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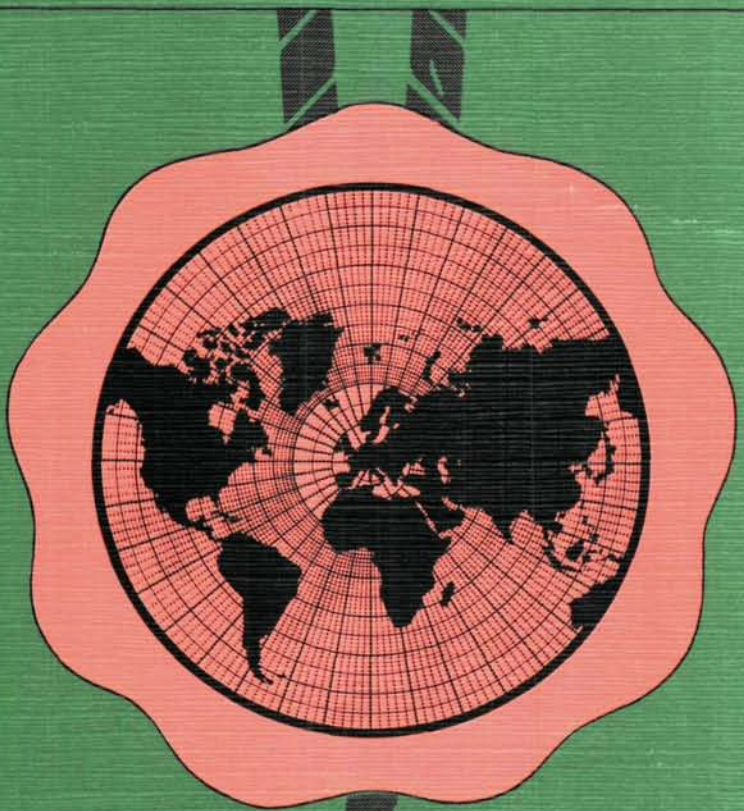
IAEA SAFEGUARDS

GUIDELINES FOR STATES' SYSTEMS OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIALS



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1980

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GUIDELINES FOR STATES' SYSTEMS OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIALS

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York, it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

Printed by the IAEA in Austria
December 1980

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INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

It is widely recognized that setting up and maintaining an adequate States' System of Accounting for and Control of Nuclear Material (SSAC) by States is important for achieving the potential effectiveness and establishing the credibility of IAEA safeguards.

In particular the following factors are considered of primary importance: cooperation between the Agency, the State and the facility operator in implementing the safeguards; the adequacy of the SSAC in relation to IAEA requirements for accounting for and control of nuclear material; the capability of the Agency to verify independently the completeness and quality of material balance measurements; and the willingness of the State to promote the implementation of the safeguards. To facilitate effective IAEA safeguards with minimal intrusiveness, it is important for the State and facility operator to provide the Agency with all information required by the Safeguards Agreement, perform the necessary accounting and control measures in a manner assisting the IAEA in meeting its safeguards objectives, and ensure that the accounting and control procedures and arrangements are being applied correctly.

To assist Member States in establishing, maintaining and reviewing their SSAC, this document presents guidelines for the organization and functions of the SSAC with respect to obligations arising from Safeguards Agreements concluded by a State with the IAEA, including the elements of the System and the performance required from it at the State and facility levels. The guidelines are intended for use by all Member States of the IAEA having agreements based upon INFCIRC/66/Rev.2 or INFCIRC/153.

These guidelines have been developed from discussions that have taken place at various Agency meetings, including a Panel Meeting in Tokyo, 5–9 November 1973; an Advisory Group Meeting at Brno, 21–25 July 1975; and an Advisory Group/SAGSI Meeting in Vienna, 3–7 April 1978. Since this last meeting several experts from Member States have been invited to assist the Agency in preparing the guidelines, and the results of their work have been commented on by those who had attended the April 1978 meeting.

The guidelines, in the form now brought to the attention of all Member States, reflect a consensus of contributions of the experts, comments made by some governmental organizations, and the view of the IAEA Secretariat.

The Agency wishes to thank all those who have contributed to the preparation of the present document, and encourages comments which might result in its further improvement.

This is the second publication in the Safeguards Information Series following the IAEA Safeguards Glossary (IAEA/SG/INF/1). Two additional publications are currently under preparation: "IAEA Safeguards: An Introduction", and "IAEA Safeguards: Methods and Procedures". More publications in the series are planned for the future.

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PART 1. INTRODUCTION

1.1. GENERAL[1]

1.1.1. Whenever costly, dangerous, or otherwise important material is used, an accounting and control system is necessary to keep track of it and to contribute to the detection of any loss or theft. From the time of the first nuclear programmes, systems of accounting for and control of nuclear material have been developed and implemented in nuclear research centres and industrial facilities. Very often, accounting and control systems have been administered by governmental authorities, especially in countries where nuclear material is owned by the government or governmental authorities.

1.1.2. In many countries where private ownership of nuclear material has been authorized, and in others where the material is in government ownership, the systems of accounting for and control of nuclear material which have evolved include as main features:

(a) A legal structure, in which the government has established its area of control
(b) Organizational and functional elements at the State level
(c) Organizational and operational elements at the facility level.

1.1.3. Concern about the potential military use of nuclear material, the development of international trade in nuclear material and related equipment, and the entering into force of certain international treaties have led to the establishment of systems of international safeguards which rely to varying degrees on the systems of accounting for and control of nuclear material established by States.

1.1.4. The objectives of IAEA safeguards are set out in the IAEA Statute and in documents INFCIRC/153 (Corrected) and INFCIRC/66/Rev.2. Document INFCIRC/153 (Corrected) provides the basis for Safeguards Agreements between the IAEA and States pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and INFCIRC/66/Rev.2 provides the basis for other Agency Safeguards Agreements.

1.1.5. A Safeguards Agreement conforming to INFCIRC/153 (Corrected) is required to provide that " ... the State shall establish and maintain a system of accounting for and control of all nuclear material subject to safeguards under

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[1] Specialized terms in this document are defined in the IAEA Safeguards Glossary (IAEA/SG/INF/1).

the Agreement ..."[2], the basic elements of which are set forth in paragraph 32 of that document. Safeguards Agreements conforming to INFCIRC/66/Rev.2 do not explicitly call for States to establish and maintain a "system" of accounting for and control of nuclear material, but the fact that the document calls for agreement between the IAEA and the State on a "system of records" and a "system of reports" implies the need for a system. The establishment of a State System of Accounting for and Control of Nuclear Material (SSAC) can serve a useful purpose in all IAEA Safeguards Agreements, whether or not such a system is explicitly required.

1.2. OBJECTIVES OF A SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL

1.2.1. A system of accounting for and control of nuclear material may have, inter alia, the following objectives:

(a) A national objective, to account for and control nuclear material in the State and to contribute to the detection of possible losses, or unauthorized use or removal of nuclear material
(b) An international objective, to provide the essential basis for the application of IAEA safeguards pursuant to the provisions of an Agreement between the State and the IAEA.

1.2.2. These two objectives are different in nature, and the organization and functions of a system of accounting for and control of nuclear material having only one of these objectives will differ in many respects from those of a system having only the other. Nevertheless, there are many elements of each system which would contribute to the attainment of both objectives.

1.2.3. It is for each State to decide whether or not it wishes to establish one combined system or independent systems to pursue these different objectives. When a State decides to establish a combined system, it will be necessary to distinguish clearly those requirements which are necessary for the application of IAEA safeguards from those which are necessary only for other purposes. Such a distinction is necessary in order to identify clearly those elements which must be verified or agreed to by the IAEA in the application of IAEA safeguards and those which do not require such verification or agreement.

1.2.4. States may use containment and surveillance measures to provide assurance, largely independent from that provided by nuclear material accounting, that there has been no unauthorized use or removal of nuclear material from a facility. Such measures may include, for example, secure facility perimeters, seals, surveillance

[2] INFCIRC/153 (Corrected), paragraph 7.

cameras and portal monitors. These measures are not normally the same containment and surveillance measures as instituted for IAEA safeguards, although they may by agreement serve the dual purposes of the State and the IAEA. It is recommended that States take these possibilities into consideration particularly during the design and construction phases of new facilities.

1.3. AIM AND SCOPE OF THE DOCUMENT

1.3.1. The aim of this document is to make a series of guidelines for the organization and functions of an SSAC designed to meet the obligations of States arising from Safeguards Agreements which have been concluded with the IAEA in order to assist States in establishing, maintaining and reviewing their System. The document also addresses the elements of the System and performance required at the State and facility levels.

1.3.2. Since the extent and manner of the development and use of nuclear energy within States will differ, the organizational structure and the specific functions necessary for an effective SSAC in a State may differ from the guidelines in this document, provided that the obligations arising in the Safeguards Agreement concluded with the IAEA are fulfilled.

1.3.3. The guidelines contained in this document are not intended to add to, subtract from, or amend in any way the rights and obligations defined for the Agency and the States in documents INFCIRC/66/Rev.2, INFCIRC/153 (Corrected), or in any specific Safeguards Agreements concluded with the Agency, but only to provide a source of guidance to which States may refer in the exercise of their rights and the discharge of their obligations.

1.3.4. In this document, the term "control" should be interpreted as administrative or management control over the possession, use and transfer (including import and export) of nuclear material, and over the organization, functions and performance of nuclear material accounting systems within the State. Specifically excluded are:

(a) Control of nuclear material for the purpose of protecting the health and safety of plant operating staff and the public
(b) Control of nuclear material by means of physical protection: such control measures and the elements of a State System for their implementation are recommended in document INFCIRC/225/Rev.1.

1.3.5. Some provisions which serve the national purposes of the State but which at the same time are useful for IAEA safeguards implementation are identified in this document for the information of States.

1.3.6. The remainder of this document is divided into two Parts followed by a List of Contributors. Part 2 contains the features of an SSAC conducted at the State level, and Part 3 contains complementary features at the facility level. The List of Contributors includes the experts who have assisted the Agency in the preparation of the Guidelines for an SSAC, and IAEA staff members who were involved in this work.

PART 2. ORGANIZATION AND FUNCTIONAL ELEMENTS AT THE LEVEL OF A STATE

2.1. AUTHORITY AND RESPONSIBILITY

The responsibility for establishing, implementing and maintaining an SSAC within a State or Group of States party to a Safeguards Agreement with the IAEA rests entirely with the Government of that State or with that Group of States[3]. To establish an SSAC, the State should:

(a) Define its objectives in establishing an SSAC.

(b) Designate a nuclear material accounting and control Authority[4] (hereinafter referred to as the "Authority") with the responsibility for:

(i) Establishing or assisting in establishing provisions governing the possession, transfer and use of nuclear material, taking into account the State obligations under IAEA Safeguards Agreements

(ii) Ensuring that the State's nuclear material accounting and control objectives are met

(iii) Serving as the point of contact in implementing Safeguards Agreements concluded with the IAEA

(iv) Developing, approving and implementing nuclear material accounting and control procedures as necessary to enable the State to discharge its obligations under IAEA Safeguards Agreements.

There may be certain advantages in forming the Authority as a single body, but the foregoing responsibilities may be discharged by several separate bodies provided that the duties and responsibilities of each are defined clearly.

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[3] In the rest of this document the word "State" is used in relation to either a single State or an organized Group of States having nuclear material accounting and control responsibilities.

[4] The Authority could be also vested with responsibilities related to the State's national objective for nuclear material accounting and control. In such cases, the State may wish to assign the Authority additional responsibilities, for example: (a) to establish provisions for granting and denying approval for activities related to nuclear material; (b) to establish respective roles of nuclear material accounting and control, and physical protection measures, as appropriate for protection against theft or unauthorized use at facilities and in transit; (c) to inspect facilities to ensure that they are operated in compliance with their conditions of authorization; and (d) to examine the practical application of those provisions to ensure that their intended objectives are realized.

(c) Establish appropriate arrangements for the prompt notification of responsible Government authorities in the event that evaluation of accounting and control information suggests losses, unauthorized use or removal of nuclear material[5].

2.2. LAWS, REGULATIONS AND OTHER MEASURES

The State should make (and regularly review) the necessary laws, regulations or other measures to ensure that the requirements for nuclear material accounting and control, in particular those under Sections 2.3 and 2.4 below, and those implicit in obligations entered into by the State in international agreements, are met throughout the area within its jurisdiction. These laws, regulations or other measures should include[6] the requirements in respect of nuclear material, facilities, international transfers.

2.2.1. Nuclear material

The provisions should include requirements for:

(a) Conditions for possession, including possession outside facilities, for transfer, including imports, exports and domestic transfers, and for use
(b) Starting point of accounting and control, and termination or exemption from accounting and control
(c) Categorization of nuclear material
(d) Records and reports
(e) Measurement systems, including sampling and analysis, as appropriate
(f) Reports on materials shipped and received, produced and consumed
(g) Physical inventory taking and nuclear material flow control
(h) Material balance closing
(i) Arrangements for accounting for small quantities such as those contained in laboratories and small research facilities
(j) Inspections, including audits
(k) Notice of transfer of nuclear material from one authorized recipient to another.

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[5] Sanctions or penalties, if any, for non-compliance, while not in themselves part of an accounting and control system, should be specified by the State.

[6] For the State's own needs, the measures may also cover: (a) requirements for construction and authorization for operation; (b) conditions for revocation, suspension or modification of authorization to construct and operate facilities and to process, use or transfer nuclear material; (c) identification of non-compliance; and (d) establishment of enforcement measures.

2.2.2. Facilities[7]

The provisions should include requirements for:

(a) Sampling and recording systems
(b) In-plant equipment for measurements, and accounting and control mechanisms
(c) Containment and surveillance measures
(d) The reporting and updating of design information for review
(e) Organization of facilities for accounting and control
(f) The granting of appropriate access for inspection by the Authority and the Agency during construction and operation.

Where the Authority competent for the SSAC is also competent for the approval of the design and construction of a nuclear facility, such approval may usefully be made contingent upon, inter alia, the institution of adequate provisions for accounting and control and cooperation in facilitating the assessment of those provisions. For example, the provisions in this case may include the submission and review of relevant information at appropriate stages of facility design and construction to ensure that adequate accounting and control measures are defined, incorporated, and approved before receipt of nuclear material at the site or before initiation of operation, and the submission of required applications.

2.2.3. International transfers

In order to ensure that safeguards procedures related to the international transfer of nuclear material are met, the State or the Authority on its behalf should:

(a) Be in close contact with other national authorities responsible for giving approvals for international transfers
(b) Determine in agreement with these authorities and with other States involved in the transfer the points at which the transfer of authority and responsibility for nuclear material accounting and control should take place.

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[7] The definition of facility varies somewhat from State to State depending upon the relevant regulations. The definition of facility as used in the IAEA safeguards system (INFCIRC/66 Rev.2; INFCIRC/153 (Corrected)) excludes any location where nuclear material in amounts equal to or less than one effective kilogram is customarily used. The same approach is used in this document.

2.3. SSAC INFORMATION SYSTEM

The Authority should establish and maintain an SSAC information system with the following main activities:

(a) The recording and processing of information on nuclear material accounting and control, provided by facility operators and reported to the Authority; and
(b) The collecting, processing and recording of the information by the Authority and preparing of reports for evaluation internally and for submission to designated bodies as necessary to satisfy international and possibly national obligations.

2.3.1. Elements of the information system

The SSAC information system should contain the following basic elements to the extent relevant to the nuclear activities within the State:

(a) A listing of current facilities and of other locations[8] with information on material accounting and control procedures, including containment and surveillance
(b) A record of data on nuclear material inventories possessed at each facility and location in sufficient detail to permit categorization of the material for accounting and control purposes and for planning SSAC inspection activities (see Section 2.5.2) as appropriate
(c) Data on transfers
(d) A record of inspection data and all operational information required for the evaluation and review of loss mechanisms, shipper/receiver differences, material unaccounted for (MUF) and measurement uncertainties associated with MUF, as appropriate.

2.3.2. Functions of the Authority related to the information system

The Authority should, inter alia:

(a) Receive reports of inventories and inventory changes of nuclear material, including domestic and international receipts and shipments
(b) Maintain a record of all nuclear material (showing types, amounts and locations) and of responsible individuals

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[8] Other locations are those locations where nuclear material in amounts equal to or less than one effective kilogram is customarily used, or temporary storage locations.

(c) Process and evaluate information acquired during inspections (see Sections 2.5.2, 2.5.3) and information submitted by the facility operators
(d) Audit and evaluate facility records and reports, as appropriate
(e) Review loss mechanisms, shipper/receiver differences, MUF and measurement uncertainties associated with MUF, as appropriate.

2.4. ESTABLISHMENT OF REQUIREMENTS OF NUCLEAR MATERIAL ACCOUNTING AND CONTROL

The Authority should, taking into account the requirements of Safeguards Agreements with the IAEA and, as appropriate, applicable laws, regulations or other measures (see Section 2.2), establish the requirements of accounting for and control of nuclear material. These requirements, cited in Sections 2.4.1 to 2.4.12 below, should enable the IAEA to establish in a timely fashion whether there has been any diversion of significant quantities of nuclear material.

2.4.1. Starting point, termination and exemption of accounting and control

The Authority should establish the following:

(a) The starting point for the application of accounting for and control of nuclear material should be at least as early in the nuclear fuel cycle as is required by the State's international obligations

(b) Accounting and control should be terminated on nuclear material upon determination that the material has been consumed or has been diluted in such a way that it is no longer usable for any nuclear activity or has become, in practice, irrecoverable
(c) The conditions for exemption from and termination of accounting and control should be specified, consistent with the State's international obligations.

2.4.2. Categorization of nuclear material

Categorization of nuclear material should be established in order to enable an appropriate balance to be maintained between the significance and accessibility of material and the intensity of accounting and control measures. This categorization should consider characteristics of significance for accounting and control, e.g. the material type and isotopic composition (including in particular the content of fissile isotopes) and the irradiation level. The categorization should be used, in

conjunction with information on quantities of nuclear material involved, in specifying the intensity of accounting and control measures, including the taking of physical inventories and the determination of MUF.

For example, plutonium and high enriched uranium could be in the highest category, followed by low enriched uranium, then natural uranium and finally depleted uranium and thorium.

2.4.3. Material balance areas

The SSAC Authority should establish the factors to be taken into account and the criteria to be met in the determination of material balance areas (MBAs). They should include the existence and location of key measurement points, containment and surveillance possibilities (particularly to help ensure the completeness of flow measurement, the accuracy with which the material balance can be established, and the type of accounting, i.e. item or mass accounting). The Authority should approve the facility MBAs. States which concluded with the IAEA a Safeguards Agreement based on document INFCIRC/153 (Corrected) should as far as possible use a system of MBAs which is compatible with the system agreed in the Subsidiary Arrangements between the IAEA and the State. The material balance areas required under Safeguards Agreements may be further sub-divided for the State's own purpose.

2.4.4. Records and reports system

The Authority should establish the requirements (for material both in identifiable items and in bulk form) for accounting and operating records and reports for each MBA, providing relevant data on nuclear material transactions and operations that affect the accounting for and control of nuclear material.

2.4.5. Measurement system

The Authority should establish requirements for a measurement system and measurement uncertainties, including provisions for the determination of nuclear material received, produced, shipped, lost or otherwise removed from inventory and for the determination of inventory quantities based on sampling and chemical or non-destructive analysis, as appropriate.

2.4.6. Nuclear material flow

The Authority should establish requirements, when relevant, for the accounting and control of the flows of nuclear material, taking into account the degree

of assurance to be obtained from containment and surveillance measures. Requirements for measuring, including corresponding uncertainties, and for identifying receipts, shipments, and transfers within a facility should be defined as necessary to provide for periodic material balances.

2.4.7. Physical inventory taking

The Authority should establish the requirements, including the completeness, frequency and allowable limits of measurement uncertainty, for the different categories of material, of the physical inventories to be taken by the facility operators, taking into account the degree of assurance to be obtained from containment and surveillance measures. Provisions should be made to notify the IAEA in advance of dates when physical inventories will be taken.

2.4.8. Shipper/receiver differences

The Authority should:

(a) Establish the requirements for identifying, reviewing, resolving and evaluating differences in all shipper/receiver measurements and for deriving the limits of measurement uncertainty of transfers between MBAs within its control

(b) Describe the procedures to be followed when shipper/receiver differences or their limits of measurement uncertainty exceed specified values.

2.4.9. Material balance closing

The Authority should:

(a) Establish the requirements
   - for the striking of material balances, and for calculating MUF together with its limits of measurement uncertainty
   - for the determination of the components of the material balance through the use of measurements or derived estimates based upon measurements
   - for the evaluation of accumulations of unmeasured inventory and unmeasured losses and their limits.

(b) Require that MUF should be held down to the lowest practicable level

(c) Specify limits for MUF and for the measurement uncertainties associated with MUF, conforming substantially with (or being superior to) the latest international standards[9], and procedures to be followed to routinely monitor conformance to these standards
(d) Prescribe procedures to be followed when MUF or the measurement uncertainties associated with MUF exceed the appropriate specified level.

2.4.10. Measurement control

The Authority should require the setting up of a measurement control programme with the objectives of ensuring, inter alia, that the adequacy of routine operation of the measurement systems is confirmed; that measurement systems are recalibrated at appropriate intervals; that random and systematic errors are properly estimated for propagation so that the limits of measurement uncertainties associated with MUF can be established; and that clerical errors are, so far as practicable, detected and corrected.

2.4.11. Application of containment and surveillance measures

Containment and surveillance measures are necessary or convenient in some situations to enable the Authority, as part of its nuclear material control function, to monitor flows, to confirm the integrity of stores, and in general to indicate when material present in an MBA or facility is removed without appropriate accounting action[10].

2.4.12. International transfers of nuclear material

The Authority should establish requirements for international transfers of nuclear material with time specifications on necessary arrangements for advance notifications, accounting and control responsibility, and reporting on nuclear material shipped and received.

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[9] Data on the uncertainty of closing the material balance have been compiled by the IAEA and examples for several types of facilities are presented in IAEA publications (e.g. IAEA-SM-231/112, Volume 1 of the Proceedings of a Symposium on Nuclear Safeguards Technology, Vienna, 2–6 October 1978, IAEA, Vienna (1979)).

[10] When containment and surveillance or accountancy measures have failed or indicate possible unauthorized removal of nuclear material, the facility operator should be required to conduct a comprehensive investigation and to take appropriate corrective actions which may include re-establishing of corresponding inventories.

2.5. ENSURING COMPLIANCE

2.5.1. General

Assurance of operator compliance with the requirements of the system of accounting and control established by the State and the assessment of its effectiveness can be achieved only by means of a comprehensive audit and inspection programme. Such a programme should have the first of the following objectives, and may have others, including the second:

(a) To ensure that the capability of, and performance by, each facility operator for the discharge of his responsibility for accounting for and control of nuclear material satisfy the requirements of the Agreement with the IAEA[11].

(b) In addition, a State may wish to derive assurance, through independent verification at facilities by the Authority, that the accounting and control measures implemented by the facility operator are effective and, in conjunction with other measures, to conclude that there has been no unauthorized removal or use of nuclear material.

These assurances contribute to the establishment by the IAEA, through its independent verification activities, whether there has been any diversion of significant quantities of nuclear material. The Authority should establish criteria against which the operator's capability and performance and the results of SSAC inspections and evaluations can be assessed.

2.5.2. Inspections

The inspection activities of the Authority outlined below are aimed at, inter alia, contributing to attainment of the two objectives referred to in Section 2.5.1.

To achieve the first objective, the Authority should:

(a) Examine the design information presented in the licence application or by any other agreed means and the proposed operating practices in order to determine the capability of the applicant to perform the required accounting and control functions;

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[11] In objective (a) above, "capability" refers to the actual presence at the facility of the records, equipment, trained personnel, documented procedures and other resources needed for adequate accounting and control of nuclear material at the facility; and "performance" refers to the actual use of the capability for accounting and control of nuclear material at the facility. Objective (a) may include some independent verification activities by the Authority (e.g. through measurements and observations).

(b) Conduct periodic inspections at operating facilities after the start of operations to determine whether the performance of nuclear materials accounting and control reaches the standard set by the Authority. For this purpose the following activities may be appropriate[12]:

(i) Examination of records, including laboratory and operating records of measurement quality, of calibration data, of data on unmeasured inventories and losses, and of measured discards

(ii) Observation of physical inventory taking and of operators' measurements, including especially measurements of receipts and shipments

(iii) Independent measurements to assess the quality of operators' measurements

(iv) Check of seals and other containment and surveillance equipment;

(c) Evaluate data presented in accounting and operating reports for abnormal trends in book inventory, MUF, cumulative MUF, shipper/receiver (S/R) differences, measured discards, calibration data and the corresponding limits of measurement uncertainties in order to provide assurance that:

(i) State-prescribed requirements for the detection of losses of nuclear material are met

(ii) The estimates of measurement uncertainties are correctly stated

(iii) All significant contributions to the measurement uncertainties associated with MUF and S/R differences are identified

(iv) The figures for measured discards, accumulated unmeasured inventory and losses are credible and do not exceed pre-established limits

(v) The figures for MUF and S/R differences have been correctly calculated and explained in a satisfactory manner; and

(d) If the Authority is also responsible during construction and start-up of a facility, it should conduct inspections during those stages, with particular attention to start-up, to determine whether the arrangements for nuclear accounting and control it has approved have been satisfactorily implemented.

To fulfil the second objective cited in Section 2.5.1, the Authority should, in addition to the activities described in Section 2.5.2, conduct inspections to verify operator findings through independent measurements of flows and inven-

[12] If the State System is to serve the national objective in addition to the international objective for accounting for and control of nuclear material, the scope of related activities will be broadened. For example, in addition to the items noted, the Authority may be required by the State to analyse periodically various possibilities for loss, unauthorized use or theft of nuclear material and formulate measures to reduce or eliminate these possibilities.

tories, based, where appropriate, on attribute and variable sampling plans designed to detect mistakes, falsification and bias, and to verify operator measurement accuracy. These independent inspection activities by the Authority would not in any respect limit the IAEA's right to conduct its own independent verification activities in a State.

2.5.3. Guidance for and evaluation of inspections

To ensure that its inspections are efficient and effective, the Authority should, as appropriate for the State inspection objectives (see Section 2.5.1):

(a) Establish the criteria for the evaluation of operators' reports and of the findings resulting from independent verification of inventory figures;
(b) Establish procedures for the independent verification activities needed to provide the required assurance that State objectives with respect to timeliness, quantities of nuclear material to be detected if missing, and limits of measurement uncertainty are met;
(c) Establish procedures to verify independently that quantities reported for receipts, shipments, discards and inventory are acceptable i.e. free from detectable mistakes and falsification of accounting data. The procedures should take into account the location, form, quality and quantity of the nuclear material in flow and in inventory and the extent to which data from different MBAs can be correlated (e.g. shipper/receiver differences and isotopic compositions);
(d) Establish provisions for defining and correcting inadequacies in accounting and control at the facility;
(e) Evaluate inspection data in order to provide independent assurance that:
    (i) Detectable errors, inadvertent or otherwise, in the facility accounting and control recording system (see Section 3.3.4(b) below) are corrected or resolved, and
    (ii) The inspection data are sufficient for demonstrating compliance with the State's requirements.

2.6. TECHNICAL SUPPORT

2.6.1. Training programme

Training of the personnel responsible for accounting for and control of nuclear material, at State and facility levels, is recommended for the successful operation of an SSAC.

2.6.2. Technical assistance

The State should facilitate the provision of adequate technical assistance, from external sources if necessary (see Section 2.6.3), to facility operators in the area of material accounting and control to enable the operator to fulfil the requirements placed on him by the Authority. This assistance could include, for example, help in establishing adequate measurement systems, incorporating non-destructive assay techniques as well as data processing and analysis procedures, making available international standards, and in establishing containment and surveillance measures.

2.6.3. Research and development activity

Results of research and development aimed at improving accounting and control measures will be of interest both to the State and to operators. A number of States are engaged in their own research and development programmes aimed at improving the accounting for and control of nuclear material and might be requested to cooperate in disseminating the results of such activities.

PART 3. SSAC ORGANIZATION AND OPERATION AT THE LEVEL OF A FACILITY

3.1. PURPOSE AND SCOPE

The requirements for nuclear material accounting and control at the level of the facility arising from obligations undertaken by the State in the Safeguards Agreement with the IAEA are set out in Subsidiary Arrangements associated with the Agreement. These requirements should be met in a manner which will facilitate the verification by inspecting organizations of data declared by the facility operator on the location and quantities of nuclear material.

Every facility should institute a system meeting the basic requirements of the SSAC; but the extent to which the system need be elaborated will depend, inter alia, on the types of nuclear activity, and the form, and quantities of nuclear material.

3.2. INITIAL INFORMATION FOR SSAC

3.2.1. Organization

The facility operator should describe the functions and responsibilities of the organizational units within the facility responsible for developing, approving and implementing nuclear material accounting and control at the facility.

In addition the operator may find it useful to define the relationship between the nuclear material accounting and control organization and other organizational units within the facility, with the object of avoiding the duplication of related data collection and analysis.

3.2.2. Facility description

The facility operator should provide information on facility design and operations involving nuclear material in sufficient detail to permit evaluation of the adequacy of the facility accounting and control system for the application of IAEA safeguards. These details should include identification of the type of facility, its general arrangement, nuclear material used and the features relevant to nuclear material accounting and control.

3.3. ESTABLISHMENT AND OPERATION OF SSAC ELEMENTS AT A FACILITY

The facility operator should establish, maintain and operate the following functional elements in accordance with the requirements of the Authority arising from, inter alia, Section 2.4 above and obligations accepted by the State in Safeguards Agreements with the IAEA.

3.3.1. Starting point, termination and exemption of accounting and control

The facility operator should establish the corresponding starting point for accounting and control, and conditions for termination or exemption of accounting and control of nuclear material, in accordance with criteria specified by the Authority, as cited in Section 2.4.1.

3.3.2. Categorization of nuclear material

Nuclear material should be categorized as prescribed by the Authority as cited in Section 2.4.2.

3.3.3. Material balance areas and key measurement points

Determination of MBAs and key measurement points should meet requirements of the Authority prescribed under Section 2.4.3 above. Advantage should be taken of any opportunity to use containment and surveillance to help ensure the completeness of measurement of flows and of inventories and thereby to simplify accounting and control measures. The quantity of nuclear material in each transfer into or out of each MBA and the physical inventory of nuclear material in each MBA must be measurable, when necessary, by the measurement systems specified by the Authority under Section 2.4.5 above.

3.3.4. Facility accounting and control system

The facility accounting and control system should include the following:

(a) Assignment of organizational and custodial responsibilities for the nuclear material in the facility.
(b) A system for recording and reporting nuclear material inventories and transfers that provides for adequate and timely measurement of material in inventory and being transferred, and for estimating measurement uncertainties; documents describing this system should:

(i) Define all data to be maintained in accounting and operating records, establish time limits for the completion of records and make provisions for storing records for the stipulated time

(ii) Define all data to be included in accounting reports, and include specimen report forms.

(c) Procedures for:

(i) The preparation, review and submission of reports to the Authority, taking account of the required reporting frequency and maximum allowable time for submission after each reporting period.

(ii) The striking of a material balance at intervals specified by the Authority.

(iii) The calculation and examination of MUF and shipper/receiver differences

(iv) The adjustment of accounts to accord with physical inventories, known biases, shipper/receiver differences, and correction of errors, in order to obtain as accurate a statement as practicable of the quantity, form and disposition of the nuclear material in the facility, and

(v) Batch identification to facilitate accounting.

(d) An information processing system for accounting at a facility to provide timely processing of working records, evaluation of data and identification of anomalies. This system should have access to all pertinent measurement control and accountability data of value in tracing data on measurements and transfers back to their source documents. It should also provide for internal checks to minimize errors, including a check of report entries against records. It should facilitate audits of records and provide detailed and summarized information as needed.

3.3.5. Flow measurements

Procedures for material flow measurements should be developed as necessary and when required for the IAEA's safeguards purposes, including the verification of the credibility of declared values of nuclear material received, produced, shipped, lost or otherwise removed from inventory. Particular consideration should be given to providing opportunities to verify receipts before processing, use or placement in inaccessible locations, and to verify material to be shipped before it is dispatched.

3.3.6. Physical inventory taking

Procedures for physical inventory taking[13] should meet the requirements specified by the Authority under Section 2.4.7 above. These procedures should also take into consideration, inter alia, the following:

(a) The category of nuclear material contained and its chemical and physical form
(b) The nature of the facility operations, operating schedules and specialized features of the facility
(c) The nature of containment and surveillance measures adopted in the facility, together with the frequency and intensity of inspections
(d) The measurement uncertainty in the nuclear material balance
(e) The practicability of measuring or deriving estimates of the in-process inventory and other difficult-to-measure inventories.

3.3.7. Measurement uncertainty in the material balance

Arrangements for determining the measurement uncertainty in the nuclear material balances for the facility should be made to meet the requirements of the Authority under Section 2.4.9. The operator should design his measurement system for establishing material balances in such a way that it conforms to the latest international standards or is equivalent in quality to such standards.

3.3.8. Containment and surveillance

Containment and surveillance as applied or required by the Authority in accordance with Section 2.4.11 above may include, for example, observation by responsible personnel; tamper-resistant instrumentation or other equipment; seals to ensure that the integrity of containment has not been breached; doorway monitors to detect removal of nuclear material; closed circuit television surveillance equipment in combination with a video recorder, or film cameras, to take and store pictures for subsequent review.

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[13] Examples of frequencies of physical inventory takings reflecting current practice are given in IAEA publications (e.g. IAEA-SM-231/112, Volume 1 of the Proceedings of a Symposium on Nuclear Safeguards Technology, Vienna, 2–6 October 1978, IAEA, Vienna (1979)).

3.3.9. Miscellaneous controls

In addition to the basic accounting and control procedures associated with MBAs and key measurement points, there are a number of specialized techniques[14] which may be used by the operator for his own objectives, or those of the State, in order to provide confirmatory information, to indicate departures from normal operating conditions, or to provide more timely and specific information on the possible unauthorized removal or use of nuclear material. Such techniques could be of use to the IAEA when it is necessary to maintain continuity of knowledge of flows and inventories of nuclear material.

3.4. REQUIREMENTS FOR BULK HANDLING FACILITIES

In addition to the general organization and functional requirements (see Section 3.3), additional specific requirements for facilities using nuclear material in bulk form should be established as appropriate. In determining the extent to which each of these measures applies, consideration should be given to finding the optimum combination of accountancy, containment and surveillance that will provide effective safeguards.

3.4.1. Material flow controls

For material flow control the following should be noted:

(a) In addition to normal flow measurement procedures, adopted in accordance with Section 3.3.5, it might be useful to establish containment and surveillance measures in order to contribute to the continuity of knowledge of material flow and inventory during periods between physical inventory takings, particularly where physical inventory takings are difficult. In such cases the SSAC should establish a basis and procedures for the identification and control of nuclear material transferred into and out of MBAs, including the specifying arrangements and location where nuclear material may be verified by the Authority and the IAEA.

(b) Procedures should be established to maintain the quantity of nuclear material in difficult-to-measure forms at the minimum level attainable with accepted accounting and control measures.

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[14] Some of the techniques under consideration are: *(a) Batch accounting:* Striking a balance for the processing of a single batch or several batches of nuclear material. *(b) Shift accounting:* Striking a balance at the beginning and end of a shift for the material within the responsibility of the shift supervisor. *(c) Consistency check:* Certain inherent characteristics of the material being processed, such as isotopic composition or the presence of minor isotopes, may be used to provide some check on the nature, identity, or amount of material processed.

3.4.2. Measurement system

A measurement system should be provided for the determination of the quantities of nuclear material received, produced, dispatched, discarded or otherwise removed from inventory, and of the quantities on inventory. For each key measurement point established for accounting and control purposes, the operator should describe the methods and techniques to be used for weight or volume determination, for sampling and chemical analysis, for non-destructive measurements, and for the calculation of nuclear material content including methods of calibration and establishment of conversion factors to determine the weight of element and individual isotopes, as appropriate.

3.4.3. Measurement control programme[15]

A measurement control programme should be designed and implemented for ensuring the required precision and accuracy of measurements and the credibility of facility material balance statements. This programme should:

(a) Make use of certified standards and other standard materials for calibration of measurement systems and to estimate the calibration error
(b) Provide for the incorporation of bias adjustments to accounting data and corresponding adjustments to the measurement uncertainty
(c) Provide the basis for the estimation of measurement uncertainty, including derived estimates of random and systematic errors associated with weight, volume, sampling and analytical measurements, and non-destructive assay measurements
(d) Employ approved statistical methods for processing measurement and calibration data, in order to propagate uncertainties associated with inventory changes, and physical inventories, and so to derive the measurement uncertainties associated with MUF; and
(e) Compare the estimated measurement uncertainties at the facility with corresponding limits prescribed by the Authority and initiate actions if appropriate.

3.4.4. Shipper/receiver differences

Procedures should be designed and implemented to reconcile shipper/receiver differences including:

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[15] The terms used in this sub-section are explained in Part F of the Safeguards Technical Manual, IAEA-174, IAEA, Vienna (1977).

(a) Establishing procedures for identifying, reviewing, evaluating and resolving differences in shipper/receiver measurements, as appropriate; and
(b) Providing the basis for the derivation of the measurement uncertainty in shipper/receiver differences.

3.4.5. Procedures for physical inventories

Procedures for taking physical inventories should be established. These procedures may be different for particular facilities, depending, inter alia, on the types, forms and quantities of nuclear material, on the mode of facility operation, on the accuracy and effectiveness of flow control and on containment/surveillance applications.

(a) General provisions are as follows:
  (i) To establish procedures for the assembly of nuclear material in a way facilitating inventory taking
  (ii) To establish a system for the stratification[16] of the nuclear material in the inventory
  (iii) To establish identification procedures to ensure that each item is inventoried, without duplication
  (iv) To identify the basis for accepting measurements already made, including provision for the use of seals to ensure the validity of previous measurements
  (v) To define procedures, when relevant, for the complete or partial clean-out of plants, provide a basis for the determination of the degree of completeness of the clean-out required, and institute methods to ensure that such requirements are met
  (vi) To determine requirements for measuring in-process inventory when agreed to be necessary
  (vii) To establish procedures for the detection and determination of inadvertent discards and accumulations of nuclear material
  (viii) To establish procedures for the prompt striking of material balances at intervals not longer than those prescribed by the Authority under Section 2.4.7, and for the calculation of MUF and the measurement uncertainties associated with MUF
  (ix) To provide a basis for taking special physical inventories under abnormal circumstances, as appropriate, e.g. unusually large MUF, operating accident or unusual loss.

[16] Grouping of a number of batches of similar physical and chemical characteristics for the purpose of establishing a material balance and its verification by the IAEA.

(b) Pre-inventory preparation should include:

(i) Advance scheduling and notification to the Authority in sufficient time to permit the planning of inspectors' work programmes. (It is expected that, when practicable, the requirements of the Authority for inventory taking under Section 2.4.7 will require inventory taking to coincide with the completion of batch operations, or planned shutdowns)

(ii) Development of an inventory work plan, designation of inventory personnel, assignment of responsibilities, and training

(iii) Preparation of work papers for the collection, identification and assay of material

(iv) Preparation of the preliminary physical inventory listing, grouped by material category and stratum within each category, indicating the location of material to facilitate verification, together with the measured values recorded for the nuclear material content of each item identified.

(c) Inventory taking should include:

(i) Checking, where practicable, of process equipment and associated locations where nuclear material may accumulate to ensure that all quantities of nuclear material are available for inventory taking, except relatively small quantities (within pre-established limits) remaining in process after clean-out

(ii) Checking the preliminary physical inventory listing for completeness and accuracy

(iii) Updating the physical inventory listing to incorporate current determinations of nuclear material quantities.

(d) Post-inventory assessment procedures should include:

(i) The preparation of a final physical inventory listing, by category and stratum

(ii) Calculation of the measurement uncertainty associated with the inventory

(iii) Calculation and assessment of MUF and measurement uncertainties associated with MUF, including assessment of their significance (see Section 3.4.5 (a)(viii))

(iv) Preparation of reports.

3.5. REQUIREMENTS FOR REACTORS AND ASSOCIATED STORAGE AREAS, AND LOCATIONS CONTAINING SMALL QUANTITIES OF NUCLEAR MATERIAL

The following sections give an illustration of the practical way in which the aforementioned recommendations could be applied to reactors and associated storage areas and locations containing small quantities of nuclear material.

3.5.1. Reactors and associated storage areas

Accountancy practices for nuclear material at certain types of reactors and storage areas, where nuclear material is present in well-defined and sealable containers, can be simplified by the use of item accounting, and containment and surveillance measures, to ensure continued accounting for those materials. Provided that such containers can be uniquely identified and their integrity can be ensured, such measures may result in considerable reduction in the degree to which verification requires intrusion into normal plant operations.

In the case of power or high burn-up research reactors, calculations should be made to estimate the residual fissile content of each fuel item or batch, as appropriate, following irradiation. These calculations should be made upon discharge from the reactor for light water reactors (LWR) and on a monthly basis for fuel discharged from on-load fuelled power reactors.

In the following paragraphs the recording and reporting requirements for the calculated values for nuclear loss and production are enumerated for different reactor types.

(a) Research reactors fuelled with high enriched uranium

For research reactors fuelled with uranium enriched to or above the level prescribed by the Authority, nuclear loss should be calculated for each irradiated fuel element and the burn-up (in MW · d/t or equivalent) should be recorded and reported upon discharge from the reactor core or upon shipment from the facility, as appropriate. Nuclear production need not be calculated, recorded or reported. Blanket assemblies or test assemblies in which plutonium or uranium-233 can be generated should be treated in the same way as for power reactor assemblies (see Section 3.5.1 (b) below).

(b) Power reactors and other research reactors

For power reactors, and for research reactors fuelled with other than high enriched fuel (cf. item (a) above), nuclear loss and production should be recorded as calculated and reported for each fuel assembly at the appropriate time. Special

batch definitions should be established for natural uranium fuelled reactors and other reactors which are not fuelled with identifiable fuel elements (e.g. reactors using fuel in the form of pebbles, liquids, gases). Weights of total and fissile uranium and total plutonium in each LWR fuel assembly, as calculated to allow for nuclear loss and production and for fuel element (rod) exchange, if any, and the burn-up (MW · d/t or equivalent) should be reported, together with the nuclear loss and production. Isotopic composition, if calculated, may also be reported when useful in isotopic correlations for confirmation of plutonium measurements at reprocessing plants.

3.5.2. Locations containing small quantities of nuclear material

(a) Locations individually using less than a quantity of nuclear material prescribed by the State or the Authority, e.g. one effective kilogram, may be combined into a single MBA, provided that:

  (i) The nuclear material accounting and control activities for all the locations are carried out by the same individual or organization

  (ii) A single, combined physical inventory can be compiled at the frequency prescribed by the Authority, for all the locations, either by simultaneous physical inventories, or by ensuring that movements of nuclear material between the locations do not occur during the period in which the inventories are being taken

  (iii) The combined inventories are within the prescribed quantity, thereby meeting the small quantity criterion.

(b) Special provisions for such locations are:

  (i) Reports on inventory changes are not required for transfers between locations within the combined MBA; however, such transfers should be recorded and transfers into and out of it should be reported

  (ii) A material balance report and physical inventory listing should be provided at least once per year. The inventory should be determined in the usual way, i.e. by item counting, measurements, or by use of conversion factors,to determine the weight of element, as derived from shipper's data

  (iii) Reporting of, and evaluation of measurement uncertainties for, material balance quantities and MUF are not required.

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80-04053

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA, 1980