E.C.
ENGR. _____ MFG. _____
Q.C. _____
PRJ MG _____

PARENT #: V0494306 BEAM TUBE MANWAY,18",LA SITE MIDJOINT

DEO #:000627 REV: 0 REV DATE: 1998/09/02

ITEM	PART NUMBER	DESCRIPTION	U/M	QTY	P/M
1	V049P7801 1	PLATE,A240 304L CMTR,1/2" X 21-1/4"X37" ROLL LONG DIM TO 24-1/2" INSIDE RAD MANUFACTURER'S MATERIAL TEST REPORT REQUIRED	EA	1.00	P
2	V049P7802 1	SHELL,A240 304L CMTR,1/4" X 5" X 56-3/16" ROLL TO 17-5/8"ID BEVEL SEAM ENDS MANUFACTURER'S MATERIAL TEST REPORT REQUIRED	EA	1.00	P
3	C132001-18 1	CAP,SA403 WP304L CMTR, WPW, 18" SCH 10S, MANUFACTURER'S MATERIAL TEST REPORT REQUIRED	EA	1.00	P
500	AV0494306	DWG,BEAM TUBE MANWAY,18",LA SITE MIDJOINT,REV 0,DEO 000627	EA	1.00	M

END OF REPORT