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Richard C. McCall
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# ACTIVATION OF WATER DURING BEAM TESTS

During the October and November beam tests with Sectors 1 and 2, Roger Coombes performed some experiments using a BSY protection collimator as the straight-ahead beam dump. Records were kept of the beam history during this period. It seemed worthwhile to look for possible resulting radioactivity in the cooling water.

Three accelerator cooling loops were examined, Sectors 1, 2, and 3. The Sector 3 cooling loop contained only the analyzing magnet and the protection collimator. Sectors 1 and 2 cooling loops handled the associated drift sections. Each cooling loop is approximately 400 gallons and has a bypass demineralizer attached. These are mixed bed "Permutit" ion exchange resins in stainless steel containers. At the time of our measurements, the conductivity of the water in the three loops was measured and this showed that the demineralizers were still performing at or beyond specifications.

Preliminary measurements with a scintillation survey meter showed that only the Sector 3 demineralizer contained any activity. At contact it indicated about 20 times background. This demineralizer was removed from service and a duplicate one inserted. Water samples were taken from all three loops. The water samples were sent to two commercial laboratories for measurement of tritium, gross beta and $Be^7$ ($Be^7$ decays by pure electron capture and can only be detected through the 0.477 MeV $\gamma$-ray emitted ~12% of the time). The demineralizer was taken to the laboratory and a $\gamma$-ray spectrum was measured with a scintillation spectrometer. No $\gamma$-rays other than that of $Be^7$ were detectable. Neither company detected any activity in the water samples as follows:

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|---|---|---|---|
| $H^3$ | $\leq$ | 0.01 | $\mu$Ci/liter |
| $Be^7$ | $\leq$ | 130.0 | dpm/liter |
| gross beta | $\leq$ | 0.8 | dpm/liter |

A NaI crystal and multichannel analyzer were used to make a better check of the Sectors 1 and 2 demineralizers. No $Be^7$ was detected and, if present, was less than 0.1% of that in Sector 3.

In order to measure the amount of $Be^7$ present it was necessary to remove at least a known portion from the ion exchange resin. The vendor's standard method of removing cations is to flush the resin with sulphuric acid solutions up to 10% in concentration. This did not remove any of the $Be^7$ as far as we could tell, certainly less than 0.1%. We finally managed to remove about 8.5% by washing with 10% hydrochloric acid, winding up with the activity in about 3 gallons of solution in a five-gallon jug. This was measured at a distance with a scintillation spectrometer and the activity calculated using theoretical efficiencies and photofractions.[1] The results were $(50 \pm 20)$ $\mu$Ci $Be^7$ where the standard deviation is estimated from measurement errors and the uncertainty in the $\gamma$-ray abundance in $Be^7$.

To compare with expected values we used DeStaebler's calculations.[2] The protection collimator had received a total of 85 KWH in two series of runs. The beam was directed so that it passed through the first six holes for cooling water. W. R. Nelson calculated from the results of our 1 GeV shower measurements that 3% of the energy was absorbed in the water. Using this value and correcting for decay to the time of measurement (December 20, 1965), one arrives at 75 $\mu$Ci of $Be^7$. This is remarkable agreement with the measured value above.

DeStaebler also calculates tritium production in water.[3] Using his results we would expect 6.6 $\mu$Ci of $H^3$ or $4.4 \times 10^{-3}$ $\mu$Ci/liter. This is below the sensitivity of the measurements and hence, consistent.

The $Be^7$ will present a certain problem in the handling of the demineralizers. Those containing more than 50 $\mu$Ci cannot be given to an unlicensed firm for reprocessing and there are additional rules concerning total amount of activity they can have, safeguards against concentration, etc. Possibly some of the demineralizers along the accelerator will reach 50 $\mu$Ci and some of the research area loops will be in the curie range. Either the demineralizers can be sealed and disposed of as waste (expensive) or they can be stored and allowed to decay (inconvenient with a 53 day half life). Another possibility is to provide for reprocessing them in house. Since the $Be^7$ sticks so well to the resin and is a rather weak $\gamma$-ray emitter, it might work well to reprocess them in the normal manner and leave the $Be^7$ on the resin. Normal reprocessing would probably be about once a year and the $Be^7$ would not build up beyond saturation anyhow. Otherwise, we would accumulate awkwardly large quantities of contaminated liquid waste. It is also possible that there is a demand for $Be^7$ since it is a rather difficult isotope to produce.

## REFERENCES


1. R. C. McCall and K. Liden, Arkiv för Fysik, 22, 497 (1962).
2. H. DeStaebler, TN-63-92, "Photon-Induced Residual Activity" (November 1963).
3. H. DeStaebler, TN-64-6, "Tritium Production in Water" (January 1964).