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ACCREDITATION OF IONIZING RADIATION
PROTECTION PROGRAMS

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Abstract

Accreditation is a process for evaluating the performance of organizations that provide essential information. The first element in an accreditation program is a written standard that delineates the criteria for judging acceptable performance from such organizations. It is also necessary to have an officially recognized group to administer the program and grant accreditation. Finally, it is necessary to designate a laboratory that will evaluate performance, and to appoint site assessors to audit the organizations seeking accreditation.

There are over one million workers in the United States who have the potential to be exposed to ionizing radiation. Therefore, it is necessary to determine accurately the quantity of radiation to which they may have been exposed. This quantity is measured by personnel dosimeters that are carried by individuals requiring radiation monitoring.

Accreditation of the organizations which evaluate this quantity provides official recognition of the competence of these organizations. Accreditation programs in the field of ionizing radiation protection have been in operation for a number of years, and their experience has demonstrated that such programs can help to improve performance. The National Voluntary Laboratory Accreditation Program (NVLAP) and the Department of Energy Laboratory Accreditation Program (DOELAP) accredit nearly all of the organizations that offer personnel radiation dosimetry services in the United States.

Introduction

The risk associated with exposure to ionizing radiation can be quantified by measuring radiation dose, or dose equivalent. Absorbed dose is the quantity of radiation energy deposited per unit mass of a substance. The dose equivalent is the product of the physical absorbed dose deposited in the human body and a quality factor that reflects the relative biological effect of the particular type of radiation. Radiation protection programs use electronic instruments to measure dose equivalent rates in the workplace, along with personnel dosimeters to measure the dose equivalent delivered to individual workers.

The accuracy and uniformity of the results obtained from personnel dosimeters have been studied,⁽¹⁻³⁾ and these studies recommended the formation of a national program to accredit the processors of personnel dosimeters. The federal agencies concerned with the regulation of ionizing radiation proposed new rules to cover the accreditation of personnel dosimetry.

The Nuclear Regulatory Commission (NRC) sponsored a pilot accreditation program⁽⁴⁾ to test the proficiency of personnel dosimetry processors. The testing was based on an American National Standards Institute (ANSI) standard⁽⁵⁾ entitled, "Proficiency Testing of Personnel Dosimetry Systems". After the results of this pilot study were evaluated, a full-scale program was initiated. It is administered by the National Institute of Standards and Technology (NIST) as part of the National Voluntary Laboratory Accreditation Program (NVLAP). NRC requires its licensees to obtain dosimetry services from processors that participate in and gain accreditation from the NVLAP personnel dosimetry program.⁽⁶⁾

The Department of Energy (DOE) also developed a personnel dosimetry accreditation program for the specialized needs of its facilities. The Department of Energy Laboratory Accreditation Program (DOELAP) is based on a DOE performance testing standard,⁽⁷⁾ and participation by DOE dosimetry processors is required by a DOE Order.⁽⁸⁾

Accreditation Methodology

Once consensus standards have been established that describe methods for evaluating performance in a specified area, it is necessary to implement the accreditation program. This implementation process includes: proficiency testing according to the methods set out in the standard, onsite assessments of organizations seeking accreditation and committees to decide on, and subsequently grant, accreditation to organizations that have successfully met all of the requirements contained in the standard (or other documents defining the program).

Proficiency testing for the personnel dosimetry accreditation programs requires evaluation of the accuracy and precision of a series of test measurements made using personnel dosimeters that are submitted to a performance testing laboratory by the organization seeking accreditation. The measurements are repeated using different types of radiations that are similar to the types expected to be measured by the dosimeters under actual working conditions.

In order to have a quantitative measure of performance, it is necessary to define a performance criterion and to define a method for comparing performance to this criterion. The two variables that are considered to be rele-

vant to the performance of personnel dosimeters are accuracy and precision. Accuracy is defined as the difference between the dose equivalent value measured by a dosimeter and the actual dose equivalent delivered by the performance testing laboratory. This quantity is often expressed as a fraction of the delivered dose equivalent and, in this case, is referred to as the bias, B. The standard deviation, S, is determined by evaluating the variance in the value of the dose equivalent measured by a group of dosimeters exposed to the same quantity of radiation.

When evaluating a measurement system, it is possible to have a series of measurements that is, on average, quite accurate. This would be reflected by a small value of the bias. However, this same set of measurements may have a large standard deviation indicating a lack of reproducibility. On the other hand, a series of measurements might be very reproducible, but might have a large bias, indicating poor accuracy. Neither situation is acceptable, therefore the personnel dosimetry testing programs use a combination of bias plus standard deviation that is compared to the performance criterion, L. This is expressed in the inequality below.

$$B + S \leq L$$

The absolute value of the bias is used because it is equally likely that the bias can be either positive or negative. The values for the performance criterion are given in the consensus standards and are based on recommendations of national and international standards documents.⁽⁹⁾ In the case of the personnel dosimetry accreditation programs, values ranging between 30 and 50% are used, depending upon the radiation and the testing category.

A group of technical experts is appointed to make onsite assessments of the organizations seeking accreditation. These assessors visit the organizations and audit the key elements of the dosimetry processing operation. These elements include: the quality assurance system, laboratory record books, laboratory procedures, equipment, dosimeters, calibration procedures, data reports and personnel. The onsite assessors report on their findings to the program administrators. Any serious deficiencies identified require a written plan for resolution. When an organization has successfully completed the performance tests and the technical evaluation by the onsite assessors, accreditation is granted for a specified time period (usually two years). After this time has expired, the organization must apply for re-accreditation.

Current Status of Dosimetry Accreditation Programs

The DOELAP and NVLAP programs have been in operation since 1984. From this time to the present, many performance tests and assessments have taken place. Initially, the performance of some processors was poor but as improvements were made in dosimetry systems performance improved. The average values of the performance are presently well below the performance criteria limits. Typical values in the NVLAP program range from 0.14 to 0.19, compared to the performance criteria limits which are between 0.30 and 0.50.⁽¹⁰⁾ Performance in the DOELAP program is comparable.

Both programs are considering revisions, updates and expansions into new areas of accreditation. Extremity dosimeter testing and accreditation is under development and should commence this year.⁽¹¹⁾ A bioassay testing program is being developed to accredit facilities that perform in-vivo and

in-vitro bioassay measurements for the purpose of determining the dose delivered to individuals from the intake of radionuclides. In addition, methods are being developed to accredit internal dosimetry programs.⁽¹²⁾

Summary

Studies of the performance of personnel dosimetry programs in the U.S. indicated that there was a need to upgrade the performance of these programs and that a national effort should be undertaken to achieve this goal. Two programs were developed in response to this recommendation, and they were DOELAP and NVLAP. These programs have been in operation since 1984 and they have helped to improve the performance of personnel dosimetry processors. The programs are now investigating new areas that would benefit from the accreditation process, including: extremity dosimetry, bioassay and internal dosimetry programs.

The techniques used to by the DOELAP and NVLAP programs can be adapted for use in other fields. In any other area where critical information is generated by a measurement process, the accreditation process can be used to evaluate and document the performance capability of the organizations that provide such information. This approach is particularly useful in areas where the information relates to the health and safety of individuals.

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