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PERSONNEL DOSE ASSIGNMENT PRACTICES

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FOREWORD

This paper has been prepared for presentation at the U.S Department of Energy (DOE) Radiation Protection Workshop to be held in Las Vegas, Nevada, during April 1993. One objective of the workshop is to provide a technical forum for the exchange of information related to radiation protection programs. A variety of radiation protection issues are included in the agenda for this meeting. This paper proposes changes in DOE N 5480.6 Radiological Control (RadCon) Manual requirements, which require minimizing the assignment of personnel dosimeters, as well as changes in Article 514's requirements for a comprehensive area dosimetry program. The proposed changes are 1) for an overall assessment of program dosimetry capabilities to meet recommendations of National Council on Radiation Protection and Measurements (NCRP) Report No. 114 ("Maintaining Radiation Protection Records") and 2) to ensure programmatic availability of evidentiary information that documents the determination of radiation dose to employees or visitors in the work environment. The paper concludes that, frequently, assignment of personnel dosimeters to individuals provides the most cost-effective alternative to meet overall program commitments.

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ABSTRACT

Implementation of DOE N 5480.6 Radiological Control Manual Article 511(3) requirements, to minimize the assignment of personnel dosimeters, should be done only under a broader context ensuring that capabilities are in place to monitor and record personnel exposure both for compliance and for potential litigation. As noted in NCRP Report No. 114, personnel dosimetry programs are conducted to meet four major objectives:

- radiation safety program control and evaluation
- regulatory compliance
- epidemiological research
- litigation.

A change to Article 511(3) is proposed that would require that minimizing the assignment of personnel dosimeters take place only following full evaluation of overall capabilities (e.g., access control, area dosimetry, etc.) to meet the NCRP objectives.

1.0 INTRODUCTION

Selected recommendations, taken individually, of the DOE N 5480.6 Radiological Control (RadCon) Manual appear to conflict with policies adopted historically to monitor radiation exposure. Several DOE sites (i.e., Hanford, Idaho National Engineering Laboratory, Oak Ridge National Laboratory, Savannah River Site, etc.) have numerous facilities, burial grounds, etc., where it is not feasible to maintain controlled access. Historically, dosimeters are routinely assigned to personnel or visitors who have the potential to enter one or more of these areas. This approach has many advantages, as illustrated under the Case Histories section. At Hanford, an ad hoc committee was formed to review the assignment of dosimeters in preparing procurement specifications for a commercial dosimetry system. This review was completed in January 1990, prior to publication of the RadCon Manual. This committee recommended

continued individual assignment of dosimeters, where some exposure potential exists, as the most effective and least costly alternative. Substantially greater costs would be incurred with any other alternative and, importantly, likely would not provide assurance that all program commitments are being met. Other alternatives considered, such as relying on area dosimetry and positive access control, would not achieve recognized radiation monitoring objectives, such as those identified in Report Number 114 of the National Council on Radiation Protection and Measurements (NCRP 1992). In particular, there was substantial concern regarding the ability to assure others, such as the state boards of industrial insurance appeals, that following established work procedures would measure all significant personnel exposures.

2.0 COST-BENEFIT OPTIMIZATION

Personnel dosimetry programs are established for all major DOE facilities. These systems typically include highly automated reader systems, computerized data storage and retrieval, and many thousands of dosimeters. Often, the dosimetry system is used for site-wide whole-body, extremity, area, nuclear accident, and environmental dosimetry purposes. For personnel whole-body dosimeters, the dosimetry program must meet the requirements of the DOE 5480.15 Laboratory Accreditation Program (DOELAP) (DOE 1989). Primary costs are attributable to the staff and equipment necessary to provide a DOELAP-accredited program with the capability to achieve compliance with applicable DOE dosimetry, quality assurance, and record requirements. Secondary costs result from the number of dosimeters processed.

A cost-optimization review should be conducted of all program dosimetry commitments (i.e., personnel, area, extremity, nuclear accident, etc.); regulatory compliance; record retention and retrievability; litigation support; etc. to arrive at the best overall policy. In particular, program requirements for an effective area dosimetry program should be specified to ensure that reductions in personnel dosimeter assignments can be reasonably effected. Often, an equivalent area dosimetry capability, which, at a minimum, requires the capability to assign dose based on dosimeter records and staff occupancy, will cost substantially more than assigning a personnel

dosimeter to each individual. In addition, there are often technical inadequacies in assigning a dose to an individual based on dosimetry records. This approach can be used in only the most simple of work and exposure environments.

3.0 EXISTING AND PROPOSED RADCON REQUIREMENTS

There are two sections of the RadCon manual that appear to cause the most difficulty regarding this issue. These sections, along with recommended changes, follow:

Chapter 5, Article 511, Page 5-3, Item 3

Existing Wording:

3. To minimize the number of personnel in the dosimetry program, the issuance of dosimeters is discouraged to other than personnel entering Radiation Areas, High Radiation Areas, or Radiological Buffer Areas where there is a potential for external exposure. Although issuing dosimeters to personnel who are not occupationally exposed to radiation can appear as a conservative practice, it creates the impression that the wearers are occupationally exposed to radiation.

Proposed Wording:

3. An evaluation of personnel to be issued dosimeters shall be conducted to determine consistency with dose control, area dosimetry, ALARA, and personnel-monitoring practices. Optimization of overall dosimeter-processing requirements for personnel and area dosimetry is encouraged. Minimizing the number of personnel dosimeters is encouraged where it can be demonstrated that there is no potential to receive occupational radiation exposure.

Chapter 5, Article 514, Page 5-6

Existing Wording:

Establishment and maintenance of a comprehensive area monitoring program minimize the number of areas requiring the issuance of personnel dosimeters and demonstrate that doses outside Radiological Buffer Areas are negligible. Minimizing the number of personnel dosimeters issued saves in the costs of operating the dosimetry program and reduces costs associated with maintaining personnel with enhanced training and qualifications.

1. Area monitoring dosimeters shall be used to record and document radiation levels in routinely occupied areas adjacent to areas where radiation or operations with radiation exist.
2. Area monitoring dosimeter results should be used to support dosimetry investigations where personnel express concerns about their work environments and exposure to ionizing radiation.
3. Area monitoring dosimeters should be used in Controlled Areas to supplement existing monitoring programs and to provide data in the event of an emergency.

Proposed Wording:

Establishing and maintaining a comprehensive area monitoring program should be considered as a means to minimize the number of areas requiring the issuance of personnel dosimeters and to demonstrate that doses outside Radiological Buffer Areas are negligible.

1. Same as existing wording.
2. Same as existing wording.
3. Area monitoring dosimeters may be used

When area dosimeters are used to provide the primary record of radiation exposure to personnel, record requirements of Chapter 7.0 shall be met to ensure availability of information necessary to demonstrate compliance with DOE requirements or for the purpose of litigation.

4.0 CASE HISTORIES

Over the years, there have been many cases in which the value of individually assigned dosimeters has been evident. Four examples are summarized in this section. In reading these examples, consider what could have happened if personnel dosimeter data were not available.

- Several construction personnel were disposing of "non-contaminated" waste. After several days, it was learned that the waste was actually contaminated with ^{137}Cs , which resulted in monitoring surveys of cars, homes, recreational facilities, etc. All of the involved personnel wore personnel dosimeters that showed no detectable radiation exposure. This case was widely reported in the media. The results of the dosimeters along with the results of the surveys were presented to the media to illustrate that no significant exposure occurred to personnel and, by inference, to

anyone else (i.e., it was reasonable to expect maximum exposure to contaminated personnel).

- Two visitors driving a rental car accidentally drove the car into a ditch on a major DOE site. The visitors were able to push the car out of the ditch and resume their travels. Later it was learned that the visitors had become contaminated. This required monitoring surveys of the car, the personnel, etc. Both of these individuals wore dosimeters, which showed no detectable radiation exposure.
- In a mixed contractor occupied facility, the dosimeter worn by a secretary, with no anticipated potential for radiation exposure, routinely recorded low-level neutron exposure. Upon examination, it was learned that a sealed neutron source was being used by the other contractor in an adjacent laboratory. This situation was quickly detected and resolved through assignment of personnel dosimeters to each individual with a potential for exposure.
- In a state industrial compensation hearing, a widow, with expert testimony from an oncologist, stated that radiation exposure to her husband during his employment at a DOE facility caused his fatal cancer. The facility was widely reported to be one of the most contaminated places on earth and, most recently, the risk of cancer from radiation exposure was estimated to be at least a factor of 4 greater than previously thought. The person faithfully worked at this facility throughout his 20-plus-year work career. It was stated that this person was undoubtedly extremely sensitive to the harmful effects of radiation. The widow related several of her husband's stories of poor worker protection, contamination everywhere, unmonitored exposures to radionuclides such as tritium, and, in particular, an unreported accident when her husband saw a blue flash. Basically, the claim was made that any amount of occupational exposure could have caused the fatal cancer, and there are likely many situations of unmonitored exposure. Fortunately, the facility had dosimeter results for all periods of employment, along with training forms, which included employee responsibilities for wearing dosimeters, signed by the employee. Expert testimony was provided about the sensitivity of the dosimeter to all probable sources of exposure. A lifetime radiation dose profile was presented, based on the history of personnel dosimeter results, which showed measured occupational dose was a relatively small fraction of the lifetime dose received from naturally occurring radiation and average medical exposure.

In each of the foregoing cases, it would be very difficult to provide credible information without the individually assigned personnel dosimeters. In fact, assignment of dosimeters is often based on a policy of ensuring that personnel dose is measured in the event of an accident or, typically, of any unforeseen events. In litigation cases, frequently the actual occupational dose received

is a small fraction of regulatory limits and, perhaps, even of exposure received from natural background radiation. Importantly, the court can readily understand dose measured with individually assigned personnel dosimeters.

5.0 SUPPORTING INFORMATION

The NCRP Report Number 114 (NCRP 1992) identifies four major potential uses of personnel dosimetry as follows:

- radiation safety program control and evaluation
- regulatory compliance
- epidemiological research
- litigation.

Historically, DOE and its predecessor agency contractors assigned dosimeters to essentially all personnel with some potential for radiation exposure. Relatively complete exposure history records resulted from this practice. These records have been used successfully during litigation, particularly during state Workmen's Compensation hearings, and are the cornerstone of DOE epidemiologic radiation exposure studies. Recently, the DOE RadCon Manual (DOE 1992) introduced recommendations that, taken individually, imply that assignment of dosimeters to personnel should be minimized (cf. Article 511, requirement 3).

RadCon recommendations should be used in an integrated manner that assures continuity of a comprehensive personnel-monitoring program. An effective personnel-monitoring program should include selected elements of the following (RadCon references in parentheses):

- Positive access control that tracks personnel or visitor entry into areas with a potential for radiation exposure (Chapter 3, Part 3)
- A comprehensive area dosimetry program that documents the potential for exposure within or adjacent to radiation areas (Article 514)
- A DOELAP-accredited external dosimetry program that monitors radiation exposure to individual employees or visitors (Article 512)

- A comprehensive internal dosimetry program for monitoring potential employee exposure (Article 521)
- Determination of annual effective dose equivalent and lifetime occupational radiation exposure from all sources of occupational exposure (Chapter 2, Part 1)
- Retrievable records that relate personnel and the potential level of radiation exposure (Article 722) - These records must be suitable for use in litigation or in epidemiologic studies.
- Documentation of the methodology adopted to provide a comprehensive personnel dosimetry program - Protocol for dosimeter use and assignment, as well as dose determination, should be described in the External Dosimetry Technical Basis Manual required by the DOE Radcon Manual (Article 512). Practices adopted for routine radioassay monitoring and dose assessment should be described in the Internal Dosimetry Technical Basis Manual (Article 522).

6.0 CONCLUSION

DOE contractors should adopt conservative practices to demonstrate DOE's concern for assured safety of workers. A cost-benefit analysis of alternatives for assigning dose to personnel should be conducted prior to any reduction in the assignment of dosimeters to individuals. The analysis should focus on the need for evidentiary information that documents the determination of radiation dose to employees or visitors in the work environment. Frequently, the assignment of personnel dosimeters to individuals provides the most cost-effective alternative, particularly for DOE sites with numerous facilities where it is not practicable to maintain controlled access. Employee and visitor concerns about radiation exposure should be anticipated. Emphasis on evidentiary aspects of the personnel dosimetry program is important both in the event of litigation and to ensure the capability to demonstrate compliance with applicable regulations. These needs may arise many years after the actual, or alleged, exposure occurred. RadCon and DOE 1324.2A (DOE 1988) require exposure records to be maintained for 75 years. NCRP Report No. 114 recommends maintaining retrievable records of employee exposure for 75 years after the first exposure. If the status of an individual is unknown, the NCRP report recommends maintaining exposure records for 100 years from birth.

7.0 REFERENCES

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