CONF-720614-1

COLLIMATED SCANNER ADDITION TOHANFORD SHADOW SHIELD IN-VIVO COUNTER

B.V. Andersen, J.J. Jech, and K.R. Heid

INTRODUCTION

Measurement of the deposition of transuranic radionuclides in the chest area has received a large amount of attention and some success in the last few years. ⁽¹⁾ ⁽²⁾ The increased emphasis on lung burden evaluation from inhalation exposure has resulted in a review of our normal practice with in-vivo measurement for radionuclides which emit photons of 100 keV or more. This report discusses a modified shadow shield body counting system used to determine relative radionuclide distribution in the body at the same time a normal whole body count is made.

INSTRUMENTATION

The standard shadow shield counter has been described previously ⁽³⁾ and will only be mentioned briefly. In slide I the interior of the trailer is shown with the normal lead castle and addition. The system consists of a six-foot bed which travels beneath the shadow shielded detectors, moving about 8 feet in 10 minutes. A large 4-inch thick by 11-inch diameter sodium iodide detector is used for the normal integrated whole body count. In addition, there are seven 2-inch by 2-inch sodium iodide detectors in the lead brick castle on one side of the large castle.

In slide II the seven detector assemblies are shown with some of the shielding removed. The seven detectors were carefully balanced by use of a single high voltage supply and common signal with a single amplifier and multichannel analyzer to show a uniform response at various energies from 100 keV to ~ 2 MeV. The combined resolution of the seven detectors was ~ 10 percent

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

at 662 keV when using a ^{137}Cs point source positioned on the bed beneath the detectors.

In slide III the amount of collimation and detector shielding used is shown. The window width used is 1-3/4 inches. It is desirable to have as much sensitivity as possible with moderate resolution. The scanner is designed to show only quantitatively the location of the radionuclide in the body.

Slide IV shows the single electronics required in a block diagram. All of the electronics was available in our facility except for the detectors which were purchased specifically for scanners. The high voltage supply used in this case is a Fluke model 412-A. The detectors are Packard integral line assemblies complete with dynode chain. The detectors are the most expensive part of the system costing about \$6,000. The preamplifier, amplifier, discriminator used is an inexpensive Nuclear Data Model 520 which incorporates these three features in a single width nim bin module. It is a very stable unit that we have incorporated in most of our counting systems. The count rate meter used is a Canberra model 1418 which is a single width nim bin module and has a linear readout of from 10^2 to 3×10^5 counts per minute. It also has a recorder output. The x-y recorder we are using is a Moseley x-y recorder model 2DR-2. The equipment has all operated in a very satisfactory manner for over a year. The manufacturers previously mentioned are not endorsed by inclusion here but mentioned as typical equipment that will perform in a reasonable fashion.

RESULTS

The scanner is used in those cases where an intake is suspected or when depositions are detected by the whole body counting surveillance program. The scans shown in slide V were taken from an employee who was involved in an incident at a

reactor involving the primary side of a steam generator. The employee was wearing a full set of rubber protective clothing but only a face shield. The humidity in the room was very high and fogged up his glasses. When he left the work site he was found to have facial contamination of $\sim 100,000$ c/m and nasal smears of 10,000 c/m. He was decontaminated to less than 200 c/m and sent to the whole body counter. The upper line shows the scan obtained about two hours after the incident. A standard chair count with our Ge(Li) counter showed ~ 30 significant gamma energies present with a major peak at 0.25 meV. It was possible to identify traces of ^{137}Cs , ^{60}Co , and ^{40}K . The shape of the scan indicated that external contamination was probably present and probably at low levels over a large part of his body. The scan made 24 hours later confirms this and also reflects the short half life of the material. The regular count on the second day showed no reduction in the ^{60}Co content but a very large general reduction especially at 0.25 meV. Graphical integration of the two scans shows that the second scan is about 8% of the original.

The scans shown in slide VI are from a reactor pipefitter who had spent some 2-1/2 hours on repair of some reactor tube caps. Survey indicated nasal smears of ~ 2000 c/m and nasal irrigation was required for decontamination. In this case the first scan was made about 24 hours after the incident. It is readily apparent from the slide that significant head and nasal passage contamination was present and a large fraction was present in the stomach and gastrointestinal tract. Actually the peak was reasonably centered over the crotch area. The regular in-vivo measurement showed $^{95}\text{ZrNb}$ and ^{60}Co for a total content of $\sim$ one percent of the MPBB. This illustrates the sensitivity of the scanner. We could immediately advise the employee that he would eliminate a considerable portion of the small but significant amount present during the next few days. A followup scan and regular in-vivo

measurement were made about nine days after the first count and ten days after intake. The major deposition site remaining appears to be in the lung area although some deposition is shown in the liver, kidney area or the abdominal area. His head and lower extremities appear to have little or no radionuclide deposition remaining. The regular in-vivo count showed that about 20 percent of the ^{60}Co was present in the second measurement and about 13 percent of the $^{95}\text{ZrNb}$ remained in the employee. Graphical integration of the two scans on the other hand indicated that about 30 percent of the activity remained in the employee. This is very good agreement considering the qualitative nature of the scanning device and calibration differences in the measurements.

The last case to be discussed is shown in Slide VII. We did not have any scanning equipment when this intake of ^{154}Eu and ^{155}Eu occurred. Thus the early clearance is not shown on the scans. As you can see from the slide, this intake occurred about a year and a half ago. The case has been followed by making many regular in-vivo counts and analyzing urine and fecal samples. These data will not be discussed in any detail in this paper at this time. We are using the scanner to see if we can detect movement of the europium from the lungs to other body sites.

We have prepared a set of lungs with a mixture of ^{154}Eu and ^{155}Eu uniformly distributed throughout the lungs. These have been placed in a phantom and scanned. This scan results in a peak which has a rise and fall slope of the same shape as the leading edge of the scans in the slide. Thus it is possible to examine a scan and estimate the relative amount of radionuclide in the lung or chest area. We are not able to determine if there is any concentration in the lymphatic system. In the scans of this individual it is estimated that 40 to 50 percent of the body deposition resides outside of the lung area. The

regular in-vivo counting of this case for about a year and one-half has permitted the estimation of several effective halflives for the ^{154}Eu and ^{155}Eu mixture. An effective half-life of 120 days was found for times from 10 days to 150 days with effective half-life of about 520 days for times from 150-500 days. The clearance rate may still be decreasing and the case will probably be followed for a number of years since the measurements can be readily made. Our evaluation of this case indicates that the deposit in the lungs represented an average of about 25 percent of the maximum permissible lung burden for the year 1971. A comprehensive report on this case will probably be published in the Health Physics Journal some time in the future but it seemed important to mention the effective half-lives measured in a human case.

CONCLUSION

The simplified scanner presented here will not provide the quantitative information resulting from a complex system such as developed at Idaho Falls.⁽⁴⁾ The scanner has proven very useful when measurements are made shortly after an intake, clearly showing body location and suggested external contamination in some cases. It is especially useful as a supplement to the regular count with the large detector in the shadow shield system since both measurements are made simultaneously.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

REFERENCES

- (1) L.J. Johnson, P.N. Dean and H.M. Ide, Health Physics, V.22, 410 1972.
- (2) B.V. Andersen, P.E. Bramson, H.V. Larson. Proceedings, First European Congress of the International Association of Radioprotection.
- (3) H.E. Palmer, W.C. Roesch, Health Physics, Vol. 11, 1213, 1965.
- (4) J.I. Anderson, D.G. Olson, Health Physics, V. 13, 719, 1967.

SLIDE I

SLIDE II

SLIDE III

HANFORD COLLIMATED SCANNER CROSS SECTION

HANFORD COLLIMATED SCANNER

ELECTRONICS

SLIDE IV

HANFORD COLLIMATED SCANNER!

SLIDE V

HANFORD COLLIMATED SCANNER

SLIDE VI

HANFORD COLLIMATED SCANNER

SLIDE VII