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SOME CONTROLS ON THE REMANENT EXPOSURE RATE IN ACCELERATOR ENCLOSURES

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Personnel working inside accelerator enclosures after beam turn off are exposed mostly to gamma rays. Those people actually handling accelerator components will also absorb doses from beta rays.

The gamma exposure rate has two sources: the accelerator itself and the enclosure.

There is little choice in the components of the accelerator itself (mostly Fe and Cu). However, one has some control over the ingredients of the concrete. The use of low-Z materials leads to few long-lived spallation products. Hence the use of limestone is a natural choice. Fortunately, limestone is competitively priced with other aggregates in this part of the country.

Once the main ingredients are fixed (water, cement, coarse aggregate, fine aggregate) for the concrete, a study of possible troubles caused by impurities is made. The main contributor to short-term exposure rate is ^{24}Na ($T_{1/2}$ = 15 hrs) produced mainly by the (n, γ) reaction on Na, but also from the spallation of Si, Ca, Mg and Al. One hour after beam shut-off, the exposure rate from the ^{24}Na, due to 1% of Na by weight in the concrete, would be approximately 60 times greater than the exposure rate from all other spallation products.

Hence the control of the $^{23}Na\,(n,\gamma)\,^{24}Na$ reaction is of prime importance. This is done in two ways.

Limiting Maximum Concentration of Na in Cement

If the average Na concentration in concrete is kept less than or equal to 0.3% by weight, then the exposure rate for people transiting half-way between the booster and the wall would consist of equal parts of accelerator and wall exposure rates. This is embodied on the recommendation written on January 23, 1969, and based on the calculations of one of us (P. Gollon).

Removing Thermal Neutrons on Inside Surface of Enclosure

In actual practice, the concrete that has been poured so far has had more Na than the desired maximum. The method of controlling the (n, γ) reaction by the use of thermal neutron absorbers on the inside of the enclosure was proposed therefore by one of us (M. Awschalom). Dr. R. G. Alsmiller at ORNL calculated at NAL's request the effect of lining the inside of the enclosure with a Cd-sheet 1/32 inch thick. This Cd reduced the ^{24}Na concentration near the inside of the enclosure sufficiently to decrease the ^{24}Na exposure rate by a factor of 5. Then a request was made to the ORNL group to study the effect of a 1/64 inch thick Cd-liner. The ORNL group estimated that not only a 1/64 inch thick liner would be as effective as the 1/32 inch one, but also that 0.010 inch foil might be almost as effective. They are now repeating their calculations on the Cd-liners.

The effects of using boron "frits" in epoxy resin as a thermal neutron absorber is now being calculated too.

The cost of a 1/64 inch Cd-sheet is approximately $3.85/sq ft ($5.50/lb) in quantities of 300/sq ft.

Conclusions

There exists a method, although expensive, to control in part the exposure rate from the concrete walls of the accelerator enclosures.

Acknowledgment

Mr. M. Goral of DUSAF searched for and obtained the physical and chemical properties of boron frits and suitable epoxies for this application.

REFERENCES

[1] T. W. Armstrong and J. Barish, ORNL-TM-2630 (to be published).

[2] P. Gollon, Radiation Levels in the Booster Enclosure, National Accelerator Laboratory Internal Report TM-97, Nov. 18, 1968.