DØ SOLENOID UPGRADE PROJECT

Control Dewar

Secondary Vacuum Container

D-ZERO ENGINEERING NOTE # 3823.111 EN-353

Oct. 4, 1993

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INTRODUCTION

This engineering note provides background information regarding the control dewar secondary vacuum container.

BACKGROUND

The secondary vacuum container has its origin with the CDF control dewar design. The name secondary vacuum container replaced the CDF term "Watt can" which was named after Bob Watt (SLAC), a PAC/DOE review committee member who participated in a review of CDF and recommended a secondary vacuum enclosure.

One of the most fragile parts of the control dewar design is the ceramic electrical feed throughs located in the secondary vacuum container. The secondary vacuum container is provided to guard against potential leaks in these ceramic insulating feed throughs. The secondary vacuum container has a pumping line separate from the main solenoid/control dewar insulating vacuum. This pumping line is connected to the inlet of the turbo pump for initial pumpdown. Under normal operation the container is isolated. Should a feedthrough develop a small leak, alternate pumping arrangements for the secondary vacuum container could be arranged.

The pressure in the secondary vacuum container should be kept in a range that the breakdown voltage is kept at a maximum. The breakdown voltage is known to be a function of pressure and is described by a Paschen curve. I cannot find a copy of the curve at this time, but from what I remember, the breakdown voltage is a minimum somewhere around 10^{-3} torr. Ideally the pressure in the secondary vacuum can should be kept very low, around 10^{-6} or 10^{-7} torr for maximum breakdown voltage. If however a leak developed and this was not possible, then one could operate at a pressure higher than the minima point.

REFERENCE DATA

The secondary vacuum container for the D-Zero solenoid will be similar to the CDF design. Figure 1 shows a cut-away view of the secondary vacuum container. The figure is labeled to identify the arrangement of the stainless steel bellows, ceramic insulators, and aluminum to stainless steel transition piece that together form the electrical feed throughs. Figure 2 shows the upper part of the lead in the liquid helium reservoir. A G-10 sleeve covers all but the very ends of the conductor in the reservoir.

Some relevant CDF documents are appended to this note. They discuss the history and plans of how to deal with a very small leak that is known to exist in the CDF secondary vacuum container.

FIGURE 2

(DIMENSIONS IN MM)

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Cryogenics Department--MS 219

Wilson Hall 11 West--Ext. 4849

WATT CAN

A1

January 29, 1992

TO: Kurt Krempetz
FROM: Richard Schmitt *RL*
SUBJECT: CDF Watt Can

After today's meeting, you might be interested in this 1988 summary of the Watt Can history and status (attached).

RLS/em

cc: R. Fast
R. Rucinski
R. Sanders
B. Squires
R. Stanek
A. Stefanik
R.P. Smith
D. Markley
R. Yamada

Fermilab

Cryogenics Department — MS#219
Wilson Hall 11th Floor — Ext: 4849

February 15, 1988

To: W. Fowler
From: R.L. Schmitt *R.L. Schmitt*
Subject: Watt Can Status

This transmittal is to formalize our plans regarding the Watt Can.

Purpose

The function is to provide a secondary vacuum enclosure around the ceramic power feedthroughs. Refer to RWF's letter of 2/11/88, attached.

History

During the last physics run, there was an electrical breakdown. It occurred during a routine check of the solenoid. Investigation determined that the breakdown voltage was a function of pressure in the Watt Can. The shape is typical for a Paschen curve. A copy of the logbook data is attached.

The physics run was completed using a vacuum pump system to keep the pressure low. It was low enough to keep the breakdown voltage above 600 V, magnet to ground. The leak was so small that the Watt can was only pumped out for two minutes every two to three weeks.

Plans for the Upcoming Operation

We have made plans to deal with the leak, whether it stays the same or gets worse. The attached data and plans of 11/16/87 summarize them. The specific changes have been made on the process and instrument schematic.

Since this plan was made, we have attempted to measure the leak with the magnet warm. The leak was immeasurable. The vacuum pump system is completely installed and the breakdown voltage at various pressures will be measured before the magnet is energized.

cc: R. Fast, J. Norris, R. Stanek, R. Sanders, R. Kephart,
J. Urbin, K. Krempetz, R. Scherr, C. Bonham, G. Tool

Fermilab

Cryogenics Dept. - MS #219
Wilson Hall 11th Floor - Ext. 3381

February 11, 1988

TO: W. B. Fowler
FROM: R. W. Fast *RW Fast*
SUBJECT: Origin of the "Watt" Can

On November 6, 1982, there was a PAC/DOE review of CDF. Bob Watt (SLAC) was the member of the review committee who reviewed the superconducting solenoid, cryostat and refrigeration system. My meeting notes show that Bob recommended a secondary vacuum enclosure around the ceramic power feedthroughs, and the committee report formalized this recommendation.

I cannot determine whether the Fermilab Cryosafety Review Panel, chaired at that time by Roger Dixon, received a copy of the committee report. The minutes of panel meetings in November and December make no reference to it.

As far as I can remember and/or reconstruct the chain of events, the Cryosafety Panel did not require that we accommodate the recommendations of the PAC/DOE committee, but we did anyway. Single O-rings leading from the ambient into the main insulating vacuum were either eliminated or changed to double O-rings with an intermediate pumpout. Hitachi designed and later fabricated a secondary vacuum vessel around the feedthroughs in the bottom of the central dewar. We named this secondary vessel the "Watt" can.

RWF/lls

cc R. Schmitt

Encl.

III. The Coil and Cryogenic System

The cryogenic system includes the coil and cryostat, vacuum tank and the refrigeration system.

The purpose of the system is to provide a magnetic field whose value is guaranteed to be 1.3 Tesla with an operating value as high as 1.5 Tesla.

1. The refrigeration system is a duplicate of the Energy Saver Satellite which has been operated for a few months. The refrigerators have reliability problems but presumably these will have been solved by mid-1984 in time for the magnet tests.

2. The coil is a new design where the current carrying conductor is wound inside of a support tube rather than the customary outside winding (see Fig. 1). This design takes advantage of the magnetic forces on the conductor to push the conductor out against the support tube which is the source of cooling for the coil. In the present proposal there will be about 3mm of filled epoxy between the coil and the support tube through which the coil-produced heat must be conducted to the refrigerator loops. If this epoxy were to be put in tension or crack for some other reason, it is quite probable the heat conductor path would be ruined. If enough area is involved, the coil could be very marginal in its thermal stability. It would be well worth the effort if a scheme could be devised to pull the

support tube out radially during the epoxy curing, so that on releasing the radial tension the support tube would put the epoxy in compression.

When cold, the coil and support surface at 4.5°K is very large and has a pumping speed for freezing nitrogen of several million liters per second. If a leak of a few standard cc/sec developed in a nitrogen line, one would not detect it and it may be possible to freeze a large amount of nitrogen ice on the cold surface. During a quench, this ice would melt and fall to the bottom. If care is taken in wrapping the radiation shield so that it is also a reservoir to collect the liquid it would not fall on the warm vacuum tank below. A pressure rise in excess of 3 psi may cause the inner vacuum tank wall to collapse and the above precaution could prevent such a pressure rise.

3. The vacuum tank is well designed and except for the inner wall limitation mentioned above has only two other problems that are obvious.

There will be a large number of "O" ring seals used on the radial support adjustments. The use of double "O" rings and pump outs could guarantee the vacuum integrity at these points.

The power lead-in points in the control dewar will contain a ceramic insulator on each power lead and the insulators will quite probably crack at some time and cause

a vacuum leak (see Fig. 2). An effort should be made to enclose each of these insulator systems in an outer secondary insulator so the region can be pumped in the event of a leak.

4. In summary, the magnet design is going along quite well and with some attention to these modifications it should be a good final design. The final design review is scheduled for March 1983 with construction to start soon after.

The Hitachi group is planning a large scale prototype to test the techniques of inserting the coil in the support tube and impregnating the system with epoxy.

IV. Electron and Hadron Calorimetry

Energy measurements are to be made in three distinct regions: the central region (30° to 150°), the end plug region (10° to 30°), and the forward region (2° to 10°). All three regions are to be equipped with both electromagnetic and hadronic calorimeters. In the central region, the showers are sampled with plastic scintillator whereas everywhere else, gas chambers are used.

Calorimetry is of obvious importance and the choice of uniform and fine granularity in rapidity-phi space is well suited to the expected event configurations. The committee heard a presentation from H. Jensen regarding beam tests on the end plug calorimeter.

WATT CAN PRESSURE RISE

Facts

1. Approximate leak rate measured, 1×10^{-6} ATM cc/sec of helium. Based on rate of rise during Spring 1987 run.
2. The leak is helium. Any other possible gas would have a much lower vapor pressure at 4.5K. In addition, the gas is easily pumped out.
3. The breakdown voltage must be at least 400v.
4. The distance between leads is about the same as the distance to ground.
5. The pumping frequency in Spring 1987 was about 3 weeks.

11-16-87

If the leak remains the same:

1. Install a turbomolecular pump cart, valves and gauges on the watt can. Normally, the pump will be valved off. When the pressure gets too high, pump out the can and reclose the valves. The pumping is about every three weeks.
2. With better vacuum gauges, repeat the high pot tests and confirm the Paschen curve to determine the operating limits, both at high and low pressure.
3. Get spare insulators and other parts needed to rebuild the watt can.
4. Check for gross leakage with the magnet warm.
5. Consider coating the can interior.
6. Consider addition external volume to slow the pressure rise.

If the leak is twice as bad:

Same procedure as no change, above.

If the leak is twenty times worse:

1. The watt can would be pumped daily or continuously.
2. A spare pump cart would be needed.
3. If the pump failed, the pressure rise would be about 5 microns per day, allowing a one day period to repair or switch pumps, requiring access to the collision hall.
4. A slight chance of air leakage is possible. If it were bad, a magnet warm-up would be required. Proper valves and interlocks will keep this possibility low.

If the leak is 400 times as bad:

1. The response time would be about one hour. This would require a magnet slow trip immediately after a pump failure.
2. All else the same as above.

If the leak is much worse, than 400 times as bad:

1. The leak is so bad that the pump cannot give us a reasonable time to trip the magnet before the pressure exceeds 8 microns.
2. Backfill the watt can to about 900 microns and maintain this pressure.
3. Move the turbomolecular pump to the main insulating vacuum and use it if necessary. A valve is being added for this.
4. If the leak is bad enough, use a back-up pump.
5. At the end of the run, remove the bottom of the dewar and repair the watt can.

R2A 11-16-87