Fermilab

Particle Physics Division
Mechanical Department Engineering Note

Number: MD-ENG - 063 Date: 1 November 2004

Project Internal Reference: WBS 1.1.7

Project: NuMI, (Project 200)

Title: Carrier Tunnel 12" beam pipe vacuum vessel calculations

Author(s): Dave Pushka

Reviewer(s): Ang Lee (11-3-04)

Key Words: Vacuum Vessel Calculation, FESHM 5033

Abstract Summary: Simple calculations to show that the 12 inch beam pipe is safe from mechanical failure due to vacuum loading.

Applicable Codes: FESHM 5033, AISC 9th ed, TM 1378, TM 1377

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
		NuMI		

SUBJECT: Carrier Pipe Vacuum Vsl Calcs.

NAME: Dave Pushka

DATE: 11/1/04

REVISION DATE:

Ref. TM-1378

NuMI Carrier Tunnel vacuum pipe.

A312 TP 304L 12" SCH 10S, I.D. = 12.390

I.D. > 12" ∴ Vacuum Note Req'd.

$t_{WALL} = 0.180"$

$t_{REQ'D} = 0.093$ From TM-1378 Chart

$t_{WALL} > t_{REQ'D}$ ∴ OK

Supports - Pipe is supported every 12 feet. Per TM-1377, Req'd spacing for steel pipe, 12"Ø, an 1/16" deflection is every 36 feet, Deflection criteria is more sever than stress criteria. ∴ Pipe is more than adequately supt'd.

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Axial Load: $(15\ psi) \cdot 120.57\ in^2 = 1808.55\ \#$

Metal Area $= 7.11\ in^2$

$$\sigma_{Axial} = \frac{1808}{7.11} = 254\ psi$$

$L \doteq 220$ ft.

Braced every 12'

$$r = \frac{\sqrt{12.75^2 + 12.390^2}}{4} = 4.4446\ in$$

$$\frac{kl}{r} = \frac{(2.0)(12') \cdot {}^{12\ in}/_{1\ ft}}{4.4446\ in} = 64.7$$

From AISC 9th Ed, pg 3-16 for 36 ksi steel

$\frac{kl}{r} = 65$, $F_a = 16.94$ ksi

$\sigma_{Axial} = 254\ psi \ll F_a = 16{,}940\ psi \therefore$ OK

Pipe will not buckle from axial compression

EXHIBIT A-1

Vacuum Vessel Engineering Note
(per Fermilab ES&H Manual Chapter 5033)

Prepared by	Dave Pushka	Date	November 2004	Div/Sec	PPD/MSD/ME
Reviewed by	Ang Lee	Date	11/18/04	Div/Sec	PPD/MSD
Div/Sec Head		Date		Div/Sec	

1. Identification and Verification of Compliance

Fill in the Fermilab Engineering Conformance Label information below:

This vessel conforms to Fermilab ES&H Manual Chapter 5033

Vessel Title	NuMI Carrier Tunnel Beam Pipe
Vessel Number	Not applicable
Vessel Drawing Number	FESS Drawing No. 6-7-6 Sheet PP3
Internal MAWP	No internal MAWP assigned (only used for vacuum)
External MAWP	Full Vacuum
Working Temperature Range	20 °F 200 °F
Design/Manufacturer	Not applicable
Date of Manufacture	2003
Acceptance Date	November 2004

Director's signature (or designee) if vessel is for manned area and requires an exception to the provisions of this chapter.

_____

Amendment No.	Reviewed by:	Date:

Laboratory location code	NuMI Carrier Tunnel
Laboratory property number	No property number assigned
Purpose of vessel	Beamline vacuum

List all pertinent drawings

Drawing No.	Location of Original
FESS Drawing No. 6-7-6 Sheet PP3	FESS archives

2. Design Verification

Provide design calculations in the Note Appendix.

3. System Venting Verification

Can this vessel be pressurized either internally or externally? [ ] Yes [X] No
If "Yes", to what pressure? _____

List all reliefs and settings. Provide a schematic of the relief system components and appropriate calculations or test results to prove that the vessel will not be subjected to pressures greater than 110% beyond the maximum allowable internal or external pressure.

Manufacturer	**Relief**	**Pressure Setting**	**Flow Rate**	**Size**
No relief valves are installed or needed as there is no means of pressurizing this vessel				

4. Operating Procedure Section

Is an operating procedure necessary for the safe operation of this vessel?
[ ] Yes [X] No *(If "Yes", it must be appended)*

Is a testing procedure necessary for the safe acceptance testing (acceptance testing) of this vessel?
[ ] Yes [X] No
If "Yes", the written procedure must be approved by the division head prior to testing and supplied with this Engineering Note.

5. Welding Information

Has the vessel been fabricated in a Fermilab shop? [ ] Yes [X] No
If "Yes," append a copy of the welding shop statement of welder qualification.

6. Exceptional, Existing, Used and Non-Manned Area Vessels

Is this vessel or any part thereof in the above categories? [ ]Yes [X] No
If "Yes" follow the Engineering Note requirements for documentation and append to note.