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OF STATE SYSTEMS OF ACCOUNTING FOR  
AND CONTROL OF NUCLEAR MATERIALS



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OBJECTIVES, DIVERSION OF NUCLEAR MATERIAL,  
AND THE IAEA SAFEGUARDS SYSTEM

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I. OBJECTIVES OF IAEA SAFEGUARDS

A. Introduction

Nuclear and non-nuclear material, services, facilities, equipment and information which are to be used for legally defined purposes may be deliberately diverted from these purposes. The actions aimed at the detection and deterrence of this diversion are known as safeguards.

Potential diverters are facility operators, individuals or groups of individuals, and States. IAEA safeguards are aimed at the timely detection of diversion in or by States having undertaken to accept safeguards in accordance with an agreement between the IAEA and the State and at the deterrence of such diversion by the risk of early detection by the IAEA.

B. Safeguards in the Statute of the IAEA

The Statute authorizes the IAEA "to establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy."<sup>1</sup> The Statute, therefore, limits the application of safeguards to IAEA-sponsored projects and to activities for which a specific request is made by a State.

The IAEA shall, according to the Statute,<sup>2</sup> enter into an agreement with the State or group of States submitting a project, which agreement shall include undertakings that "the assistance provided shall not be used in such a way as to further any military purpose;" and that "the project shall be subject to the safeguards provided for in Article XII, the relevant safeguards being specified in the agreement."<sup>3</sup>

Furthermore, the Statute specifies the IAEA safeguards rights and responsibilities concerning projects and arrangements.<sup>3</sup> These rights and responsibilities include, inter alia, the use of inspectors "who shall have access at all times to all places and data, as necessary to account for source and special fissionable materials supplied and fissionable products and to

determine whether there is compliance with the undertaking against use in furtherance of any military purpose."<sup>4</sup>

### C. Project Agreements, Safeguards Transfer Agreements and Unilateral Submissions to IAEA Safeguards

Since 1961 the IAEA has entered into "projects agreements" for the supply of materials, equipment and facilities made available by or through the IAEA; "safeguards transfer agreements" in which the States transfer to the IAEA their safeguards responsibilities set forth in their cooperation agreements; and agreements for "unilateral submissions" by a State to IAEA safeguards of certain facilities, nuclear material or all the State's nuclear activities.

All such agreements are based on the safeguards system which the IAEA set up in 1961,<sup>5</sup> extended in 1964,<sup>6</sup> revised in 1965,<sup>7</sup> and extended in 1966<sup>8</sup> and in 1968.<sup>9</sup> This system<sup>5-9</sup> does not specify further than the Statute does<sup>4</sup> either the objective of safeguards or the conclusion of the IAEA verification activity in stipulating that nuclear material, facilities and equipment shall not be used to further any military purpose and that the IAEA shall determine whether there is compliance with the terms of the agreements. The undertaking by a State has been explicitly stated in "safeguards transfer agreements" concluded since 1975<sup>10,11</sup> as not to use nuclear material, facilities and equipment for the manufacture of nuclear weapons or to further any other military purpose, or for the manufacture of any other nuclear explosive device.

### D. Safeguards Agreements Pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force in March 1970.<sup>12</sup> Each non-nuclear weapon State party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the IAEA in accordance with the statute of the IAEA and the IAEA safeguards system, for the exclusive purpose of verification of the fulfillment of its obligations assumed under the Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.<sup>13</sup> Procedures for the safeguards required shall be followed with respect to all source or special fissionable material whether it is being produced, processed or used in any nuclear facility or is outside any such facility. The safeguards required shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such a State, under its jurisdiction, or carried out under its control anywhere.

Each State party to the Treaty also undertakes not to provide source or special fissionable material, or equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear weapon State for peaceful purposes, unless the source or special fissionable material is subject to the required safeguards.<sup>14</sup>

At the time of the entry into force of the NPT, most of the governments concerned expressed the view that the IAEA safeguards system was insufficiently defined. All members of the IAEA were therefore invited to take part in a specially convened "Safeguards Committee." The Committee agreed on "the structure and content of the agreements between the Agency and States required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons,"<sup>15</sup> which has served as a basis for every agreement concluded in connection with the NPT.

The basic undertaking by the State in NPT safeguards agreements is to "accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices."<sup>16</sup>

The objectives of safeguards are further defined in these agreements to be the "timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection."<sup>17</sup> The inclusion of the expression "for purposes unknown" is very important for the practical application of safeguards for it means that the IAEA does not have to attempt to determine the use to which diverted material is put and, in particular, does not have to determine whether diverted nuclear material is for "the manufacture of nuclear weapons or of other nuclear explosive devices." In addition, it is not an objective of IAEA safeguards to determine who is responsible for any diversion.

The agreements provide for "the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures"<sup>18</sup> and also provide that "the technical conclusion of the Agency's verification activities shall be a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated."<sup>19</sup>

#### E. Implementation of Safeguards by the IAEA

The IAEA safeguards system is laid down in two IAEA documents, INFCIRC/66/Rev. 2<sup>9</sup> and INFCIRC/153.<sup>15</sup> The first document forms the basis for bilateral agreements, transfer agreements and unilateral submissions under which equipment, facilities, nuclear material, other material and information are subject to safeguards. The second document forms the basis of all agreements required by Article III.1 of the NPT, under which all nuclear material in all peaceful nuclear activities of a State is subject to safeguards. INFCIRC/153 obliges the IAEA to draw from its verification activities a technical conclusion in respect to nuclear material for each material balance area. INFCIRC/66/Rev. 2 does not include the required specifics of a conclusion, but the IAEA is obliged by the Statute to make a determination of

compliance and, where non-compliance has been concluded, to report to the Board of Governors. INFCIRC/66/Rev. 2 provides the IAEA with names to draw in respect to nuclear material the same type of technical conclusion as required by INFCIRC/153. The IAEA has to judge in each particular situation whether the application of its nuclear material verification procedures permits it to fulfill the responsibility of safeguarding equipment, facilities, non-nuclear material or information.

Implementation of nuclear material safeguards requires quantification of the objectives for each situation. To provide guidelines for the implementation requires identification of the possible strategies that a State may adopt for diverting nuclear material and specification of the measures that the IAEA must employ in its safeguards system in order to be able to counter successfully these diversion strategies. These subjects are treated in the following sections.

#### REFERENCES

1. IAEA Statute, as amended up to 1 June 1973, Article III, Item A.5, p. 6.
2. IAEA Statute, Article XI, Item F.4, p. 25.
3. IAEA Statute, Article XII, pp. 26-29.
4. IAEA Statute, Article XII, Item A.6, p. 27.
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6. INFCIRC/26/Add. 1, The Agency's Safeguards, 9 April 1964.
7. INFCIRC/66, The Agency's Safeguards System (1965), 3 December 1965.
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12. INFCIRC/140, Treaty on the Non-Proliferation of Nuclear Weapons, 22 April 1970.
13. INFCIRC/140, Article III.1.
14. INFCIRC/140, Article III.2.
15. INFCIRC/153 (Corr.), The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, June 1972.
16. INFCIRC/153, Article 1.
17. INFCIRC/153, Article 28.
18. INFCIRC/153, Article 29.
19. INFCIRC/153, Article 30.

## II. DIVERSION OF NUCLEAR MATERIAL

### A. Introduction

In the context of IAEA safeguards, the State with its corresponding capabilities and resources is considered as the potential diverter, and the probability of attempted diversion is considered small but finite. The purpose of diversion is assumed to be the acquisition of nuclear material for uses proscribed by the relevant safeguards agreement.

### B. Diversion Strategies

The plans for diverting nuclear material and for either delaying the detection of the diversion or avoiding it are known as diversion strategies.

Diversion strategies could involve a single facility or a number of facilities cooperating in the diversion and its concealment. Diversion could involve material already in a form suitable for the intended use or in a form requiring further processing before such use. This further processing could be undertaken immediately or the diverted material could be stockpiled for processing and use at a later time. The diverter may attempt to use safeguarded facilities to process material which has been diverted at another safeguarded facility, or material which either is at the starting point of safeguards or has already undergone some processing and which must be under safeguards but has not been declared by the State. Such an attempt would provide the IAEA with a chance to detect at a facility material which had not previously been in a safeguarded facility or material which had been previously diverted.

The material might be diverted in either a single removal or repeated removals. Immediate detection by the IAEA can only be possible if it applies strict containment and surveillance measures. Verification of the physical inventory and of the material balance provides for a delayed opportunity for detection of diversion.

To conceal the removal of nuclear material the diverter may present evidence that the material:

- Was never received at the facility in question;
- Was shipped to some other facility or facilities;
- Was discarded or accidentally lost; or
- Is still present at the facility:
  - With complete items missing;
  - With part of the items missing;
  - With portions of materials from all items missing;
  - With a combination of the above three possibilities;
  - By substituting, for the diverted material, non-nuclear material or material of lesser value to the diverter;
  - By presenting material for counting more than once;
  - By borrowing the needed quantity of material from another facility and returning it after inventory verification has passed.

The strategy of concealment that gives the inspector only one opportunity to detect the concealment may be called final concealment, as opposed to temporary concealment. The recording of fictitious discards is an example of final concealment. If the fictitious discard is not detected at the time of the discard itself, it will never be detected, because no second opportunity for verification will exist. The falsification of inventory data, in contrast, is an example of temporary concealment and transfers the diversion into the next material balance period, where it has a second chance of being detected. In temporary concealment the facility operator must continue to attempt to conceal the removal until he can achieve final concealment.

1. Falsification of Records and Reports. The concealment of the removal of nuclear material which has previously been included in the records and reports available to the IAEA would presumably involve some falsification of these documents as part of the diverter's attempts to conceal the shortage from the IAEA and, in particular, to avoid detection by audit. Such falsification can be classified as understatements or overstatements of inventory or flows and introduction of "mistakes" in the transcription of data or in calculations.

In cases where the facility receives material from unsecured facilities, the operator may understate receipts by not recording all receipts or by recording smaller than actual quantities for some receipts. Another possibility would be to arrange for a receipt to arrive just prior to a physical inventory to replace material already removed and to record the transfer as a receipt which occurred after the inventory.

There are many possibilities for the falsification of records by the introduction of "mistakes:" recording a number and reporting a different one, recording an incorrect total, recording a correct net weight and analysis and recording an incorrect total, etc.

2. Deceiving IAEA Measurements. Concealment strategies could also involve attempts to deceive IAEA measurements with respect to either the completeness or the correctness of the measurements. Examples are partial or periodic bypassing of flow key measurement points, alteration of containers, biasing of instruments, and biasing of sampling devices.

3. Declaring Diverted Material as MUF. A diverter could choose to divert material without alteration of the inventory and inventory change data and allow the removal to be shown as MUF. This strategy may, or may not, be supported by inflation of the measurement uncertainties and might be supported by explanations designed to portray the MUF as being due to legitimate causes.

### C. Importance of Diversion

The importance of the diversion depends on the type and amount of the diverted material. Materials, e.g., plutonium and highly enriched uranium, which are of immediate use for nuclear explosive devices, represent a greater hazard than does material

which requires a lengthy and complex process to be used for these devices.

Rough estimates of the times required to convert different materials to material suitable for nuclear explosive devices are given in Table I. The times listed in Table I are dependent, among other factors, upon the amount of materials involved and the capabilities of the facilities carrying out the processing. If the necessary processing is carried out in a large unsafeguarded facility, the shorter times in each range would apply. If done in a large safeguarded facility by unreported introduction and removal of the material at less than full capacity rate, the intermediate times in each range might apply. If the processing is carried out in small unsafeguarded facilities or activities, the longer times would apply. These times provide the basis for the requirements for the timeliness of detection by the IAEA of diversion and, hence, for the frequencies of verification by the IAEA of its containment and surveillance measures and of physical inventories.

TABLE I  
IMPORTANCE OF DIVERSION\*

<u>Required Conversion of Nuclear Material to the Manufacture of Nuclear Explosive Devices</u>	<u>Material Form</u>	<u>Approximate Range of Times Required to Convert Nuclear Material to the Form Suitable for Manufacture of Nuclear Explosive Devices</u>
Physical change; or chemical and physical change, but no purification	Plutonium and highly enriched metal, oxide or solution	Days to weeks
Chemical and physical change with purification	Irradiated fuel, radioactive solution, cold scrap	Weeks to months
Isotopic, chemical and physical change	Natural and low enriched	Up to one year

\*Based on the approximate time required to convert the material suitable to manufacture of nuclear devices.

### III. THE IAEA SAFEGUARDS SYSTEM

#### A. Introduction

The IAEA safeguards system must enable the IAEA to verify that a State has complied with its undertaking as specified in the relevant safeguards agreement. The safeguards responsibilities and rights of the IAEA cannot, therefore, be delegated to the State or to any organization to which the State has delegated the State's responsibilities. The IAEA system has been conceived to ensure the timely detection of diversion that might be attempted by the wide range of strategies described in Sec. II. For these reasons the IAEA must verify the completeness, formal correctness and validity of the information (including all records and reports) made available by the State, regardless of the nature or level of the verification activities carried out by the State.

By means of its safeguards system, the IAEA shall be able to verify, in particular, that:

- The quantities of nuclear materials imported into a State, produced within a State or otherwise becoming subject to safeguards in any peaceful nuclear activity are not understated by the State;
- The quantities of nuclear materials on which safeguards are to be terminated, for example, exports or consumption, are not overstated by the State; and
- Physical inventories are not overstated by the State, at intervals appropriate for satisfying the requirement for the timely detection of diversion.

Essential elements of the IAEA safeguards system are:

- A Safeguards Agreement between the IAEA and the State, including Subsidiary Arrangements and Facility Attachments;
- Provision by the State to the IAEA of all information relevant to the operator's accountancy, containment and surveillance of the material according to State's regulations, which must be in compliance with the terms of the Agreement; and,
- Verification by the IAEA that the State is complying with the basic understanding as laid down in the Agreement.

The different types of safeguards agreements have been described in Sec. I. Section III-B describes the operator's measures of accountancy, containment and surveillance. Sections III-C and D describe, respectively, the information to be provided by the State and the verification to be carried out by the IAEA.

#### B. Accountancy, Containment, and Surveillance of Nuclear Material

Accounting for nuclear material is defined as the knowledge of the material's identity, composition, quantity, and location.



Agreements of the INFCIRC/153 type require that "the State shall establish and maintain a system of accounting for and control of all nuclear material subject to safeguards."<sup>1</sup> They prescribe that the system shall be based on a structure of material balance areas, a measurement system, a records and reports system and a system of control by the State that the accounting procedures are being operated correctly. INFCIRC/66/Rev. 2<sup>2</sup> does not refer explicitly to a State's system of accounting for and control of nuclear material or to some of the above elements of such a system, but it does prescribe the accounting and operating records to be kept by the State and the accounting and operating reports to be submitted by the State to the IAEA.

The undertaking by a State in an INFCIRC/153 type agreement requires the State "to accept safeguards.., on all source or special fissionable material."<sup>3</sup> Such agreements also specify the starting point of safeguards<sup>4</sup> and the conditions for the termination of safeguards<sup>5</sup> and for exemptions from safeguards.<sup>6</sup> Similar provisions exist in the agreements of the INFCIRC/66/Rev. 2 type.

The basic principle of the accountancy system required by INFCIRC/153 is the operator's recording at the facility and the State's reporting to the IAEA, for each material balance area, initial inventories of nuclear material and subsequent inventory changes. Additions to and subtractions from the initial inventory yield the "book inventory,"<sup>7</sup> the amount of nuclear material which, according to the operator, is expected to be in a given facility or a given material balance area. Periodically, the facility operator takes a physical inventory<sup>8</sup> in the material balance by measuring the nuclear material which "is" actually present. For facilities having nuclear material in unsealed bulk form, because of the measurement uncertainties, there is usually some difference between the book inventory and the physical inventory. There may also be discrepancies for other reasons, for example, failure to measure parts of the inventory or an unmeasured loss of material. The difference between book inventory and physical inventory is the "material unaccounted for,"<sup>9</sup> abbreviated to "MUF." As a variable derived from measurements, MUF is, like the measurements themselves, subject to uncertainties.

INFCIRC/153 provides definitions for the fundamental concepts of material accountancy, namely, book inventory;<sup>7</sup> physical inventory,<sup>8</sup> material unaccounted for,<sup>9</sup> adjustment,<sup>10</sup> batch,<sup>11</sup> batch data,<sup>12</sup> corrections,<sup>13</sup> enrichment,<sup>14</sup> inventory change,<sup>15</sup> key measurement point,<sup>16</sup> material balance area,<sup>17</sup> nuclear material,<sup>18</sup> shipper/receiver difference,<sup>19</sup> and source data.<sup>20</sup>

Containment, as employed by the State or the operator, is understood as the restriction of the movement of or access to nuclear material. Containment measures are used by facility operators for physical protection of the material, safety of personnel and convenience of operational procedures. In general, containment measures are not provided specifically for safeguards purposes, but their existence in a facility often simplifies surveillance for safeguards.

Surveillance means instrumental or human observation to indicate the movement of nuclear material. Surveillance may

indicate the effectiveness of containment and, therefore, has for the operator the same use as containment.

Both containment and surveillance are, for the IAEA, important measures complementary to material accountancy.<sup>21</sup> They should not impose any physical restriction on the movement of or access to material; but they have to provide to the IAEA information as to whether such movement or access occurred while inspectors were not present, in order to preserve the integrity of prior measurements of nuclear material by the IAEA and to provide the IAEA with knowledge of material flows at important points in a fuel cycle.

### C. Information

Both documents, INFCIRC/66/Rev. 2 and INFCIRC/153, require that the State:

- Provide the IAEA with information in respect to facility design features and other information relevant to safeguards;
- Arrange that records are kept in respect of each material balance area; and
- Provide the IAEA with reports in respect of nuclear material based on the records kept.

INFCIRC/153 prescribes the required design information<sup>22</sup> and the required systems of records<sup>23</sup> and of reports.<sup>24</sup> Member States have further advised the IAEA on the detailed design information to be provided by the States.<sup>25</sup> The IAEA Secretariat has prepared design information questionnaires for different types of facilities.<sup>26</sup> The IAEA Secretariat has established model Subsidiary Arrangements and Facility Attachments,<sup>26</sup> which contain, inter alia, reporting forms and explanations for their use.<sup>27</sup>

### D. Verification

Although INFCIRC/153 does not contain a formal definition of verification, it does specify the activities, including independent measurements, to be used by the IAEA for achieving verification and it does specify that verification applies to the location, identity, quantity, and composition of all nuclear material subject to safeguards.<sup>28,29,30.</sup>

Accordingly, the IAEA's verification process consists of:

1. Examination of the information provided by the State in:
  - Design information;<sup>31</sup>
  - Accounting reports;<sup>32</sup>
  - Special reports;<sup>33</sup>
  - Amplification and clarification of reports;<sup>24</sup> and
  - Advance notifications of international transfers.<sup>35,36</sup>
2. Collection of information by the IAEA in:
  - Inspections for verification of design information;<sup>37</sup>

- Ad hoc and routine inspections;<sup>38,39</sup> and
- Special inspections.<sup>40</sup>

3. Evaluation of the information provided by the State and collected in inspections for the purpose of determining the completeness, correctness, accuracy, and validity of the information provided by the State.

The purpose of inspections of facilities "to verify design information"<sup>37</sup> is to enable the IAEA to evaluate the validity of the design information made available to the IAEA. This verification is carried out with respect to design information submitted for existing and new facilities and for subsequent modifications of these facilities. The purpose of the examination of design information is:

- To identify the features of facilities and nuclear material relevant to the application of safeguards to nuclear material in sufficient detail to facilitate verification;
- To determine material balance areas to be used for IAEA accounting purposes and to select those strategic points which are key measurement points and which will be used to determine the nuclear material flows and inventories;
- To establish the nominal timing and procedures for taking of physical inventory for IAEA accounting purposes;
- To establish the records and reports requirements and records evaluation procedures;
- To establish requirements and procedures for verification of the quantity and location of nuclear material; and
- To select appropriate combinations of containment and surveillance measures and the strategic points at which they are to be applied.

Accounting reports provide information on the initial inventory,<sup>41</sup> inventory changes,<sup>42</sup> and material balances.<sup>43</sup>

The ad hoc inspections by the IAEA are carried out in order to verify the information contained in the initial report and to identify and verify changes that have occurred since the date of the initial report. Ad hoc inspections are also carried out for the purpose of identifying and, if possible, verifying the quantity and composition of nuclear material involved in international transfers.<sup>38</sup> In the case of transfers out of a State, these inspections, including the affixing of seals by the IAEA, are to be carried out at the time the material is being prepared for shipping. In the case of transfers into a State these inspections are to be carried out at the time the material is unpacked.<sup>44,36</sup>

The purpose of routine inspections by the IAEA is:

- To verify that the information contained in the reports submitted by the State to the IAEA is consistent with the accounting and operating records maintained by the State;

- To verify the location, identity, quantity and composition of all nuclear material subject to safeguards; and
- To verify information on the possible causes of material unaccounted for, shipper/receiver differences and uncertainties in the book inventory.<sup>39</sup>

Special inspections are to be carried out by the IAEA:

- To verify information contained in special reports; and
- To collect additional information when the IAEA considers that the information provided by the State and the information obtained through routine inspections are not adequate for the IAEA to fulfill its responsibilities.<sup>40</sup>

The activities of the IAEA in the course of ad hoc, routine and special inspections are in general for the purpose of collecting information whereby the IAEA can independently establish that the information provided by the State is:

- Complete in that it covers all nuclear material that has been present in the material balance area;
- Formally correct in terms of being free of mistakes;
- Valid with respect to the actual location, identity, quantity and composition of all nuclear material subject to safeguards; and
- Accurate in terms of the conformity of the measurement data of the State (random and systematic errors) with internationally accepted measurement accuracy.

These activities include: examining records, making independent measurements on all nuclear material subject to safeguards using IAEA equipment and also State's or operator's equipment by verifying its proper functioning, calibration and procedures; obtaining samples and ensuring their proper collection, treatment, handling, and shipping; using and servicing IAEA surveillance equipment; affixing and removing IAEA seals; and using other objective methods which become available.<sup>29,30</sup> Containment and surveillance measures in particular are to be used to help ensure the completeness of flow measurements.<sup>45</sup>

The right of access,<sup>46</sup> frequency,<sup>47</sup> and notice<sup>48</sup> of inspections, designation<sup>49</sup> and visits<sup>50</sup> of inspectors are provided for in INFCIRC/153. INFCIRC/66/ Rev. 2<sup>2</sup> contains similar provisions.

The IAEA shall "make every effort to ensure optimum cost-effectiveness"<sup>51</sup> and, in order to ensure it, should use, among other means, "the concentration of verification procedures in those stages in the nuclear fuel cycle involving the production, processing, use or storage of nuclear material from which nuclear weapons or other nuclear explosive devices could readily be made, and minimization of verification procedures in respect of other nuclear material on condition that this does not hamper the IAEA in applying safeguards."<sup>52</sup> Therefore, the statements on material unaccounted for and its limits of accuracy must not

necessarily be based on equally intensive verification activities in all types of facilities or for all types of nuclear material. These activities must, however, in all cases enable the IAEA to satisfy the objective of safeguards, that is, the timely detection of diversion of significant quantities of nuclear material."<sup>53</sup> In structuring its verification system, the IAEA takes into account not only whether material can be readily made into nuclear weapons or explosives but also the relationship between various parts of the nuclear fuel cycle. For example, although low enriched uranium cannot be directly fabricated into nuclear weapons, its value as a starting point for the production of plutonium or for further enrichment cannot be overlooked.

To achieve optimum cost-effectiveness while ensuring the capability to detect the range of diversion strategies indentified in Sec. II., the IAEA's verification system involves two different types of approaches, depending upon the type of nuclear facility. For facilities in which nuclear material is produced, such as enrichment facilities and power reactors and the larger research reactors, and for chemical reprocessing facilities where the material produced in reactors is separated from the other components of the irradiated fuel, the verification of all flows is of critical importance. In other types of facilities, the primary inspection activity is inventory verification.

The technical conclusion of the IAEA's verification activities shall be "a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated."<sup>54</sup> It is important as a measure of the degree of agreement between the measurements of the operator and those of the IAEA and as a measure of the extent and accuracy of the IAEA's measurements that the technical conclusion of the IAEA's verification activities includes the operator's MUF adjusted for any differences between the IAEA's and the operator's measurement and an estimate of the combined measurement uncertainties.

The IAEA shall inform the State of the results of inspection and the conclusions it has drawn from its verification activities in the State, in particular, by means of statements in respect of each material balance area.<sup>55</sup>

## REFERENCES

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5. INFCIRC/153 (Corrected) Article 35
6. INFCIRC/153 (Corrected) Articles 36, 37
7. INFCIRC/153 (Corrected) Article 102
8. INFCIRC/153 (Corrected) Article 113
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29. INFCIRC/153 (Corrected) Article 74
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31. INFCIRC/153 (Corrected) Articles 43, 44, 49
32. INFCIRC/153 (Corrected) Articles 62-65, 67
33. INFCIRC/153 (Corrected) Article 68
34. INFCIRC/153 (Corrected) Article 69
35. INFCIRC/153 (Corrected) Article 92
36. INFCIRC/153 (Corrected) Article 95
37. INFCIRC/153 (Corrected) Article 48
38. INFCIRC/153 (Corrected) Article 71
39. INFCIRC/153 (Corrected) Article 72
40. INFCIRC/153 (Corrected) Article 73
41. INFCIRC/153 (Corrected) Article 62
42. INFCIRC/153 (Corrected) Articles 63, 64, 65
43. INFCIRC/153 (Corrected) Article 67
44. INFCIRC/153 (Corrected) Article 93
45. INFCIRC/153 (Corrected) Article 46 (b) (ii)
46. INFCIRC/153 (Corrected) Articles 76, 77
47. INFCIRC/153 (Corrected) Articles 78-81
48. INFCIRC/153 (Corrected) Articles 83, 84
49. INFCIRC/153 (Corrected) Article 85
50. INFCIRC/153 (Corrected) Articles 87-89
51. INFCIRC/153 (Corrected) Article 6
52. INFCIRC/153 (Corrected) 6 (c)
53. INFCIRC/153 (Corrected) 28
54. INFCIRC/153 (Corrected) 30
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