D Zero Collider Detector

CC Initial Vacuum Pumping Preparation and Procedure

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General

The initial vacuum pumping of the fully loaded cryostats immediately upon completing the minimum head welding necessary[1] for the cryostat vacuum loading is important to 1) water removal, 2) high vapor pressure (micron level) outgassing, 3) helium mass spectrometer leak checking sensitivity, and 4) a less well understood concern for LAr background contamination. The CC pumping preparation and procedure that has been utilized is recorded here. Recommendations are incorporated in italics and in context to improve the EC vacuum preparations and pumping performance.

The estimated pumping loads of large assemblies of (G10) water laden modules are calculated in EN 270. The predicted and experienced water pumping period was ca. 45 days. The cryopump specifically designed to serve this purpose is described in EN 291. These notes are recommended background reading for this work.

Preface

The cryogenic design of the cryostats seeks to lengthen the paths of warm to cold, especially port, connections, decrease port diameters to the minimum required and fill feedthrough ports as completely as possible to minimize heat leak. High conductance (C) vacuum connections require short paths and large, uncluttered, cross-sections. Since the cryostat is the operating device and the PV vacuum pumping primarily a one time construction requirement, the burden of the conflicting requirements is entirely born by the design of the vacuum pumping system. No specific cryostat design heat leak concession was made to accommodate the initial vacuum pumping speed (S) requirement. Note that the signal, high voltage, and instrumentation ports will have their respective cables in place at this time.

No attempt has been made to vacuum pump modules prior to installation to reduce the dehydration required of the assembled modules. An experiment of weight loss (gain) measurement of module sample materials under vacuum pumping (storage in a controlled humidity) might provide helpful answers here.

Preparations for PV and VV pumping

1. Locate Vacuum Pumping Ports
   a. Identify all possible existing pumping ports
   b. Calculate the conductance (C) of each port

2. Pumping Port Selection[2]
   a. Consider relief, rupture, P&P, and drain lines for PV
   b. Consider DP for VV
   c. Calculate the limiting pumping speed (S=C) of each port
   d. Select the best set of existing pumping ports

[1] The overnight, between weld shift, periods are used to vacuum pump as soon as the vessel is structurally sound for vacuum loading.

[2] See Appendix A-1, attached.

3. Consider Temporary Pumping Port(s)
   - *a. at the instrumentation box top plate*
   - *b. at the high voltage box (2) top plate(s)*
   - c. at the signal box (4) outboard, side plate(s)

4. Study, Design the Pumping Systems[3]
   - a. physically locate the pumps
     1. Mechanical/Blower pumps
     2. Cryopump*(s)*
     3. Turbo-pump(s)
   - b. procure all the mechanical pumps required
   - c. procure, *or build*, all the cryopumps required[4]
   - d. design branch piping to effect $\geq$ 85% of S @ $L_{(branch)} = 0$

5. Nitrogen Trap all Mechanical Pump Inlets
   - a. provide isolation valves, gauges, for on-line warm-up
   - b. equip each trap with $\geq$ two shift @ 200 microns trap life, or
   - *c. equip each trap with an automatic fill valve, or both*
   - *d. improve the entry geometry detail to minimize ice plugging*[5]

6. Cryopump Auto-fill
   - a. provide the cryopump(s) with auto-fill valves
   - b. provide the necessary area for the source of LN2 selected

7. LN2 Source
   - a. assemble a fleet 160 liter dewars and provide for refilling, or
   - *b. run a line to a distribution manifold with a "stay-wet" valve at the end.*

8. Vacuum Measurement
   - a. a DV6 at each mechanical/blower pump, with common R/O
   - b. a calibrated Piranni and historical trend the vacuum

9. Leak Detector, Residual Gas Analysis
   - a. arrange for (or the loan of) a Leak Detector and the use of an RGA, as required
   - b. provide strategically placed leak detector and RGA connections with appropriate valving

10. Purge Source
    - a. provide a convenient source of GN2 to break vacuum
    - b. provide adequate source and vessel pressure relief
    - c. provide a convenient, tight, valving arrangement

11. Crane Coverage
    - a. arrange for the coverage needed to change dewars, reactivate the cryopump, and provide for the initial installation.
    - b. consider coverage for the replacement of equipment without major system disassembly.

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[3] The actual PV pumping schematic is shown in Appendix A-4, CC Pumpdown

[4] The cryopump could use upgrade modifications (see EN 291), and if more than one is required its fabrication must be initiated soon.

[5] Make 45 degree bottom plate for the nitrogen vessel and pin to orient the lowest point opposite, and furthest from, the center of the inlet opening, see A-2.

12. Exhaust Vapor Eliminators, Oil Drain Valves
    a. provide sufficient exhaust vapor eliminators for "overnight", frequent, pump downs on at least half the mechanical pumps
    b. provide each mechanical pump oil sump with a convenient drain valve to allow the draining of water

13. Power Loss Isolation
    a. fit all mechanical pumps with NC inlet solenoids
    b. power the inlet solenoid when the motor is powered
    c. test the closure of the inlet valve on power loss
    d. no mechanical pump should pump on the cryostat without a properly functioning power loss solenoid

14. Electrical Service
    a. semi-permanent (ca. 30 day) for pumps, controls, gages, and heaters as re quired.

15. Superinsulation Fixture
    a. design, fabricate, test
    b. modify for EC up and downstream heads, or
    c. universally, if it is to be used to help mount the insulation on both heads

the previously prepared and superinsulation loaded fixture through the roof and fit, interleave, and secure the superinsulation to one head. Repeat the operation for the other head.

SPECIAL NOTE

The actual CC gas load in final leak checking, P about 20 microns, was predominantly hydrogen. Hydrogen has the effect of deflecting the output of the DuPont leak detector negative, precluding its use. We found that the Veeco leak detector wasn't sensitive to the hydrogen and the final leak check was completed using that unit. Dan Markley and the CC Cleanroom Pump logbook should be consulted for further detail.

PRIOR TO VV HEAD, CENTER TUBE, CLOSURE

1. Test, install, and test the "operating" level gauge. Superinsulate as required. Install and test the vacuum cover plate PO until tight.

2. Check and establish that each VV PO is He tight to the inside and the outside before the heads close the vessel. Repair PO's that leak and swagelok cap all PO lines.

3. Blank off the Turbo-molecular pump cart and assure it pumps to 10^{-5} mmHg or less.

4. Fit the connecting vacuum piping from the pump cart to the DP pump port and provide a Leak checking port. Blank at the joint nearest the VV, leak check the line and connections, and repair and replace as required.

AFTER VV HEAD, CENTER TUBE, CLOSURE

1. As soon as the VV heads and center tube have been seal welded AND welded to provide sufficient weld metal to support vacuum loading at the weakest point, the VV should be vacuum pumped. Pumping should resume each time the VV weld shift ends. Secure the weld purge gas as required to begin. Leak check as soon as practical and as required to assure the VV is tight everywhere.

The turbo-cart fore-pump should be fully ballasted to pump water vapor, the mechanical pump should be fitted with effective exhaust oil vapor eliminators to keep from smoking up the room and setting off the fire alarm smoke detectors, and <500 micron pumping should be done with an active, serial, LN2 trap, or not at all. The trap serves to eliminate oil back streaming, and traps and allows a quantitative measurement of the water vapor being pumped.

2. Break the vacuum with a quick, efficient, safe and safety approved arrangement in anticipation of the resumption of welding and reestablish the weld purge as required. The scheduling of this work should allow the welding shift work to begin without delay.

3. Periodically, repeat the leak checking, repair of leaks, and rate-of-rise measurements, at ever greater sensitivity. Temporarily fix all leaks as found. The goal is to put the VV vacuum only on the leak detector with the throttle valve wide open.

4. When the VV head and center tube are completely welded, all the leaks have been properly repaired, all the cleats ground off and removed, and all the "pick-ups ground smooth, perform and carefully document a final leak check.

5. Assemble the 4" DP in place, plumb it with water, power it with electricity, provide a fore vacuum and pump the insulating vacuum at the earliest opportunity. *A 10^{-4} mmHg , or better, vacuum should be required before cooldown is attempted.*

Final Piping Connections

The making of the final piping connections will require breaking the insulating vacuum, the PV vacuum, or both. It is difficult to write a procedure at that level of detail, but it should be clear that all welds defining the boundary of the two volumes are potential sources of leaks. The ultimate tightness of the vessels is a function of the worst, communicating, weld or seal, but you already know that.

Leak checking needs to be repeated, in whole of in part, for each extension of the volume and a final installed leak check performed and documented.

See Appendix A-3 for the final blowdown test of the drain line to assure loose materials that can be displaced by a high velocity gas flow are removed from the system.

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Appendix A-1

C.C. Vacuum Pumping Ports

orig. 5/2/90, rev. 4/8/91

Possible Pumping Port	Dia.[a] In.	Len. cm	Pipe Cond. (cfm)[bd]
1. PV215(P&P)	**2"**	**305**	**85**
2. PV219(Drain)	**1.5"**	**254**	**26**
3. Rupture Disk[f]	2"	240	108
4. Relief	**2.5"**	**315**	**201**
5. Sig. F/T cover	4(*)		
5a. Sig. port	**8"[e]**	**46**	**10,000**
6. HV F/T	2(*)		
6a. HV port	6"[e]	46	
7. Instr. F/T	1(*)		
7a. Instr. port	4"[e]	46	

Notes:

a. (*) indicates a flange diameter to be determined.

b. C=0.182(D**4)(Pbar)/L, l/s for air, D in cm, Pbar is avg. press., microns, and L is length, cm. Accurate for D(Pbar) >500 micron-cm, i.e. to, ca., > 100 microns.

c. Air, D(Pbar) <500 micron-cm, C=12.1(D**3)/L, definitions same as above.

d. Calculated at Pbar = 100 microns.

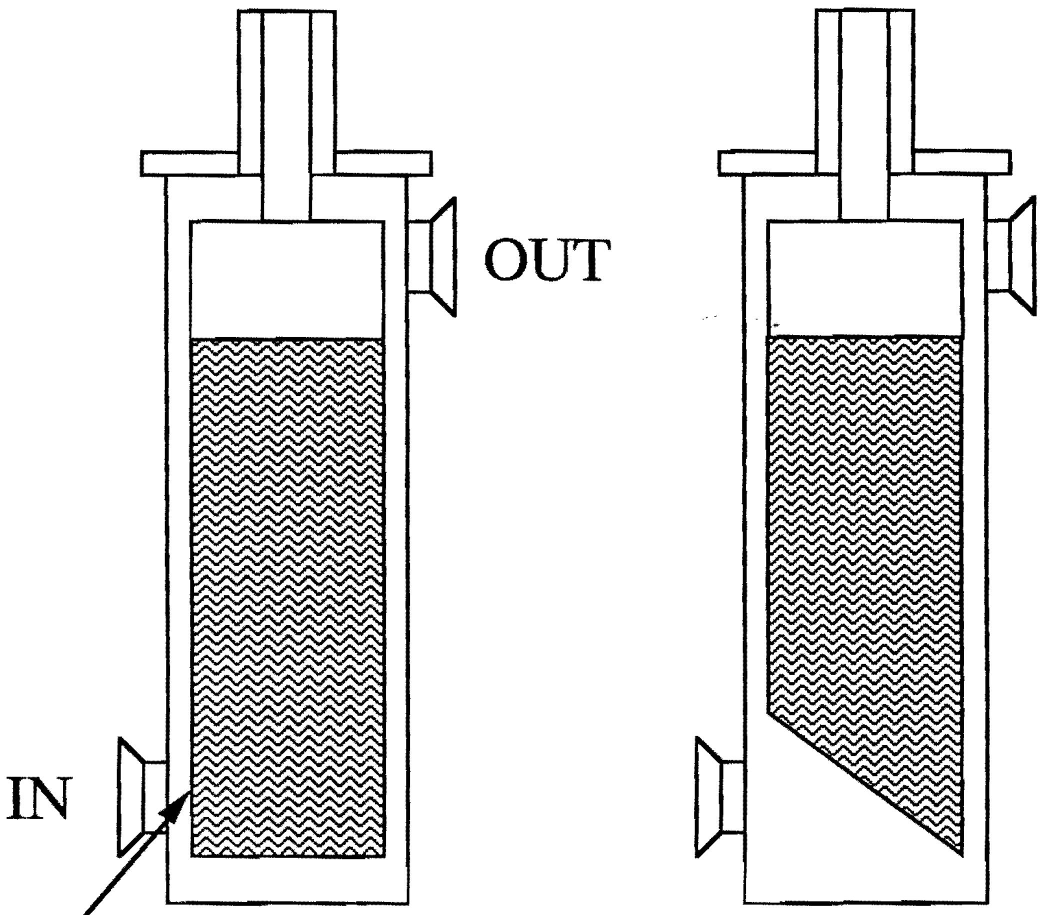
e. As restricted by cables.

f. Must be removed and proper RD's inserted.

Appendix A-2

LN2 Trap Modifications

BEFORE AFTER



Ice buildup and blockage occurs here

The orientation must now be fixed by some mechanical arrangement

Appendix A-3

Drain Line Blowdown Procedure

December 10,1990

Preface

These procedures will be reviewed for safety considerations by T. J. Sarlina.

1. Cap the KF 40 drain line flange.

2. Pressurize the CC to 5 psig from the LAr 100 liter dewar. Stand clear of the Vent line in case the rupture disk blows prematurely.

3. Close the Cold Valve. Isolate the LAr dewar at the dewar.

4. Remove the KF40 cap. Arrange a suitable, lined, vented canister (a trash can with rags in the bottom) about the exhaust pipe and secure it in place against the force of the exhaust stream.

5. Stand clear, open the Cold Valve and exercise the system.

6. Test the effluent for radioactivity. Modify the setup as may required by the results of the test.

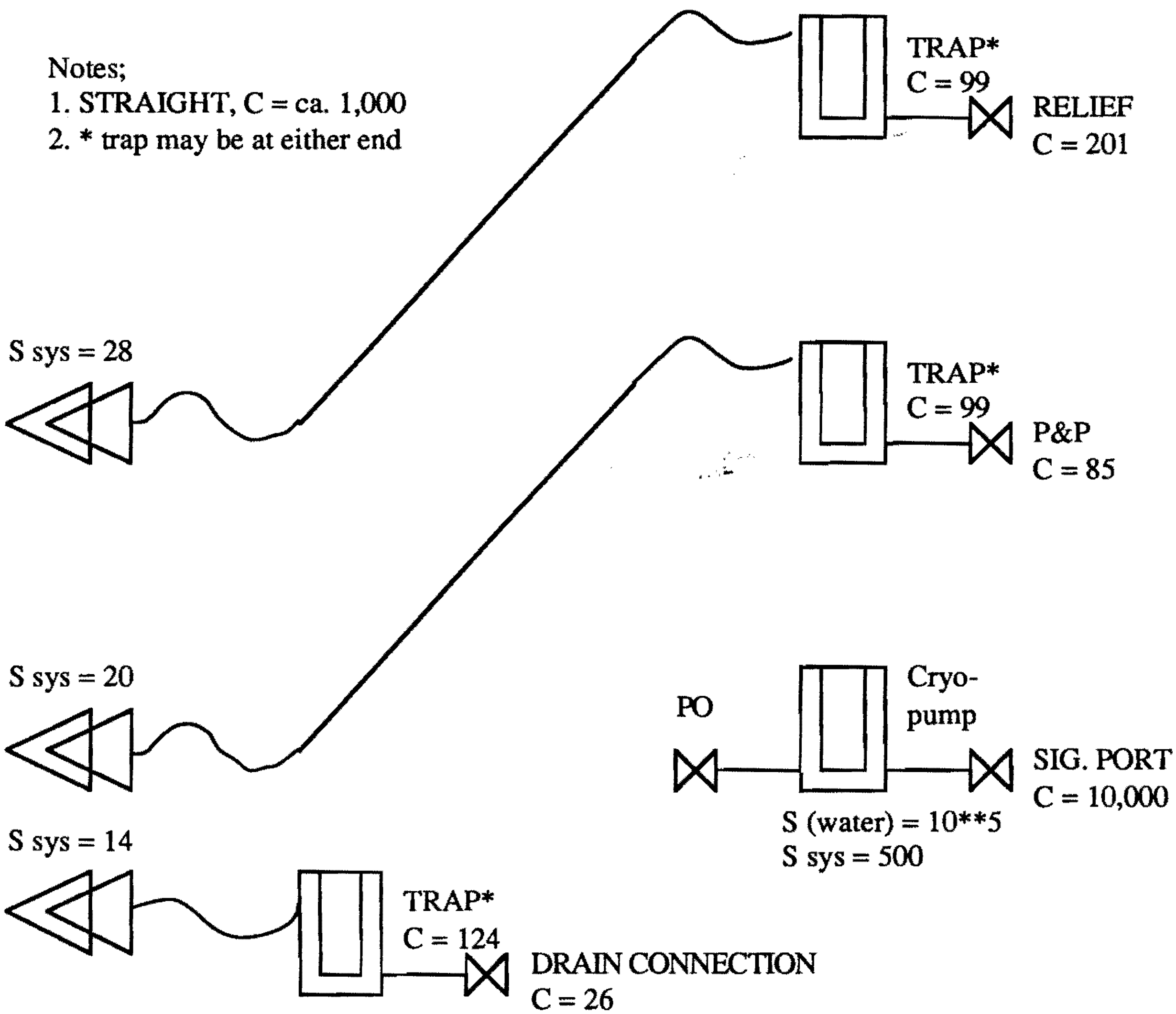
7. If indicated by the results of (6) repeat the test (1-6) for 10 psig.

8. Repeat the test for radioactivity and cleanup and secure the test.

Appendix A-4
CC Pumpdown

May 30,1990

ALL SPEEDS AND CONDUCTANCES IN CFM



Note;

1. all the powered pumps have power fail soleniods and TC gages at the pump.
2. the power fail solenoids have an approximate C = 149 cfm

Appendix A-5
CC Cleanroom Vacuum System