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To: Dr. Karl Z. Morgan

Date: March 30, 1950

From: L. B. Farabee

Subject: REVIEW OF THE EXPLORATORY SURVEY FOR EXCRETED FISSION PRODUCT ACTIVITY

The extent to which radioactive fission products might be ingested or absorbed into the body by employees who work with large quantities of such materials has been a matter of concern for some time. Prior to a recent survey, no determinations had been done to ascertain whether significant quantities of fission products were being ingested. The analytical procedures customarily used for gross analysis of fission products in human urine were not satisfactory with respect to the recovery of some elements. This situation emphasized the need for a program to analyze body fluids in order to determine the extent of excretion of certain beta-gamma emitting fission products considered most hazardous from the point of view of Oak Ridge National Laboratory operations.

In order to assay urine for all of the fission products, elaborate specific procedures would have to be worked out for each element. This would be cumbersome and impractical. The large bulk of urine to be handled and the low level of activity excreted would further increase the difficulties. Therefore, it was decided to work out a procedure that would isolate at one operation the largest possible number of our hazardous beta-gamma emitting fission products.

Development of the methods was done by the Radiochemistry Group of the Biochemistry Section of the Biology Division, with the cooperation of one member of the Chemistry Group of the Health Physics Division. Procedures are published in report ORNL-368, entitled "Procedures for the Radiochemical Analysis of Barium, Strontium and Rare Earths in Human Urine," by Paul C. Tompkins, L. B. Farabee and J. X. Khym. The procedure is essentially quantitative for lanthanum and yttrium. The recovery for barium was found to be around 95% while that for strontium was approximately 90%.

Since the level of activity to be found in some urine samples may be only slightly above the background of the counters, it was necessary to eliminate any extraneous beta activity that might be introduced in the carriers or chemicals used in the procedure. Yttrium and lanthanum carriers did have some activity due to impurities. These impurities can be removed by the use of synthetic cation exchange resins. Experimental runs on distilled water samples showed essentially no beta activity above background of the counters.

The urinalysis survey was started in September, 1949. Twenty-four hour urine samples were collected for analysis. The samples were submitted by personnel in the Operations Division. For control purposes, 24 hour urine samples from 7 persons employed in the Health Physics Division, who have little or no exposure to fission products, were assayed. The average activity of the 7 control samples was 1.1 cts/min., with a maximum of 2.2 cts/min. To date, the survey includes analysis on samples from 38 individuals. Most of the higher results were followed up by resampling at later dates. A tabulation of the results of the analyses is listed below. The beta-gamma activity was determined by counting the sample on a GM counter with a thin mica window. The geometry was 27.5%.

Results of Survey of Beta Activity Excreted by Plant Personnel

Net cts/min Excreted per day	Number of Individuals
< 5	15
5 to 10	9
10 to 20	5
20 to 50	2
> 50	7

Detailed studies have been made of the nine cases which showed excretion of material with activity greater than 20 cts/min per day. Seven of the nine samples showed a decay with a half-life of approximately 60 days. The belief that this activity was due to Sr^{89} was substantiated by absorption curve studies. The activity of the other two samples was found to be due to Sr^{90}. This was proven by absorption curve studies as well as by chemical separation with subsequent study of the decay and/or growth of the component parts.

Of particular interest was one case which showed the highest activity found to date. The employee was taken from laboratory work about one week after the highest activity was found, and the case was studied in detail by analyses of weekend samples for seven consecutive weeks. Additional samples were collected on the 11th and 15th weeks. The following table shows the beta activity found in the nine samples:

<u>Variation of Excreted Activity with Time</u>

Time of Collection	Activity Excreted per Day* (cts/min)
1st week	830
2nd "	214
3rd "	201
4th "	82
5th "	59
6th "	56
7th "	54

11th "	60

15th "	65

* Activity due to Sr^{90}- Y^{90} in equilibrium.

The comparatively high elimination during the early part of this period is characteristic of strontium recently taken into the body and not fixed in the tissues of greater retentivity. If all of the activity had been due to recent exposure, one might have expected a greater decrease. One does not, however, conclude from the above data that a very large fraction of the active material in the body at the beginning of the sampling period was eliminated. These data do not permit one to distinguish between decrease in elimination due to reduction of body content and decrease due to transfer to tissues of greater retentivity.

<u>Experimental Study on Sr^{90}-Y^{90} Excretion in Urine</u>

The case discussed above offered an opportunity to study the manner in which the beta activity was excreted. Previous analyses had shown the activity in the samples was Sr^{90} - Y^{90}. Whether the Sr^{90} - Y^{90} was excreted in equilibrium, or whether the excretion was primarily strontium was not known, since, under routine methods of sampling, the time lapse from the collection of the sample to the final counting was three to four days in some cases. By this time it was impossible to determine definitely any growth of Y^{90}. This difficulty was obviated by collecting the gross fission products, and counting immediately. The following table gives the results:

Growth of Activity with Time

Time Lapse after Zero Time* in hrs.	Net cts/min
15-1/2	13.4 ± 1.8
32	16.4 ± 1.9
56	19.2 ± 2.0
64	21.3 ± 2.0
128	22.6 ± 2.0
230	26.8 ± 2.0

* Zero time is considered as the middle of the sampling period.

The growth of the Y^{90} daughter follows very closely the calculated growth at this level of activity. Assuming that a Sr^{90} - Y^{90} equilibrium existed in the body, these results would indicate that the Sr^{90} is excreted preferentially.

Conclusion:

Although the exploratory survey included only a limited number of employees, the results appear to indicate that operations are of such a nature that employees may but seldom do take significant quantities of beta emitting isotopes into the body. The principal hazard appears to be due to strontium. Sr^{90} is particularly hazardous because of its combination of long radioactive half-life and very low elimination rate from the skeleton. It is recommended that employees working with large quantities of fission products be sampled periodically, and that persons working with radioactive strontium should be sampled relatively frequently.

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