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Department of Energy

Washington, DC 20585

March 31, 2010

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue NW, Suite 700
Washington, DC 20004-2901

Dear Mr. Chairman:

This letter is to inform you of the completion of Commitments 5.3.1.1, 5.3.1.2, and 5.3.1.3 in the Department of Energy (DOE) *Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 2007-01,* dated October 24, 2007.

Commitments 5.3.1.1 through 5.3.1.3 identify *in situ* nondestructive assay (NDA) personnel training and qualification, equipment capabilities, and directive needs. No interim actions are necessary. A report documenting the NDA needs is attached.

If you have any questions or need further information, please contact me at (301) 903-4218.

Sincerely,

Chip Lagdon
Chief of Nuclear Safety
Office of the Under Secretary
U.S. Department of Energy

Enclosure

cc:
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OFFICE OF THE CHAIRMAN

Nondestructive Assay (NDA) Holdup Measurement Program Needs

The purpose of this report is to identify attributes of an NDA holdup program that are necessary for the safe and cost-efficient elimination or mitigation of criticality safety hazards. The summary statement of the needs identification deliverable is:

5.3.1 Identify DOE NDA holdup measurement needs and technical bases for personnel training and qualification; equipment capabilities; directives; research and development; quality assurance; oversight; and any interim actions.

The needs identification deliverable is further broken down into six subparts. This report addresses deliverable subparts 5.3.1.1, 5.3.1.2, and 5.3.1.3. Deliverable subparts 5.3.1.4, 5.3.1.5 and 5.3.1.6 will be discussed in a separate report. Upon completion of the needs deliverable, The Department will conduct a gap analysis using the outcomes of the extent of condition, state-of-the-practice, and DOE NDA holdup measurement needs reviews as the basis for developing a plan that is prioritized to address identified gaps in personnel training and qualification; equipment capabilities; policy, directives, and standards; research and development; quality assurance; and oversight.

Actions will then be taken to address the identified needs and to close gaps between current NDA holdup measurement practices and state-of-the-practice. This may require either introducing commercial practices or equipment into the DOE complex, or research and development for new equipment or practices. Potential gap-filling actions will be risk- and cost-prioritized.

Specific deliverables are broken out of the summary statement and are discussed separately:

5.3.1.1 Identify **in situ** *NDA personnel training and qualification needs and any interim actions.*

5.3.1.1(a) Personnel Qualifications

There is a noticeable, continual high turnover rate for NDA professionals and technical specialists performing holdup measurements. The loss of experienced personnel at sites under the purview of the Office of Environmental Management (EM) and the National Nuclear Security Administration (NNSA) creates several needs for the training and qualification of new measurement personnel. Formal qualification is especially important to provide continuity of measurement quality as less experienced personnel assume new responsibilities. ASTM International Guide C1490, *The Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel,* provides good practices for the selection, training, qualification, and professional development of personnel performing analysis, calibration, physical measurements, or data review using NDA equipment, methods, results, or techniques. The guide also covers NDA personnel involved with equipment setup, selection, diagnosis, troubleshooting, or repair.

Personnel qualification needs are:

- A site-specific formal transition program is established for turnover of NDA measurement personnel.

- Personnel qualifications are formally defined, identified, and tracked, similar to the process used in the field of criticality safety.

5.3.1.1(b) Training

The training of *in situ* NDA measurement personnel is essential to the quality of the measurements and the development of a reliable measurement program. Training should have minimum curriculum requirements and be formal, consistent, and geared towards enabling each category of personnel within a measurement program to perform its defined tasks. The training program should include a combination of formal classroom training, on-the-job learning, and continuing education.

Training needs are:

- A uniform, consistent training curriculum that includes fundamental physics, measurement of nuclear material, holdup software usage, statistical propagation of errors, measurement uncertainty and the magnitude of contributors, minimum detection limits, use of field transmission measurements, and measurement limitations for customers using NDA holdup data;

- An accessible, formal holdup training course that meets a minimum training requirement, includes proficiency testing and practical exercises, and is taught by an NDA professional as defined by the ASTM Training Guide;

- Periodic continuing education training courses that keeps current with new hardware and software technologies; and

- Site-specific testing and re-testing, with performance demonstration, to demonstrate the mastery of skills and to identify deficiencies in knowledge or practices.

5.3.1.2 Identify* in situ *NDA equipment capabilities and needs and any interim actions.

EM and NNSA sites rely predominantly on gamma-ray assay techniques. The fundamental equipment technology used at the sites is adequate to meet current measurement needs. The technology is not obsolete for the intended purposes. Some sites rely on high-resolution (i.e., germanium) techniques, while other sites rely mostly on low-resolution (NaI) techniques. However, when necessary, all sites use high-resolution equipment. Medium-resolution equipment, such as cadmium zinc telluride (CdZnTe) and cadmium telluride (CdTe), is not in routine use at this time.

Even though the technology is adequate, the actual equipment used at most sites has been used in the field for many years and is developing reliability issues. The lack of automation with the older technologies is a potential weakness compared to current equipment capabilities at some sites. The technology is not obsolete for the intended purposes; however, more effective component integration would aid the users' ability to acquire data in a more efficient manner.

Nuclear material calibration standards, while not currently a problem, are a risk due to the continuous pressure to reduce quantities of special nuclear materials at facilities. This is an especially serious concern for nuclear facilities that are not graded Safeguards Category I facilities or are reducing their security postures to Category II or lower. Single-point failures currently exist in the area of calibration standards. Nuclear material standards for measurement validation and training need improvement at some sites.

If appropriately applied, the currently available equipment can meet measurement needs. Identification of areas where improvements in detector design and implementation would reduce human error, reduce the difficulty of application, improve equipment reliability, and provide improved source term determination are listed in the following subsections.

The *in situ* NDA equipment and capabilities need is to:

- Improve detector design to reduce human error, improve equipment reliability, and provide improved source term determination.

5.3.1.2(a) Reliability

Measurement system improvements that would increase operator productivity include the following:

- More reliable, more robust measurement systems;
- Fewer cables;
- Improved ruggedization; and
- Software sustainability and system design that enable efficient migration to future operating systems and NDA hardware.

5.3.1.2(b) Human Factors Engineering

The use of smaller, lighter detectors and shielding; specifically:

- Upgrading to mechanically-cooled, high-purity germanium (HPGe) detectors that are physically smaller and lighter than the liquid nitrogen-cooled detectors currently in use; and

- Miniaturization and integration (fewer components).

5.3.1.2(c) Ancillary Measurement Technologies

Advanced technologies that could be applied to better define the source term:

- Ultrasound distance and thickness measurements;

- Digital cameras that record equipment or measurement details; and

- Laser imaging techniques may be of use in some measurement scenarios.

5.3.1.3 Identify* in situ *NDA directive needs and any interim actions.

5.3.1.3(a) Use of Consensus Standards (where available and applicable)

Currently, one consensus standard exists that is directly applicable to *in situ* NDA holdup measurements. ASTM C-1455-07, *Standard Test Method for Nondestructive Assay of Special Nuclear Material Holdup Using Gamma-Ray Spectroscopic Methods,* provides direction for activities involved in performing holdup measurements. C-1455 was first written as a guide in 2000; after the completion of the five-year revisions to the document, it is now an ASTM International Standard. This Standard was developed by safeguards and NDA experts and is reviewed and updated every five years. Information included in this Standard concern planning for measurements, selection of equipment, potential interferences, and further information necessary for conducting holdup measurements. In addition to this Standard, several reference documents are available for holdup measurement practitioners. Two primary references are Nuclear Regulatory Commission Regulatory Guide 5.23, In Situ *Assay of Plutonium Residual Holdup*, and Los Alamos National Laboratory Report LA14206, *Gamma-Ray Measurements of Holdup Plant-Wide: Application Guide for Portable, Generalized Approach.* Other active ASTM International guides and standards applicable to *in situ* NDA holdup measurements include C1673, *Standard Terminology of C26.10 Nondestructive Assay Methods*; C1490, *The Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel*; and C1592, *Standard Guide for Making Quality Nondestructive Assay Measurements.*

Multiple voluntary consensus standards are either being written or being considered for development within major consensus standards-developing organizations. Undergoing final editing after being approved by committee ballot is an ASTM International Standard on the selection of modeling techniques for performing *in situ* measurements. Standard C1726-2010, *Standard Guide for Use of Modeling for Passive Gamma Measurements,* discusses technical considerations as well as the pros and cons of multiple methods of applying modeling methods to *in situ* measurements.

Two standards are being developed in direct response to issues raised by Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2007-1. A team of writers in the American National Standards Institute (ANSI) N15 committee is developing a standard to address administrative practices related to determining and reporting holdup measurement results in an understandable manner for stakeholders, including nuclear criticality safety engineers. A parallel effort within the ANSI N16 committee is developing a standard for the use of *in situ* measurement results by nuclear criticality safety engineers.

ASTM International has recently started developing a neutron holdup measurement standard, which will combine with the Modeling Standard and the current Gamma-Ray Holdup Standard to provide standards for the major methods of performing holdup measurements in the United States.

The use of consensus standards need is to:

- Ensure the use of applicable NDA consensus standards. Requirements for using applicable NDA consensus standards should be defined in a manner similar to the requirements for using criticality safety consensus standards.

5.3.1.3(b) Documenting User/Customer Expectations of the NDA Measurements

Good communications between the nuclear criticality safety (NCS), engineering, operations, waste, and NDA organizations are necessary to clearly define customer expectations. A Data Quality Objective (DQO) program is one such method that has proven to be an effective process for defining customer expectations and determining the NDA organization's capability to meet those expectations.

The user/customer expectations need is to:

- Have a consistent method for defining customer needs, such as a DQO.

5.3.1.3(c) Calculations

The area of calculating and applying Minimum Detectable Activity (MDA) values can be combined with the calculation of estimates of uncertainty. However, the use of qualified statistical support is limited.

Calculation needs are:

- The use of checklists for the qualitative determination of measurement uncertainty contributions and magnitude is an effective means for reducing the inadvertent exclusion of sources of uncertainty. While many of the checklist items will be the same from site to site, the checklist for each site should be specific to the types of measurements made at that site to avoid unnecessary information from being included when not needed;

- Access to routine statistical support in evaluating mathematical computations;
- Access to routine peer review of all calculations, including MDA and uncertainty reporting;
- Requirement for peer review by an NDA-knowledgeable individual of in situ NDA results that are used as controls for criticality safety; and
- Standardization of the usage of terms, especially in the area of correction factors and uncertainty determination.

5.3.1.3(d) Design of New Facilities and Equipment

Design, by its very nature, is applied to future activities. It does not translate directly into a need, per se, but rather into a collection of recommendations and lessons learned for future design projects. DOE O 420.1B, *Facility Safety*, states: "Facilities that conduct operations using fissionable material in a form that could inadvertently accumulate in significant quantities must include a program and procedures for detecting and characterizing accumulations." The Order does not provide additional guidance on this topic.

DOE G 421.1-1, *DOE Good Practices Guide, Criticality Safety Good Practices Program Guide for DOE Nonreactor Nuclear Facilities*, provides an extensive compendium of design guidance, but little of it is relevant to the engineering features required to minimize inadvertent accumulations or enhance holdup measurement. ASTM C1217-06, *Standard Guide for Design of Equipment for Processing Nuclear and Radioactive Materials,* is intended for the design of "shielded cell or canyon facilities" that has some relevant information, but is not generally applicable to non-shielded facilities.

The design need is to:

- Capture NDA holdup measurement recommendations and lessons learned into a guidance document (similar to DOE Order 6430.1A, *Design Criteria*, or DOE G 421.1-1) for DOE and others to use to aid and guide design projects.

5.3.1.3(e) Measurement Validation

One area where NDA differs from destructive analysis (DA) is in the ability to produce validation measurements. This is because the sample is usually delivered to the DA measurement laboratory; but for NDA, the measurement is made on the item. The other issue is the complexity and variation in the different "item" characteristics for NDA. This leads to a difficulty in producing useful NDA measurement standards or validation items. As a result, the only viable method of fully validating NDA measurement is through cleanout of measured items. This is expensive, time-consuming, and often not feasible for operating systems. When possible, NDA measurement validation studies using equipment cleanout can benefit the NDA program by building confidence in the measurement techniques and resulting measured values.

The measurement validation need is to:

- Document and distribute validation studies.

Conclusion

The generic *in situ* NDA holdup measurement program needs identified in this report are based on the results of state-of-the-practice reviews at three sites within the scope of the Implementation Plan, and do not represent site-specific needs. Given the programmatic differences amongst the sites, including relative criticality risk associated with fissionable material holdup, a graded approach will be applied to tailor the generic needs for specific sites. Given the recently conducted *Nondestructive Assay Holdup Measurements of Uranium and Plutonium Materials Training* conducted at Los Alamos National Laboratory and ongoing support for standards development, no interim actions have been identified in the areas covered in this report.