CC Pressure Test

3740.214-EN-259

July 12, 1990
K. Dixon

Checked by ATM.

Vessel Status Prior to Testing

The inner vessel heads including bypass and beam tubes had just been welded into place and dye penetrant checked. The vacuum heads were not on at this time but the vacuum shell was on covering the piping penetrating into the inner vessel. Signal boxes with all feed through boards, the instrumentation box, and high voltage boxes were all installed with their pump outs capped. All 1/4" instrumentation lines were terminated at their respective shutoff valves.

All vacuum piping used for pumping down the inner vessel was isolated using o-ring sealed blind flanges. PV215A (VAT Series 12), the 4" VRC gate valve isolating the cryopump, and the rupture disk had to be removed and replaced with blind flanges before pressurizing due to their pressure limitations. Stresses in plates used as blind flanges were checked using Code calculations. Before the CC test, vacuum style blanks and clamps were hydrostatically pressure tested to 150% of the maximum test pressure, 60 psig.

The Code inspector and Research Division Safety had all given their approval to the test pressure and procedure prior to filling the vessel with argon.

Test Results

The test was a major success. Based on the lack of any distinguishable pressure drop indicated on the pressure gages, the vessel appeared to be structurally sound throughout the duration of the test (approx. 3 hrs.). A major leak in the instrumentation tubing was discovered at half of the maximum test pressure and was quickly isolated by crimping and capping with a compression fitting.

There were some slight deviations in the actual procedure used (see attachments). The 44 psig relief valve located just outside the cleanroom had to be capped until the pressure in the vessel indicated 38 psi. This was to allow higher supply pressures and hence, higher flows through the pressurizing line. Also, in order to get pressure readings at the cryostat without exposing any personnel to the potentially dangerous stored energy near the maximum test pressure, a camera was installed at the top of the vessel to view the indicator mounted there. The monitor was viewed at the ante room adjacent to the cleanroom.

The holding pressure of 32 psig (4/5 of the maximum test pressure) was only maintained for about 20 minutes instead of the half hour recommendation in the procedure. We felt that this was sufficient time to Snoop test and perform the pressure drop test.

After the test was completed, the inspector for CBI Na-Con and the Research Division Safety Officer signed all of required documentation.

From: FNAL::MULHOLLAND 6-JUL-1990 12:47:23.92
To: KDIXON
CC: MULHOLLAND
Subj: As you requested.

7/5/90 Final version

PTest is the CC Pressure Test

This note describes the rationale for the test pressure of the completed CC calorimeter Pressure Test, provides a detailed operating procedure, and a Safety documentation and interface outline.

TEST PRESSURE

The CC vessel was pneumatically pressure tested to 50 psig at the fabricator, LOX in Delphi, Indiana. The test pressure was determined as follows,

MAWP	15.0	psig
+ Vacuum	14.73	psig
LAr head	10.0	psig
-----	-----	-----
Sum	39.73	psig

Test Pressure 1.25(Sum) 49.66 psig

Removal and replacement of the heads and the installation of the nozzle extensions (4 signal boxes, 2 high voltage boxes, 1 instrumentation box, cold valve, and other appurtenances) are considered justification to repeat the pressure test on the completed calorimeter.

The vessel's multiple extensions will never see an operational pressure more than 15 psig, i.e. they don't see the vacuum because they are outside the vacuum envelope and they don't see the head (or at least any significant portion thereof) pressure. To Pneumatically test the vessel to 125% of the sum of the MAWP and liquid head, tests the upper portions of the vessel to 166%, and the nozzle extensions and their parts to 333%, of the respective maximum allowable working pressures.

The solution to the upper and lower vessel disparity is to fill the vessel with liquid for the test, and the solution to the vacuum loading is to install the vacuum jacket before the pressure test. Unfortunately, the vessel can not be filled with liquid without compromising the integrity of the calorimeter modules. The vacuum vessel can not reasonably be put in place (welded) to provide the vacuum loading, if the final leak check is to follow the pressure test. The latter is the accepted practice for obvious reasons.

The usual accomodation is to relinquish the head pressure requirement. That works well on high pressure vesssels, those with small heights (horizontal vessels), and/or those with low density liquids (Helium) because the effect is a small fraction of the maximum load test pressure. The resolution for low pressure, tall, and high density liquid vessels (our situation) is more difficult, and not as obvious. The compromise proposed in this case, and by extension for the EC's, is,

Source		Remarks
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MAWP	15 psig	Relief is 13 psig
+ Vacuum	14.36 psig	707' above sea level

	Head LAr	10.0	psig

	Sum	39.36	psig
Test Pressure	ca. Sum	40.0	psig

In that way the upper pressure is limited to 136% of its maximum allowable value, the lower portion is tested to 100% of its maximum allowable pressure plus head, and the nozzle extensions pressures are limited to 267% of their maximum allowable pressures. Note that there are extension items that will necessarily, be removed for the pressure test and later reinstalled (see the Procedures, below), and others that must remain (e.g. signal boxes). GAR will be used as the pressurizing gas because it is the operating fluid.

Conclusion

The pneumatic test pressure will be 40.0 psig, GAR, as the best compromise among competing requirements.

PROCEDURE

General

Provide a source (actual calculated requirement is 1840 scft, but provide 5000 scf minimum) of GAR through a LP regulator and a line fitted with a 110% test pressure relief valve of larger flow capacity than the LP regulator. Provide two test gauges, one on an independent cryostat port, the other on the pressurizing line. A shutoff and then a vent valve should be located just downstream of the LP regulator and relief. All of the equipment, except for the cryostat pressure gage, must be located out of the line of sight of the vessel and behind a barrier of sufficient strength to assure shrapnel, that might be created in a vessel failure, can not reasonably be expected to injure the test operators at the pressure test stand.

The test will be performed insitu, in the clean room of the D Zero Assembly building, and must be done with the building empty of all personnel not essential to the test as the vessel is pressurized. All entry doors should be equipped with a sign warning of the test and clearly stating "Keep Out". One member of the test team should make it his task to assure stray spectators do not find their way to the test area. See the last section on Safety participation and abide by those constraints as well. Complete any necessary or desirable communication with CBI NACON or their Code inspector before conducting the pressure test.

Actual Procedure

1. Assure that the two immediately preceeding paragraphs are read, understood, and all actions taken and completed.

2. The vessel should be inspected to assure it is properly closed and does not exhibit any irregularities that might preclude a successful test.

2a. The following extension items must be removed and their nozzles suitably capped before the pressure test;

- A. The pump and purge valve, it has a one atmosphere rating.
- B. The 18 psig Rupture disk assembly.
- C. The 13 psig Relief valve assembly.
- D. Vulnerable (over ranged) Pressure Transmitters.

E. All vacuum pumping appendages not Test Pressure rated.

3. The pressure in the vessel (ca. 660 cft) shall be gradually increased with GAr to not more than one-half of the test pressure. The agreement of the test station and vessel pressure gages should be verified or corrected as required. Thereafter, the test pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure is reached. The test pressure should be held for a minimum of ten minutes. The pressure shall be reduced to a value equal to four-fifths of the test pressure and held for a time sufficient to permit complete inspection of the vessel. The visual inspection will be augmented with a half-hour or more gas pressure drop test and Snoop checking as may be required. All observations will be carefully and chronologically recorded in a logbook expressly for that purpose.

4. Should any sign of vessel failure or distortion be observed the test is terminated immediately by reducing the pressure to one atmosphere. A final disposition for the vessel will be arranged with the appropriate authorities.

5. Upon successful completion of the test the pressure is slowly reduced to atmospheric pressure, the test stand and source secured, and the pressure test precautions relaxed and signs removed.

SAFETY

The "Technical Appendix to Pressure Vessel Testing", Fermilab safety manual, 5034TA, is the appropriate and governing document. The salient points will be repeated here for continuity of context, but no attempt is made to provide another authority. Read 5034TA, attached.

The test requires a Pressure Testing Permit, see the last page of the TA, 5034TA-6, it is the permit application. It must be signed by the Test Coordinator (Kelly Dixon), Safety Officer (Bill Freeman), and the Division Head (Peter Garbincius). The test must be witnessed by the Safety Officer or his designee; a duly authorized Safety representative must be present for the test. Rick Luther, who has been directing the closure of the vessel and dealing with the construction crew, will coordinate this note with the requirements of the CBI NACON ASME Pressure Vessel Code inspector. Any modifications arising from those discussions will be made a part of this Procedure and be subject to approval by the Fermilab Safety office.

This test and procedure will be communicated to the DO Cryogenic Safety committee, but pressure testing is a Safety Office function and need not be approved by the Cryogenic Safety committee.

Fermilab

EXHIBIT B

Pressure Testing Permit*

Date: 10 July 90Type of Test: ☐ Hydrostatic ☒ PneumaticTest Pressure: 40 psig Maximum Allowable Working Pressure: 29.36 ^{**}psigItems to be Tested: CC CALORIMETER & ITS EXTENSIONS -
AFTER HEAD REASSEMBLY AND EXTENSION INSTALLATIONLocation of Test: DAB Clean Room Date and Time: _____Hazards Involved: ONLY THOSE ASSOCIATED WITH A PNEUMATIC TESTSafety Precautions Taken: ISOLATED TEST, TEST STAND, SOUND DESIGN,
REMOVAL OF L.P. DEVICES, & CONSISTENT WITH 5034TA.Special Conditions or Requirements: TEST MUST BE MADE WITH VACUUM
JACKS OFF (NOT YET ASSEMBLED)Test Coordinator: Kelly J. [Signature] Dept/Date: RD/DP 6 July 90Division/Section Safety Officer: T. [Signature] Dept/Date: RD Safety 9 July 90Division/Section Head: [Signature] Dept/Date: R.O. Office 9 July 90Results: Pressure test was completed successfully. Pressure was held
at 40 PSIG, then reduced to 32 PSIG and the entire assembly was
leak checked. One variation from the original procedure was the
installation of a TV camera monitor to remotely view the
pressure gage on the vessel in the clean room.Witness: T. [Signature] Dept/Date: 10 July 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.** 15 psig + Full Vac on J.A. CRATE
 $15 + 14.36 = 29.36$ 5034TA-6
6/86

July 9, 1990

CC Pressure Test Check List

- ☒ Check O-ring groove requirement for signal box, relief port flanges
- ☒ Make sealing provisions for above flanges
- ☒ Hydrostatically test 4" Marmon and KF50 flange/cap ass'ys to 60 psi
- ☒ Install pressurization field piping at outside cryobridge
- ☒ Install female VCO fittings at pump #90 trap
- ☒ Install pressure indicator on top of vessel
- ☒ Install transducer, chart recorder and associated wiring if available
- ☒ Perform leak analyses using RGA and HMSLD
- ☒ Call TJ Sarlina to confirm testing time
- ☒ Break vacuum and perform ROR until 2PM, then bring vacuum up the rest of the way to 1 atm
- ☒ Regenerate cold traps if manpower is available
- ☒ Remove pirani gage on top of vessel and plug
- ☒ Remove rupture disc assembly and install blind flange
- ☒ Remove relief valve port vacuum hose and install blind flange
- ☒ Remove cryopump gate valve and the pump if necessary, install blind flange.
- ☒ Remove PV215A and install KF50 cap and clamp
- ☒ Remove Welch pump vacuum hose at Marmon flange and install cap

and clamp

- ☐ Using a second party, check all bolts on blind flanges for tightness
- ☒ Replace 10 psi relief with 44 psi one
- ☒ Place warning signs at building entryways, ensure non-essential personnel has been evacuated

CC Pressure Test