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Criteria for Performing Multiple Dosimetry

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Foreword

(This foreword is not part of American National Standard ANSI/HPS N13.41-2011.)

Normal practice for monitoring personnel for exposure to radiation originating outside of the body is to locate a single dosimeter at a location that gives a reasonably accurate but conservative estimate of the dose received. To do so, the dosimeter is placed at the location of maximum exposure. However, this practice can greatly overestimate the effective dose to the individual. Therefore, the use of more than one dosimeter should be considered in order to arrive at a more realistic effective dose.

Whereas it may be necessary to use multiple dosimeters throughout an individual's monitoring period, a more likely practice may be to use multiple dosimeters for specific operations or activities. The results obtained are then added to the personal dose equivalent measured during the remainder of the monitoring period with the single dosimeter for determination of compliance.

This standard provides criteria for when and how to use multiple dosimeters under conditions incident to routine activities in the presence of ionizing radiation. It also contains the recommended methodology for determining the effective dose from external sources when the use of multiple dosimeters has been deemed necessary by radiation protection professionals.

In 2007, the International Commission on Radiological Protection (ICRP) released Publication 103, "2007 Recommendations of the ICRP." The concepts regarding effective dose contained in ICRP Publication 103 form the basis for the recommendations in this standard. However, provisions for application under ICRP Publications 60 and 26 guidance are included as well.

Suggestions for improvement of this standard are welcome. Suggestions should be sent to the Health Physics Society, 1313 Dolley Madison Boulevard, Suite 402, McLean, VA 22102.

Criteria for Performing Multiple Dosimetry

1.0 Introduction

For uniform external exposures of the whole body, the International Commission on Radiological Protection (ICRP) acknowledges the use of personal dose equivalent as determined by means of dosimeters worn on the torso of the body as an acceptable means of determining the effective dose from external radiation sources. However, radiation fields may vary spatially as a result of job- or location-specific conditions. Conditions that may contribute to this variability include source geometry (e.g., point sources, line sources, plane sources, or non-uniform deposition patterns), source-to-worker distance and general orientation of the worker with respect to the source, and the presence of equipment or other barriers that may provide non-uniform radiation shielding of the worker. Other pertinent factors are the energy and/or composition of the radiation field and changes in these as a result of interactions of radiation with matter in the working environment.

Data from radiation surveys are essential for assessing how these factors affect radiation field variability with respect to a worker and for determining the need for more than one dosimeter. The following are just a few examples of conditions that may indicate such a need:

1. Work in close proximity to point or line sources of radiation that presents greater exposure potential for the hands and varying exposure potential over the torso;
2. Maintenance work at facilities where variation in source geometry or partial local shielding exist as a result of structures, equipment, and other barriers;
3. Operations performed in the vicinity of radiation shielding leaks (e.g., pin-holes, cracks), or work involving the use of partial (shadow) shields;

4. Work on reactor, accelerator, and laboratory components, or handling of radioactive waste when the materials in question contain radioactivity that is not uniformly distributed; or
5. Work while using protective clothing or leaded garments that may result in non-uniform exposures between protected and unprotected parts of the body.

“Multiple dosimetry” is the practice of placing more than one dosimeter on an individual’s body to determine the doses at various regions of the torso, head, arms, and legs. This practice may be implemented for a number of reasons, including demonstration of compliance with federal and state regulations or administrative requirements, identification of the location of highest exposure, evaluating the effectiveness of radiation control measures before and after a particular activity, other circumstances when a single measurement may not provide sufficient information for dose control purposes, or to estimate the effective dose from external sources.

Multiple dosimeters may be used to monitor different areas of the body when variations in the radiation field result in significant variations in personal dose equivalent over the body. The significance of exposure to a variable radiation field is dependent upon the exposure to each organ (e.g., blood-forming organs, lens of the eye) and the applicable regulatory dose limits.

The criteria presented in this standard provide guidance on when to monitor with multiple dosimeters and where to place such dosimeters when their use is deemed necessary, and the interpretation and recording of results after the dosimeters are processed or evaluated.

2.0 Scope

The final decision on whether to use multiple dosimeters for external dosimetry purposes instead of a strategically placed single dosimeter is left to the judgment of radiation

protection professionals. Once multiple dosimeter use has been deemed appropriate, this standard contains criteria applicable to routine occupational activities on when and how to use them to monitor the body and extremities of individuals exposed to external sources of ionizing radiation. Such conditions may be encountered at medical, research, commercial, weapons disposition, fuel processing, power reactors and other sites. In addition, recommendations for selecting dosimeter types, placement of dosimeters on the body, interpretation of multiple dosimeter results, and recording of dose information are presented. A program that is compliant with this standard shall include the requirements of the standard, but not necessarily its recommendations.

This standard does not address the cases of internal deposition of radioactive materials, external contamination of the body, or working conditions that do not permit job pre-planning. Sudden or unexpected changes in the radiation environment as might occur during accidents are also beyond the scope of this standard. Fetal monitoring is not addressed because it represents a special case not necessarily related to non-uniform irradiation. (Fetal monitoring is for the purpose of estimating the dose to a separate entity, the fetus, and demonstrating an appropriate rate of equivalent dose accumulation for the period of gestation. Since it is not an example of multiple dosimetry, it is not addressed herein.¹) Skin exposures where the area of irradiation is less than 10 cm² (e.g., from a hot particle) are not addressed.² Finally, the recommendations of this standard do not supercede specific regulations or license requirements.

This standard assumes that dosimeter assemblies worn for multiple dosimetry

¹The dose to the fetus from external sources is often assessed by mounting a dosimeter on the abdomen of the pregnant worker.

²The National Council on Radiation Protection and Measurements, in NCRP Report No. 106, *Limit for Exposure to "Hot Particles" on the Skin*, provides guidance on assessing the radiation exposure of small skin areas (NCRP 1999).

purposes are calibrated and processed to provide an estimate of equivalent dose. Specific guidance on dosimeter processing methodologies, calibrations, and performance criteria are included only by reference.

3.0 Definitions of Terms

In this standard, definitions given by the American Nuclear Society (1986), the International Commission on Radiation Units and Measurements (1980, 1993), the International Commission on Radiological Protection (1984, 1991, 2007), and the National Council on Radiation Protection and Measurements (1985) apply, supplemented by those given below.³

Absorbed Dose: Mean energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The unit of absorbed dose is the gray (Gy) or rad. One rad is equal to 0.01 Gy.

Compartments: Areas of the body that are of dosimetric importance for purposes of multiple dosimetry and for which the dose is assumed to be generally uniform.

Compartment Factors (W_C): Factors used to weight the results from dosimeters placed over various compartments in order to relate the fractional risk to the organs in the compartment to the total risk from uniform irradiation of the whole body.

Dosimeter: A wearable package of absorbers and radiation-sensitive elements used to estimate personal dose equivalent received by an individual over a specific time period.

Dosimetry System: A system used to assess personal dose equivalent from external radiation. This system includes the selection, placement, and processing of the

³Throughout this standard, the terms "dose" and "effective dose" may be used interchangeably. For the sake of clarity, several examples have made use of conventional units, such as the "rem."