LA-UR- 11-04120

Approved for public release;
distribution is unlimited.

Title:	The Importance of Nondestructive Assay (NDA) Measurements to Nuclear Safeguards, Material Control and Accountability, Safety, and Security
Author(s):	Peter Santi, Stephen Croft, and James K. Sprinkle, LANL David Bracken, INL
Intended for:	52nd Annual INMM Meeting Palm Desert, CA July 17-21, 2011

Los Alamos
NATIONAL LABORATORY
EST. 1943

Form 836 (7/06)

The Importance of Nondestructive Assay (NDA) Measurements to Nuclear Safeguards, Material Control and Accountability, Safety, and Security

Peter A. Santi, Stephen Croft, and James K. Sprinkle Jr.
Los Alamos National Laboratory

David Bracken
Idaho National Laboratory

ABSTRACT

Nondestructive Assay (NDA) measurements are performed to determine properties of nuclear material bearing items without opening the item or altering the physical or chemical state of the nuclear material. Applications of NDA measurements range from simple *qualitative* detection or identification of nuclear materials to the accurate *quantitative* determination of the amount present. The results of NDA measurements are used for various purposes associated with nuclear facility operations to determine whether a facility is operating in a safe, secure, and compliant manner. The improper performance or application of NDA measurements within a facility has the potential of misleading both facility personnel and outside inspectors or auditors into inaccurate conclusions regarding aspects of the operation of the nuclear facility or the usage of nuclear material. Since NDA techniques provide a core capability in determining defensible accountability values across the domestic U.S. nuclear complex, providing independent measured values for international inspectors, providing input into criticality safety compliance, and are a key part of enabling process flow and production in all facilities; any major weakness in the application of NDA techniques has the potential to suspend facility operations. Personnel who are involved in performing, analyzing, managing or using the results of NDA measurements must be properly trained and supported in their activities to reasonably expect that NDA measurement results with the requisite accuracy are achieved and to have confidence that facilities are compliant with regulations and procedures. Consistent and comprehensive NDA training is required to give such personnel a broader understanding of how their work affects the operations of their facility and will help ensure that the application of NDA measurements across the industry is uniform.

The Importance of Nondestructive Assay (NDA) Measurements to Nuclear Safeguards, Material Control and Accountability, Safety, and Security

Peter A. Santi, Stephen Croft, and James K. Sprinkle
Los Alamos National Laboratory

David Bracken
Idaho National Laboratory

July 21, 2011

Background

- At the January 2009 Nondestructive Assay (NDA) Users Meeting in Atlanta, a discussion was held on the importance of appropriate and sufficient training for personnel who perform, analyze, and implement NDA measurements within a nuclear facility.
- As part of this discussion, it was determined that the best way to emphasize the importance of NDA training to the community at large was to first emphasize the importance of NDA measurements to the operations of nuclear facilities in general.
- This talk will review the importance of NDA measurements for the safe and secure operations of a nuclear facility and discuss how an effective NDA training program is necessary to support these activities.

Importance of NDA

- NDA measurements involve the detection and analysis of radiation emitted from Special Nuclear Materials (SNM) to detect, identify, locate, and often quantify the composition and/or mass of material.
- NDA measurements have several advantages over DA measurements
  - produces faster results
  - can be performed with the material in situ
  - produces no waste
- Results from NDA measurements are used for a wide range of facility operations including material control and accounting (MC&A), nuclear security, criticality safety, and waste management.

Spill at Processing Facility

Role of NDA Measurements - Safeguards

Domestic Safeguards

- Most frequently implemented measurement techniques to reliably determine the characteristics of SNM. (e.g. 65-75% of all Pu inventory measurements at LANL performed using NDA)
- NDA measurements for MC&A purposes include
  - Accountability Measurements
  - Confirmatory Measurements
  - Shipper/Receiver Measurements
  - Process control measurements
- Impact of poor quality or erroneous NDA measurement results include possible safety impacts (crit safety), security impacts (loss of nuclear material) and economic impacts (cost of re-measuring items)

Role of NDA Measurements - Safeguards

International Safeguards

- Enables safeguards inspectors ability to independently verify operator's declared activities by verifying a subset of the operator's inventory.
- NDA measurements used to enable unattended monitoring of facility operations.
- Impact of poor quality NDA measurements on an inspection effort can vary widely from having no impact due to canceling errors, to erroneously indicating that a State is or is not in compliance with its agreements.

Charm Detector – combined gamma-neutron detection system

UF_6 storage container

NNSA Los Alamos 5

Role of NDA – Criticality Safety

- NDA measurements are essential to maintain an adequate criticality safety envelope as few material and item types (i.e. feed stock and intermediate product) in facility operations have mass accountability values based on anything other than NDA measurements.
- For criticality safety, in-situ NDA measurements provides essential data to criticality safety engineers to calculate whether a facility is operating within an appropriate criticality safety envelope. .
- Impact of poor quality, poorly reported, or erroneous NDA measurements can directly lead to criticality incidents.

HEU found in K-29

Holdup measurements at LANL

NNSA Los Alamos 6

Importance of NDA Measurements - Security

- NDA measurements such as screening measurements using hand-held monitors or portal monitors and quantitative measurements used for the accounting system, provide crucial information to the physical protection community regarding the location and relative importance of the nuclear assets they are protecting.
- Impact of poor quality or erroneous NDA results can lead to high false alarm rates or failures to operate properly.

NDA Training

- Improper implementation, execution, or interpretation of NDA measurements can lead to a wide range of consequences which can potentially impact the safety and security of a facility.
- It is up to the personnel who are involved in the measurement (equipment operators and NDA professionals) to ensure that an NDA measurement is performed properly by taking into consideration how a number of different factors (including item packaging, ambient background, presence of light-element impurities, etc) can affect the measurement being performed.
- As one cannot physically sense how gamma-rays or neutrons are being affected by their environment, a certain level of education and experience is needed to become an effective NDA practitioner.

Effective NDA Training Program

- Needs to develop or expand personnel's knowledge of and experience with fundamental physics associated with specific NDA techniques and build that knowledge upon itself.
- Needs to discuss not only what NDA techniques can and cannot measure, but with what accuracy and precision one can expect from the technique, and how to properly calculate the uncertainty of a result.
- Program should discuss best practices.
- Presentation of concepts should be done through a combination of lectures and hands-on laboratory work
  - Involve as many of student's senses as possible
  - Students operate instrumentation and decide how to perform measurement

Current status of NDA Training Programs

- A coordinated NDA training program has not existed in the U.S. since 2007.
- While NDA training opportunities still exist at several national laboratories, this ad hoc approach to NDA training does not necessarily allow an NDA practitioner to progress from learning fundamental concepts to advanced concepts in a logical manner.

Possible methods for improving NDA Training

- A formalized training and certification program for NDA practitioners, similar to those that are present in related areas such as criticality safety engineers and health physicsts, would standardize NDA training throughout the DOE complex
- Certification program would also acknowledge the NDA professional as holding an essential position with a facility.
- Expand the current ASTM consensus standard on NDA training to include specific principles and topics that should be included in a training program
- Efforts that are being undertaken by the Technical Support Group of the DNSFB 2007-1 this FY to evaluate the resources that are available for a formal NDA training program.

Summary

- High quality NDA measurements of nuclear material with knowledge and understanding about the associated uncertainties are necessary for routine safe, secure, and compliant operation of facilities that operate nuclear material.
- Appropriate training of personnel performing these measurements is essential to achieve high quality NDA measurements.
- If the personnel who rely on NDA measurements results to make important safety and security decisions within a facility (such as criticality safety engineers) are required specific or standardized training, shouldn't there be requirements on the personnel whose measurements they base their decisions on?