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# Personnel Neutron Dosimetry Studies at the Lawrence Livermore National Laboratory

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The School of Public Health at the University of Michigan recently performed a 2-year pilot study of personnel dosimeters in the U.S. for the NRC. The results from this study indicated that some of the failures by participants in the neutron category could be traced to the use of various types of phantoms. Since no standard phantom has been established, a variety of phantoms of various sizes, shapes and materials have been used.

We conducted a study to determine the effect of phantom size, shape and composition on the response of an albedo neutron dosimeter. The results of this study were published in Health Physics, Vol. 39, pp 580-584 (1980). The results indicated that the most important feature of a phantom was the shape. A flat surface resulted in the highest albedo response. A phantom with single curvature, jug-shaped or cylindrical, resulted in less albedo response; a double curvature, such as a sphere, gave the lowest response. We also found that for albedos worn at various locations on the chest region of a body, variations in the response of the albedo of up to 17% could be expected and are caused by chest curvature and effective density of the area under the albedo.

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The above study showed that only a small phantom was required to give a response equal to that obtained on a person. We investigated concurrently the possible use of albedo dosimeters as area monitors mounted on various concrete walls. The albedo responses on the walls were small and variable. We tried placing the albedo dosimeters on a small (4 X 4 X 2 inch thick) block of polyethylene mounted on the walls and found that reproducible responses could be obtained. The albedo dosimeter response is low by about 30% compared to its response when placed on a phantom in air, but it is reproducible and independent of neutron spectra. A modified method of using the 9- to 3- inch sphere ratio technique was devised since the spheres could not be placed at the exact location as the dosimeter because of the wall. The results of this study have been accepted by Health Physics for publication as a note in the September 1981 issue.

One concern which has not been resolved is the determination of the dose equivalent rate from a californium neutron source. We made a literature search and compared the dose rates determined by using the various conversion factors being used to convert neutron source strength to dose equivalent rates at a distance of one meter from the source. We also included measurements made by tissue-equivalent ion chambers with appropriate QF values and with a Long Counter. Ten different dose rates were determined which varied from 2.39 to 3.02 rem/h for our Cf source.

There are several reasons for the variations. The first is the spectra shape of the Cf source which is slightly different, depending upon which reference is used. A second cause is the type of extrapolation used between neighboring points in ICRP and NCRP tables. A third effect is the use of conversion or QF tables from different ICRP or NCRP reports. The fourth, and by far the largest effect, is the failure to consider, or to properly evaluate, the effect of room-return neutrons. We have been making measurements in our calibration facility to study this effect and have been discussing this problem with Schwartz and Eisenhouer at the NBS. They also are addressing this problem in their contribution to this workshop.

I feel that, calibrations being made with sources having calculated dose equivalent rates that are not determined using a standard procedure, is a problem which must be resolved as soon as possible. A standard calibration procedure would require that agreement be reached on the following items.

1. A standard spectrum for Cf sources should be adopted.
2. We must decide which ICRP, NCRP or other conversion factors should be used.
3. The extrapolation method used between points given in the conversion factors (selected in 2) should be established. (Part of the neutron study being conducted by Harford may help resolve this point.)
4. The contribution of room return neutrons on the response of the detector or dosimeter at the calibration distance must be determined.

I suggest that one method that could be used to eliminate many of the calibration problems caused by the above would be as follows: have the NBS or some other organization establish a "standard" dose rate at a distance of 1 meter from a Cf source, outdoors at a reasonable distance from the ground (2 or 3m). Measurements with dosimeters and instruments would then be made with the users' source under similar conditions. The source would then be moved into the users' calibration facility and additional measurements made. These higher readings would be used as the "in-facility" dose rate for that particular instrument or dosimeter. This dose rate would then include the difficult-to-measure room return and scattered component. This technique should make it possible to eliminate the errors that presently exist between various calibration facilities and is simple enough to be used accurately by anyone having a calibration facility.