D-Zero High Voltage Electrical
Feedthrough Leak Detection Fixture

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Approved: [Signature]
Introduction:

The high voltage pee-wee connectors to be welded into the cryostat must not allow any air to pass into the inner volume of the cryostat. Therefore each must be leak checked before installation. Since the connectors may be exposed to LAr temperatures, they should be tested under cryogenic conditions. In order to perform such a test, it was necessary to design and build a test fixture and test it. An integral part of this test fixture was the seals employed between the feedthrough and the fixture. Three varieties of seals were tested: silicone o-rings, glass impregnated teflon o-rings (Fluorogreen), and c-seals. All had dimensions of ID = 15/16", OD = 1-1/16", and 1/16" free height and were tested using a 0.100" shim (3740.515-MC-273904-2), except where noted. Since no complete feedthroughs were available at the time of the test, a "cup" was welded into the top of a feed through shell in order to test the fixture. Later, a finished feedthrough was tested.

The Test Fixture:

The test fixture had to be designed to several specifications. Since 320 feedthroughs will have to be tested twice (once by Reynolds Ind. in California, once by Fermilab), the test had to be relatively quick. Obviously, it had to be nondestructive. Since leaks of order 10^-8 atm * cc He / sec. through the connector are a concern, the fixture ought to seal to 10^-9 or 10^-10 atm * cc He / sec. The test fixture also had to accommodate Reynolds' leak detection equipment, thus the stainless steel base (drawing call #10) was designed with appropriate ports and threads. A brass spanner nut (#3) was made in such a way as to push down on the flange (protruding from the middle of the feedthrough shell) via a stainless steel split ring (#2). This left the top of the fixture exposed so that LN2 could be poured onto the top of the feedthrough. One of three sized stainless steel rings (#5, #6, #7) is placed in the fixture underneath the flange in order to protect the feedthrough from bottoming out. A brass washer (#1) was made to go on top of the split ring to insure that the compression is evenly distributed and that the spanner nut and split ring do not wear. A brass guide ring (#8) that threads onto the lower half of the feedthrough was included to insure that the feedthrough came down on center. Two identical fixtures were fabricated, one for Reynolds Ind. and one for Fermilab; both fixtures work equally well.
Seal Test:

The test consisted of several steps:
1) assemble and rough pump the fixture and seal
2) spray with GHe (quick warm check)
3) determine a Minimum Detectable Leak (MDL)
4) tent fixture and flood with GHe (thorough warm check)
5) remove tent
6) fill cup with LN2 - allow to cool down
7) spray with GHe while keeping LN2 in cup (cold check)
8) allow to warm up and spray with GHe

Seals that did not pass the quick warm check (step 2) did not proceed to further steps (except where noted). A chart recorder which was used to record leakage rates was occasionally turned off during calibration periods, warm up periods, and other noncritical times (this often resulted in unimportant spikes after a calibration as the system cleaned up and graphing multiplication factors were adjusted). It was noticed that, occasionally, the graphed baseline would shift after a calibration while the He level as shown on the leak detector gauge seemed unchanged. For this reason a new baseline was established after calibration. Each horizontal major line on the graph paper represents 10 units of He flow; each major vertical hash represents 15 seconds.

Silicone O-rings:

The silicone rings (part number 2-021, material S0899) were obtained from Parker Seals ((606) 269-7510). They are to seal to about -175 °F. They were primarily selected for their low cost ($0.32 each). Of four tested, none sealed warm due to insufficient contact area because of the feed through's geometry. One, under inspection with a magnifying glass after a failed attempt at sealing, was discovered to have a deep nick in the material. It is believed that this nick was present before the sealing attempt since none of the other samples showed such wear either before or after testing. All attempts to seal were made over the full range of ring compression. One attempt was made to seal an o-ring cold; it failed. One attempt was made using the 0.095" shim (3740-MC-273904-1); it failed.

Fluorogreen:

The teflon o-rings were obtained from United Polymer, Inc. ((713) 466-5401). They are to seal at about 0 K. They were selected for their price ($2.49 each) and their ability to seal at extremely cold
temperatures. Of two tested, neither sealed.

C-seals:

The c-seals were bought from EG & G Pressure Science ((301) 937-9551). They were selected for their high reliability and excellent sealing characteristics at cryogenic temperatures. They cost $7.44 each. Of five seals tested, only one (c-seal 03, see below) showed a significant leak rate. Two attempts were made to reuse c-seals; both failed.

C-seal 01 was placed in the fixture and the spanner nut turned hand tight prior to testing. It had wear marks easily visible to the naked eye, yet it still sealed warm for 1 minute and cold for nearly 10 minutes. Maximum leak rate: less than 5.90*10^{-10} (atm * cc He)/(sec). An attempt to reuse the c-seal failed.

C-seal 02 was taken from the package and immediately sealed under light compression with the spanner wrench. Maximum leak rate: 1.22*10^{-10} (atm * cc He)/(sec).

C-seal 03 may not have sealed. The first attempt to check it was made with the seal under light compression (hand tight). The seal leaked and the fixture was flooded with Helium. The pump was not cleaning the system out so the fixture and the c-seal were disassembled and cleaned with acetone. The fixture and seal were reassembled and compressed slightly with the spanner wrench. The system was still slightly contaminated, but no gross leaks (such as the one seen before) were detected. The fixture was again disassembled, cleaned, and fitted with c-seal 04 which sealed perfectly. No printout for c-seal 03 was made since the He contamination made it difficult to prove that it had sealed warm.

Maximum leak rate for c-seal 04: less than 8.0*10^{-10} (atm * cc He)/(sec).

Maximum leak rate for c-seal 05: less than 8.9*10^{-10} (atm * cc He)/(sec).
A failed attempt was made to reuse c-seal 05.

Fixture Test:

The second fixture was tested to insure that it was capable of sealing. It was tested once with a c-seal and found to have a maximum leak rate of less than 1.7*10^{-9} atm * cc He / sec.

Prototype #4 which had failed electrically was tested once in one of the
fixtures to prove that the fixture did not damage the feedthroughs. The leak detector was kept on the 10000 times scale throughout the test. No leak was detected when the feedthrough was placed against a vacuum plate with a rubber seal. No leak was detected when the feedthrough was placed in the fixture, tented and flooded warm. No leak was detected after flooding with LN2. No leak was detected after allowing the feedthrough to warm up.

**Fixture Instructions:**

1) Measure the distance between the bottom of the feedthrough and the top of the flange. If the distance is 0.450 in. or less, use the 0.095 in. stop shim. If the distance is between 0.450 in. and 0.445 in. use the 0.100 in. shim. If the distance is more than 0.445, use the 0.105 in. shim. Replace stop shim in fixture with proper shim.

2) Replace c-seal in fixture with new seal.

3) Thread guide ring onto lower half of feedthrough until contact occurs between ring and feedthrough flange.

4) Place split ring into feedthrough groove above flange.

5) Place feedthrough, guide ring, split ring assembly on top of c-seal in test fixture.

6) Tighten spanner nut with provided spanner wrench to 30 ft*lbs. **DO NOT EXCEED 60 FT*LBS!**

7) The feedthrough is now ready to test.

**Conclusion:**

Obviously neither type of o-ring will work for our application. It will be necessary to pay the premium for the c-seals in order to test the high voltage pee-wee connectors. An adequate compression will be necessary in order to not waste the seals by contaminating them with He. Although no torque wrench was available to make an accurate measurement, we estimated that approximately 30 ft*lbs consistently sealed the c-seals. Any attempt to reuse the seals appears to be a waste of time. Both fixtures appear to work equally well. If used properly, the c-seals and test fixtures ought to seal adequately and reliably.
scale?

+4b

+Removal Test

Teased & Sprayed with He.

+X1

Closed Cal. Leak

M.D. = 5.90 x 10^-10

+2.9 x 5

Closed Cal. Leak

Open Cal. Leak 2.19 x 10^-8

+X1

C-Seat

Warm

C-Slot 61