Estimates of Emanated Radon Load

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March 27, 1992

SNO-STR-92-016

We estimate how much ^{222}Rn is emanated by the materials submersed in the H_2O. The ^{222}Rn emanation rates are the measured rates into a vacuum taken from the December 1991 Summary Report on Radon Emanation (SNO-STR-91-083).

Inside the PSUP

(Between the acrylic vessel and PSUP)

	Area m^2	^{222}Rn per m^2 per hr	^{222}Rn/hr
Acrylic vessel	452	<0.1	$<5 \times 10^1$
Rope	180 m	< 0.3 m^{-1}hr^{-1}	$< 5 \times 10^1$
PMTs	473	<1.6	$<8 \times 10^2$
Reflectors	673	0.65	4.4×10^2
Plastic PSUP	3665	0.8	2.9×10^3
S. Steel	410	<0.3	$<1 \times 10^2$
Dust ($0.4\ \mu g/cm^2$)	5673	44 g^{-1}hr^{-1}	1.1×10^3
Total			$<5.4 \times 10^3$ Rn/hr *

* This is $<7.1 \times 10^5$ radon supported (or 0.7×10^{-13} gU/g or 0.4 Rn/liter)

We have not included the radon contribution from the water purification system. Recirculated water will enter the inside of the PSUP at two positions away from the acrylic vessel. Locally there could be a "hot" cloud of incoming recirculated radon-laden water but the PMTs will not see this if it is more than one meter from the acrylic vessel.

The above total emanated radon can be compared to 1700 tonnes of H_2O inside the PSUP at 15.0×10^{14} gU/g which supports 1.5×10^6 radon.

Outside the PSUP

(Between the PSUP and cavity liner)

	Area m^2	^{222}Rn per m^2 per hr	^{222}Rn/hr
S. Steel	650	<0.3	<200
Coax cables	1.9×10^5 m	0.06 $m^{-1}hr^{-1}$	1.1×10^4
Plastic liner	2000	2	4×10^3
Plastic PSUP	1250	0.8	1.0×10^3
Dust (4 $\mu g/cm^2$)	6400	44 $g^{-1}hr^{-1}$	1.1×10^4
Total			2.7×10^4 Rn/hr *

* This is 3.6×10^6 radon supported (or 3.5×10^{-13} gU/g or 2 Rn/liter)

(The coax cables will be bundled and the exposed area is estimated to be 2500 m^2)

If the cover gas contains 2×10^{-4} pCurie/liter of radon, then it contributes an equivalent of 1×10^{-13} gU/g to the water (see B. Sur, Some Elementary Considerations about Cover Gas).

The dust outside the PSUP will be hard to clean up so there is a range (1 to 10 $\mu g/cm^2$) in the estimated cleaning level which can be achieved. We have chosen 4 μg of dust per cm^2 which matches the contribution from the cables.

The above total emanated radon can be compared to 5300 tonnes of H_2O outside the PSUP which will be at least 15.0×10^{-14} gU/g and which will support at least 4.8×10^6 radon (or about 0.9 Rn/liter).

Note that the present liner design goal is to have the contribution from radon penetrating the liner will make the water outside the PSUP no worse than an equivalent of 10^{-13} gU/g.