Flexible Membrane and Universal Interface Seals

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Introduction

The SNO detector is lined on the bottom and sides with Urylon. The top deck has its bottom sealed with Urylon. Thus there are three remaining places where the detector has to be sealed against the mine air — (1) the gap between the Urylon sides and the deck bottom, (2) the gap between the deck and the acrylic vessel neck, and (3) the Universal Interface which penetrates the deck and is used to insert calibration sources, etc. For the gap between the detector sides and the bottom of the deck and the gap between the deck and the acrylic vessel neck, it is planned to use a flexible membrane. To seal the Universal Interface, a gasket sealing material is to be used.

The choice for the flexible membrane and universal seal will be made based on the material's mechanical strength (creep, swell, tensile strength, flame resistance, etc.), its flexibility, compatibility with the other materials it will be in contact with, permeability, radon emanation rate, etc.

This report makes material recommendations for the flexible membrane and Universal Interface seals from a **radon emanation point of view only**. A material which has an acceptably low radon emanation rates may not meet the other criteria (mechanical strength, flexibility, etc.)

Flexible Membrane

The area (one-side only) of the flexible membrane between the deck and the acrylic vessel neck has been estimated to be 84.87 ft^2 (7.88 m^2) in a Monenco April 15 memo. If this membrane is a filled elastomer (similar to Buna-N or Viton) then the ^{222}Rn emanation rate could be around 2000 Rn $m^{-2}hr^{-1}$ (it is believed to mainly come from the carbon-black and clay fillers used to give the elastomer its hardness). The equilibrium level of ^{222}Rn emanated from 7.88 m^2 of elastomer is then

$$2000 \times 7.88 \times 3.8 \text{ days} \times 24 \text{ hr} / \ln(2) = 2.1 \times 10^6 \text{ Rn}.$$

If 3% if these goes into the D_2O, we have 6×10^4 Rn going into the D_2O from the membrane. (Under completely static conditions about 25% of the radon goes into the D_2O according to Henry's Law.) Compare this to the 6×10^4 Rn in the D_2O due to a level of 10^{-14} gU/g and one sees that the membrane is a significant source of radon.

We conclude that the membrane material used for the gap between the deck and the acrylic vessel neck should not emanate more than 20 Rn $m^{-2}hr^{-1}$. Urylon is acceptable from a radon emanation point of view. To prevent radon from the mine air permeating through the Urylon, it should be more than 0.2 inches thick.

Alternatively it could be 0.030 inch thick on a clean thin metal backing. Whether the Urylon will have enough flex to take up movements of the deck needs to be looked at from an engineering point of view.

Urylon is also acceptable (from a radon emanation point of view) for the flexible membrane between the Urylon coated sides of the cavity and the deck bottom.

Universal Interface Seals

The area of gaskets used in the Universal Interface seals is estimated to be 1.05 ft^2 (Monenco April memo) or 0.093 m^2 which is small compared to the flexible membrane area. Hence radon from the Universal Interface seals is not expected to be a problem. Foamed silicon rubber or urethane are acceptable from a radon emanation point of view. The gasket should be thick enough that radon in the mine air does not permeate through it at a significant rate.

Radon Emanation Testing

If there are other candidate materials for the flexible membrane, samples should be purchased (minimum 1 m^2) and sent to the WET Lab (Queen's) for radon emanation measurements.

Please note that many classes of materials fall under a generic name (eg. polypropylene, teflon, etc.) but the exact composition (additives, colors, catalysts, etc.) is very supplier and product dependent. Hence as close to the actual proposed material to be used should be measured.