D-Zero Signal Board Feed-Thru, Instrumentation and Hi-Voltage Boxes

Engineering Note #3740.210-EN-241

Issued: February 14, 1990

Originator: Rick Luther

Checked: Al Jaques

D-Zero Engineering Note
3740.210-EN-241
Issued 2/14/90

D-Zero Signal Board Feed-Thru, Instrumentation and Hi-Voltage Boxes

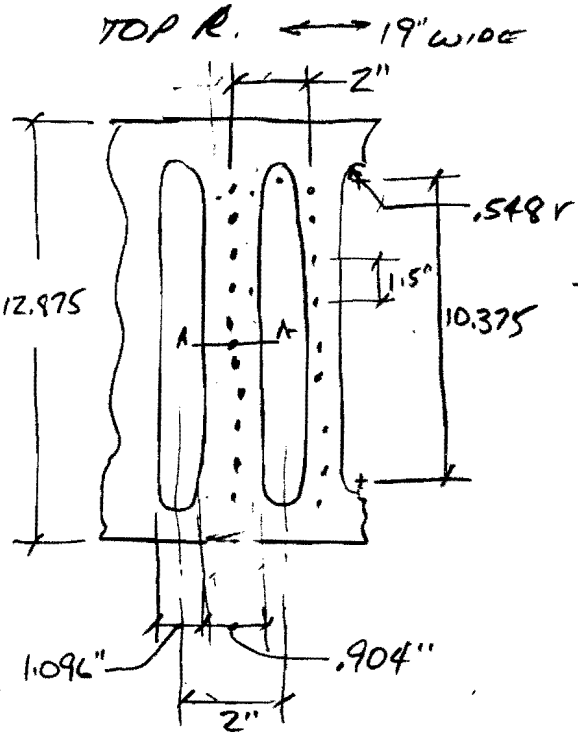
Al Jaques

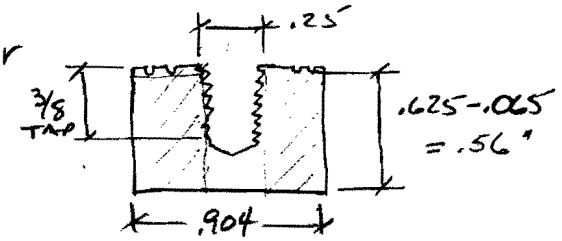
The three boxes being reviewed all operate at a pressure of less than 15 psig. Since they are relieved at 13 psig, they fall outside the scopes of the ASME Pressure Vessel Code, Fermilab Engineering Standard SD-37B, and Chapter 5031 of the Fermilab Safety Manual, therefore a Pressure Vessel Engineering Note showing compliance with SD-37B is not required.

In calculating the design stresses, only the largest of the three boxes, the signal board feed-thru box, was analyzed. This box had the largest spans and areas and would experience the largest pressure-related forces. The thinnest walls of each box were found to be in the top plates and they were also the side of the box which exposed the largest amount of area to internal pressure. The signal board feed-thru box top plate had at least twice the pressure area than either the instrumentation or hi-voltage boxes' top plates. This large disparity overshadows the slight difference in top plate thicknesses between the three boxes (0.56" vs. 0.25" and 0.3125", respectively).

Therefore, we felt the analysis of the larger signal board feed-thru box would justify the design of the smaller instrumentation and hi-voltage boxes. Appended to the end of this engineering note are the weld procedure, assembly report and the pressure test procedure & results for the signal feed-thru box. Also, included as a reference is a list of the drawing numbers for the parts and assembly of the signal board feed-thru, instrumentation and hi-voltage boxes.

SIGNAL FEEDTHROUGH BOXES





MIN SECTION

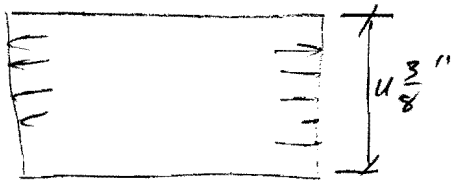
$A = (.904 - .25)(.56)$

$= 0.366 \text{ in}^2$

$I = \frac{1}{12}(.904 - .25)(.56)^3$

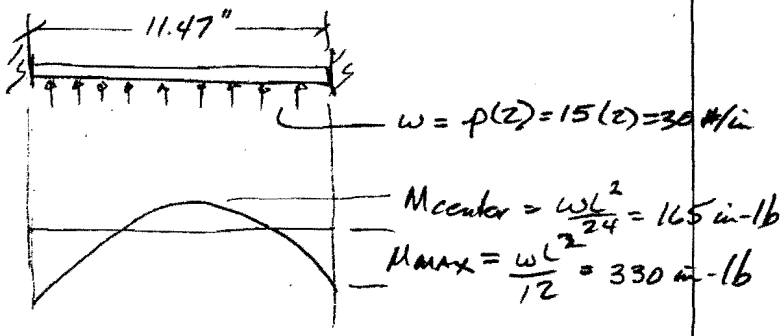
$= .0096 \text{ in}^4$

$S = \frac{I}{c} = \frac{.0096}{(.56/2)} = .0342 \text{ in}^3$



$f_a = \frac{15(2)(11\frac{3}{8})}{.366} = 470 \text{ psi}$ negligible.

MOMENT



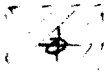
$f_b = M_S = \frac{330}{.0342} = 9650 \text{ psi}$

$F_b = 0.75 F_y = .75(30) = 22.5 \text{ KSI}$

OK

inserts in the slots will prevent buckling.

BOLTS

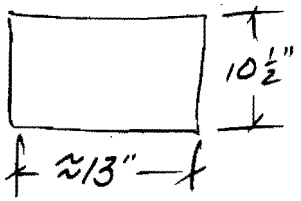


$R_x A = 15(1\frac{1}{2} \times 2)$

$= 45 \#$

$f_s = \frac{F}{A_s} = \frac{45}{.027} = 1670 \text{ psi}$ OK

End Plates



$p = 15$ psi $\quad \frac{a}{b} = \frac{15}{10\frac{1}{2}} = 1.24$

$\beta = .392$

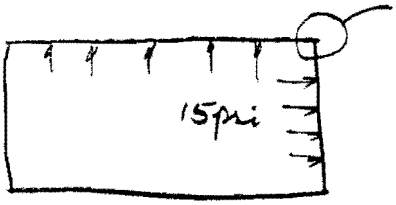
$\alpha = .065$

$$f_{bmax} = \beta \frac{p b^2}{t^2} = .392 \frac{(15)(10\frac{1}{2})^2}{.5^2}$$

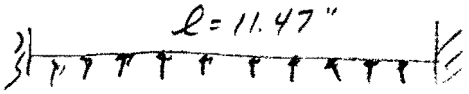
$$= \underline{2600 \text{ psi}} << .75 F_y = 22{,}500 \text{ psi}$$

OK

Corner Welds

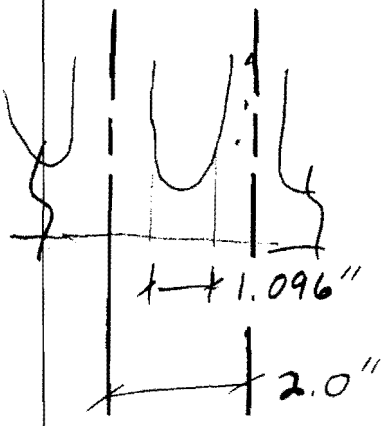


The max moment occurs at this corner. It must be less than the moment at the edge of the larger plate if the edge is assumed fixed. From the previous page



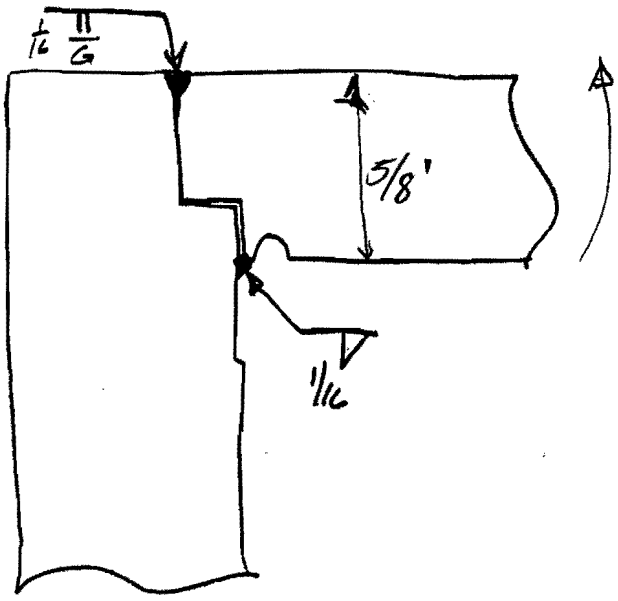
$w = p(2) = 30$ #/in

$$M_{max} = \frac{w l^3}{12} = 330 \text{ in-lb}$$



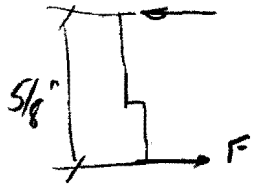
This moment is carried by 2.0" of weld. The max. stress is calculated as follows:

RDC 2/6/90



$$M_{MAX} = \frac{330 \text{ in-lb}}{2.0"} = 165 \frac{\text{in-lb}}{\text{in}}$$

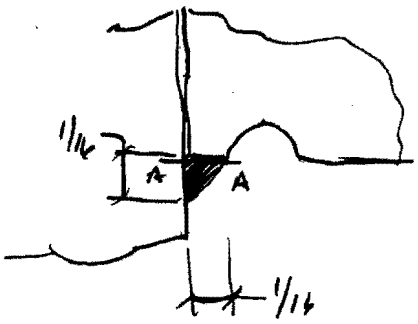
The moment is carried by a couple formed by tensile stress in the lower weld in combination with bearing stresses at the upper weld.



$$F \times 5/8 = 165$$

$$F = \frac{165}{5/8} = 264 \#/\text{in}$$

Shear stresses in the lower weld control the design.



Shear on A-A

$$f_s = \frac{264 \text{ lb/in}}{1/16 \text{ in}} = 4224 \frac{\text{lb}}{\text{in}^2}$$

$$F_s = 0.4 F_y = 0.4(30000)$$

$$= 12000 \text{ psi} > f_s$$

OK

Drawing #'s & Titles for Signal Board Feed-Thru Box

3740.223-ME-224540	D-Zero EC Signal Board Feed-Thru Box - Assembly
" -ED-223283	" " " - W/Seal
" -MD-223298	" " " - Seal Block Ass'y
" -ME-223636	" " " - Welded Unit
" -MD-223637	" " " - Side Plate
" -MC-223638	" " " - Seal Clamp
" -MC-223665	" " " - Test Plug
" -ME-224533	" " " - Top Plate
" -ME-224534	" " " - Bottom Plate
" -MD-224535	" " " - End Plate
" -ME-224536	" " " - Side Flange
" -MC-224539	" " " - End Seal Clamp

Drawing #'s & Titles for High-Voltage Box

3740.515-ME-255662	D-Zero CC High-Voltage Box - Assembly
" -MD-255663	" " " - Dbl. Seal Top Flange
" -MD-255664	" " " - Bottom Plate
" -MC-255665	" " " - Side Plate
" -MC-255666	" " " - Front Plate
" -MC-255667	" " " - Top Plate

Drawing #'s & Titles for Instrumentation Box

3740.515-ME-224803	D-Zero CC Instrumentation Box - Assembly
" -MD-224804	" " " - Top Flange
" -MD-224805	" " " - Bottom Plate
" -MC-224806	" " " - Top Plate
" -MB-224807	" " " - Front Plate
" -MB-224808	" " " - Back Plate
" -MB-224809	" " " - Side Plates

SIGNAL FEEDTHRU BOX WELD PROCEDURE

3740.210-EN-123

BOB FERRY NOVEMBER 12, 1987

1. Firmly bar clamp the box together in all directions. When all directions have been secured, tack weld each outside seam of the box in 4 or 5 places along it's length. Remove clamps and ~~procede~~ PROCEED to weld all outside seams. Care should be taken that ~~a~~ THE maximum weld cross section does not exceed 1/16" x 1/16".

2. To help stabilize the metal as it cools we will install all slot plugs,(.MC-223665), and one side cover plate,(MD-223637). Inside welds for this side plate will be MADE done thru the opposite side flange. Weld cross sections should be held to a 1/16" maxium depth and width.

3. Weld the inside of the end plates, (MD-224535), using the weld relief as filler material. After the box has cooled, weld the top plate (ME-2244533) to the side flange (ME-224536) and then to the bottom plate (ME-224534).

4. Repeat this procedure for the opposite side.

5. Helium leak check the welds, inside and out, by plugging the slot pumpout holes and pumping on the pump out line. Remember that the clearances are very tight in the space that is to be pumped. Allow plenty of time for a good pumpdown and leak check. Leak detection should be on the most sensitive scale on a helium leak detector with a minimum sensitivity of 10E-9 ATM CC/SEC.

6. See 30 psig. pressure test procedure.

PROTOTYPE SIGNAL FEEDTHRU BOX #2

ASSEMBLY REPORT BOB FERRY NOV. 11 1987

Upon delivery of the 8 machined plates they were inspected for any deviations from the detail drawings. All measurements made were within the set tolerances and they were submitted for welding.

Welding of the plates falls into two catagories, Outside fusion welds, and inside fillet welds. Because fillet welds require more heat and longer time spent in any given place, these are the most critical. As in all of our applications using 304 Stainless Steel a 308L filler rod was used.

The box was clamped together to check fit and that all joints ~~were~~ MATED as expected. A learned group of indivduals was then assembled to discuss the technique for best welding results. All concured that weld reliefs on the inside of the box would be the safest method for reducing the warp due to contraction of the cooling weld area. It was also noted that some of the plates had been drawn with 1/16 " chamfers on the edges. We will rework these by building up weld material then remachining to sharp 90 degree edges. Revised drawings were generated removing the chamfers and adding 1/16" x 1/16" weld reliefs to the end plates.

Reassembly of the box took place on November 9 and welding began that afternoon. Welding was done by the weld procedure attached ~~to this memo.~~ During the leak check which followed three small leaks were detected, all in corners. After all leaks were repaired the box was sucessfully pressure tested to 30 psig.

SIGNAL FEEDTHRU BOX PRESSURE TEST

3740.210-EN-123

Bob Ferry November 13,1987

On November 14, 1987 a pressure test of the prototype II Signal feedthru box was performed. The following is a description of how this test was performed and ~~what~~ the results ~~were~~ obtained. The people conducting the test were Jim Harder and ~~myself~~ the author.

1. A completed Signal feedthru box is outfitted with it's standard side plates, drawing number MD-223637. The indium seals are not installed for this test. A full set of slot plugs, drawing MC-223665, are installed into the top plate of the box. During this pressure test the indium and the O ring seals are installed. By doing this now I am able to do a complete leak check of the slot pumpouts and the captured weld area before and after the pressure test.

2. A bottom plate was fabricated using the same drawing as the final assembly flange which is used on the CC cryostat. This drawing number is ME-223235 sheet 3 of 8 view BB. Some obvious exceptions should be noted

a. The C seal groove is omitted.

b. The plate was made as a blank and not a flange.

c. a 1/4" pressure tap supply port was added.

3. A test area was set up at at the RF barn and all acess to this was halted. The box was pressurized to15 psig. and allowed to sit for 10 minutes, at which time the box was snopped and found to be leak free. A second test at 30 psig. was also done in the same manner with no leak present.

4. The box was then measured for flatness and these numbers were within the .002 " flatness that was measured after the welding operation.

page 3

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4. The box was then measured for flatness and these numbers were within the .002 " flatness that was measured after the welding operation.

Date: _____

Accelerator Division Permit For Safety Tests

Safety Test: SIGNAL FEEDTHRU BOX #2

Location of Test: RF BARN

Hazards Involved: POSSIBLE WELD SEAM RUPTURE

Safety Precautions Taken: BOX PLACED REMOTELY FROM THOSE PERFORMING THE TEST 50PSIG RELIEF ON CHARGE LINE

Time of Test 15:13 NOV 17 1987

Approvals (Signature and date: time of test must be within one week of signature date. All signatures must be received at least 1 working day before safety test.

Test Coordinator: R FERRY JIM HARDER Date: NOV 17 1987

Division Safety Officer: _____ Date: _____

Division Head: _____ Date: _____

Special Conditions or Requirements FOLLOWED TEST PROCEDURE 3740.210-EN-123

Robert Ferry

Please Note: This form is required for all tests in which there is a question of either personnel or equipment safety.

Date: 5-17-88

Accelerator Division Permit For Safety Tests

Safety Test: Signal Feed Thru Box #3

Location of Test: old tunnel hoops across from AP-0

Hazards Involved: Possible rupture at welded seams. bolts may strip out on flanges when under pressure

Safety Precautions Taken: Signal Box placed inside concrete hoop, pressurizing from outside hoop. 50# relief in pressurizing line

Time of Test 1000 HRS

Approvals (Signature and date: time of test must be within one week of signature date. All signatures must be received at least 1 working day before safety test.

Test Coordinator: Ken Allen Paul Vining Date: 5-17-88

Division Safety Officer: _____ Date: _____

Division Head: _____ Date: _____

Special Conditions or Requirements Pressurized Box to 15 psig for 10 min, then soap leak checked all seams. Pressurized to 30 psig for 10 min, depressurized and re pressurized to 30 psig for 10 min. soaped again -

SEE PRESSURE TEST PROCEDURE 3740.210-EN-123

Please Note: This form is required for all tests in which there is a question of either personnel or equipment safety.

Date: 5-17-88

Accelerator Division Permit For Safety Tests

Safety Test: Signal Feed Thru Box #4

Location of Test: old tunnel hoops across from AP-0

Hazards Involved: Possible rupture of welded seals, bolts may strip out on flanges when under pressure

Safety Precautions Taken: Signal Box placed inside concrete hoop, pressurizing from outside of hoop 50# relief in pressurizing line.

Time of Test 0915 HRS

Approvals (Signature and date: time of test must be within one week of signature date. All signatures must be received at least 1 working day before safety test.

Test Coordinator: Ken Allen Paul Vierig Date: 5-17-88

Division Safety Officer: _____ Date: _____

Division Head: _____ Date: _____

Special Conditions or Requirements Pressurized Box to 15 psig for 10 min, then snoop leak check all seams. Pressurized to 30 psig for 10 min, depressorized and repressurized to 30 psig for 10 min. Snooped again

NOV 13 1987

SEE PRESSURE TEST PROCEDURE 3740.210-EN-123

Please Note: This form is required for all tests in which there is a question of either personnel or equipment safety.

Date: 10-5-88

Accelerator Division Permit For Safety Tests

Safety Test: Signal Board Feed thru Box #5

Location of Test: Old tunnel hoops across from AP-0

Hazards Involved: Possible rupture of welded seams, bolts may strip out of flanges when under pressure

Safety Precautions Taken: signal Box placed inside concrete hoop, pressurizing from outside of Hoop. 45# relief in pressurizing line

Time of Test

Approvals (Signature and date: time of test must be within one week of signature date. All signatures must be received at least 1 working day before safety test.

Test Coordinator: Ken Olsen Date: 10/6/88

Division Safety Officer: Date:

Division Head: Date:

Special Conditions or Requirements pressurized box to 15 psig for 10 min. then swoop leak check all seams. Pressurize to 30 psig for 10 min depressurize and repressurize to 30 psig for 10 min. swoop again

Please Note: This form is required for all tests in which there is a question of either personnel or equipment safety.

Date: 10-5-88

Accelerator Division Permit For Safety Tests

Safety Test: Signal Board feed thru Box #6

Location of Test: Old tunnel hoops Across from AP-0

Hazards Involved: Possible rupture of welded seams, bolts may strip out on flanges when under pressure

Safety Precautions Taken: Signal box placed inside concrete hoop. Pressurizing from outside of hoop. 45# relief in pressurizing line

Time of Test

Approvals (Signature and date: time of test must be within one week of signature date. All signatures must be received at least 1 working day before safety test.

Test Coordinator: Ken Alexander Fred Wallen Date: 10/6/88

Division Safety Officer: Date:

Division Head: Date:

Special Conditions or Requirements pressurized box to 15 psig for 10 min. then SNOOP leak check all seams. Pressurized to 30 psig for 10 min. depressurized and repressurized to 30 psig for 10 min, SNOOP again.

Please Note: This form is required for all tests in which there is a question of either personnel or equipment safety.

Fermilab

EXHIBIT B

Pressure Testing Permit*

Date: 12/26/89

Type of Test: ☐ Hydrostatic ☒ Pneumatic

Test Pressure: 30 psig Maximum Allowable Working Pressure: 15 psig

Items to be Tested: High Voltage Feed thru Box.

Location of Test: East Booster Tower Date and Time: 12/27/89

Hazards Involved: 30 psig Argon Gas Press.

Safety Precautions Taken: Test inside can, which is located inside welding hood. Personnel located outside welding hood.

Special Conditions or Requirements:

Test Coordinator: Fred Walters Dept/Date: 12/26/89

Division/Section Safety Officer: R.H. Lewis Dept/Date: 12/26/89

Division/Section Head: G. Dugan Dept/Date: 12/26/89

Results: Tested OK.

Witness: Raymond H. Lewis Dept/Date: AD/Safety 12/27/89
(Safety Officer or Designee)

*Must be signed by division/section safety officer and division head prior to conducting test. It is the responsibility of the test coordinator to obtain signatures.

5034TA-6
6/86

Fermilab

EXHIBIT B

Pressure Testing Permit*

Date: 6/19/90

Type of Test: ☒ Hydrostatic ☐ Pneumatic

Test Pressure: 48 psig Maximum Allowable Working Pressure: 32 psig

Items to be Tested: SIGNAL BOX FOR DØ CALORIMETER FOR USE AT TS[illegible], BUT 48 psig TEST PRESSURE.

Location of Test: E Booster Tower Date and Time: 6/19/90, 3:35 PM

Hazards Involved: High velocity water due to trapped air pockets depressurizing.

Safety Precautions Taken: HYDROSTATIC [illegible] TEST. TARGET AREA

Special Conditions or Requirements: PRESSURE BOX STRAIGHT WEST BUILDING & AREA, AND TEST P.O. BEFORE AND AFTER)

Test Coordinator: Kelly Dixon Dept/Date: DØ 6/19/90

Division/Section Safety Officer: W. L. Freeman Dept/Date: RD/Safety 6/19/90.

Division/Section Head: [signature] for PHG Dept/Date: RDO 6/19/90

DIXON Freeman Montgomery

Results: No inelastic deformations observed at max pressure or after depressurization. Had small pinhole leak through gasket pumport space due to leak past indium seal.

Witness: G. T. Mulholland Dept/Date: DØ Const. 6/19/90

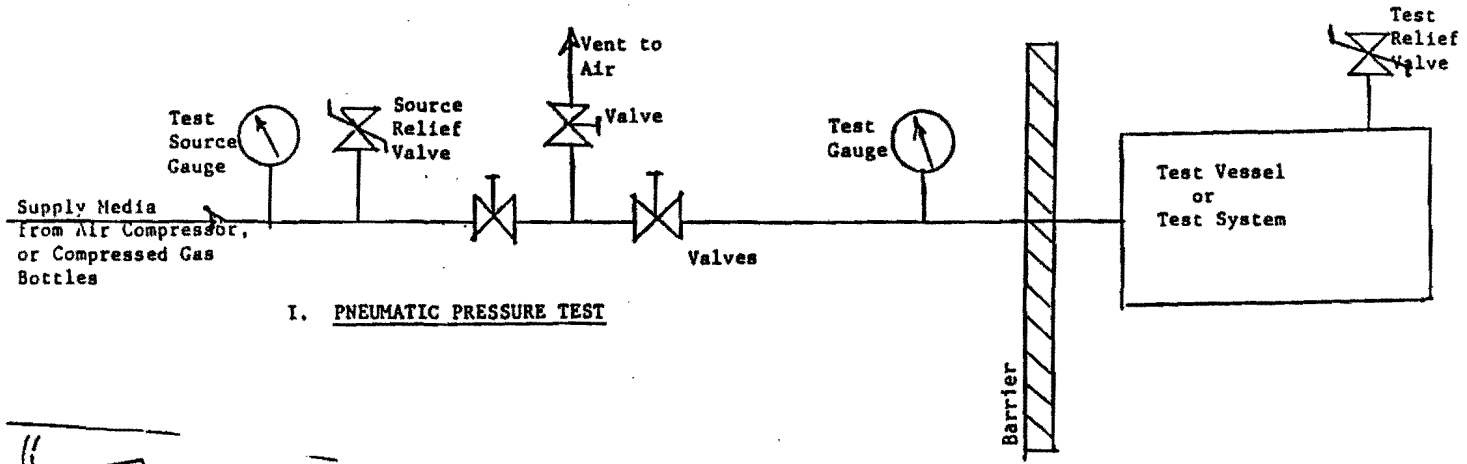
(Safety Officer or Designee)

*Must be signed by division/section safety officer and division head prior to conducting test. It is the responsibility of the test coordinator to obtain signatures.

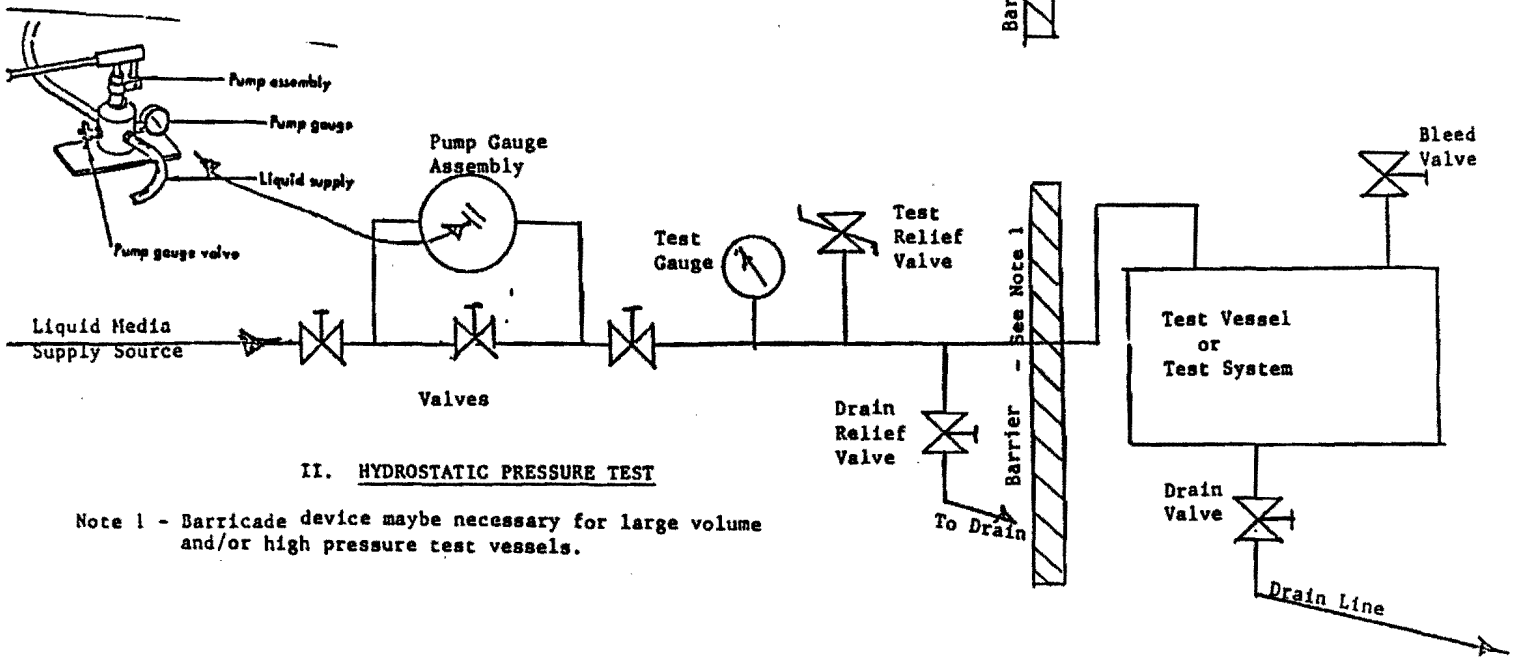
G. T. Mulholland p.850

5034TA-6
6/86

SCHEMATIC SETUP FOR PRESSURE TEST EQUIPMENT



I. PNEUMATIC PRESSURE TEST



II. HYDROSTATIC PRESSURE TEST

Note 1 - Barricade device maybe necessary for large volume and/or high pressure test vessels.

EXHIBIT A

5034TA-5
6/86