Backgrounds from the Deck Region
SNO-STR-92-096

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December 8, 1992

Since the initial shielding calculations were done the relative heights of the light and heavy water have been moved apart to a separation of about 2 m. To compensate for the loss of water shielding that resulted from this, the light water level was moved up closer to the top of the cavity. These changes were first modelled in an investigation of the shielding available for calibration sources placed over the vessel neck [1]. The information provided in that report makes it possible to make a reasonable estimate of the deck region contribution to the total external background. The purpose for doing this at this time is to evaluate the cost-effectiveness of boronated concrete in the deck.

Calculation

Early background calculations [2] indicate that neutrons from the walls interacting with 0.25" thick steel plating produce of the order of 200 γs per m^2·day above 7 MeV entering the cavity. This number can be doubled to account for γ rays from 5 to 7 MeV. The amount of steel in the deck with the present design is about 51 tonnes, so it is equivalent to a deck covering approximately 1" thick (except over the neck).

Attenuation factors have been calculated for three positions on the deck in the neck region [1]. Making the reasonable assumption that the attenuation factors follow a simple exponential radial dependence in the segment over the neck and for radii greater than that of the neck, an analytic expression can be used to describe the attenuation factor for γ rays from the deck steel reaching the detector. From that it is possible to make an analytic calculation of the contribution to the external background from the deck region.

In order to make a pessimistic estimate of the deck contribution to the total external background, attenuation factors of 2.6×10^{-7} for a source position at the center of the deck, 1.1×10^{-7} at a radius of 75 cm, corresponding to the position of the neck acrylic and 7.9×10^{-10} at a radius of 1.75 m were used [1]. These values are for 7 MeV γ rays with scatter down to 5 MeV even though the source strength includes γ rays down to 5 MeV. Correcting for the fact that the steel source term is for a 2π source, using these approximations and assuming that the total mass of steel is uniformly distributed from a radius of 1.2 m (inner steel deck ring) to 10 m, a value of $8\times10^{-5}\gamma$s (E $>$ 5 MeV) per day enter the detector. This is very small compared to the estimated total external background([3] of $3.8\times10^{-2}\gamma$s per day.

This implies that boronation of the concrete in the deck (which was introduced in order to reduce the γ ray flux of (n,γ) γ rays from the deck) should only be used if it does not incur any significant cost or installation time penalties.

Neck Cover Background Estimate

Using the above attenuation factors it is also possible to estimate the contribution to the total external background from the platform material over the neck out to the inner steel ring. Assuming an average thickness of 1/4" of steel or equivalent, a total of $3.3\times10^{-4}\gamma$s (E $>$ 5 MeV) per day enter the detector, with approximately 2/3 coming from the part directly over the neck. This constitutes approximately 1% of the total external background, and is four times greater than the contribution from the rest of the deck. (At the same 1" thickness it would be 16 times greater.) This indicates that if the neutron flux from the dome is to be reduced it should be done over the neck before considering the rest of the deck.

Conclusions

Since the criterion for taking corrective action on other contributions to the external background was a 10% increase, it can be concluded therefore that it is unneccessary to use boron concrete in the deck and it is unnecessary to use boron shielding over the neck unless the steel equivalent for the cover over the neck reaches a thickness of 4".

References

[1] I. Stairs, P. Skensved and B. C. Robertson, **Background γ-rays from Calibration Sources Stored Above the Detector**, SNO-STR-92-065.

[2] P. Skensved and B. C. Robertson, **Shielding Report**, July 1987.

[3] P. Skensved, H. Lee, B. Bray, E. T. H. Clifford and B. C. Robertson, **Detailed Cavity Background Evaluation**, SNO-STR-90-102.