American National Standard Institute Development of New Standard (N14.36): Measurement of Radiation Levels and Surface Contamination for Packages and Conveyances – 11610

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ABSTRACT

This paper describes the development and current status of the new standard "Measurement of Package and Conveyance Radiation Levels and Surface Contamination," approved by the American National Standards Institute (ANSI) in 2007. The purpose of the standard is to minimize variability and therefore help to demonstrate uniform compliance of contamination and radiation levels with regulatory limits, thus promoting public and occupational health and safety during transportation and the handling of radioactive materials.

A 33-member subcommittee (N14.36) was formed to develop the standard according to the procedures of ANSI Accredited Standards Committee N14, "Packaging and Transportation of Radioactive and Non-Nuclear Hazardous Materials." The subcommittee includes representatives from the radioactive material packaging and transportation industry in the United States and Canada, non-governmental organizations, and U.S. regulatory and government agencies (both federal and state). Included is the U.S. Department of Energy.

In developing this standard, the subcommittee considered the existing operating and administrative procedures, methods, instruments, and processes used in industry and government. Certain basic general requirements in the standard are applicable to all radioactive material packages; however, a graded approach as an overall optimization process was considered by the subcommittee in determining package-specific requirements. The contents of this standard include the processes, procedures, equipment, and training required for consistent, reliable, and reproducible measurements of radiation levels and surface contamination on and near radioactive material packages and conveyances.

INTRODUCTION

Transportation of radioactive materials is a necessity for any modern society. Every year, millions of radioactive material packages are transported via road, rail, air, and water within the United States and around the world. The safety of these shipments depends on strong commitments from regulators, shippers, receivers, and transporters to protect the public and the environment in all phases of transportation operations. The safety of these shipments also depends on reliable and consistent methods to verify that shipments have been prepared according to applicable regulations. Shippers, transporters, and receivers of radioactive materials are required to comply with applicable domestic and international regulatory requirements. Standard N14.36 specifies methods for measuring radiation and surface contamination in support of regulatory compliance.

Radiological measurements may be used to determine the radiation level and surface contamination of packages and conveyances in preparation for, during, and after transportation. The purpose is to minimize variability in the radiation/contamination measurement processes, equipment used, and training and qualifications of operators, as well as in the communication of results. It is important to define and standardize the measurement systems to achieve consistent, reliable, and reproducible radiation and contamination surveys before, during, and after transportation. There is a need for a national consensus standard to promote consistency in these measurements.

The N14.36 subcommittee was established in 2007 under the procedures of the American National Standards Institute (ANSI) Accredited Standards Committee (ASC) N14, "Packaging and Transportation of Radioactive and Non-Nuclear Hazardous Materials," and the Project Initiation Notification System for the development of a new standard "Measurement of Package and Conveyance Radiation Levels and Surface Contamination," was approved in 2007. The ASC N14 is responsible for preparation of standards in the United States for the packaging and transportation of fissile and radioactive materials and non-nuclear hazardous materials, including waste and mixed materials but not including movement or handling during processing and manufacturing operations.

Since 2007, the N14.36 subcommittee has held monthly conference calls and a number of meetings to discuss the development of the standard. To facilitate exchange of information among members and to provide a resource database for members' use, the subcommittee established a password-protected web site. At present, the draft standard includes (in addition to the initial sections on scope) the graded approach, definitions, regulatory requirements for radiation and contamination during transportation, survey program elements, procedures for conducting survey activities, documentation of radiological survey activities, and a list of references. The standard also includes two annexes discussing factors to be considered in survey design and radiation detection equipment. Within each section, several subsections encompass relevant areas of radiation surveys and contamination measurements of packages and conveyance. This paper discusses these areas briefly.

SCOPE

The standard sets forth methods for measuring radiation and contamination during packaging and transportation of radioactive material by all modes and during all phases of transportation operations. The standard is meant to be performance based. In view of the wide range of operational circumstances in a diverse industry that depends on packaging and transportation operations — ranging from frequent shipment of pharmaceutical products, to intermittent shipment of high-activity packages such as spent nuclear fuel — there exists a need to consider the frequency and comprehensiveness of survey. This standard addresses that need by incorporating procedure-oriented aspects into the provisions designed to address the graded approach.

Standard N14.36 is not a substitute for regulations. Nothing in this standard relieves individuals and organizations from complying with applicable federal and state requirements governing the transportation of radioactive material.

GRADED APPROACH

The standard incorporates a graded approach as an overall optimization process for designing an appropriate survey plan. The provisions extend the safety considerations built into current design and

performance standards and procedures for radioactive material packaging and transportation by specifying survey methods to verify that potential radiation or contamination levels meet the prescribed regulatory limits and achieve ALARA (as low as reasonably achievable) principles throughout the transportation operation. These survey methods should be implemented in a graded approach consistent with the confidence and reliability needed in the measurements to assure compliance.

In general, for radioactive material packages and contents that have reliable and detailed process knowledge and well-characterized physical design survey factors, effective assessment of the potential for excessive external package radiation or contamination is possible by means other than a full physical survey. Such packages and contents may undergo a survey of limited scope, if warranted by the assessment. Conversely, a general lack of process knowledge or physical design survey factors indicates that a more comprehensive survey is required to characterize a package for compliant shipment.

REGULATORY REQUIREMENTS

The standard provides a comprehensive review of radiation and contamination regulatory requirements of both international and domestic organizations for packages and conveyances involved in the transport of radioactive material. For example, the radiation levels associated with radioactive material transport are controlled, in part, by the Transport Index (TI). The TI is a dimensionless number that restricts the number of radioactive material packages that can be safely accumulated on a conveyance or in a storage area.

For contamination levels, the non-fixed contamination on the surface of radioactive material packages must be kept as low as reasonably achievable, and maximum permitted levels are provided in the regulations. Often, smears (wipes) are used to assess the removable contamination levels; however, techniques other than smears may be used to assess the removable contamination if they have equal or greater efficiency.

SURVEY PROGRAM ELEMENTS

The standard discusses the elements of a survey program that are specific to transportation, including survey design elements, instrumentation selection and use, qualification and training of personnel, survey optimization, and roles and responsibilities.

Elements Common to All Transportation Survey Programs

Elements that are common to all survey programs include safety considerations for the surveyor, ALARA considerations, and instrument calibration.

Survey Design Elements

The process for designing and optimizing a transportation survey starts with the collection of information about process knowledge, physical survey factors, and data quality objectives. This information provides a basis for assessing the types, numbers, and frequency of measurements needed for a survey. Process knowledge is documented information concerning the physical and chemical characteristics, history of prior use, and inherent radioactivity of the materials and/or equipment

considered for shipment. Physical survey factors are aspects of the survey item's shape, structure, and composition that affect the detection of radiation by the survey meter. Data quality objectives are specifications of the type, quality, and quantity of data needed to meet the objectives of a specific type of survey.

Survey Instrumentation Selection

The ultimate success of a survey depends on the ability of an instrument to measure radiation accurately, with a precision that permits a reliable distinction between the measured radiation and the regulatory limit.

Surveyor Qualifications and Training

A function-specific qualification and training program shall be developed and implemented by using performance-based concepts. Surveyor training programs shall include specific instruction in the various survey methods and reporting techniques that are to be utilized for the collection of survey data for packages and conveyances.

Survey Optimization

Survey optimization is a process for the identification and incorporation of survey design elements, ALARA considerations and controls, physical limitations, and workplace hazard controls into the design of the survey. The goal of survey optimization is to design a survey that provides reliable and consistent data for compliance, while ensuring safety and cost-effectiveness and also satisfying production and delivery schedules. Figure 1 illustrates the steps involved in designing an optimized survey plan for packages and conveyances. These steps are as follows:

1. Collect information in the following areas: survey design factors; surveyor training, qualification, and reliability; instrument capability; and safely/ALARA considerations.

2. Analyze the collected information to assess the balance of the probabilities and risks of incorrect survey results versus the efficiency of the survey. On the basis of decisions concerning acceptable risk versus efficiency, optimization of the survey plan occurs. The better the available information, the more dependable these decisions will be.

3. Specify the survey plan in terms of key optimized parameters such as

    - Number, types, and locations of measurements;

    - Action levels and decision rules;

    - Probabilistic criteria for selecting items to be surveyed;

    - Calibrated, maintained instruments with appropriate detection capability for the measurements to be performed; and

    - Surveyors with appropriate training, qualifications, and human factors reliability.

The final outcome of the optimization process is accurate and consistent compliance with regulations. The whole process is iterative in nature.

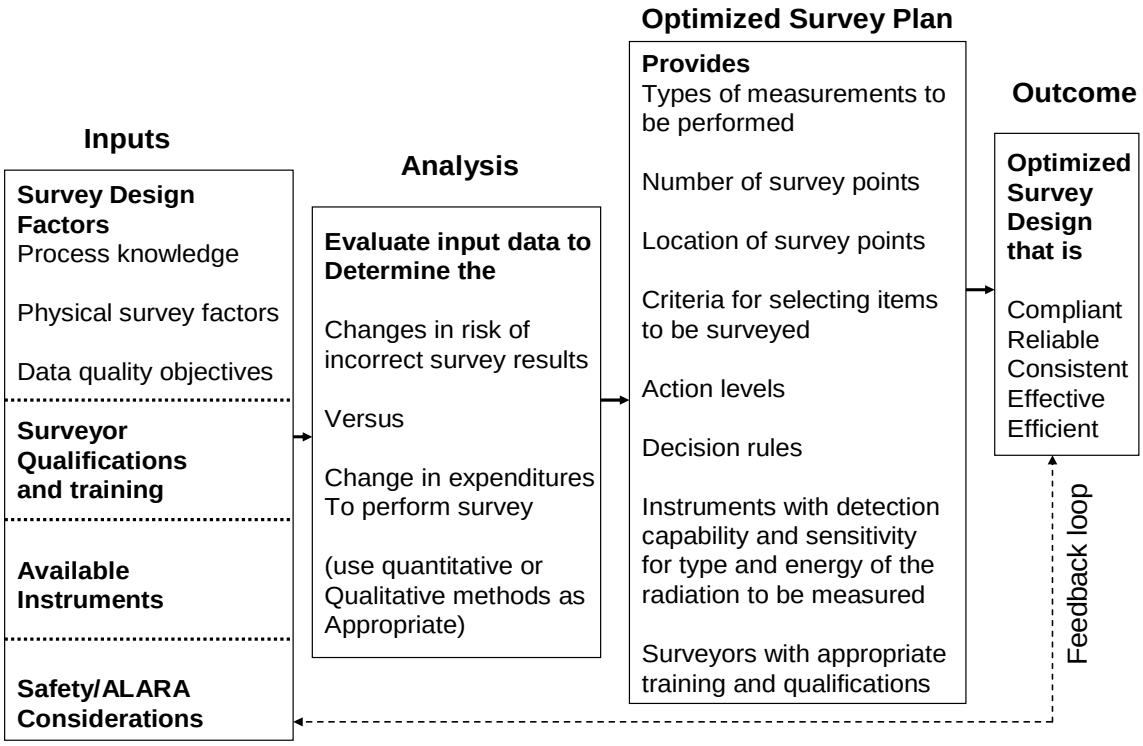

Fig. 1. Elements of and conceptual approach to the optimization process.

CONDUCTING SURVEY ACTIVITIES

Surveys provide quantitative data that are utilized directly to ensure compliance with applicable requirements. The standard addresses the precautions and limitations for package and conveyance surveys, general technical and design considerations that should be followed when performing survey activities, practices to be followed for measurement of removable contamination, and guidance on practices for radiation measurements. This section of the standard also includes general considerations and practices, including precautions and limitations for both packages and conveyances, that should be followed when performing survey activities.

DOCUMENTATION OF RADIOLOGICAL SURVEY ACTIVITIES

Once a radiological survey is documented, it is maintained as a radiological record to document radiological conditions. Survey documents are considered permanent records, and their maintenance should be described in the particular survey program design document. Well-maintained records and supporting data may also assist in demonstrating compliance and protection during regulatory action or litigation. Specific documentation requirements for radiological surveys of packages and conveyances should be based on the data quality objectives for the particular survey and specified in the procedures

for each survey program. Records of the radiological survey program should consist of policy statements, procedures, work authorizations, instrument calibration data, training data, surveys, and supporting data. The records should be maintained in a manner that will allow correlation with the corresponding support information. For example, procedures for performing radiation surveys should be identifiable with the survey results.

ANNEX 1: FACTORS TO BE CONSIDERED IN SURVEY DESIGN

The purpose of Annex 1 is to provide additional details about process knowledge and physical survey factors, as outlined below.

Process Knowledge

Process knowledge consists mainly of information on the radioactivity of the materials and equipment considered for shipment, a description of the process for packaging the radioactive material, and the history of the packaging and transportation operations. The information is derived from material generation and packaging operations, together with knowledge of the radioactive contents of interest.

- *Material Characteristics/Package Contents*: Current material-based regulatory requirements have taken into account package contents, as well as radiological characteristics, to accommodate the potential for increased radiation level or surface contamination associated with transportation operations.

- *Description of the Process for Packaging Radioactive Materials*: A well-defined, controlled process serves as one of the most important parameters for the graded approach. It includes operational knowledge that pertains to production, handling, packaging, and transportation of the radioactive materials or waste.

- *History of Packaging and Transportation Operations*: The history of packaging is also a factor to be considered. For example, packages that are reused (as opposed to new) or were previously exposed to a contaminated environment may have increased potential for unexpected surface contamination. In addition, environmental conditions, such as humidity and atmospheric pressure, may induce or enhance surface contamination during shipment. Although a lesser concern, the conveyance type, together with the mode of transportation, may sometimes influence the survey approach. This concern applies specifically to prolonged shipment duration, such as a long-distance shipment campaign or international shipping (by air or sea). Exclusive-use versus non-exclusive-use transport for package shipments should also be a consideration for survey design.

Physical Survey Factors

The physical factors influence the approach taken for the radiation survey and surface contamination measurements. For radiation surveys, changes in source-to-detector distance, shielding, and shape and in the distribution of the radioactive material are the factors that could result in changes in radiation level during transportation. Emphasis should be placed on instances where an asymmetrical radiation field could be caused by irregularities of the container shape, the arrangement of the radioactive material, or variations in the shielding configuration contained in the package. Survey of surface

contamination depends on container surface size and complexity. The package and environmental conditions could also affect the survey design. Such conditions might include potential degradation of the package during prior activities in storage, handling, or shipment.

ANNEX 2: RADIATION DETECTION EQUIPMENT

The purpose of this Annex 2 is to provide a brief background on radiation detection equipment applicable to the standard. The focus is on a more narrow discussion of equipment used in the transportation of radiological materials.

CONCLUSIONS: PATH TO APPROVAL

Upon completion of the draft standard, the subcommittee will submit the standard to ASC N14 by January 19, 2011, for review and balloting approval. Under the N14 Operating Procedures (based on "ANSI Essential Requirements: Due Process Requirements for American National Standards"), the voting period for balloting ends six weeks from the date of issue or as soon all ballots are returned, whichever comes first. Approval of a new standard requires that a majority of the consensus body cast a vote and that at least two-thirds of those voting approve. On the basis of the N14 process and allowing time for disposition of views and objections (including those from ANSI *Standard Action*), subcommittee members anticipate that this standard will be approved by the end of 2011.

REFERENCES CITED IN THE STANDARD

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