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

A. Kapoor
U.S. Department of Energy

J. Williams
U.S. Department of Transportation

S. Y. Chen and S. Kamboj
Argonne National Laboratory

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 21-member subcommittee (N14.36) was formed to develop the standard following 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, United States regulatory and government agencies (both federal and state governments), and includes 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 (RAM) packages; however, the risk-informed, graded approach was considered by the subcommittee in determining package-specific requirements in the standard. 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 RAM 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 upon 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. Standard N14.36 specifies methods for measuring radiation and surface contamination; shippers, transporters, and receivers of radioactive materials are required to comply with applicable domestic and international regulatory requirements.

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 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" in 2004, 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 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), graded approach, definitions, radiation and contamination regulatory requirements for transportation, survey program design elements, guidance for conducting survey activities, documentation of survey activities, and the list of references. The standard also includes two appendices on radiation detection equipment factors to be considered in survey design. Within each section, there are several subsections encompassing relevant areas of radiation surveys and contamination measurements of package 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. It is a process-oriented standard designed to enumerate the steps, procedures, and protocols for measurement of radiation levels and surface contamination for packages and conveyances. It is not a performance standard, but rather, cites the relevant performance standards needed to comply with regulations.

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 large quantities, yet low-activity pharmaceutical products, to intermittent shipment of high-activity packages such as spent nuclear fuel—there exists a need to factor the frequency and rigor of surveillance into the equation.

Standard N14.36 is not a substitute for regulation. 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 design of the appropriate radiation surveillance plan for radioactive material transportation should incorporate a graded approach. Since not all radioactive material transported in the United States has similar radiological properties, transport environments, or process knowledge histories, there is a need to "tailor" (or grade) the prescriptive steps to account for the differences.

The provisions in this standard extend the safety considerations built into current design and performance standards and procedures for radioactive material packaging and transportation. This objective is achieved by specifying surveillance measures for verifying that the potential radiation or contamination levels meet the prescribed regulatory limits and achieve As Low As Reasonably Achievable (ALARA) levels throughout transportation operations. These surveillance efforts should have a quality (i.e., extent and rigor) graded in accordance with the confidence and reliability needed in the measurements resulting from these efforts.

In general, for radioactive material packages and contents that have a highly reliable pedigree (detailed process knowledge, together with well-characterized geometry and measurement configurations), it is possible to assess the potential for excessive external package radiation or contamination; thus, permitting such packages and contents to undergo a relatively simple surveillance effort, if warranted by the assessment. Conversely, a general lack of information or established pedigree requires a more complex effort for sampling and monitoring. The graded approach concept is illustrated in Figure 1 and Figure 2.

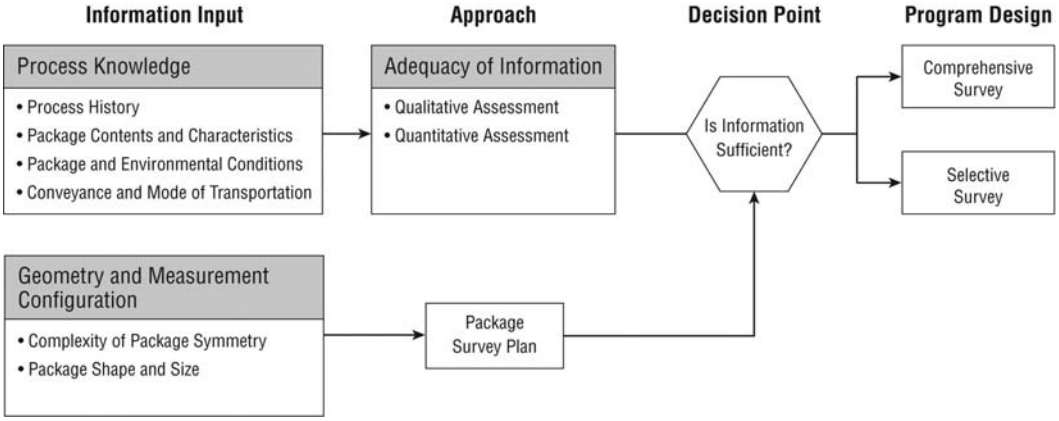

Figure 1. Conceptual Approach for Survey Program Design

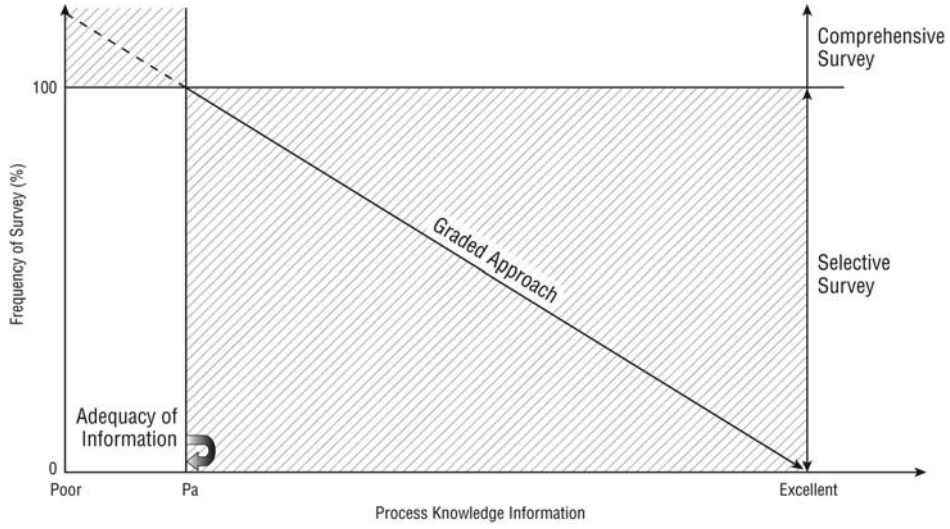

Figure 2. Conceptual Design for Graded Approach Based on Process Knowledge

REGULATORY REQUIREMENTS

This section provides a comprehensive review of radiation and contamination regulatory requirements for packages and conveyances. Both international and domestic organizations provide the radiation and contamination regulatory requirements 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 DESIGN ELEMENTS

This section of the standard discusses the survey program elements specific to transportation. Elements that are common to all survey programs include safety considerations for the surveyor; ALARA considerations; and instrument calibration. Survey optimization is a process for the identification and incorporation of process knowledge, historical data, package design considerations, ALARA considerations and controls, physical limitations, and workplace hazard controls into the design of the survey. The data quality objective (DQO) process as described in this section is intended to provide a generic framework through which survey objectives are established, documented, and optimized, to ensure that quality data are generated to demonstrate compliance with survey limits, while considering the efficiency and effectiveness of the survey method. This section consists of subsections providing guidance on survey program design elements such as survey optimization, data quality objectives, action levels for radiation and surface contamination, survey instrumentation selection and use, and surveyor training.

CONDUCTING SURVEY ACTIVITIES

Surveys provide quantitative data that are directly utilized to ensure compliance with applicable requirements. This section of the Standard addresses the precautions and limitations for package and conveyance surveys, general considerations that should be followed when performing survey activities, practices to be followed for removable contamination measurement, and guidance on the practices that should be employed when performing radiation measurements. This section 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 DQOs 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 authorization, 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.

APPENDIX 1: RADIATION DETECTION EQUIPMENT

The purpose of this appendix 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 those markets serviced by this standard, namely the transportation of radiological materials.

APPENDIX 2: FACTORS TO BE CONSIDERED IN SURVEY DESIGN

A. Process Knowledge: Process knowledge consists mainly of the information on the history of the transportation operation and thus, would serve as a key basis for the graded approach. The information is derived from material generation and packaging operations, together with knowledge on the radioactive contents of interest.

A.1 Process History: Process history serves as one of the most important parameters for the graded approach. It includes the operational knowledge that pertains to production, handling, packaging, and transporting the radioactive materials or waste.

A.2 Package Contents and Characteristics: Current material-based regulatory requirements have taken into account the package contents as well as radiological characteristics, to accommodate potentially increased radiation levels or surface contamination associated with transportation operations.

A.3. Package and Environmental Conditions: The package and environmental conditions could also affect the survey design. Such conditions may include potential degradation of the package during prior activities in storage, handling, or shipment. Radiation surveys in such cases should be designed to detect asymmetry in package dose to confirm compliance with the regulatory limits on the package surface.

A.4 Conveyance and Mode of Transportation: 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 long-distance shipment campaign or international shipping (by air or sea).

B. Geometry and Measurement Configurations: The package geometry and configuration will influence the approaches to surveillance of either the radiation level or surface contamination, when an action to conduct the survey is deemed necessary by information provided in the process history discussed above.

Any other relevant factors should also be considered in planning for the survey.

CONCLUSIONS: PATH TO APPROVAL

Upon completion of the draft standard, the subcommittee will submit the standard to N14 for review and balloting approval by October 30, 2010. 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 at least two-thirds of those voting approve. Based on 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

U.S. Environmental Protection Agency. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. Washington, DC: EPA QA/G-4; EPA/240/B-06/001, February 2006.

MARSAME — EPA 402-R-06-002, DOE/EH-707, December 2009.

American National Standards Institute. *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*. New York: American National Standards Institute; ANSI N323A-1997, 1997.

N14 Operating Procedure, 2008: N14 Standards Committee on the Packaging and Transportation of Radioactive and Non-Nuclear Hazardous Materials.

ANSI/HPS N13.49-2001, *Performance and Documentation of Radiological Surveys.*

ANSI/HPS N13.36-2001, *Ionizing Radiation Safety Training for Workers.*

49 Code of Federal Regulations, *Transportation.*