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Inventory Extension at the Nuclear Materials Storage Facility

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Executive Summary

The planned renovation of the Nuclear Material Storage Facility (NMSF) at Los Alamos National Laboratory will be a significant addition to the plutonium storage capacity of the nuclear weapons complex. However, the utility of the facility may be impaired by an overly conservative approach to performing inventories of material in storage. This report examines options for taking advantage of provisions in Department of Energy orders to extend the time between inventories. These extensions are based on a combination of modern surveillance technology, facility design features, and revised operational procedures. The report also addresses the possibility that NMSF could be the site of some form of international inspection as part of the US arms control and nonproliferation policy.

Based on a review of current regulations, it appears that if a number of steps are taken, it may be possible to obtain an extension of the inventory frequency at NMSF and to reduce the burden of inventories when they occur.

- The AT400A and the long-term storage container must be accepted by DOE as intrinsically sealed.
- During the loading phase, the NMSF will likely not qualify for extended inventories unless (1) caps on the cells are sufficiently massive or have mechanisms that require special tools for removal (the current conceptual electromagnetic lifting of massive plugs would seem to meet this requirement) and (2) continuous automated video monitoring is employed.
- Portions of the NMSF could qualify for extended inventories if fully loaded, and static sections are segregated from other portions that have operating inventories.
- Confirmatory measurements made inside the storage wells, without accessing the caps, are the only feasible mechanism for performing inventory.
- International Atomic Energy Agency (IAEA) safeguards physical inventories (if applicable) could serve as a required DOE physical inventory. However, this would also likely require segregation of IAEA-safeguarded material from other nuclear material within the NMSF (see comments on international inspections below).
- If inventory extension is sought for part or all of the facility, then any active systems should be redundant to avoid the requirement of an emergency inventory verification as a result of single-point system failure.
- A design that forces routine access to the vault control room through the charge deck (indicated in the November 1995 Functional and Operational Requirement document) is not recommended if inventory extensions will be sought during the facility lifetime.

Although not currently planned, the NMSF may be the site of inspections by some international group (IAEA, Russian Federation, etc.) during its lifetime. Therefore, the following measures should be carefully considered to limit the impact on the facility should an international inspection be initiated:

- As nuclear material is being loaded into the facility, attempt to avoid intermingling various categories of material (strategic reserve, components) that may fall under different inspection regimes. When possible, place any material offered for international inspection into a single location.
- Follow carefully progress at other sites in authentication of facility instruments for use by the IAEA.
- Be careful in the placement of partitions, etc., that might limit the field of view of surveillance devices.
- In the design of the container holders, consider the placement of IAEA-approved tamper indicating devices.
- If international inspections do begin, negotiate with the inspectorate an inspection schedule that allows maximum commonality with domestic safeguards; environment, health, and safety-related inspections; and maintenance.
- Plan material movements that require breaking IAEA seals so that IAEA inspectors are present.
- If international inspections seem likely and if at all possible, delay placing any material into the facility until it can be monitored by the inspectors.

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INVENTORY EXTENSION AT THE NUCLEAR MATERIALS STORAGE FACILITY

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ABSTRACT

The planned renovation of the Nuclear Material Storage Facility (NMSF) at Los Alamos National Laboratory will be a significant addition to the plutonium storage capacity of the nuclear weapons complex. However, the utility of the facility may be impaired by an overly conservative approach to performing inventories of material in storage. This report examines options for taking advantage of provisions in Department of Energy orders to extend the time between inventories. These extensions are based on a combination of modern surveillance technology, facility design features, and revised operational procedures. The report also addresses the possibility that NMSF could be the site of some form of international inspection as part of the US arms control and nonproliferation policy.

I. INTRODUCTION

The Nuclear Materials Storage Facility (NMSF) at Los Alamos National Laboratory 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 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 canyon area with a tube storage array. The canyon is covered by a charge deck that provides a surdeck for loading materials into the tubes. The storage tubes 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 tubes via an automated crane. There will be 500 to 600 tubes in the array with a capacity to store at least 5000 items. The storage tube area will be constructed to meet the requirements for the storage of Category I quantities of special nuclear material. The vault area will be controlled by locked vault-type doors with two locks and monitored by access sensors and motion detectors.

At this time, only two containers are anticipated for storage in the NMSF vault. The first is the AT400A for weapons components. This 20.0-in.-high welded container has a 14.0-in. o.d. and a .25-in.-thick wall. The second is the metal and oxide long-term storage container being developed by the Nuclear Materials Technology Division. This container consists of an inner welded product container (9.35-in. height, 4.5-in. o.d., and 0.065-in. wall thickness) and an outer welded boundary container (10.0-in. height, 5.0-in. o.d., and 0.065-in. wall thickness). These containers will be uniquely marked and can be considered to be intrinsically sealed.

When the NMSF first becomes operational, it will take several years to move all of the material from other Laboratory storage areas into the facility. The vault area will have considerable activity on a daily basis for several years until the facility is loaded. Although only the crane will move across the charge deck to pull and place items, daily access will likely require inventory for this area semiannually or more frequently. In an effort to assure that effective and feasible inventories can be performed at this facility once it is built, an evaluation of potential problems and recommendations are presented in this paper.

II. EVALUATION OF MINIMUM AND MAXIMUM TIMES TO PERFORM INVENTORY

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

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 tube.
- The facility has only one shift per day.

A. Scenario I

- The vault contains 6000 items.
- The measure of effectiveness is the number of days to perform an inventory.
- Two hundred items are randomly selected from tubes in the array.
- All items must be measured by gamma isotopics and calorimetry.

The results of this scenario indicate that inventory would take 72.25 days to perform. The same scenario was evaluated using the faster neutron measurement instead of gamma isotopic and calorimetry measurements. The results were identical (72.25 days to perform inventory). This result is due to the fact that the crane movement represents a bottleneck.

B. Scenario II

- The vault contains 6000 items.
- The measure of effectiveness is the number of days required to complete the inventory.
- Two hundred items are randomly selected from tubes in the array.
- Only 180 items are confirmed in place.
- Twenty items are measured by calorimetry and gamma isotopics methods.

The results of this scenario indicate that it would take **7.04** days to perform inventory if measured by gamma isotopics and calorimetry measurements. The same scenario was run using neutron measurements instead of gamma isotopics and calorimetry measurements. The days to perform inventory dropped 2 days. An inventory still appears to take too much time to perform.

C. Scenario III

- The vault contains 6000 items.
- The measure of effectiveness is the number of days required to complete the inventory.
- Two hundred items are randomly selected from tubes in the array.
- All 200 items are confirmed in place.

The results of this scenario indicate that 2.2 days are required to complete the inventory. This appears to be an efficient inventory.

D. Scenario IV

- The vault contains 6000 items.
- The measure of effectiveness is the number of days required to complete the inventory.
- All 6000 items will require measurement by gamma isotopics and neutron measurement.

This is the type of inventory that may be required by the International Atomic Energy Agency (IAEA) if this facility fell under IAEA inspection requirements after the facility was loaded. In a one-shift operation, this inventory would take 420 days to perform.

E. Problem Statement

Domestic Safeguards—DOE Order 5633.3B stipulates that Category I and II materials balance areas involved in activities other than processing must perform inventory at least semi-annually. Verification type measurements must be made on items that are not tamper indicating. It is clear from the scenarios run on the NMSF model that it would be too time consuming to perform verification measurements on enough items to give one any confidence in the inventory if a significant number of items was in storage. The uniquely marked welded containers that will be stored in the NMSF should be considered intrinsically sealed and therefore treated as items that require a confirmation measurement only.

International Safeguards—There are no plans at this time for the NMSF to be under IAEA inspection. Often when a facility is selected for IAEA inspection, all of the nuclear material stored at that facility is measured by the IAEA as a baseline. From the results of the model, it would take more than a year for the IAEA to perform these measurements.

III. PHYSICAL INVENTORIES AT THE NMSF

In this section we summarize DOE regulations and guidance for physical inventories as they pertain to the NMSF. Physical inventory requirements for nuclear material facilities are defined in DOE Order 5633.3B, Chapter 2, Section 3. Exemptions and modifications to these regulations are identified in Ref. 2, which provides for the application of new technologies to reduce physical inventory requirements.

A. Basic Requirements

Order 5633.3B develops a layered safeguards methodology, allowing for reduced protection and accountability requirements in areas where attractiveness or quantity of nuclear material is low. The material attractiveness and quantities to be stored in the NMSF will be material type 1B, which requires the most stringent accountability and highest physical inventory frequency. Nominally the inventory frequency for this material should be six months, as long as the facility is classified as a nonprocess area. However, Ref. 2 provides for a reduction in this frequency (increase in the inventory period). The exact inventory frequency variance from the nominal bimonthly requirement depends on the following considerations:

- methods of advanced containment and surveillance employed and
- frequency of human access to the vault.

For reducing physical inventory requirements, this latter constraint may be an important consideration in the overall facility design. For example, if personnel must access the control room through the vault (a possible physical protection delay mechanism for access to controls), then no inventory extension could be achieved under most guidelines. The absence of a personnel corridor would preclude any consideration of inventory frequency reduction based on advanced containment/surveillance techniques. However, this point is, of course, moot if the charge deck must be accessed frequently for other reasons, such as loading or maintenance operations.

B. Inventory Verification/Confirmation Measurements

As part of a physical inventory, a subset of items are statistically selected for measurement. Items that are not tamper indicating require verification measurements or confirmation of two material attributes if the item is not amenable to verification measurements. Items that are tamper indicating require a single confirmatory measurement. For this reason, it is prudent to require that all items stored in the NMSF be tamper indicating. The intrinsic sealing of the storage containers described above may meet this requirement; otherwise, the materials control and accounting lab could be overwhelmed during a physical inventory.

C. International Atomic Energy Agency Inventories

If future international agreements subject the NMSF to IAEA safeguards, Order 5633.3B allows for the possibility that IAEA physical inventories can serve in place of a scheduled physical inventory. Although it is not explicitly stated, we assume that this extends to situations where a facility is under extended physical inventory periods. However, this will depend on whether and how unclassified material (subject to IAEA safeguards) is segregated from classified material within the facility.

D. Options for Extending Inventory Frequency

Reference 2 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 access to different portions of the charge deck are partitioned so as to make multiple vaults.

Three levels of alternative measures are addressed in this guidance as follows:

1) Area/environment measures include examples such as formidable barriers and bulk containment. Generally, these approaches extend inventory periods 6-12 months in process areas. The tactic for implementing formidable barriers in the NMSF would be to qualify each tube as an independent vault so that access to one location does not subject all other tubes to an inventory requirement.

2) Location/containment measures include examples such as video surveillance and continuous item monitoring.

	No Access	1-2 Accesses/month	>2 Accesses/month
Inventory Period	2 years	1 year	0–1 year

Note: Access here is defined as controlled access, such as may be required for maintenance, under enhanced surveillance.

3) Continuously monitored item/material attributes include examples such as mass (load cell) and confirmatory gamma or neutron measurements.

	No Access	1-2 Accesses/month	>2 Accesses/month
Inventory Period	2–3 years	1.5–2 year	1.5–2 year

Note: Access here is defined as controlled access, such as may be required for maintenance, under enhanced surveillance. Extension is indefinite if continuous quantitative measurements are performed, but this is an unlikely scenario.

In evaluating whether or not (and how) to extend physical inventory periods, we must also consider redundancy. If there is no system redundancy and a system permitting inventory extension fails, then the facility may be forced into an extensive, immediate inventory situation. However, a redundant system that preferably is sufficiently different to permit protection from common failure, but that provides the same level of protection, can provide for continuity of knowledge until both systems are back on-line. Additional credit for inventory extension may be obtained for redundant systems within each of the three categories above. However, the second layer is only given half credit, the third only gets one-eighth credit, etc. The main advantage in redundancy is reliability of the overall system under a system failure scenario.

E. Possible Applications at the NMSF

Within Category A (area/environment attributes), the mass of an individual cell cap and container rack within a cell may allow for credit as "bulk containment." Such credit would require that these caps be sufficiently massive or that a locking mechanism be incorporated into them so that special tools (under controlled storage) would be required to remove the cell cap or item rack.

Within Category B (location/containment attributes), video monitoring of the charge deck could be considered one possibility. However, applicability of this type of system is open to interpretation. A video system would not monitor the items themselves, but rather would monitor access to the cell caps. Under these circumstances a strong argument would have to be presented that there is no other credible method to gain access to the containers.

Within Category C (continuously monitored item/material attributes), it may be possible to employ a real-time container-monitoring system that integrates a material-attribute measurement (mass, gamma, or neutron emissions) into the reporting protocol. Several techniques have been developed for these purposes at Sandia National Laboratories and Oak Ridge National Laboratory. The issue for this application would be one of maintainability over long storage periods. A hybrid option may be to continuously measure the total mass of the rack within a cell. This option would not provide item-specific reporting, but at the same time it would reduce the maintenance frequency by approximately an order of magnitude.

IV. NMSF MONITORING TECHNOLOGIES

The NMSF at Los Alamos is expected to be a large vault, with its primary activity being the insertion of nuclear material into storage tubes. The honeycomb of storage tubes will be an array of between 500 and 600 separate tubes, each approximately 18 in. in diameter. A large automated crane will move the nuclear material, suspended above the floor. Because the individual wells have a steel plug (weighing several hundred pounds), the crane will be used to open a well and then return with the cage containing the nuclear sample. A critical function of a monitoring system is to ensure that the crane has only accessed the well specified in the authorization log. The fact that we can verify that a well has **not** been accessed between inventories may allow each of the individual wells to be treated as a separate vault, for accounting purposes. In addition, since there will be large amounts of human activity in the vault, the video system must be able to ascertain that the human activity inside the vault has not led to access of any of the storage tubes.

There are several ways to identify which well has been opened (or whether a given well has been accessed), and we will discuss them all in this section. Several techniques track the movement of the crane, whereas others detect activity at the well trap door.

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, and that information can then log the activity of the crane. Several commercial systems are available to do video surveillance in two and three dimensions, although to our knowledge none has been used to cover such a large room. Many cameras would be needed to get good coverage of the entire floor space. Several cameras would be used 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.

Clearly such a system depends on the vault being well illuminated, and any movement of the crane when the light sources were off would have to be considered an alarm situation. A back-up solution would be to have an operating light on the crane, which would also be observed by the video system.

The individual well sizes are about 18-in. o.d., with well-to-well separations of 2 ft. This imposes a requirement that the video location system have a resolution of approximately 1 ft in all possible locations of the crane. With camera systems having a 60° field of view, along the long wall there would need to be five cameras on each side. Because each video image has a pixel count of 512×512, the pixel resolution at the far wall is smaller than 1 in. Hence, even using several pixels to define the crane location, we will be able to have adequate resolution. By having offset cameras on opposite walls, all the floor space will be covered by the video surveillance system.

Both commercial and DOE video systems have been designed to monitor human traffic through areas. These systems, commonly called video motion detection systems, have been used to monitor static storage facilities as well as provide surveillance support for large dynamic facilities such as railroad depots, convention centers, etc. Similar systems have been installed in smaller DOE storage facilities, and the use of this video surveillance has allowed extended inventory maintenance schedules. 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 recognize that unusually extended activity was being undertaken at one of the tube sites. Systems expected in the future that provide computerized video annotation would be able to describe the activity and to issue an alarm if predetermined activities were detected.

B. Radiation Sensors

The movement of nuclear materials carried by the crane head can be tracked using an array of radiation sensors. By having sensors placed along the walls (similar to the video system), and perhaps with some spread across the vault floor, the position of the nuclear material can again be logged. We have shown in a simple demonstration system (Video Time Radiation Analysis Program or VTRAP[3]) that an adaptive system using neural nets can be trained to locate a source as it moves through a room. In general, the location will be done by determining the source position that best fits the pattern of signal strengths measured.

The factors controlling the accuracy of such a system are the activity of the radioactive material being moved, the dynamic range of the detectors used, and the background radiation levels inside the vault.

Clearly this scheme does not work if the crane is not carrying a nuclear source or if the source is very much less intense than the background vault radiation level.

Another use of this system will be the simple detection that a radioactive source is present in the room. This information will be useful during other fault conditions such as too low an illumination level for the correct functioning of the video systems.

C. Active Emitter Systems

Any system that uses an active emitter, such as a light or ultrasonic source, can provide crane head location by triangulation. The light source has the advantage of working well within the suggested video system, where separate processing could be used to follow the bright spot. On the other hand, a separate acoustic source would provide a fail-safe backup to the optical system.

D. Tamper/Intrusion Alarm Systems

Another technology that is used to easily detect activity on a single vault well is the intrusion or tamper alarm. The simplest case of this would be a motion detection switch, which could detect that something is moving the heavy well cap. Sandia National Laboratories implementation of this system would have the switch connected to a monitoring computer via an rf link. The usual operation has the individual switches reporting their status on defined intervals, and then any switch in an alarm condition will report immediately. This scheme protects the entire system from tampering, as well as allowing each switch element to report motion of its well plug. Seals can also be applied to each well door, and again connected to a monitoring system via the rf link. Note that in an enclosed facility the rf links could easily be replaced by any form of hardwired network.

The Sandia Authenticated Item Monitoring System is designed to monitor in a secure and authenticated fashion the status of a number of instrumented items. This monitoring can include the above tamper alarms, but could also be information from inside the wells, such as radiation levels and weight, that might inform the system that someone is entering the individual well from the bottom.

E. In-Well Confirmatory Measurement System

As described in previous sections, removal of individual containers for even confirmatory measurements as part of periodic physical inventories would be unduly time consuming. An alternative approach is to perform the required confirmatory measurements *in situ* in the well. Depending on the presence of tamper indicating devices, one or two confirmatory measurements would be required. These could be provided by neutron and/or gamma signatures from the individual objects in the wells. This approach seems feasible, but would have to be demonstrated.

The type of system envisioned would require lowering detector systems with a diameter of 1 in. or less down a tube on the wall of each well. 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.

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 IAEA and a bilateral inspection regime most probably with the Russian Federation.

A. IAEA Inspections

Since the end of World War II, the United States has been a leader in trying to prevent the spread of nuclear weapons capability to other countries. A major part of this effort consisted of the establishment of a system of international inspection of nuclear material. As a weapons state under the Nuclear Nonproliferation Treaty (NPT), the US is not required to place any of its nuclear facilities under international safeguards. However, as a good faith gesture, the US has voluntarily offered to place over 200 nuclear facilities under safeguards. This includes essentially the entire civilian nuclear enterprise as well as a number of DOE facilities that are not of national security interest. In principle, these facilities are subject to inspection by the IAEA. However, the agreement between the US and the IAEA places no obligation on the IAEA to actually conduct inspections. The IAEA conducted some inspections at US reactors and low-enriched uranium fuel fabrication facilities up until 1991, but ceased these inspections because of limited resources. In September 1993, President Clinton ordered that some US 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. Parts of the Portsmouth Gaseous Diffusion Plant will also soon be under IAEA safeguards. IAEA inspections at Y-12 started in September 1994, at Hanford in December 1994, and at Rocky Flats in December 1995. The highest priority is currently being given to weapons-usable materials.

Current trends in US nonproliferation policy indicate a move to place all excess nuclear material under international safeguards equivalent to that required in nonweapons states under the NPT. Although the rate at which this will occur is uncertain, the direction is clear. It is possible that at least some of the plutonium to be stored at NMSF will be offered up for inspection by the IAEA. The procedures described here are based on those in the "1991-1995 Safeguards Criteria,"[4] which is published by the IAEA, and experience with IAEA inspections at storage facilities at Oak Ridge, Hanford, and Rocky Flats.

B. Placing a Facility Under International Safeguards

The initial steps in placing a facility under safeguards include completion of a safeguards agreement between the state and the IAEA, preparation of a Design Information Questionnaire (DIQ), and an initial inventory declaration. Inspections by the IAEA would be necessary to confirm the DIQ and the initial inventory. The initial inventory verification would involve measurement of essentially the entire inventory by nondestructive assay with some containers opened to remove samples for destructive assay. The IAEA would then conduct *ad hoc* inspections until a facilities attachment had been negotiated. These inspections would be quite similar to the routine inspections described below. Because the US already has a safeguards agreement with the IAEA in force (INFCIRC/288[5]), it would only be necessary to negotiate facilities attachments for each affected facility.

C. Reporting Requirements

In addition to actual inspections, a series of reports are sent by DOE to the IAEA based on information provided by the facility. These reports include inventory change reports, material balance reports, physical inventory listings, operating reports, and special reports if any significant loss of nuclear material is detected. The DOE must also notify the IAEA of international transfers of nuclear material, equipment, and facilities or transfers of these items to places within a state that are not currently subject to IAEA safeguards.

D. Routine Inspections

Routine inspections include the following activities:

- examination of records and reports,
- physical inventory verification,
- verification of domestic and international transfers,
- verification of other inventory changes,
- verification activities at interim inspections for timely detection,
- confirmation of the absence of borrowing,
- materials balance evaluation,
- discrepancy and anomaly follow-ups,
- verification of design information,
- verification of the operator's measurement system, and
- confirmation of transfer.

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.

Containment and surveillance consists of the use of devices such as surveillance cameras and seals in association with existing barriers such as walls to provide continuity of knowledge about nuclear material. Properly done, containment and surveillance can significantly lower the number of measurements that must be made at a facility. This lowers costs both for the facility and the IAEA. For NMSF this would likely involve placement of IAEA seals that would detect the removal of any container and installation of surveillance cameras to determine that a container was not accessed. IAEA inspectors during routine inspections determine that seals have not been broken, that surveillance cameras have been operating throughout the interval between inspections, and that the cameras have not recorded any unusual access to the material. In the event that these conditions cannot be confirmed, it may be necessary to do a partial or complete re-inventory of the nuclear material in the facility. To avoid remeasurement of material, arrangements are often made to have IAEA inspectors present when a seal must be broken between inspections.

Once per year, IAEA inspectors would also want to verify the site's physical inventory by selecting samples at random for remeasurement. The effort involved would be less than that involved in the verification of the initial inventory. Current IAEA plans call for these measurements to be done using nondestructive assay techniques so there would be no requirement for opening containers to obtain samples.

E. Bilateral Inspections

In addition to inspections by the IAEA under the US 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 (STI) dismantlement of each other's nuclear weapons. This is a major concern of the US government as the US continues to dismantle its own nuclear weapons. To provide the necessary verification, the US has proposed a system of mutual reciprocal inspections.

Although it is currently impossible to predict implementation details of such an inspection regime, it could be more intrusive than an IAEA regime. This is because the US 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 because it awaits passage by the Russian Duma. However, if it does become active, Russian inspectors may have some form of controlled access to US nuclear material, **including components**, for the purpose of verifying dismantlement of US nuclear weapons.

REFERENCES

1. Nelson S. Demuth, Stephen M. Nielson, and Patrick T. Reardon, "Nuclear Materials Storage Facility Simulation Model of Material Flow," Los Alamos National Laboratory document LA-CP-95-233 (November 1, 1995.)

2. George L. McFadden, "Guidance and Criteria for Reducing Nuclear Material Physical Inventory Requirements," US Department of Energy memorandum (July 21, 1992).

3. C. A. Rodriguez, J. A. Howell, H. O. Menlove, C. M. Brislawn, J. N. Bradley, P. Chare, and J. Gorten, "Video Image Processing for Nuclear Safeguards," Los Alamos National Laboratory document LA-UR-95-2510 (1995).

4. "Safeguards Criteria 1991–1995," International Atomic Energy Agency document (November 1990).

5. "Agreement Between the United States of America and the International Atomic Energy Agency for the Applicatin of Safeguards in the United States," International Atomic Energy Agency document INFCIRC 288 (November 1977).