Systems of Accounting for and Control of Nuclear Material

STATES' OBLIGATIONS TO ESTABLISH AN ACCOUNTING AND CONTROL SYSTEM

The implementation of safeguards agreements has always involved governmental organizations to a greater or lesser extent, according to the practices of the State concerned. When the Safeguards Committee 1970 defined the structure and content of agreements required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons, particular attention was paid to the contacts between States and the Agency during the implementation of such agreements. The basic idea was that in each State a national organization would, as far as possible, lay the foundations for international safeguards. Accordingly, NPT safeguards agreements contain the obligation of the State to establish and maintain a "State's system of accountancy for and control of nuclear material". The Agency document describing the structure and content of NPT safeguards agreements, INFCIRC/153, also known as the "Blue Book", lays down the basic requirements for a State's system of accounting for and control of nuclear material – SSAC for short. The same document stipulates that the Agency in its safeguards work should take due account of the technical effectiveness of the SSAC. In practice, the effectiveness of SSACs may differ widely. To take due account of their effectiveness, the Agency has to analyse them, note the elements included in them and the requirements they meet, and consider the particular situations they are designed to cope with.

A number of Agency Member States, both parties to NPT and non-parties, have expressed the view that the Agency should be prepared to assist Governments in setting up SSACs. In the course of negotiating safeguards agreements with a State, the Agency's Secretariat gives information on the requirements the SSAC has to meet. In addition, it has undertaken to publish guidelines describing the "elements and requirements of State's systems of accounting for and control of nuclear material". An Advisory Group of Experts was convened in Tokyo in November 1973 to discuss the first part of such guidelines, which deals with the elements which must be included in SSACs if States are to fulfill commitments persuant to safeguards agreements concluded under NPT. In 1975, a second Advisory Group of Experts will discuss the part dealing with the elements which should be included in the SSACs in order to satisfy the State's own requirements.

The Advisory Group which met in Tokyo in 1973 discussed, as an introduction to an analysis of the elements and requirements of SSACs, the objectives of such systems. It concluded that "a State's system of accounting for and control of nuclear material is directed against diversion of nuclear material to unauthorized uses by operators, individuals or groups within its jurisdiction".

BASIC ELEMENTS

Governmental structures, national practices and the extent to which the nuclear fuel cycle exists in a State will determine the structure of the SSAC. Despite variations one may expect to find three basis elements in any SSAC: a set of regulations, a body to implement the regulations and an organization to ensure compliance with them.

(a) Regulations on accounting for and control of nuclear material may cover:

(i) responsibility, authority and sanctions – specifying conditions for the revocation, suspension and modification of authority;

(ii) the granting of authorization to carry out nuclear activities – specifying conditions for the issuing of licenses to construct and operate facilities including their accounting and control capability and limitations on the use and quantity of material that may be held –; registration of nuclear material in Government or private possession or custody;

(iii) the classification of nuclear material on the basis of safety and safeguards requirements and States' strategic and economic considerations;

(iv) material accountancy requirements – specifying the minimum accuracy of nuclear material accountancy and the frequency of physical inventories which the State requires of operators – and requirements as regards the safe operation of facilities and the handling of materials; and

(v) an information system for enabling the State to publicize its regulations, to gather information – through records and reports – on nuclear facility design and operation and nuclear material accountancy, and to provide national bodies and international organizations with the information to which they are entitled.

(b) The body which is to implement the material accounting and control regulations will differ from State to State. In a number of Agency Member States only the State itself may engage in nuclear activities, whereas in many other Member States such activities are open to private companies. In the latter case it is possible to delegate accounting and control measures to such companies or set up an independent organization as an intermediary between them and the State. Where the State itself plays the role of nuclear facility operator, it is important to make clear the boundary between the organizational responsibility for plant operation on the one hand and that for material accounting and control on the other.

(c) The organization which is to ensure compliance with the regulations will obviously be a Governmental one, if not a branch of the Government itself. In the case of one group of States (EURATOM), a single inter-governmental organization has been set up to cover the territory of all the States.

The check on compliance with regard to nuclear material accountancy may be at one of two levels. Most SSACs are satisfied with checking that operators are able to account for and control the nuclear material in their charge; in some cases, SSACs go as far as to require that the performance of operators be checked from time to time. This is known as "level I assurance". A different situation arises if a State or a group of States requires "level II assurance", which entails continuous verification that the facility accounting and the control

of nuclear material have been effective. Level II assurance is similar to the assurance which the Agency is required to establish through its safeguards work. Consequently, where level II assurance is achieved by a State or a group of States, so that there is overlapping with the Agency's verification activities, special arrangements for coordinating the verification activities of the Agency with those of the State or the group of States are called for.

Although States distribute and/or delegate authority in many different ways, the State always remains the entity responsible to the Agency in respect to its commitments pursuant to safeguards agreements between it and the Agency.

REQUIREMENTS

Obviously, where a State has in its territory, under its jurisdiction or under its control the whole range of nuclear activities – both power reactors and the processing of nuclear material in bulk form (uranium isotopic enrichment, chemical conversion, fuel fabrication and irradiated fuel reprocessing) – very comprehensive requirements must be laid down to enable the State to fulfill its commitments to the Agency. The State is required to:

(a) Define the relationship between the functions and responsibilities of the organizational units engaged in nuclear material accountancy and those of other organizational units;

(b) Describe facility operations involving nuclear material in sufficient detail to permit evaluation of the operator's accountancy system;

(c) Establish a structure of material balance areas for the control of nuclear material (defining the criteria applied in establishing the material balance areas) and to select those strategic points whichare key measurement points;

(d) Provide for a measurement system for determinating the quantities of nuclear material received, produced, shipped and lost (or otherwise removed from inventory) and the quantities on hand;

(e) Establish procedures for evaluating the precision and accuracy of measurements and estimating the measurement incertainty;

(f) Establish procedures for identifying, reviewing and evaluating shipper/receiver differences;

(g) Establish procedures for taking a physical inventory;

(h) Establish procedures for evaluating accumulations fo unmeasured inventory and unmeasured losses;

(i) Estalish a system of records and reports showing, for each material balance area, the inventory of nuclear material and the charges in that inventory, including transfers into and out of the material balance area; and

(j) Make provisions to ensure that accounting procedures and arrangements are being implemented correctly.

Where a State has only reactors and stores of nuclear material, the requirements are fewer than those listed above; they are fewer still where the nuclear activities are restricted to "locations where nuclear material is customarily used in amounts equal to or less than one

effective kilogram". For instance, it is unnecessary to record and report measurement uncertainties relating to nuclear material in reactors because the verification of the accountancy for such nuclear material is as a rule done by counting identifiable items and inspection statements can be based on the numbers of identified items which represent a significant quantity of nuclear material.

COMPLEMENTING ACTIVITIES OF THE STATES AND THE AGENCY

High quality of accounting for and controlling nuclear material presupposes high standards in the design and operation of facilities. Through its regulatory power with regard to the nuclear activities in its territory or under its jurisdiction or control, a State has a unique role to play in setting such standards. Both the State and the Agency have a part to play in the development of the required technology – either directly, by undertaking such development, or indirectly, by disseminating technical information on it. They should co-operate in ensuring that the prescribed standards for the design and operation of facilities will result in rational nuclear material control requirements which help the operator to achieve his legitimate scientific, technical and economic objectives rather than hamper him.

The Agency bears the responsibility for ensuring the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities under its safeguards. For this purpose it must use the verification means provided in safeguards agreements. This responsibility is borne by the Agency alone; it cannot be transferred. However, depending on the effectiveness of the State's system, the Agency may establish different quantitative criteria for "timeliness" and "significance". Timeliness criteria are used to determine the approximate timing for statements to be made on the verification of the closing of any given material balance by physical inventory taking. These criteria are interdependent with criteria for the significant quantity of nuclear material which should be detected if missing given the specific composition of the State's nuclear fuel cycle. These significant quantities depend on the measurement accuracies which can be achieved in existing facilities which process nuclear material. Two sets of criteria are envisaged – one to satisfy the objectives of SSACs and the other to satisfy the objectives of Agency safeguards.

For SSACs physical inventory taking would be more frequent and the significant quantities would be smaller than for Agency safeguards. However, for SSACs the significant quantities cannot be smaller than twice the expected measurement accuracies of present measurement systems – sometimes called two sigma (standard deviation) limits. If these significant quantities are considered too large relative to the threshold amounts which are needed to manufacture a nuclear explosive device, then the only solution at present is to increase inventory frequency and/or to establish smaller material balance areas in order to improve timeliness and localize losses. Of course, this means a corresponding increase in SSAC inspection effort and cost.

The Agency's Board has in fact accepted an increase of the significant quantity of nuclear material which it should be able to detect if missing, given the specific composition of the State's nuclear fuel cycle, on condition that the State's system is able to meet its criteria for timeliness and significant quantity through independent verification, in co-ordination with the Agency's verification activities – in short, if the State continuously achieves level II

assurance. Moreover, the Agency would verify the physical inventory less often than would the SSAC. The differences between SSAC and Agency criteria are determined primarily through negotiation.

It has not been worked out in quantitative terms, however, how more stringent SSAC criteria will improve the timeliness or quality of Agency statements. At present all that can be done is to compare the SSAC and Agency statements on significant quantities – expressed as statistical confidence limits – with the threshold amounts which are needed to manufacture a nuclear explosive device (up to 8 kilograms for plutonium and up to 25 kilograms for contained uranium-235).

The main interest of the Agency, the State and the operator is that the Agency should make maximum use of the State's activities in the field of accountancy for and control of nuclear material. The State has to provide the Agency with information on the elements and requirements of the SSAC and the Agency has to analyse the level of assurance and the effectiveness which the SSAC attains for each facility.

The Agency's verification of the effectiveness of the SSAC will be based on the observation of State verification activities wherever possible in accordance with procedures specified in the safeguards agreement. The Agency's verification in respect of the significant quantity of nuclear material to be detected by it if missing will be based on independent measurements as provided for in the agreement. Both kinds of verification will help in establishing the continued validity of the information provided by the SSAC, its technical effectiveness and its findings.

Technical effectiveness is judged by the way the SSAC meets its technical objective with respect to each facility, as specified in the subsidiary arrangements. In accordance with the agreement, account is also taken of the promptness with which reports are provided to the Agency, their consistency with the Agency's independent verification, the amount of the material unaccounted for and the accuracy with which this amount is measured, as verified by the Agency.

The judgement on the effectiveness of the SSAC is reflected in the nature and intensity of the Agency's verification activities, and particularly its inspection effort. The routine inspection effort is a main component of these activities and co-ordination of the Agency's inspections with those made by the SSAC is the key to minimizing the implementation effort, and consequently also to reducing the costs of Agency verification. Arrangements for co-ordination are made whenever the assurance level attained by the SSAC makes this appropriate.

The planning of Agency inspections at a facility where there is no independent verification by the SSAC (level II assurance) consists of:

(i) a review of the continued validity of the assumptions used in estimating the Agency's verification activities on the basis of the most recent information provided by the State, of information collected during Agency inspections, of the number, intensity, duration, timing and scope of inspections actually carried out by the SSAC, of the SSAC's statistical sampling plans and of the inspection procedures and techniques used by it;

(ii) a definition of the scope of the inspection activities to be carried out; and

(iii) an estimation of the "sample size" for the examination of records, the measurement of nuclear material and the definition of sampling strategy which will ensure the randomness of each selected sample population for the Agency and the SSAC – in respect of the operator's populations, as required by the type of statement to be made.

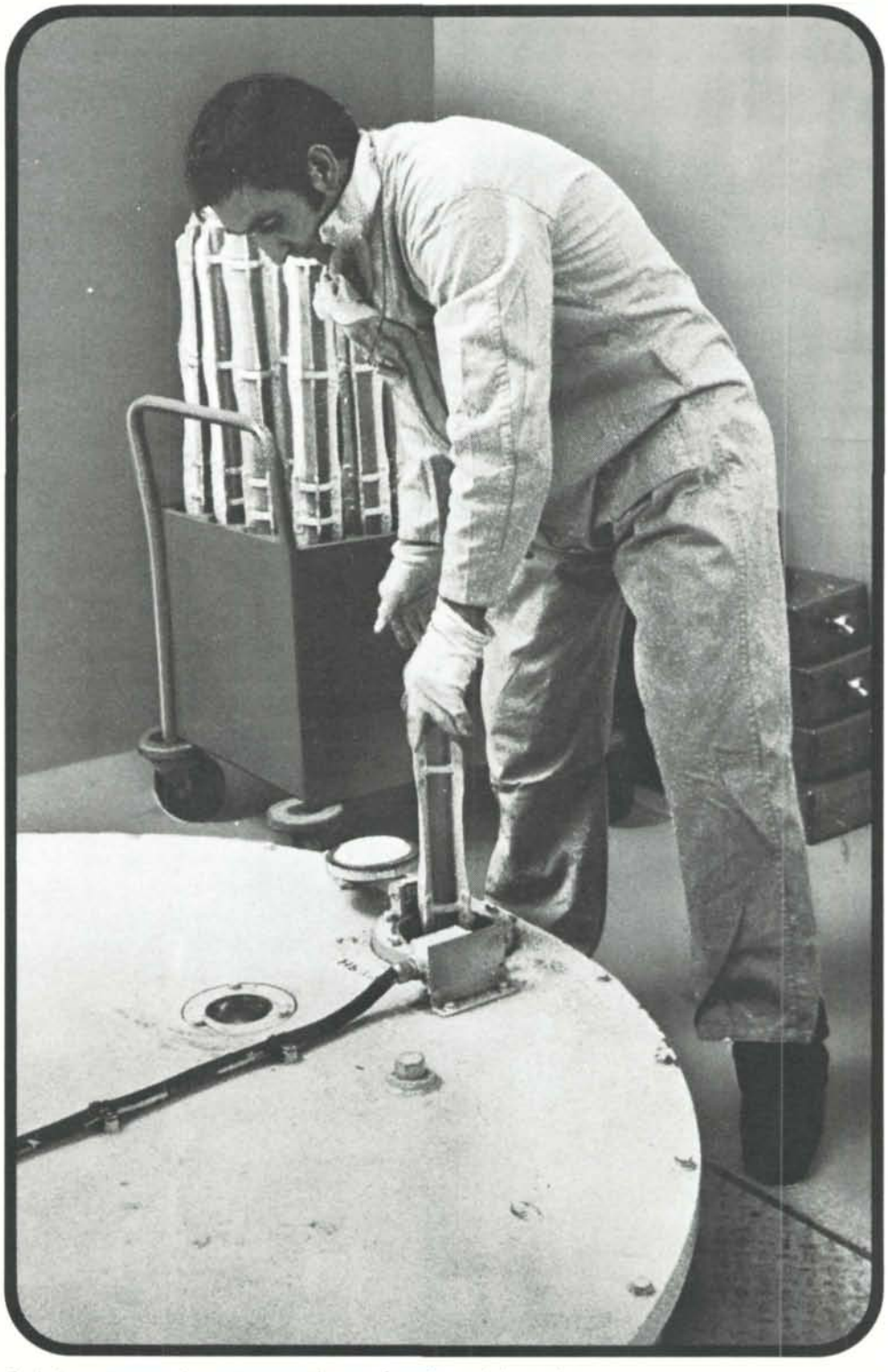
If the general requirements laid down in the co-ordination arrangements are not met by the SSAC, or if the technical objectives set for the SSAC in respect of each facility are not achieved at the outset or do not continue to be achieved thereafter, the Agency is free to increase its verification effort to the extent necessary for the achievement of its safeguards objective. In effect, this means that the significant quantity would be decreased and/or the frequency of physical inventory verification increased – to adjust the Agency's verification activities to the extend necessary. As a limit, the Agency's verification activities may be raised to the same level as in those States where SSAC provides only level I assurance.

ROLE OF THE AGENCY

NPT safeguards agreements give general guidance on the elements which SSACs must contain and the requirements which they must meet in complying with such agreements. In the negotiations on subsidiary arrangements (which include an "attachment" for each facility involved), which follow the talks on the agreement, the Secretariat has the opportunity to give national authorities further guidance on the establishment of the SSAC, for which purpose it will make use of the recommendations of the Advisory Group which met in Tokyo.

The Guidelines formulated by the Advisory Group relate to the requirements which must be met if the SSAC is to comply with the commitments under safeguards agreements concluded pursuant to NPT. During the meeting of the second Advisory Group of Experts in 1975, it is planned to extend these guidelines to requirements other than those imposed by NPT commitments.

Accountancy, containment and surveillance are the measures upon which Agency safeguards are based, and any research and development aimed at improving these measures will be of interest both to the State and to the Agency. Although various States are engaged in their own research and development programmes aimed at improving the accountancy for and control of nuclear material, such research and development work has by its very nature an international impact. The Agency has an important role to play in co-ordinating the various research and development programmes in the field of safeguards.



Fuel elements are an important constituent of a safeguards inspection.