Fermilab

Cryogenics Department — MS#219
Wilson Hall 11th Floor — Ext: 4686

August 15, 1986

To: J. O'Meara
From: R. Sanders
Subject: Transmittal of Design Note #34 for Heat Exchanger #5 in Muon Lab

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Attached is a copy of Design Note #34, which is the 14.1 engineering note for heat exchanger #5 at New Muon Lab.

cc: w/o print:
Fast
Dachniwskyj
Kelley
Smith, R.P.
Stoy
Stone
Bennett

w/print:
Bonham
Carter
McInturff
Misek
Scherr

PRESSURE VESSEL ENGINEERING NOTE
PER MANDATORY STANDARD SD37
(CHAPTER 14.1, LAB SAFETY MANUAL)

Prepared by: R. R. BENNETT
Preparation date: 6/25/86

5.1 Description and Identification

Fill in the label information below:

This vessel conforms to engineering standard SD37
Vessel Title HEAT EXCHANGER (MUON #5)
Vessel Number RD-1144 ← Obtain from Division/Section Safety Officer
Vessel Drawing Number FERMI 2753.700-ME-193163
Maximum Allowable Working Pressure (MAWP) 360 PSI
Working Temperature Range -320 °F 100 °F
Contents HELIUM GAS
Designer/Manufacturer CDM MACHINING AND FABRICATING CORP.
Test Pressure (if tested at Fermi) Acceptance Date:
PSI, Hydraulic Pneumatic
Accepted as conforming to standard by K.C. Stanfield ← Actual signature required in this space
of Division/Section Research Division

NOTE: Any subsequent changes in contents, pressures, temperatures, valving, etc., which affect the safety of this vessel shall require another review and test.

Reviewed by: J. Hess Date: 8/4/86
Director's signature (or designee) if the vessel is for manned areas but doesn't conform to the requirements of the standard.

Date:

Lab Property Number(s):
Lab Location Code: NEU-NMS (obtain from Safety Officer)
Purpose of Vessel(s): HELIUM TO HELIUM HEAT EXCHANGER (PRE-COOLING COMP. DISCHARGE USING CVM RETURN)
Vessel Capacity/Size: 6 5/8" O.D X 22' LONG. (2 SECTIONS).
Normal Operating Pressure (OP) 250 PSI
MAWP-OP = 100 PSI
Is the above enough to provide relief cracking pressure tolerance plus system uncertainty tolerance per M-9. YES
As an option, provide a photo of the entire vessel in the Appendix.

List the numbers of all pertinent drawings and the location of the originals. (Append copies).

Drawing #	Location of Original
2753.700-ME-193163	WH - 11TH FLOOR
2753.700-MC-193164	WH - 11TH FLOOR
2753.700-MC-193165	WH - 11TH FLOOR
2753.700-MC-193166	WH - 11TH FLOOR

5.2 Design Verification

Does the vessel(s) have a U stamp? Yes X No ____. If "Yes", fill out data below and skip page 3; if "No", fill out page 3 and skip this page.

Staple photo of U stamp plate below.

Copy "U" label details to the side if photo is not clear of if copies are unreadable.

1st U Stamp:

Copy data here:

W U MFG & CERT. BY
ROBINSON MFG CO.
DENVER COLO
SER I-8
350 PSI INT AT 100°F
15 PSI EXT AT 100°F
HD 134 SH 134
HR ELL
YR 1986

2nd U-stamp is same as first except ~~line~~ the 4th line is
SER I-7

5.3 **System Venting.** Provide the system schematic in the Appendix, if the vessel safety is system sensitive.

Is it possible to isolate the relief valves by a valve from the vessel?

Yes____ No X

If "Yes", the system must conform to M-5. Provide an explanation on the appended schematic. (An isolatable vessel, not conforming to M-5 violates the Standard.)

Is the relief cracking pressure set at or below the M.A.W.P.?

Yes X No____ Actual setting 320 PSI
(A no response violates the Standard.)

Is the pressure drop of the relief system at maximum anticipated flow such that vessel pressure never rises above the following? (UG 125)

Yes X No____

110% of MAWP (one relief)
116% of MAWP (multiple reliefs)
*121% of MAWP (unexpected heat source)

Provide test or calculational proof in the Appendix.
(Non-conforming pressure rises violate the Standard.)

List of reliefs and settings:

Manufacturer	Relief	Setting	Flow Rate	Size
AGCo	89S44-2	320	~~89~~ scfm(air)	½"
Circle Seal (not code stamped)	5159-B	65	64.3scfm (Air)	½"

Is the relief device an ASME stamped device? Yes X No____

5.4 **Operating Procedure**

Is an operating procedure necessary for the safe operation of this vessel?

Yes____ No X. If "Yes", please append.

5.5 **Welding Information**

Has the vessel been fabricated in a Fermilab shop? Yes____ No X

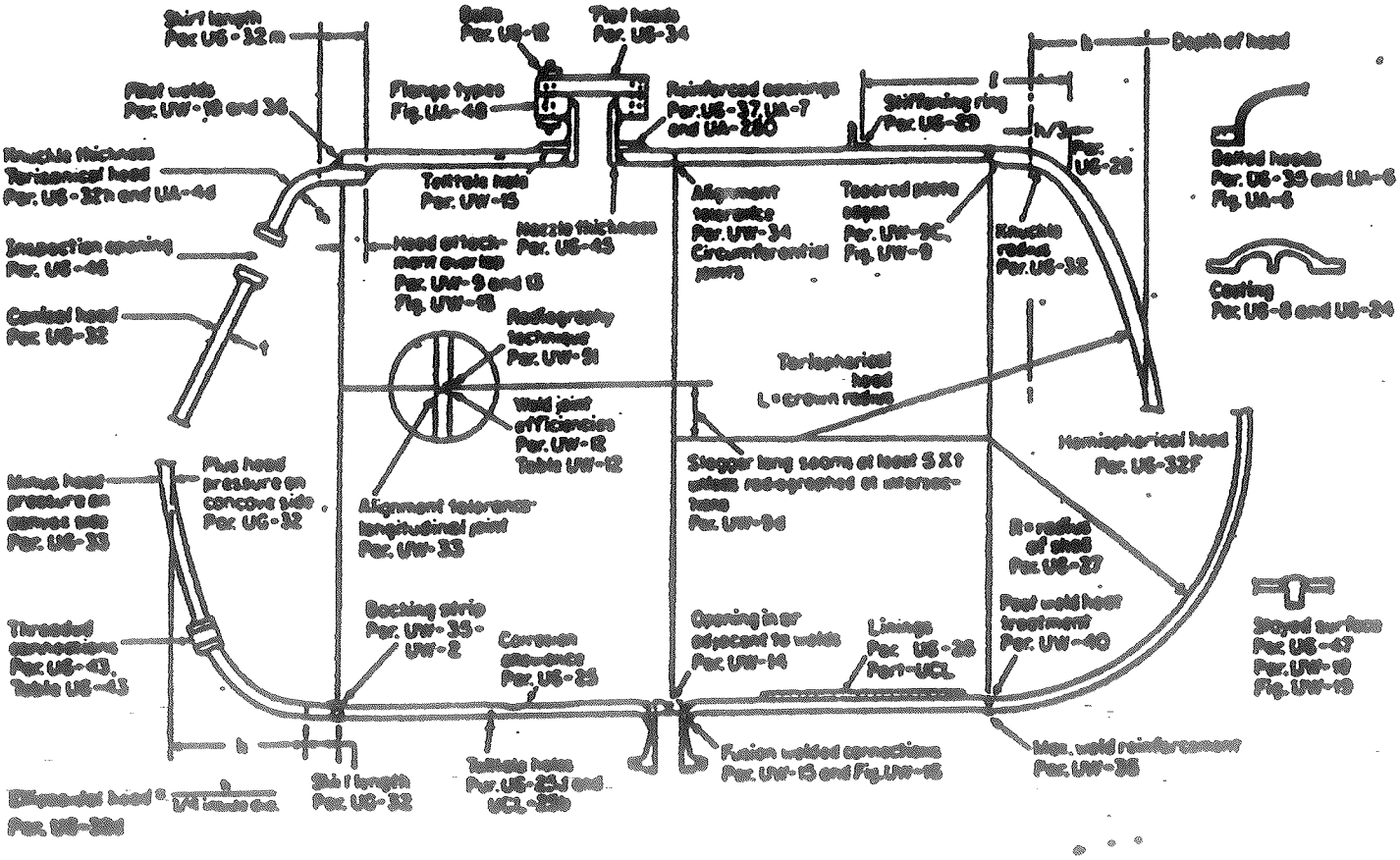
If "Yes", append a copy of the welding shop statement of welder qualification and a copy of the Welding Procedure Specification (WPS) used to weld this vessel.

5.6 **Exceptional, Existing, Used, and Non-Manned Area Vessels**

Is this vessel or any part thereof in the above categories? Yes____ No X

If "Yes", follow the Engineering Note requirements for documentation in free form below.

On the sketch below, circle all applicable sections of the ASME code per Section VIII, Division I. List the results of all calculations. (Insert copies of calculations in the appendix).



Summary of ASME Code

Item	Reference ASME Code Section	CALCULATION RESULT (Required thickness or stress level vs. actual thickness or calculated stress level)
		vs.
		vs.
		vs.
		vs.
		vs.

If this vessel is exceptional or had exceptional parts, list their details under 5.6. Yes_____ No_____

Sizing of Relief Valve for Heat Exchanger 5

Heat exchanger #5 can be pressurised only by the compressors in Lab A, a trapped volume warming up or a fire. As for the compressors, their capacity is relieved at Lab A and the relief setting is 50 psig lower than the MWAP of the heat exchanger and therefore overpressure by the compressor is not a concern. Each compressor has a kickback valve capable of bypassing the full compressor flow back to suction. This valve should keep compressor discharge at or below 300 psia for the Mycom and 250 psia for the Norwalk. In addition each compressor has a relief valve back to suction which for the Mycom is set for 300 psig and for the Norwalk is set for 275 psig. Suction has three relief valves each sized to handle the flow of at least two compressors.

A fire condition is by far more severe than the simple case of a trapped gas volume warming up. The heat exchanger is surrounded by foam insulation with a minimum thickness of three inches. In the case of fire the aluminum skin encasing the insulation would remain intact but the insulation would eventually decompose.

The CGA Code S-1.3 section 5.3.2 states "For uninsulated containers for non-liquefied gases the minimum required flow capacity of the pressure relief device shall be calculated by using the formula:

$$Q_a = 0.029\ W_c$$

where

Q_a = flow capacity in CFM of free air
W_c = water capacity of container in pounds

Ignore the internal parts of the heat exchanger. The volume of the 44 feet of 6" schedule 10S pipe that comprises its shell is 9.7 ft^3. As a result

$$W_c = 62.4\ lb/ft^3 \times 9.7\ ft^3 = 605.2\ lb$$

and

$$Q_a = (0.029)(605.2) = 17\ SCFM\ of\ air$$

which is the required capacity of the relief valve. The relief valve is a code stamped Anderson and Greenwood model 89-S44-2 with a 0.014 in^2 orifice, a stamped capacity of 89 SCFM air and a pressure setting of 320 psig. The valve number is SV-509-H and is located on the 1" inlet pipe to the heat exchanger as shown on page 3 of drawing #2753-700-MR-157052.

In addition there is a trapped volume relief SV-510-H on the 2" low pressure helium outlet. This protects the internal piping and is a Circle Seal model 5159-B set for 65 psig and a capacity of 64.3 SCFM air at 1660 R. It is not a code stamped valve. Both relief valves will be placed within 3' of the heat exchanger to minimize pressure drop.