Criteria for Conducting State-of-the-Practice (Nondestructive Assay *in situ* Holdup) Site Reviews

December 2008

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LA-UR-08-07716
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1. Background

The Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 2007-01 on 25 April 2007. The Department of Energy (DOE or Department) accepted DNFSB's Recommendation on 28 June 2007.

The DNFSB stated, in Recommendation 2007-1, that there are many situations in which the quantity and composition of radioactive material must be determined *in situ.* In some instances, access to the material is impossible or undesirable; consequently, weighing, laboratory analysis, and calorimetry are not viable measurement options. In these cases, *in situ* nondestructive assay (NDA), based on the measurement of signature emissions from a specific isotope of interest, is used to provide an estimate of the type and quantity of radioactive material present. However, large uncertainties can occur in estimating the type and quantity of radioactive material using *in situ* NDA. These uncertainties and biases can be caused by any number of contributing factors such as having limited knowledge about actual shielding properties or spatial distributions of radioactive material. Measurement uncertainties, in turn, can lead to potential adverse criticality safety conditions, misstated inventory values, unexpected radiation exposure to workers, and misestimation of radioactive material available for release in accident scenarios.

The *Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation* 2007-1 (IP) was accepted by DNFSB on 04 April 2008. Included within this IP are requirements to evaluate the extent of condition of defense nuclear facilities: (1) containing fissionable material in quantities greater than the single parameter subcritical fissionable mass limits (ANSI/ANS-8.1-1998, R2007, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*, and ANSVANS-8.15-1981, R2005, *Nuclear Criticality Control of Special Actinide Elements)* and (2) that rely upon *in situ* NDA measurements to address criticality safety issues.

The technical justification for the extent of condition evaluation is based upon the following:

- DOE O 420.1B specifically addresses fissionable material holdup and requires that "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."
- DOE O 420.1B requires criticality safety programs (CSPs) for those "… nuclear facilities and activities that involve, or potentially involve, nuclides in quantities that are equal to or greater than the single parameter limits for fissionable materials listed in ANSVANS-8.1 and 8.15."
- DOE O 420.1B further requires that the CSP "...description document must describe how the contractor will implement the requirements in the contractor requirements document (CRD) including the standards invoked by this Chapter. The CSP description document must be approved by DOE and implemented as approved."

Nuclear criticality safety in operations with fissionable materials outside reactors, at defense nuclear facilities, presents a criticality risk to DOE that can be effectively managed through appropriate criticality safety programs supported by the protocols, methodologies, calculations, and assumptions applicable to NDA holdup measurements performed at DOE sites. Using the following approach, DOE has developed an IP that is consistent with Integrated Safety Management System principles:

- Evaluate the condition of *in situ* NDA programs against evaluation criteria, which will be developed;
- Identify good practices, both commercial as well as within the Department, in training and qualification, design requirements for new facilities and equipment, standards for conducting *in situ* NDA, implementation of standards, and oversight;
- Identify relevant ongoing research and development activities;
- Identify what is needed and resulting gaps in personnel capabilities and training, equipment capabilities, policy and directives, quality assurance, and oversight; and
- Establish requirements, programs, and guidance, as needed.

Three main issues were identified in the IP as being of primary significance to the current technical and regulatory landscape regarding *in situ* NDA measurements: (1) lack of standardized requirements for performing measurements, (2) lack of design requirements for new facilities that would facilitate accurate holdup measurement, and (3) lack of research and development activities for new instrumentation and/or measurement techniques.

2. Technical Support Group (TSG)

To assist in completing the IP, an NDA Technical Support Group (TSG) of subject matter experts (SMEs) was established on 31 July 2008. The TSG consists of Federal employees from Headquarters and Field Elements and DOE management and operating contractors who have expertise in NDA holdup measurement. The TSG assists the Department in the specific areas of concern highlighted in Recommendation 2007-01.

The TSG was formed on 31 July 2008 in response to DNFSB Recommendation 2007-01 and is comprised of personnel from DOE staff and contractors as described above.

The primary function of the TSG is to provide operational and technical expertise to the DOE through the Chief of Nuclear Safety (CNS). The TSG provides advice and technical support to meet the needs of the DOE complex for *in situ* NDA, supporting all the unique programmatic needs of sites under the Office of Environmental Management (EM) and the National Nuclear Security Administration (NNSA). Specific TSG functions include the following:

- Assistance, as requested, to support DOE's efforts in accomplishing the IP for DNFSB Recommendation 2007-1;
- Programmatic input regarding the development and implementation of an effective NDA holdup measurement program;
- SMEs to assist in conducting periodic assessments to ensure that NDA holdup measurement programs are using appropriate technology, consensus standards, and processes;

- A mechanism to identify and address major NDA holdup measurement issues that have crosscutting impacts across the DOE complex or within a site;
- A forum for sharing lessons learned, ideas, and proven processes or programs to both DOE and contractor management; and
- A forum for ensuring that advances in DOE and consensus standards are made when appropriate.

A graded approach will be used for all TSG reviews.

3. IP Commitment 5.2.1: Establish Criteria for Conducting State-of-the-Practice Reviews

3.1 *Issue*

Identify the state-of-the-practice and good practices with respect to training and qualification, design requirements for new facilities and equipment, standards for conducting NDA holdup measurements, implementation standards, research and development, quality assurance, oversight, and roles and responsibilities.

3.2 Basis

DOE has not established requirements or guidance for performing *in situ* NDA measurements in its directives system. Many of the problems that require *in situ* NDA to determine fissionable material holdup have occurred because facilities were designed and built before the need for NDA technology was evident. Furthermore, *in situ* NDA was promulgated on a "grassroots" basis at the various sites based on specific needs and facility conditions. As a result, no consistent attempts were made to design facility systems to minimize holdup or facilitate its measurement.

3.3 Resolution Approach

The Department will conduct reviews where appropriate, either in office or onsite, to:

- Determine whether the protocols, methodologies, calculations, and assumptions used in practice to obtain NDA results are technically defensible and adequate for their intended purpose. This review should take into consideration lessons learned from recent events.

- Identify domestic and international (to the extent practical) good practices with respect to training and qualification, design requirements for new facilities and equipment, standards for conducting NDA holdup measurements, implementation of standards, research and development, quality assurance, and oversight.

- Establish criteria for conducting state-of-the-practice reviews of a) training and qualification; b) design requirements for new facilities and equipment; c) standards for conducting NDA holdup measurements; d) implementation of standards; e) research and development; f) quality assurance; g) oversight, and h) roles and responsibilities.

Some DOE sites have made progress in establishing ***in situ*** NDA programs. Further commercial guidance for NDA is available in a series of standards published by the American Society for Testing and Materials International (ASTM). The Department will draw on the experience of the TSG, DOE sites, and commercial experience in determining good practices.

4. Implementation of State-of-the-Practice Reviews, Sites to be Reviewed, and Schedule

4.1 Implementation of State-of-the-Practice Reviews

Site state-of-the-practice reviews will be conducted by members of the TSG while onsite; nominally, over a one-week period. Reviews will be scheduled to permit a majority of TSG members to be present onsite. Nearly all of the review criteria information will be elicited via preapproved lines of inquiry. Each topical area will have a comprehensive list of questions or requests for information. Following the site visit, the answers to the lines of inquiry and the supplied information will be compiled into a site report. After the selected sites have been reviewed, the state-of-the-practice review reports will be evaluated for suggested improvements to DOE and NNSA ***in situ*** NDA measurement programs. The evaluation results will be useful to provide recommendations on standardization of methodology of ***in situ*** NDA holdup measurements and reporting of final gram quantities and uncertainties.

The review criteria will be provided to each site prior to the beginning of a site visit. A total of eight topical areas will be reviewed for each site. Seven of the review topics are explicitly required by the IP; these areas are 1) training and qualification, 2) design requirements for new facilities and equipment, **3)** standards for conducting NDA holdup measurements, 4) implementation of standards, 5) research and development, 6) quality assurance, and 7) oversight. An eighth topical area was added during the development of the review criteria: roles and responsibilities. The topical areas of design requirements for new facilities and equipment, and roles and responsibilities, will be reviewed independently of the other six areas. The other six topical areas require input from the same group of professionals at a site, while the two aforementioned topical areas require input from completely different organizations.

4.2 Sites to be Reviewed

NNSA and EM Site Offices identified facilities at their sites that met the specific criteria for inclusion under the IP. Excerpts fiom the memoranda sent to the DNFSB Chairman from DOE sites found to be within the scope of the IP are included below:

NNSA

> ***The*** Y-12 ***Site*** *Office (YSO)* ***prioritized*** Y-12 ***facilities in terms of criticality accident risk. YSO described the basis for establishing criticality accident risk in their submittal. The*** Y-12 ***facility criticality risk*** *ranking from* ***highest risk to lowest risk is: Building*** 9212 ***and Building*** 9215 ***followed by Buildings*** 9206, 9204-2E, 9720-5, 9204-4, ***and*** 9995. ***Buildings*** 9212 ***and*** 9215 ***have approximately*** 2,100 ***of the total of about*** 2300 ***NDA measurement locations at*** Y-12, ***and are the two highest risk facilities that have a dependence upon in situ NDA for criticality control. A single in situ NDA program, the Uranium Holdup*** *Survey* ***Program (UHSP), covers all*** Y-12 ***facilities.***

EM

All EM facilities were identified as low risk with the exception of the Plutonium Finishing Plant at Hanford and the HB Line at the Savannah River Site which have been identified as medium risk.

The list of sites identified includes:

- Hanford – Plutonium Finishing Plant (PFP),
- Savannah River Site,
- Y-12, and
- Paducah-Portsmouth.

4.3 Tentative Schedule

Develop initial schedule to conduct state-of-the-practice reviews for EM and NNSA sites.

The initial schedule is:

- February 2009 – Savannah River Site HB Line
  - During this site visit, an out-of-IP-scope peer review of ***in situ*** holdup measurements and mass calculation performed in the Plutonium Fuel Fabrication (PuFF) facility will also be conducted.
- May 2009 – Y-12 Buildings 9212 and 9215
- August 2009 – Hanford PFP

Tentative site review schedule:

- Monday: half day premeeting TSG/Core
- Tuesday: Thursday: Interviews, documentation review, observation of measurements
- Friday: Outbrief with opportunity for site personnel to clarify initial comments and one-half day document preparation

5. Site Review Criteria

The site visits are not assessment visits. As such, typical assessment status briefings will not be conducted. The site will be provided with a final report summarizing the TSG team conclusions. The intent is to ascertain the state of the practice of ***in situ*** NDA holdup measurements. The outcome of the reviews will be an identification of commonality of practice, good practices, and best practices. This data will be useful to provide recommendations on standardization of methodology of ***in situ*** NDA holdup measurements and reporting of final gram quantities and uncertainties.

5.1 Training and Qualification of in situ *NDA Holdup Measurement Personnel*

5.1.1 Section Lead: Cynthia Gunn (Y-12)

5.1.2 Section Members: Steve Smith (ORNL), Brian Keele (Hanford),

5.1.3 Lines of Inquiry

I. Duties and Experience

Lines of Inquiry for Individuals

1. What is your position in the organization?
2. What are your responsibilities?
3. What is your educational background?
4. What is your NDA/science-related work background?
5. How many years of NDA experience do you have and in what NDA methods?

II. Selection

Lines of Inquiry for Management

1. What process is used for the selection of NDA personnel?
2. What skills do you consider valuable in hiring an NDA professional? An NDA technician?
3. What is the history of retention of NDA personnel at this facility?

III. Training

Lines of Inquiry for Individuals

1. Did you attend a formal holdup course? Where?
2. Have you had any on-the-job training (OJT)? How long?
3. Have you had any retraining? How often?
4. Have you ever taught in a formal holdup course?
5. Did your training cover radiation sources and detectors, transmission of radiation, calibration, facility operations, and error analysis?
6. What other knowledge areas would you like to see covered to enable you to do your job better?
7. Does training get updated to capture latest revisions of procedures, changes in instrumentation, calculation methods, and lessons learned?
8. How are operating requirements that require *in situ* NDA measurements for nuclear criticality safety, material control and accountability (MC&A), and waste management conveyed to you?

Lines of Inquiry for Management

1. How is training of NDA personnel obtained (locally, National Training Center, other…)?
2. Is there a written document on required training and retraining?
3. Do you have any on-site, formal or informal, training?
4. Is there a mentoring program within your team?
5. Are NDA personnel training requirements uniform throughout the facility?
6. Are training requirements, if requirements exist, uniformly applied?
7. Are individuals with no training or equivalent experience used?
8. What are the radiation safety, nuclear criticality safety, MC&A, industrial safety, and security training requirements for NDA staff conducting holdup measurements?

9. Describe training and qualification programs for operators, maintenance, and facility management personnel with regard to NDA.
10. Describe training and qualification programs for nuclear criticality safety, MC&A, and waste management personnel with regard to NDA.
11. How do the nuclear criticality safety and NDA groups interact to improve understanding of what holdup measurements are, what their limitations are, current status and results of measurements, and how the measurements are to be used?
12. What training is required for NDA supervisors?
13. How does level of training compare with the level of technical skill required to complete the desired measurements?
14. How does your facility identify sufficient funding to properly train NDA individuals?
15. Are the job tasks required for competent job performance identified and incorporated into existing training program documentation?
16. What written and oral tests of NDA measurement personnel are used to demonstrate knowledge adequacy?

IV. Qualification

Lines of inquiry for Management

1. How are technical and management backgrounds and qualifications determined to be commensurate with responsibility?
2. Are training and qualification programs in place for each category of NDA measurement personnel in your program?
3. How are personnel designated as qualified to make a particular measurement, review the measurement result and so on?
4. Is the level of expertise in your NDA group appropriate to maintain and update your measurement program?
5. How will you continue to maintain the required level of expertise in your program as personnel retire or leave?
6. Do you have levels of advancement defined for NDA personnel to achieve increases in expertise and encourage retention of employees?
7. Is there formal oversight of individuals that are not well qualified to perform the work when they are used?
8. How does qualification compare with the potential impact of making an inaccurate measurement (i.e., safety, security, MC&A, facility authorization basis violation, waste management)?

V. Qualification Level Determination

ASTM International C 1490–04, *Standard Guide for the Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel*, contains detailed descriptions for four categories of NDA personnel. These four categories (Senior NDA Professional, NDA Professional, NDA Technical Specialist, NDA-Qualified Instrument Operator) are based on levels of education, expertise, and duties.

The hierarchy described in ASTM International Test Method C 1490 – 04 is only one set of possible tiers. Other tiered hierarchies providing equivalent functions are equally valid. The important consideration is the increasing level of required expertise and independence of action with increasing job level function. Based on site-specific practices and policies, the four levels presented above may be collapsed or expanded and the duties listed may move to other tiers in the hierarchy.

In addition to the NDA personnel described above, the services of other specialists are often required. These include statisticians to help establish measurement uncertainties, control limits, and other criteria. Also, personnel trained in the maintenance and repair of electronic and mechanical systems may be required. In all cases, the value of the services provided by these specialists is enhanced if they have a basic understanding of NDA methods and instruments. [1]

Designate and document all NDA personnel based on the criteria detailed in the standard and normalize job content and measurement activities to personnel qualification.

When compared to the training and qualification levels defined in C1490-04, what level are the NDA personnel at this site?

5.2 Design Requirements for New Facilities and Equipment

5.2.1 Section Lead: Glenn Pfennigwerth (Y-12)

5.2.2 Section Members: Tom Nirider (DOE)

5.2.3 Lines of Inquiry

I. Design Process

1. How are NDA measurement needs integrated into the design review process?
2. How are NDA measurement needs identified?
3. How is holdup minimized within the design?
4. Does the contractor have a procedure that requires a design review to identify needed ***in situ*** NDA measurement capabilities, measurement locations, and engineered features during the design process?
5. Does the contractor obtain input from a qualified NDA professional during the project design phase?
6. Do the contractor's design criteria include a requirement to incorporate ***in situ*** NDA capabilities?
7. Are periodic design reviews conducted which address ***in situ*** NDA needs?

II. Requirements Implementation

1. Do modifications to equipment and/or processes result in a review by the ***in situ*** NDA staff prior to implementing the modification?

[1] ASTM International C 1490-04, ***Standard Guide for the Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel,*** Sections 4.2 – 4.4

2. Are there documented surveillances or methods that ensure that new or modified operations conform to site applicable *in situ* NDA requirements?
3. Do new or modified designs require applicable verification steps be performed before implementation?
4. How are surveillance frequencies established for engineered controls that are relied upon to ensure that the controls are performing their intended function?

III. Design Details that aid in situ Holdup Measurement and/or Control

1. Have traps and/or low points been eliminated or minimized that can contribute to accumulations?
2. Do collection points in piping have sufficient clear space to allow in *situ* NDA measurements during routine operations from at least three sides?
3. Have engineering controls been provided to limit material from entering the process off-gas system?
4. Are filter media appropriate for measurement and recovery of entrapped material?
5. Have cleanout ports/access been provided for inspection and clean out of potential accumulation points?
6. Do equipment designs enable decontamination using standard methods?
7. Have materials of construction been selected to enable decontamination?
8. Do surfaces requiring decontamination have a surface finish of ASTM A480 #4 or better?
9. Have mist removal mesh or pre-filters been provided at or near the source of mist or particle generation to prevent intrusion into ventilation, offgas handling, and downstream piping?
10. Have joints been sealed to prevent accumulations and collection of material?
11. Have collection devices (e.g., traps, cyclones, filters) been located close to the source of generation?
12. Has dedicated process monitoring of exhausts been performed for each process?

IV. Containers

1. Are containers designed to permit nondestructive analysis of the contents; e.g., minimize shielding?
2. Do containers have known/uniform wall thickness and geometry?

V. Facility issues

1. Is background radiation kept to a minimum by shielding and/or distance from measurement point?
2. Are key measurement points ergonomically located to enable routine measurement?
3. Are accurate as-built drawings available that detail equipment design and internal configurations?
4. Are process construction materials well characterized to enable assignment of appropriate attenuation correction factors?
5. Are alternative methods for controlling and/or preventing inadvertent accumulations of fissile material considered and documented; e.g., filters, elimination, process changes, cleanout?

5.3 Standards for Conducting NDA Holdup Measurements

5.3.1 Section Lead: David Bracken (LANL)

5.3.2 Section Members: Brian Keele (Hanford)

5.3.3 Lines of Inquiry

I. Measurement Program

1. What kinds of measurements are performed? (qualitative, characterization, identification, quantification)?
2. How are measurements performed?
3. What procedures are followed?
4. Are all NDA measurements performed according to approved procedures?
5. Are operations personnel, NDA personnel, and management involved in developing procedures?
6. Are the NDA procedures free of unnecessary detail and directly applicable to the job task being performed?
7. Do the NDA operators find the instructions in NDA procedures easy to understand and follow?
8. How is version control implemented for procedures so only the most recent version is used?
9. How is it determined if procedures are being followed?
10. Is there a documented and reviewed technical approach to the measurements?
11. What NDA measurement technique(s) are in use? Please describe.
12. Are any consensus standards (i.e., ASTM International, ANSI, and ISO) used or referenced in procedures?
13. Where referenced methods are required, are these methods referenced to nationally accepted sources, such as DOE methods or national or international standards?
14. Have the criteria for evaluation of qualitative gamma scanning data to support quantitative NDA measurement methods been described in a technical basis document?
15. Does the technical basis document address the distribution of fissile isotopes to ensure that the degree of homogeneity with respect to the radioactive material present is correctly determined and is this information used to support the appropriate characterization technique?
16. Has verification been conducted that the procedures match the actual working conditions and actions that are required to be performed?
17. Are the elements and objectives of an *in situ* NDA Holdup Measurement Program plan clearly defined and documented? Do they include any of the following:
    - selection and qualification of appropriate *in situ* NDA instrumentation;
    - calibration of the *in situ* NDA equipment;
    - acquisition, preparation, use, and storage of radioactive calibration sources, standards, and check sources;

- use of *in situ* NDA instruments to perform measurements, including daily QC checks, and background evaluation, source geometry assumptions, at the location of interest;
- analysis and report of measurement control data;
- analysis and report of measurement assay results; training, qualification, and requalification of measurement personnel;
- assurance of quality of measurement performance;
- response plan for out of control conditions;
- conduct of program reviews and assessments and information management (material identification/tracking; NMC&A; Waste Management; Safety; Radiation Safety; Criticality Safety)?

II. Changes to Procedures

1. Are procedures or mechanisms in place to ensure that modifications to equipment and/or processes results in a review of NDA measurements?
2. Are lessons learned integrated into documentation?
3. Do instrument operators have a feedback process whereby improvement to procedures can be implemented?
4. Are adequate resources available to facilitate procedure improvements as they are identified?
5. How often are procedures reviewed? Revised?
6. Are facility operations reviewed periodically to determine if procedures are still relevant? How often? By whom?
7. Are procedures in place to verify that changes to process and/or equipment over time have not degraded the ability to make NDA measurements or invalidate assumptions?
8. Have non-standard methods been appropriately validated and is documentation available?
9. Where modifications to the published method have been made, are changes clearly described?
10. What configuration management system insures all changes to *in situ* NDA requirements in operations or other non-NDA procedures are reviewed by appropriate personnel?

III. Results and Calculations

1. Is there a procedure that describes how raw measurement data is used to calculate final gram quantities of nuclear material?
2. Is there any peer review of reported results?
3. Is there a standardized reporting format?
4. Is a checklist used for contributions to uncertainty?
5. How is ancillary information (i.e. sketches, instruments used, procedure) included or linked to final report?
6. Do procedures document the formulas for calculating combined standard uncertainty, including both systematic and random error?
7. Do you have procedures specifying calculations?
8. Does software documentation include, as applicable: numerical methods, mathematical models, physical models, control flow, control logic, data flow, process flow, data

structures, process structures, and the applicable relationships between data structures and process structures?

5.4 Implementation of Standards

Observation of measurements in the field will need to be observed to compliment information gathered via lines of inquiry.

5.4.1 Section Lead: Frank Lamb (Unwin)

5.4.2 Section Members: Tracy Wenz (LANL)

5.4.3 Lines of Inquiry

I. Measurement Program

1. How are measurement needs defined?
2. What are NDA holdup measurements used for? (i.e., demo, operations, waste removal, upset investigation, criticality safety, MC&A)?
3. What are the NCS requirements for ***in situ*** NDA Holdup measurements? Are these requirements stated as "limits" or as "detection of inadvertent accumulation"? Programmatically, how is this accomplished?
4. Is the determinationlselection of the appropriate NDA procedure based on the consideration of the physical characteristics of the items to be measured, as well as the goals of the measurement program (e.g., the accuracy and reliability required for NCS)?
5. Are screening measurements used to identify quantification measurement needs?
6. How many measurements are made per day on average?
7. What percent of the required holdup measurements are behind schedule or have not been done?
8. Of the possible holdup at the site, what percent could remain as unmeasured at this point? (best estimate)
9. How is process knowledge utilized during NDA measurements and characterization campaigns?
10. What historical engineering and analytical reports are cited and used for describing material chemistry and enrichment? Have any of the historical data been validated or questioned for application? If so, what parameters in the model are in question?
11. How is the NDA methodology selected?
12. What measurement methods are used at the site to characterize and quantify holdup?
13. What are the different types of measurements made (i.e. U hold up all same enrichment, Pu mixed enrichments, LEU, HEU, etc.)?
14. Are other techniques or technologies being considered to improve safety, costs, accuracy, or precision? Should other augmenting technologies be considered?

II. Source Term

1. How are source terms (i.e., the shape, size, thickness, form) of held up material) defined?

2. What do you do to ensure that the measurement geometry matches holdup models? How do you correct when they do not match?
3. How are measurement point selections made?
4. How are all credible holdup locations identified for measurement?
5. For a single measurement, how is the measurements position defined (bar code, yardstick)?
6. How do you determine how many measurements to make on a nonuniform holdup deposit?
7. How do you determine what length or area to apply to a measured specific mass?
8. How do you determine the width of a line or point deposit to use in attenuation correction calculations?
9. Do you consider counting statistics in setting the count time for a measurement?

III. Backgrounds and Interferences

1. How are background measurements made? Location decided? Direction of detector? Background variations?
2. What count time is used for background measurements? How is background corrected for attenuation effects?
3. How are background and net peak areas determined?
4. How is Compton background subtracted? What setup is used to determine Compton background?
5. How do you check for radionuclide interferences? How often?
6. What types of shielding materials are used and how are they used?

IV. Minimum Detectable Activity (MDA)

1. Are lower limit of detectability determined for the detector and measurement performed?
2. How does the data system track less than MDA values, less than zero values, zero values, and uncertainty? (In particular, if the measurement technician believes there is a high background problem, how does the data system deal with an issue that could have or did lead to a negative result, when in fact it was a matter of crosstalk background?)
3. What is the MDC/MDA of an instrument for various geometries of pipe or process equipment?

V. Attenuation

1. Which methods of attenuation correction are used: transmission measurement technique, differential peak absorption technique, conservative matrix density technique, or other?
2. What evaluation of material self-shielding has been made?
3. When performing a re-measurement of a system that has already been modeled and which has pre-designated measurement locations, do you check for changes in material distribution? How often?
4. Do you perform transmission measurements to determine the true attenuation of the measured signal? How often? With what setup?
5. How do you measure high-density items? What is the lowest transmission allowed to still report a result?

1. What assumptions are made about pipe dimension, pipe material, and pipe thickness, as well as nuclear material chemistry/density/geometry, in order to estimate attenuation and loss of signal?

VI. Enrichment/Isotopics

1. What assumptions and/or measurements are made on the isotopic composition of the material being measured?
2. Is an enrichment measurement methodology used or potentially available? Does the methodology require enrichment to be known? If so, what is the methodology (measurement, process knowledge)?

VII. Equipment

1. What *in situ* NDA equipment, including spare parts, is available on site? Used?
2. How do you select and qualify new NDA instrumentation for your program?
3. Is the selected equipment appropriate? How old is it?
4. Is the Maintenance Program defined, implemented and sustained?
5. Is equipment maintenance performed in-house or by an outside vendor?
6. For the neutron measurements, what are the design specifications for the detector packs (neutron moderation, He-3 tubes, Cd shielding)? What is the procedure to estimate and separate source intensity from room scatter (background)? What other information is used, either process knowledge or other testing technique to refine calibration assumptions by cell, including count rate per unit mass, chemical composition of material, degree of hydration (best case, worst case, nominal case); and how are the uncertainty terms propagated in the reduction of data and analysis.
7. For the gamma-ray measurements, what are the design specifications for the detector (e.g., NaI, HPGe, CsI, lanthanum bromide) and collimator combination? What are the design specifications for the SCA or MCA acquisition system? How do the design specifications and procedural specifications meet the precision and accuracy specifications from the data quality objectives (DQOs) (assuming DQOs are performed and available)?
8. What are the equipment handling and storage requirements?

VIII. Measurements

1. What is the operational protocol for making a measurement?
2. Are the formality and discipline of operations adequate to conduct work safely and are programs in place to maintain this formality and discipline?
3. How do you attempt to keep the detector in its optimal position? What is an optimal position?
4. How do you determine source to detector distance?
5. What data are stored and recorded and how are they stored?
6. What portion of the spectrum do you store for analysis and measurement records?
7. How is the reproducibility of measurement positions controlled (i.e., dramatically changing background, storage or removal of material in the area)? Are repeat measurements performed and is reproducibly documented?
8. How is the quality of a measurement verified (i.e., gain shifts, infinite thickness, high dead times (pulse pileup), secular equilibrium)?

IX. Calculations Including Uncertainty

1. How are mathematical corrections (i.e., geometry, attenuation) and assumptions implemented?
2. How are measurement uncertainties determined? Propagation of error?
3. Are the mathematical equations used for quantification and error propagation including assumptions therein comparable to accepted practices identified in consensus standards?
4. What are the sources of greatest measurement uncertainties in your experiences?
5. Have calculation processes been automated when possible to reduce human error?

5.5 Research and Development

5.5.1 Section Lead: Tracy Wenz (LANL)

5.5.2 Section Members: David Bracken (LANL)

5.5.3 Lines of Inquiry

1. Areas to evaluate: instrumentation, data analysis, procedures, automation, uncertainty, process, techniques, nuclear material standards, and calculation.
2. Are facility R&D needs regularly assessed?
3. What R&D needs exist at the facility?
4. What technology upgrades are needed? How are technology needs identified?
5. What is the state of your equipment compared to the state-of-the-practice? How is the comparison done?
6. Do you have any site developed technologies that would be useful to the complex? How could they be made available?
7. What innovations have you developed to improve equipment reliability?
8. What equipment modifications are necessary to improve equipment reliability?
9. Is commercially available equipment appropriate to serve your program?
10. Have appropriate nuclear material standards been developed for your needs?
11. Is appropriate funding available for R&D? Who manages that funding?
12. How are lessons learned shared on site? To the complex?
13. Does the facility staff participate at national-level conferences in order to stay informed about recent developments and applications? What conferences? How many people attend?
14. Is there a formal process for notifying project/facility management of R&D needs in NDA?
15. Do you have any research collaborations with universities? Industry? Other U.S. or foreign government laboratories?
16. How many holdup-related publications has the site published in the last five years? NDA-related publications?
17. Are the authors still at the site? Are they still working in the field?
18. What R&D is being conducted in the following areas:
    a. instrumentation;

data analysis;

c. procedures policies and standards;
d. process and measurement automation;
e. uncertainty determination;
f. process technologies;
g. measurement techniques;
h. nuclear material standards;
i. calculational tools and techniques?

5.6 Quality Assurance

Consensus standards relevant to quality assurance of ***in situ*** NDA holdup measurements:
ANSI N15.36-1994, ***Nondestructive Assay Measurement Control and Assurance***

ASTM C 1455-00, ***Standard Guide for Nondestructive Assay of Special Nuclear Material Holdup Using Gamma-Ray Spectroscopic Methods***

5.6.1 Section Lead: Steve Smith (ORNL)

5.6.2 Section Members: Cynthia Gunn (Y-12) David Dolin (Savannah River)

5.6.3 Lines of Inquiry

I. Program Management

1. Where does the NDA QA program reside in the organizational structure?
2. Who is assigned primary responsibility for the holdup measurement control program?
3. Is there a QA plan for the measurement?
4. How is conflict of interest avoided in the structure of your measurement control program?
5. What steps do you incorporate in your measurement program to ensure the quality of measurement performance?
6. Does your QA program meet all your customer's needs? Which customers have the most stringent requirements?
7. Does each customer have a defined and documented DQO?
8. Is the measurement precision and minimum level of detection (MLD) adequate for the customer's need?
9. Do you have examples where biases were detected and corrected? How were the corrections made?

II. Documentation and Calibration

1. Are the QA/QC data available to all project-level engineers, safety specialists, waste management specialists, and criticality safety personnel?
2. Is there a consolidated, consistent database where all raw measurement data, reduced data, and analysis results are stored and indexed to a location, piece of process equipment, stored material, or waste?

3. Is color relied upon to disseminate information (i.e., fading, black-and-white copies and printers)?
4. What documentation do you maintain of calibrations? Instrument manuals? Maintenance records? Quality control data and evaluations? Out-of-control situations and resolutions?
5. Are reports (results) uniquely identified? How?
6. Are instrument calibrations performed in a single use low background area?
7. Are adequate levels and numbers of standards analyzed to properly determine calibration equation?
8. Is the range and capability of the measurement system adequately calibrated?
9. Specifically how is the radiological or qualitative survey equipment calibrated and implemented to flag NDA follow-up at a desired set-point, limit, or threshold?
10. Is equipment suitably marked or otherwise identified to indicate calibration status?
11. Has in *situ* NDA equipment used for characterization been calibrated and maintained to ensure that DQOs are sufficiently met?
12. Is component-level substitution of measurement equipment evaluated for potential impact on system calibration, and retained in the equipment file?
13. How and how often is a calibration validated?
14. Is the system calibration/verification frequency determined and implemented by explicit definition or by use?

III. Nuclear Material Calibration Standards

1. How are nuclear material standards selected?
2. How were your calibration standards prepared?
3. Are nuclear material standards well characterized? Traceable?
4. Is the uncertainty of the calibration standards known?
5. How representative are the calibration standards of the unknown item to be assayed?
6. Are the standards periodically verified by analysis with another method or through a sample exchange program?
7. How are your standards stored and secured from tampering, environmental degradation, and other sources of damage?

IV. Check Sources and Control Charts

1. What measurement control requirements exist? Frequency? How is instrument quality assurance maintained?
2. How is the integrity of detector system maintained (i.e. change in relationship between collimator and detector)?
3. What is actually measured for measurement control?
4. How are measurement control data analyzed and reported?
5. How are measurement control data transferred to the program administrator? How do you attempt to keep measurement quality feedback timely?
6. Do you perform measurements to look for detector contamination changes?

7. How does the instrument operator in the field know if or when he or she has a measurement control problem?
8. What would be your response for an out-of-control condition detected by measurement QA?
9. Do you take routine measurements of a static process equipment item as a working source?
10. Are control limits (or no-action bands) calculated using valid statistical techniques? Has the measurement control program been reviewed and approved for technical (statistical) adequacy & accuracy?
11. What indicators do you watch for detector deterioration or overall electronic degradation?
12. Has your measurement control program been reviewed and audited? By whom? How often?

V. Miscellaneous

1. How are measurement techniques validated (operation vs. D&D)?
2. What information and data (e.g. a performance test and verification report, PTVR) are available to validate the NDA measurement process? Have prior confirmatory analyses (by sampling and analysis) been used to bound measurement uncertainties? What methods have been used to bound measurement uncertainties? Can the project team and the DQO process accept the bounded uncertainties?
3. Are any results benchmarked (i.e., comparison of results with cleanout, verification by use of nuclear material standards, alternate measurement technique)? How often? How many?
4. Are in *situ* NDA characterization data tracked and trended to identify significant changes from process knowledge data or previous results?
5. How is software verified and maintained?
6. Are all calculational software (including spreadsheets) and input values properly configuration controlled?
7. Under what QA requirements are the software tested and validated to meet intended functionality?

5.7 Oversight

5.7.1 Section Lead: David Dolin (Savannah River)

5.7.2 Section Members: Frank Lamb (Unwin), Glenn Pfennigwerth (Y-12)

5.7.3 Lines of Inquiry

1. Of the following types of oversight: Internal organizationally, external organizationally, external to site, which have occurred in the last two years and how frequently (i.e., inspections, safety management evaluations, special reviews, special studies, and follow-up reviews, fact finding meetings, QA reviews to be a calibrating organization, HQ reviews, and DNFSB reviews)?
2. How are reviews and assessments performed (i.e., LOIs, document reviews, walkthroughs, interviews, compliance vs. performance-based, etc.)?
3. Are there internal/external/self assessment schedules and how are the schedules determined?
4. How are assessment results documented?

5. How are action items determined?
6. How are holdup measurement personnel involved in responses to corrective action plans (CAPs)?
7. Are root cause analyses performed?
8. How are corrective actions tracked and closure packages completed?
9. Are corrective action packages allowed to close based on planned action?
10. How are assignments of responsibility assigned for addressing oversight activities?
11. What criteria or focus area did oversight and reviews use as a basis for their reviews/findings?
12. Are performance metrics generated, or some other means, to promote practices that prevent repeat findings?
13. Are outside consultants utilized to provide an independent viewpoint on the overall holdup measurement program?
14. How are NDA lessons learned from other facilities reviewed by the NDA Staff for potential application at the facilities?
15. How are holdup measurement performance metrics established, and if so, what types?
16. Where does the in *situ* NDA holdup program reside in your facility?
17. Who provides NDA technical oversight for your entire program?
18. Who performs technical data reviews?
19. Does the NDA staff demonstrate that they are fully knowledgeable of their assigned tasks and can conduct the operation in a safe and effective manner?

5.8 Roles and Responsibilities

5.8.1 Section Lead: Larry Berg (DOE)

5.8.2 Section Members: Tom Nirider (DOE)

5.8.3 Lines of Inquiry

1. How does line and/or program management maintain tracking and resolution of holdup measurement deficiencies?
2. How are Holdup Measurement funding levels proposed, approved, and adjusted when additional requests are received?
3. What are the roles and responsibilities of NDA and holdup measurement staff?
4. Where in the organization does the holdup measurement group reside? Where do support personnel (i.e., statisticians) reside?
5. Is there adequate staffing to meet demands? How is adequate determined?
6. Are the organization structure, functional responsibilities, levels of authority, and lines of communication for the NDA Program and the Holdup Measurement program documented and understood?

7. Are the responsibilities of the holdup measurement project and/or program manager and for the NDA Program clearly defined and understood?
8. Do operations and support personnel fully understand functions, assignments, responsibilities, and reporting relationships and can they support line management control of safety?
9. Are responsibilities between interfacing organizations well defined and provide for clear and effective communications?
10. Are adequate vendor qualifications and oversight programs in place for all procured equipment and service providers?
11. Who is responsible for oversight of criticality safety-related NDA measurements? Is the same person responsible for safeguards and accountability NDA measurements?
12. What are the roles and responsibilities of the NDA personnel in addition to NDA measurements?
13. Does the NDA Staff review and concur with the applicability of in *situ* holdup measurements for the proposed NCS requirement and the practicality of proposed limits, controls, and/or measurements that require holdup measurements?
14. Does the DOE Field Office retain NDA-cognizant staff!
15. Does the NDA Staff review all operating procedures involving holdup measurement and the use of the data?
16. Is the NDA staff involved with decommissioning and construction planning and scheduling prior to commencement of the activities?
17. Do all NDA design-related technical documents receive an independent technical peer review before approval for use?
18. What organization or job title selects instrumentation and makes instrumentation performance specifications?
19. What organization or job title performs initial calibration of instruments? What organization or job title performs routine calibration and validation?
20. What organization or job title provides consultation on NDA holdup matters to various facility organizations such as nuclear safety, nuclear materials control and accountability, and waste management?
21. Has the minimum number of staff required for operational responsibilities been defined?
22. How are specific required measurements delegated and assigned?

Department of Energy
Washington, DC 20585

October 2, 2008

MEMORANDUM FOR: DISTRIBUTION

FROM: RICHARD H. LAGDON, JR.
CHEF OF NUCLEAR SAFETY
ENERGY AND ENVIRONMENT

SUBJECT: DNFSB RECOMMENDATION 2007-1 SITE REVIEWS NDA Programs at Savannah River, Y-12 and Hanford

On July 31,2008, the Office of Environmental Management (EM) established the Non-destructive Assay (NDA) Technical Support Group (TSG) per Commitment 5.5.1 of the Implementation Plan (IP) for Defense Nuclear Facilities Safety Board Recommendation 2007-1. An initial face-to-face meeting of the TSG was held in Richland, Washington from August 26 – 28,2008. Representatives from each of your offices or contractors attended the meeting.

Schedules were developed for conducting the state of the practice reviews in FY 2009 at Savannah River (January 2009), Y-12 National Security Complex (April 2009), and Hanford (June 2009). Members of my staff will be contacting your offices to establish site review planning and logistics, including finalization of review dates. The site reviews should be integrated into your existing site oversight schedules using the proposed FY 2009 dates.

If you have any questions about the 2007-1 site review schedule, please contact me at (202) 586-9471.

Distribution:
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Jeffrey M. Allison, Manager, Savannah River Operations Office (SR)
Ted Sherry, Manager, Y-12 Site Office(YSO)

cc:
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