

Split Quad Testing & Costs



2 March 2010

J Kerby

SLAC Test Stand

- Present on site at FNAL
- Reservations on status of safety documentation and any possibility to put in service
- Reservations on investment of people w/ respect to other programs at Fermilab
- Investigating new, joint cryostat w/ mu2e

The vacuum vessel is probably exempt by volume

however....we still have to demonstrate system safety, including device documents....(and complete an internal pressure vessel)

VACUUM VESSEL SAFETY

INTRODUCTION

Vacuum vessels, including evacuated chambers and insulating jackets on dewars, pose a potential hazard to equipment and personnel from collapse, rupture, or implosion. This chapter specifies the procedure to be followed in designing, fabricating, testing, and operating vacuum vessels in order to reduce hazards.

All vessels within the scope of this chapter shall have a written Engineering Note, as described in this chapter.

SCOPE

This chapter applies to any vacuum vessel used at Fermilab except:

1. Any vacuum vessel whose inside diameter or cross section diagonal is under twelve inches with no limitation of length.
2. Any portions of beam pipes buried underground.
3. Any vessel with a volumetric capacity of less than 35 cubic feet.
4. Any vessel under external pressure whose product $P \times V$ is less than 515 (psi) (cu. ft.), where P is the external differential MAWP and V is the volumetric capacity.
5. Thin vacuum windows for beam lines are specifically excluded from this chapter, and are covered under FESHM Chapter 5033.1.

DEFINITIONS

The Code -ASME Boiler and Pressure Vessel Code, Section VIII, Divisions 1 and 2. The revision of the Code to be applied to a given vessel is the latest revision at the start of the vessel's design.

Vacuum Vessel - any vessel having atmospheric pressure outside the vessel and a pressure less than atmospheric inside the vessel, or any vessel which is operated with a differential pressure greater on the outside than on the inside, except those operating under an external pressure greater than one atmosphere, which are covered under FESHM Chapter 5031.

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As far as I can tell (so far), no engineering note or equivalent exists. We will have to remake it. There are some design calculations in the log book.

Engineering Note - a written analysis demonstrating that a given vessel satisfies the requirements of this chapter.

Qualified Person - a person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter.

External Design Pressure - The external design pressure or maximum allowable external working pressure (MAWP) shall be greater than or equal to the maximum expected operating pressure differential. Reference ASME Code, Section VIII, Div. 1 Part UG28(e)

Volumetric Capacity - the internal vacuum volume of the vessel. (Does not include volume occupied by pipes, valves, instruments, or other objects.)

SPECIAL RESPONSIBILITIES

The division/section head who controls the area of operation of the vessel is responsible for carrying out the requirements of this chapter. The Division/Section Head, or designee, shall arrange for the review of required Engineering Notes by a qualified persons and shall certify vessels comply with this chapter by signing the Engineering Notes. The Division/Section Heads shall maintain an open, updated file on all vacuum vessels within the scope of this chapter located in their areas of operation. After certification, the Fermilab engineering standard conformance label shall be attached to the vessel. The original Engineering Note shall be placed into the Laboratory Vacuum Vessel master file maintained by the ES&H Section.

The ES&H Section shall audit the divisions and sections on their compliance to this chapter.

The Mechanical Safety Subcommittee (MSS) and/or Cryogenic Safety Subcommittee (CSS) shall serve the division/section heads and ES&H Section in a consulting capacity on all vacuum vessel matters. These committees may propose appropriate modifications to this chapter as necessary. Changes in policy and responsibility shall be recommended by the Laboratory Safety Committee after consulting with the division/section heads. Changes in procedure shall be recommended by the Mechanical Safety Subcommittee and/or Cryogenic Safety Subcommittee.

TECHNICAL APPENDIX TO VACUUM VESSEL SAFETY

PROCEDURES AND REQUIREMENTS FOR DESIGN, FABRICATION, INSPECTION, AND TEST

1. Purchased Vessels: All vacuum vessels purchased by Fermilab or its experimenters shall be made (designed and fabricated) in accordance with the "Procedure" section of Chapter 5033.
2. In-House Built Vessels: All vacuum vessels built at Fermilab or experimenter's shops shall be made (designed and fabricated) in accordance with the "Procedure" section of Chapter 5033.
3. Vessels with Thin Windows: If the thin windows can be detached from the vessel, the vessel falls within the scope of this chapter and shall be made (designed and fabricated) in accordance with the "Procedure" section of Chapter 5033. For testing, a cover plate shall be substituted for each thin window.

A vacuum vessel with a thin window that cannot be detached is covered by this chapter, but only the vessel itself, not the thin window. The thin window is covered under Chapter 5033.1 for thin windows. For testing of such a vessel, the maximum allowable differential pressure of the thin window shall not be exceeded, and the vessel shall be rated at that pressure.

4. Welding Information: Welding shall be done using qualified weld procedures and welders under the rules of the ASME Boiler and Pressure Code, Section IX. The Weld Procedure Specification (WPS), Procedure Qualification Record (PQR), and Welder Performance Qualification (WPQ) shall be attached to the Engineering Note.

Code-stamped vessels do not require welding documentation.

5. Existing Vessels In Service: All such vessels in service need an Engineering Note.
6. Used Vessels: Used Vessels shall be classified as an existing vessel and will have their previous service taken into account during the review process. Questionable vessels or those with unknown histories shall be re-tested per the "Inspection and Testing" section of this chapter.

Obtain a vessel identification number from the division or section safety officer. Describe the vessel, its purpose, site location, and how the maximum allowable working pressure (MAWP), internal or external, was established.

All drawings deemed pertinent to the safety review shall be listed and included. Include in the note a copy of the information on the engineering standard conformance label.

2. Design Verification

Provide the design calculations. For externally manufactured vessels, a copy of their design calculations is acceptable.

3. System Relief Verification

When relief devices are included in the design, provide a schematic of the vacuum vessel relief system and appropriate calculations or test results to prove that the vacuum vessel will not be subject to pressures over its calculated MAWP or under its maximum external differential pressure. (Note: If the MAWP is greater than 15 psi, a FESHM Chapter 5031 Engineering Note is required.) Prove that the relief valve(s) cannot be isolated from the vacuum vessel except as allowed by ASME Code (Reference Sec. VIII Div. 1 Appendix M and Div. 2 Appendix A). The relief calculation shall take in account a failure of any piping or vessel inside the vacuum vessel, and shall be sized according to the maximum system flow rate of that piping, and/or a reasonably expected leak rate from the inner vessel.

4. Operating Procedures

Provide cautions and operating procedures for the vessel if required for safe operation.

5. Welding Information

Attach the required welding records. Code-stamped vessels do not require welding records.

6. Extended Engineering Note for Exceptional Vessels:

The Note shall be prepared using the same or similar format as noted on Exhibit A-1, but in addition shall include the following information.

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Fabrication records essentially do not exist.

- a. *Reason for Exception:* Division/Section Head or designee shall provide a statement showing the necessity of a Director's Exception.
- b. *Analysis/Collapse Test:* The system designer shall provide a stress/collapse analysis of all exceptional parts of the vessel. Include data, formula or test results that demonstrate the anticipated safety factor. Source of information shall be referenced.
- c. *Fabrication:* The system designer shall provide a fabrication procedure, a list of planned and completed inspections and any other quality control procedures taken.
- d. *Hazard Analysis:* The system designer shall provide a description of personnel hazards associated with vessel operation and the methods used for protection. The hazard analysis shall address vessel application, operating limits and controls, possible effects in the event of vessel failure and inherent safeguards provided.
- e. *Acceptance Test:* An acceptance test shall be performed per this chapter.

Engineering Note for Existing Vessels, Used Vessels and Non-manned Area Vessels

The division/section head or his designee shall provide a written record of the decisions, judgments, tests, administrative controls and hazard analysis that were necessary to approve these types of vessels under this chapter.

In the event that the Engineering Note cannot be approved, operation shall be discontinued until appropriate modifications or administrative safeguards are instituted, or Director's Exception is granted.

DESIGN REFERENCE DATA BY TM NUMBER AND SUBCATEGORY

A Design Chart for Long Vacuum Pipes and Shells TM-1378 (SCN 0121.585).
Design Charts for Spacing of Vacuum Line Supports TM-1377 (SCN 0121.585).
Design Charts for Vacuum Plates TM-1052 Rev A. (SCN 5540.100).

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In short, as of right now I think a lot of effort will be expended with not much chance of success. I will meet with the head of the safety committee later this week to have my view better informed.

Testing

- ❑ The Magnet Systems Department has started a functional specification for a joint mu2e / split quad test cryostat.
- ❑ Assuming a decision is made in the order of a month from now it might be brought online early next year.
- ❑ It would serve both projects (throughput is not that high), conserve floorspace, and be more efficient w/ respect to test staff resources
- ❑ We are also reviewing to see that it would serve the measurement needs of the split quad program better than the SLAC cryostat.

Testing

- In the short term we propose the first test in VMTF
- In the new year the new test stand will be in place
- ILC would share costs w/ mu2e
- More detailed cost information would exist in the next couple of months

Schedule / Costs

1	Splittable Quadrupole Labor and M&S					
2						
3	Labor, FTE	Mng.	Eng.	Designer	Tech.	Total,FTE
4	SHGQ01 design/fabrication FY09	0.05	0.2	0.5	0.5	1.25
5	SHGQ02 design/fabrication FY10	0.05	0.1	0.2	0.5	0.85
6	SLAC stand relocation FY09	0.1	0.2	0.2	1	1.5
7	Horizontal Stand upgrade FY09	0.1	0.2	0.2	0.5	1
8	Stand X upgrade FY10	0.1	0.3	0.5	0.5	1.4
9	Total, FTE	0.4	1	1.6	3	6
10						
11	Items M&S Cost	FY2009	FY2010			
12	SHGQ01 parts	30				
13	SHGQ02 parts	20				
14	SLAC stand relocation to MTF Stand X	30				
15	NML Horizontal Stand upgrade	20				
16	MTF Stand X upgrade		100			
17	(new cryostat for conduction cooled magnets)					
18	Total cost	100	100			

Schedule / Costs

Labor, FTE	Mng	Eng	Des	Tech		
SHGQ01 design / fab FY10		0.05	0.2	0.5	0.5	
SHGQ01 test FY11			0.2		0.1	
SHGQ02 design fy10 /fab FY11		0.05	0.1	0.2	0.5	
SHGQ02 test FY11			0.2		0.1	
Test Stand Evaluation FY10		0.1	0.3			
Test Stand Design FY10		0.2	0.5	1		
Test Stand Installation FY11			0.2		1.5	
FY10 Labor Initial		0.2	0.6	0.7	0.5	2 500
After Test Decision		0.2	0.5	1		1.7 425
FY11			0.6		2.2	2.8 700
M&S Initial	60					
M&S After Test Decision	140					

- First request is for a total of 560k\$ (need 360k\$ in addition to the 200k\$ already given us)
- May 2010 we would request an additional 565k\$ after the test decision and plan is better formed
- FY11 funding estimated at 700k\$