LA-UR- 96-2531

CONF-960767--34

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AUG 26 1996

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Author(s): Chad T. Olinger, William D. Stanbro, Victoria Longmire, Paul E. Argo, and Stephen M. Nielson

Submitted to: 37th Annual Meeting of the Institute of Nuclear Materials Management, July 28-31, 1996, Naples, Florida

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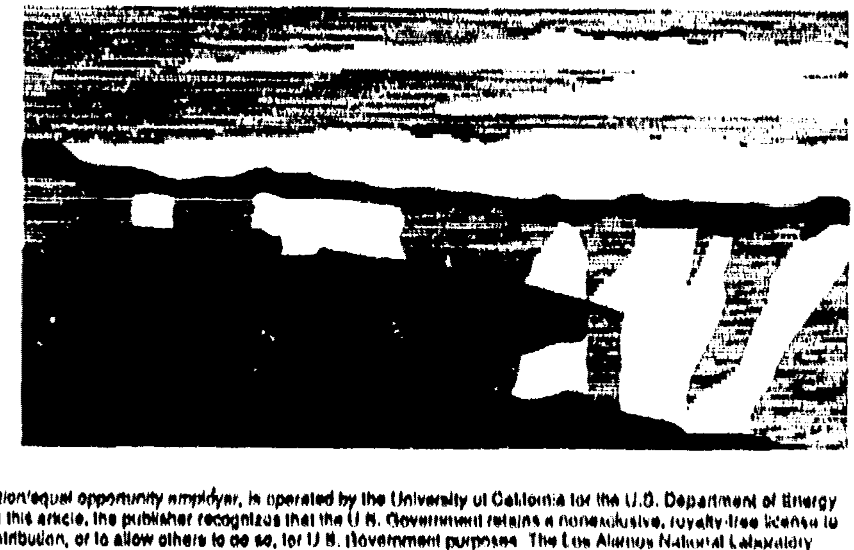

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Inventory Extension Considerations for Long-Term Storage at the Nuclear Materials Storage Facility

Chad T. Olinger, William D. Stanbro, Victoria Longmire, Paul E. Argo, and Stephen M. Nielson
Los Alamos National Laboratory
Los Alamos, New Mexico USA

ABSTRACT

Los Alamos National Laboratory is in the process of modifying its nuclear materials storage facility to a long-term storage configuration. In support of this effort, we examined technical and administrative means to extend periods between physical inventories. Both the frequency and sample size during a physical inventory could significantly impact required sizing of the nondestructive assay (NDA) laboratory as well as material handling capabilities. Several options are being considered, including (1) treating each storage location as a separate vault, (2) minimizing the number of items returned for quantitative analysis by optimizing the use of *in situ* confirmatory measurements, and (3) utilizing advanced monitoring technologies. Careful consideration of these parameters should allow us to achieve and demonstrate safe and secure storage while minimizing the impact on facility operations and without having to increase the size of the NDA laboratory beyond that required for anticipated shipping and receiving activities.

I. INTRODUCTION

The Nuclear Materials Storage Facility (NMSF) is a renovation project to an existing building located within the confines of Technical Area 55 at the Los Alamos Plutonium Facility. The NMSF will provide a long-term storage vault, shipping and receiving areas, and a nondestructive assay (NDA) laboratory. The storage vault is designed to store nuclear material that meets the 94-1 criteria for long-term storage.

The main vault consists of a well storage array. The array is covered by a charge deck that provides an access surface for loading materials into the wells. The storage wells will have fixtures for holding individual items in place and will be capped with a several-hundred-pound plug. It is envisioned that each fixture will hold 14 items that can be manipulated into and out of the wells via an automated crane. There will be 500 to 600 wells in the array with a capacity to store at least 5000 items. The storage well area will be constructed to meet the requirements for the storage of Category I quantities of special nuclear materials. Vault access will be controlled by locked vault-type doors with two locks and monitored by access sensors and motion detectors.

When the NMSF first becomes operational, it will take several years to move all of material from other Laboratory storage areas into the facility. The vault area will have considerable activity on a daily basis for several years during the loading phase.

II. EVALUATION OF MINIMUM AND MAXIMUM TIMES TO PERFORM INVENTORY

The Los Alamos National Laboratory Technology Modeling and Analysis Group (TSA-7) has developed a model of the NMSF to aid in evaluating bottlenecks in the facility. A portion of this model focuses on the movement of nuclear materials into and out of the storage vault via the automated crane and into the NDA laboratory and through various NDA instruments.[1]

In an effort to understand the constraints that may be associated with inventory in the NMSF, several inventory scenarios were run through the model. The following assumptions were made in the evaluation:

- No shipments are received into the facility during inventory.
- The crane operation takes 1 hour to perform.
- The neutron measurement takes 20 minutes to perform.
- The confirmatory measurement takes 5 minutes to set up and 1 minute measurement time per item for each item in a well.
- The facility operates on only one shift per day.
- The vault contains 6000 items.

Scenario I:

200 items are randomly selected from wells in the array.

All items must be measured by gamma isotopics and calorimetry.

Scenario II:

200 items are randomly selected from wells in the array.

180 items are confirmed in place.

20 items are measured by calorimetry and gamma isotopics measurements.

Scenario III:

200 items are randomly selected from wells in the array.

All 200 items are confirmed in place.

Scenario IV:

All 6000 items will require measurement by gamma isotopics and neutron measurement.

Table 1 demonstrates the severe operational impact that will occur under physical inventory approaches that require verification measurements on large statistical samples of containers. Below we examine methods for extending physical inventory periods and minimizing the operational impact associated with physical inventories.

TABLE 1. Time to Perform Physical Inventory

	Number of days
Scenario I	72.25
Scenario II	7.04
Scenario III	2.2
Scenario IV	420

III. PHYSICAL INVENTORY CONSIDERATIONS AT THE NMSF

Domestic Safeguards DOE Order 5633.3B stipulates that for Category I and II Materials Balance Areas involved in activities other than processing must perform inventory at least semi annually. The Guidance and Criteria for Reducing Nuclear Material Physical Inventory Requirements provides for extended inventory periods in locations where advanced containment and surveillance techniques or continuous inventory techniques are employed. Inventory extension provisions only apply to nonprocess areas. However, continuous, automated video monitoring has been used to extend inventory periods in operating vaults.

It may be possible to achieve inventory extensions on portions of the NMSF inventory during the loading phase if each well is considered an independent vault. The justification for this interpretation comes from the well caps, which constitute formidable barriers and require special tools to open. In the current concept, these caps will be flush with the charge space surface and can only be lifted with specialized tools connected to the crane. The electromagnetic crane will be disabled except during authorized material movement, preventing undetected removal of well caps.

As part of a physical inventory, a subset of items are statistically selected for measurement. The uniquely marked welded containers that will be stored in the NMSF should be considered intrinsically sealed and, thus, can be treated as items that only require a single confirmation measurement. This will reduce the burden on the facility's materials control and accounting laboratory.

Removal of individual containers for even confirmatory measurements as part of periodic physical inventories would be unduly time consuming (see Section I). An alternative approach is to perform the required confirmatory measurements *in situ* in the well. The concept would require lowering a radiation detector system down a 1-inch-diameter well on the wall of each cell. An activity signature from each item in the well could be obtained for comparison with an authenticated signature obtained at the time of initial emplacement. Conceivably, this type of operation could be commanded from the control room with little human intervention. These measurements may be supplemented by returning a small subset for laboratory NDA measurements as a secondary check.

IV. NMSF MONITORING TECHNOLOGIES

The honeycomb of storage wells at the NMSF will be an array of between 500 and 600 separate wells, each approximately 18 inches in diameter. There are several ways to identify which well has been opened (or whether a given well has been accessed). Several techniques track the movement of the crane, whereas others detect activity at the well cap. These are discussed below.

A. *Video Systems*

A set of video cameras, positioned to cover the vault floor space in two dimensions, can be used to locate the crane head at each instant in time as well as monitor activity at the well cap. Several cameras would be needed to obtain adequate coverage of the entire floor space. Cameras would be installed along each wall and perhaps the ceiling, with the location-finding software passing off information between camera elements as the crane moves out of one camera's coverage and into another's.

Similar systems have been installed in smaller DOE storage facilities, and the use of video surveillance has allowed extended inventory periods.[2] Although no systems are at present configured to solve the problems of the proposed NMSF, it is not difficult to imagine modifications to available systems that would allow the system to automatically recognize suspicious or unusually extended activity at one of the well sites.

B. *Radiation Sensors*

The movement of nuclear materials carried by the crane can be tracked using an array of radiation sensors. By placing sensors along the vault walls (similar to the video system) and floor, the movement of nuclear material can again be logged. We have shown in a simple demonstration system that an adaptive system using neural nets can be trained to locate a source as it moves through a room.[3] In general, the location will be obtained by determining the source position that best fits the pattern of measured signal strengths.

C. *Tamper/Intrusion Alarm Systems*

Another technology that is easily used to detect activity in a single vault well is the intrusion, or tamper alarm. The simplest case of this would be a motion detection switch, which could detect movement of the well cap. The Sandia wireless alarm transmission of container handling (WATCH) system is designed to detect and report movement of instrumented items.[4] This detection can include the above tamper alarms, but modifications might also include information from inside the wells, such as radiation levels and weight, that could inform the system has been accessed.

D. *In Situ Inventory Confirmation System*

A key instrument for minimizing the operational impact of physical inventories will be an *in situ* inventory confirmation system. The early concept of this instrument envisions the lowering of a radiation detector down a 1-inch tube welded to the inside of the storage well. The system will map out the radiation field as a function of height. Radiation maps will be correlated with fissile material storage locations within that tube and compared with baseline measurements recorded when the storage well is first loaded. This will provide a minimally intrusive measure to confirm that fissile material has not been removed, which reduces the overall operational impact and improves physical protection of the material over inventory scenarios that require more extensive material handling.

V. INTERNATIONAL INSPECTIONS

While current plans would appear to make the possibility of any form of international inspections at NMSF unlikely, the very changeable political environment suggests it would be prudent to examine what might be required. Two forms of international inspection will be considered: inspections by a multilateral inspectorate such as the International Atomic Energy Agency (IAEA) and a bilateral inspection regime most probably with the Russian Federation.

A. *IAEA Inspections*

As a weapons state under the Nuclear Nonproliferation Treaty, the United States is not required to place any of its nuclear facilities under international safeguards. However, as a good faith gesture the U.S. has voluntarily offered to place over 200 nuclear facilities under safeguards. Moreover, in September of 1993, President Clinton ordered that some U.S. weapons material be placed under IAEA safeguards. This process has begun with highly enriched uranium stored at Y-12 and plutonium stored at Hanford and Rocky Flats.

B. *Routine Inspections*

For a storage facility like NMSF there are two types of routine inspections. Interim inspections would be held monthly, primarily to check on containment surveillance equipment and annual inspections for physical inventory verification.

Interim inspections at the NMSF would likely involve placement and monitoring of agency seals that would detect the removal of any container and a review of surveillance camera records to determine that container accesses are consistent with declarations.

Annual inspections would involve confirmation of the physical inventory by selecting items at random for remeasurement. Current IAEA plans call for these measurements to be done using NDA techniques so there would be no requirement for opening containers to obtain samples. However, the operational impact of removing items for NDA measurement may be daunting, as suggested in the analysis in Section 1.

C. *Bilateral Inspections*

In addition to inspections by the IAEA under the U.S. voluntary offer, the possibility exists for a bilateral inspection regime involving the Russian Federation. This would probably occur as part of the effort to ensure safe, transparent and irreversible dismantlement of each other's nuclear weapons. This is a major effort of the U.S. government as the U.S. continues to dismantle its own nuclear weapons. To provide the necessary verification, the U.S. has proposed a system of mutual reciprocal inspections.

Although it is currently impossible to predict details of such an inspection regime, it may be more intrusive than an IAEA regime. This is because the U.S. Congress has modified the Atomic Energy Act to allow for exchange of Restricted Data with the Russian Federation as long as such an exchange is required as part of arms control agreements and is reciprocal. This provision is currently not in force since it awaits passage by the Russian Duma. However, if it does become active, Russian inspectors may have some form of controlled access to U.S. nuclear material, including components, for the purpose of verifying dismantlement of U.S. nuclear weapons.

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