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Rad-Hazards

[redacted]

TOLERANCE DOSE

Interpretation of Permissible Daily Dose

An ambiguity in the accepted interpretation of the permissible daily dose of 100 mr has been recognized for a long time. As far as the welfare of an exposed person is concerned, the significant dose is that received by the skin, including scattered radiation in the body. When pencil type meters are used for personnel monitoring, it is this figure which is recorded. Film badge meters more or less register the same component. However, when a work area is surveyed by portable instruments, only the incident dose is registered. For hard gamma radiation the total dose is only about 1 to 3% greater than the incident dose measured in air. For X-radiation of familiar energy the total dose is about 50% higher than the "in air" measurement, as follows:

Body Surface Dose in a wide beam for 100 mr measured in air *

Quantum Energy	Dose (mr)
50 KV	150
75	146
100	150
125	145
150	137

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* Selected from Acta Radiologica Vol. XXI p. 706, 1936

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The basic evidence on radiation hazard has been obtained by [illegible] rather than by personnel monitoring. Most protection groups have [illegible] avoided an outright statement on this point, principally so that survey readings and pencil readings could be used [illegible] without [illegible] corrections. The American Standards Association Safety Code for the Industrial Use of X-Rays" has recently made a definite commitment as follows:

"2.2.3 Dose. "Dose" is the total quantity of radiation in roentgens at a given point, measured in air, * integrated over the period of exposure.

> "The expression "measured in air" has a definite meaning in radiology namely, that the measurement is made at a given point in the radiation field without the presence of the human body."

Future practice will probably follow this policy.

The practical influence on the H. I. Section program and reports is negligible except in three specific instances:

1. <u>Known exposure to soft [illegible] or [illegible] only.</u>

   Detailed study of possible exposures occurring in the following cases may result in considering an observed pencil reading of over 100 mr as less than a permissible daily dose.
   (a) Fluoroscope operations - proposed pencil or badge limit 150 mr
   (b) X-Ray calibration - limit 150 mr
   (c) X-Ray diagnosis (Ladies hospital) - 170 mr
   (d) Intermediate energy calibrations - to be measured

2. <u>Known exposure to beta radiation from uranium on the hands only.</u>

   It has been shown that the permissible daily dose of 100 mr really permits the exposure of the skin to 150 mr measured in the tissue for familiar X-radiation emitted at about 200 KVp (~ 100 KV quantum energy). It will be universally agreed that the relevant sensitive portions of the skin of the hands can tolerate an equal tissue-dose arising from beta irradiation. On the palm of the hands, there is a natural absorber, the layer of passive absorption, at least 40 mg/cm^2 thick. This transmits 75% of the beta radiation from an extended source in contact with the hand. For 150 mrep at the base of the layer of passive absorption, the surface dose would be $\frac{150}{0.75}$ = 200 mrep.

   This value, which now includes backscatter and is not "measured in air" will henceforth be considered the permissible daily dose for this particular case. In the same terms, the dosage-rate of uranium metal in contact with the hand is [illegible] mrep/hr.

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3. **Human exposure to beta radiation from other sources and on other parts of the body.**

With the exception of the palms of the hands and the soles of the feet, other skin surfaces have a layer of passive absorption of about 10 mg/cm². The absorption in this layer is a function of the beta-ray energy spectrum, the dimensions of the source and the source distance. In our average case the transmission of the layer will be about 90%, and the permissible dose will be $\frac{150}{0.90} \approx 160$ mrep. Since the selection of 150 mrep ([illegible]) is rather arbitrary, the general beta case should be handled with a limit of 150 mrep surface dose, including scatter.

SUMMARY

For convenience in reporting, the difference between measurements "in air" and measurements "with backscatter" will normally be ignored. Special exceptions for X-ray exposures and for beta radiations, especially from uranium metal handling, will be provided. These provisions should be invoked only when the work load routinely approaches the otherwise tolerable limit. The preferred practice of restricting all planned exposure to about one-half of the permissible daily dose should be continued.

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