BNL-65182
SSN-98-05

A Suggested Approach to Applying IAEA Safeguards to Plutonium in Weapons Components*

CONF-980733--

Ming-Shih Lu and Jack Allentuck. Brookhaven National Laboratory,
Building 197C, P.O. Box 5000, Upton. New York, USA 516-344-2455/2412

ABSTRACT

It is the announced policy of the United States to make fissile material removed from its nuclear weapons stockpile subject to the US-IAEA voluntary safeguards agreement. Much of this material is plutonium in the form of pits. The application of traditional IAEA safeguards would reveal Restricted Data to unauthorized persons which is prohibited by US law and international treaties. Prior to the availability of a facility for the conversion of the plutonium in the pits to a non-sensitive form this obvious long-term solution to the problem is foreclosed. An alternative near-term approach to applying IAEA safeguards while preserving the necessary degree of confidentiality is required. This paper identifies such an approach. It presents in detail the form of the US declaration; the safeguards objectives which are met; inspection techniques which are utilized and the conclusion which the IAEA could reach concerning the contents of each item and the aggregate of all items. The approach would reveal the number of containers and the aggregate mass of plutonium in a set of n containers presented to the IAEA for verification while protecting data of the isotopic composition and plutonium mass of individual components. The suggested approach provides for traceability from the time the containers are sealed until the conversion of the plutonium to a non-sensitive form.

INTRODUCTION

It is the announced policy of the United States to make fissile material removed from its nuclear weapons stockpile subject to the US-IAEA voluntary safeguards agreement. Much of this material is plutonium in the form of pits. (HEU will also be present. Thus, wherever in this paper the word "plutonium" is used, read "nuclear material of interest.") The application of traditional IAEA safeguards would reveal sensitive information to unauthorized persons which is prohibited by US law and international treaties. Prior to the availability of a facility for the conversion of the plutonium in the pits to a non-sensitive form this obvious long-term solution to the problem is foreclosed. An alternative near-term approach to applying IAEA safeguards while preserving the required degree of confidentiality is described in the paragraphs which follow. We believe that this approach succeeds in protecting sensitive information although it might require some modification to current classification policy.

POSSIBLE MODE OF DECLARATION OF SENSITIVE ITEMS

It is assumed that the US, in the course of a nuclear weapons dismantling campaign disposes of fissile components in a set of containers; one warhead to a container. In this paper we shall refer to these containers as items. Individual items are designated, Item j. Assume the existence of an instrument known to the US and the IAEA which is capable of determining the true characteristic of Item j, X_j; e.g., X_j is the isotopics and weight of Item j. Because the US does not wish the true values of X_j revealed to IAEA inspectors, it will declare that the characteristic is the sum of X_j and an arbitrary factor A_j. A_j will not be known to the IAEA and is held completely under US control. The sum of A_j summed over all items is zero.

* This work was performed under the auspices of the U.S. Department of Energy under the Contract No. DE-AC02-98CH10886.

Following this approach, the US declares to the IAEA the number of items *n*, *the* mass of plutonium summed over *n* items, and, for each item the vector $X_j + A_j$. Depending on classification policy in effect at the time the declaration may or may not state that each item is weapons grade plutonium from a dismantled weapon.

VERIFYING THE DECLARATION

Confirmation measurements would be performed by a combination of gamma-ray and neutron coincidence (multiplicity) measurements, or whatever is the best measurement method available.

The software used for the inspection will be under dual control and compiled for application just before actual inspections so that both sides know that the measurement software is authentic. The inspection software would differ from ordinary measurement software to the extent that A_j, as provided by the US just prior to the initial measurement, is added to the measurement results. If the item identification belongs to the category "standards", $A_j=0$ is added, thus allowing the instrument to show the true characteristic.

Prior to the start of the inspection, both sides would verify the inspection software source code (stored under dual keys at the US site) before it is compiled. The US will provide the set of A_j in a diskette and observes the IAEA inspector reading it into the computer. The US continues to retain control of the disk afterward. The IAEA inspectors will sample and measure as many items as necessary and compare the measured $Y_j + A_j$ with the declared $X_j + A_j$. To test the functionality of the measurement system, the inspectors may insert some known standards during the course of an inspection. In addition, the inspector may check to assure himself that the sum of the A_j over a specified set of items is zero.

The verification approach described above enables inspectors to confirm that the declaration for each item is correct and that the total content of the *n* items is as stated. When the materials are eventually converted to a non-sensitive form, the declaration on total content can be directly verified.

IAEA MONITORING ACTIVITIES

To assure traceability, declared items would be subject to IAEA monitoring which would rely on tamper-indicating devices as well as on containment surveillance systems and verification techniques such as those currently employed in spent fuel storage areas. Such monitoring would continue until the sensitive items are reduced to a non-classified form when final verification by the IAEA of the declared content could occur.

POSSIBLE CLASSIFICATION CONCERNS

Since all of the fissile material from a single warhead would be placed in a separate container, revealing the aggregate plutonium mass in *n* containers would also reveal the average plutonium mass of *n* warheads. If all *n* warheads were of the same model, sensitive information would thus be revealed. If plutonium from several different weapon models were included, there might be a concern that the average over *n* items would also reveal sensitive information on the amount of plutonium in a warhead. Both of these problems might be resolved by including among the *n* declared containers several which contain realistic masses of non-fissile material doped with small quantities of material having the appropriate isotopics. This resolution of the problem however would prevent a statement that each item contains weapons grade plutonium from a dismantled weapon.

DISCLAIMER

DISCLAIMER

Portions of this document may be illegible electronic image products. Images are produced from the best available original document.

A BILATERAL APPLICATION

While the Suggested Approach was written in terms of direct IAEA verification, the approach remains valid in the context of bilateral verification with the IAEA initially assuming indirect involvement with a role which is somewhere between that of an auditor and an interested observer. The declaration, as described in the Suggested Approach would be made to the other side at the same time that it is made to the IAEA. Similarly, the arbitrary factor A_j will be known neither to the other side nor to the IAEA. Continuing in this manner, wherever in the Suggested Approach reference is made to the IAEA, the "other side" should be substituted. In addition an IAEA representative would observe the inspection process and retain a copy of the data thus generated.

When the classified items are reduced to an unclassified form, the IAEA may independently verify the declaration on the aggregate content of the n items.

SUMMARY

Declaration:

The U.S. declares the number of containers and for each container, a vector $X_j + A_j$ where X_j is the isotopics and mass and A_j is an arbitrary vector such that its sum over all containers is zero.

Safeguards Objective:

- Confirm the declared number of items.
- Confirm the declared mass of plutonium in individual containers using non-destructive assay techniques.
- Verify the aggregate plutonium mass in all the containers.
- Apply containment/surveillance measures to ensure the integrity of items by preventing undetected access, movement, and other interference with items.

Techniques:

- Confirm the declared number of items through 100% item counting and identification of (unique) container serial numbers.
- Based on a random sampling plan with high detection probability for defects, conduct non-destructive assay measurements designed to determine if the measured value for plutonium is statistically identical to the declared value.
- Apply containment/surveillance measures to all credible paths for tampering the contents of containers with at least two containment/surveillance devices that are functionally independent and are not subject to a common tampering or failure mode. An example of such a system would be seals on individual containers and surveillance on material access pathways.
- Make use of dedicated, mutually authenticatable equipment. Such equipment could also provide the IAEA with a yes/no result that an individual container was within a declared mass range and if the material is weapon-grade plutonium.

What is Revealed:

- This option would reveal the number of containers and the aggregate mass of plutonium in all the containers.

What is Protected:

- The isotopic composition and plutonium mass of individual components would be protected.
- Other sensitive nuclear weapon information would be protected.