Calibration and the D_2O Cover Gas

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1 Conversion Factors

D_2O inside the acrylic vessel	1000 tonnes
D_2O inside the neck	7.3 tonnes
Volume cover gas between D_2O and deck	4 m^3
Volume of calibration source box	6.5 m^3
1000 T D_2O at 1×10^{-14} gU/g	6×10^4 radon
2 pCi/liter	70000 Rn/liter

Cover gas has to be at 2×10^{-5} pCi/l

Storage time	Factor 10	12.6 days
	Factor 50	21.4 days
	Factor 100	25.2 days

2 Radon Emanation from Calibration Box

The number of radon emanated in several hours from the materials which make up the box, the cables, the calibration source, etc. is small compared to the amount of radon in the D_2O.

3 Radon Absorbed onto the Surfaces

The surface area is about 20 m^2. Typical outgassing rates quoted in vacuum technology textbooks are around 5×10^{-6} m^3/ m^2hr. Virtually all this outgasing is water. If we assume 10% of the outgassing is air, then when the source is used for 4 hours, the total amount of air that is outgassed from the surfaces is 0.04 liters. This means there will be 3×10^3 radon atoms outgassed which is small compared to 6×10^4 radon supported in the D_2O at 1×10^{-14} gU/g.

4 Lowering the source into the D_2O

Assume the source box is initially up to mine air (2 pCi/l). Then there are about 4.6×10^8 Rn atoms in the box.

(a) Worse case

If the water circulation in the acrylic neck is such that radon in the cover above the D_2O is quickly carried down into the main body of the acrylic vessel, then we have to reduce the 4.6×10^8 radon atoms down by a factor of 10^4. This means that the flushing the box with cover gas has to be 99.9999% effective in removing the radon which probably is not achievable in practice.

(b) Best case

We can probably flush effectively with cover gas to bring the radon down by a factor of 100. Then if the water circulation in the neck can provide a 25 day delay of the radon, the 4.6×10^8 radon originally in the box will not be a problem.

We conclude that because there is so much radon in the mine air, we must always have the calibration source box filled with cover gas and leak tight.