Cable Penetrations

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revised April 4, 1993

SNO-STR-93-004

Introduction

We have constructed a prototype section of a cover plate with three cable feed-throughs, each carrying a bundle of seven cables. The cover plate section sits on four pieces of stainless steel angle iron welded together into a square to simulate the deck I-beams. The critical dimensions are as Drawing Number 17-702-H-6447 Sheet 3, Rev 0. The assembly has been sealed into an acrylic box to allow for simulation of pressure changes while keeping the bottom side visible. The cover gas system is designed to maintain a pressure differential of $\frac{1}{2}$" water gauge at all times.

The section of cover plate has been tested under small pressure differentials and has been shown to be leak tight. This prototype represents 0.22% of the total cable penetrations anticipated in the deck of SNO. Scaling up gives a limit on the cover gas leakage under a pressure differential of $\frac{1}{2}$" water gauge of less than $10^{-7} l \cdot s^{-1}$.

What follows is description of the prototype construction, which will be matched by production, and the nature of the tests.

Feedthroughs

The conduits are based on a mass-produced PVC $1\frac{1}{4}$-1" reducing bushings and will each contain seven RG59 cables. The dimensions are:

1.66" OD (as per drawing)

1.875" lip across the flats (1.9375" on the drawing)

1.5" long (1.6875" on the drawing)

1.375" ID (1.3125" on the drawing).

We obtained ours from Beaver Lumber with a part number SCH40 D2466.

The cables used were from Belden with a black jacket made of T-12093 base resin with a 1% T-12094 stabilizer package. On each one was secured about $2cm$ of $\frac{5}{16}$" diameter heat shrink to aid bonding in the conduit.

A gasket was made out of 0.125" hard rubber in the form of a circle 1.375" diameter with seven $\frac{17}{64}$" holes drilled in to accept the cables. The gasket was slit from the edge to the holes so it could be mounted on the cable bundle without access to the cable ends.

The cables and gasket sat on a flange inside the conduit. This was initially fixed in place by a small amount of 5 minute epoxy, then the conduit was filled with Scotch-Weld 3M 2216 with a 1.5 hour working time and a 24 hour curing time.

An earlier plan to have a gasket on the top of the conduit has been abandoned as an unnecessary complication. Apart from this and small differences in conduit dimensions, what we have done is exactly as in Bob Willmott's drawing.

Samples of this bond have been tested by hanging weights on the end of single cables. In one case a $3.34kg$ weight has hung from a sealed-in cable for a month with no sign of the cable sliding. This fixture seems capable of withstanding careless handling. During the filling period the cables will hang on the conduits with a weight of approximately $12kg$ per bundle or $1.7kg$ per cable (Willmott) for several months.

Cover Plate

The cover plate had stainless steel rod welded around the edge as per the design. This lay on the angle pieces, bonded in place with a bead of Loctite Ultra-Black 598 RTV silicone (acetic acid free). The silicone prevented movement during handling.

The three conduits were placed in three holes in the cover plate, again sealed with the silicone. The ends of the cables had been sealed to prevent a leak path through them.

The joints between the cover plate and the angles were liberally covered with Fire Stop (Dow Corning self-levelling sealant 2003). In production, this should also be done to the PVC conduits; it was not necessary for the prototype, but 1400 conduits are hard to check on. This fire stop set to a rubbery consistency and was easy to pull off to correct mistakes. Another type tested, Thermalastic 83E, by contrast, was a mess.

Tests

The top of the assembly was filled with 1" of water and the bottom was pressurized to 6" water gauge. Thus there was a 5" differential (10 times operating level), and the top could be inspected for bubbles. None were seen in a reasonable observing time, say ten minutes. The assembly was also observed to hold its pressure for many hours, although changes in atmospheric pressure and temperature make this a qualitative observation.

If we assume bubbles to be of the order $1mm$ in diameter, one bubble in ten minutes would constitute a leak of $10^{-7} l \cdot s^{-1}$ for the entire deck under $\frac{1}{2}$" water gauge. This is a tiny rate and we can only assume that the leak will be dominated by some as yet unanticipated effect.

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March 31, 1993

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