IAEA Regional Seminar on the Protocol Additional to Nuclear Safeguards Agreements
Lima, Peru
4 - 7 December 2001

SESSION 5: VERIFYING COMPLIANCE: SAFEGUARDS ACTIVITIES UNDER INFCIRC/153

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CONCEPTS

Purpose of IAEA Safeguards

International Atomic Energy Agency safeguards are one important instrument of international non-proliferation policy. Safeguards implementation is regulated by the IAEA Statute [ST] and individual safeguards agreements. Such agreements concluded by the IAEA are based on document INFCIRC/153 (Corrected) [153]. [1]/ Paragraph 2 of [153] and stipulates that safeguards will be applied to nuclear material

> ". . . for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices."

This provision places the emphasis on the role of IAEA safeguards as a verification system. The IAEA's independent verification activities provide assurance, at the request of a State or a group of States, and of the international community, that the States are complying with their commitments concerning the peaceful uses of nuclear energy.

While safeguards activities should be attained at minimum cost, i.e., with high efficiency; they must also be credible, meaning that they must both be efficient and be perceived to be effective. Objectivity and impartiality are other necessary elements of this credibility.

Scope of IAEA Safeguards

The scope of IAEA verification activities is defined by the relevant safeguards agreements.

1/ Abbreviations in square brackets are references to the publications listed in the Bibliography

Under agreements concluded pursuant to [153], the principal object of safeguards implementation is nuclear material accountancy. Thus, the verification activities are intended to provide assurance that the material in question is not diverted from peaceful uses to the production of nuclear weapons or other nuclear explosive devices, or to other purposes unknown and to verify compliance with the undertakings of the States Parties. The main thrust of [153] is the full-scope intent of the latter [153/para.l], whereby the State accepts safeguards on all nuclear material in all its peaceful nuclear activities. It is the IAEA's right and obligation to ensure that safeguards will be applied, in accordance with the terms of the agreement, to all such material [153/para.2]. The agreement contains safeguards procedures to be followed by the IAEA to ensure compliance with the basic commitment by the State, namely not to divert nuclear material. The rights and obligations of the IAEA with respect to the full-scope commitment under [153] are therefore restricted to verifying, within the limits set by the safeguards agreement, that nuclear facilities accessible to IAEA safeguards are not connected by a nuclear material flow to other nuclear activities which might exist and which in violation of the agreement were not submitted to IAEA safeguards. Technically this is part of the normal verification procedures at facilities submitted to IAEA safeguards.

Each agreement provides for Agency review of design information, reporting and record-keeping by the State, inspection activities to be carried out by the IAEA, including rights of access and notification of inspections, and provisions related to the exemption and termination of safeguards. To the extent practical and legally permissible, efforts are made to standardize the Agency's safeguards approaches, taking into account technical variations among the States' nuclear programmes.

Safeguards agreements are complemented by Subsidiary Arrangements which describe in more detail the technical and administrative procedures for implementation of the agreements. Under [153]-type agreements, the general part of the Subsidiary Arrangements is applicable to all nuclear activities in the State concerned. For [153], specific procedures for each facility and for other locations where nuclear material is present are specified in Facility Attachments.

The Concept of Verification

Verification is a technical activity aimed at achieving the political purposes of IAEA safeguards, namely assurance and deterrence. Under the circumstances indicated above, the normal result of IAEA verification is assurance of compliance by States with their non-proliferation commitments. However, IAEA findings are credible only if verification activities are so thorough that non-compliance (diversion of nuclear material, misuse of facilities, etc.) would be detected with high probability. Therefore, in developing an effective verification methodology, the IAEA has to assume as a general working hypothesis that noncompliance cannot be excluded and that consequently a diversion risk of low but non-zero probability exists in all countries. [2]/ If careful verification activities lead to the conclusion that the diversion hypothesis cannot be substantiated, then it can be concluded with a high level of confidence that in fact no diversion or misuse has occurred. [3]/

Conceptually, IAEA verification can thus be regarded as the testing of diversion hypotheses. [4]/ Analysis of such hypotheses is therefore an important means for designing and organizing effective and

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2/ This should not be misunderstood as an expression of distrust directed against States in general or any State in particular. A comparison could be made with the philosophy of airport security. In order to be effective, airport security measures have to assume a priori and without any suspicion against a particular passenger that each bag might contain prohibited items.

3/ This interpretation of verification in the context of international safeguards is also contained implicitly in [153/para. 19] which covers the case where the IAEA is unable to verify that there has been no diversion of nuclear material.

4/ Owing to the emphasis on nuclear material in [153]-type agreements, and in order to focus in this paper on the predominant safeguards situations, we will deal mainly in the following pages with the diversion of nuclear material.

credible verification activities. In the analysis, a wide range of potential diversion strategies and possible concealment methods have to be considered in connection with all types of nuclear material and facilities. The diversion analysis includes a consideration of the characteristics of the nuclear facility, the type and location of material, and possible diversion paths, diversion rates and concealment methods.

It would, however, not be very realistic to consider scenarios in which a specific act of diversion was actually witnessed as it occurred. Rather, it is the purpose of the diversion analysis to identify anomalies, that is to say ‘observables’, that may be indicative of acts of non-compliance. [5]/ The various safeguards approaches are thus designed to ensure that verification activities are capable of leading, with a high probability, to the timely detection of such anomalies; and, to define such further activities as are needed to determine the causes of the anomalies.

There may be different reasons for the occurrence of anomalies. In general, they result from entirely innocent causes such as recording or measurement errors. However, they could also be the result of diversion or misuse. As a consequence, the IAEA as part of its verification work undertakes follow-up activities intended to resolve each observed anomaly and to ensure that no true cause for alarm is ignored or false alarm raised. If all observed anomalies are satisfactorily explained, the IAEA can state as an objective fact that during the given reporting period no anomaly that would indicate diversion was detected. The thoroughness of the verification methods applied would then permit one to conclude with a high level of confidence that no such anomaly in fact existed and therefore that no diversion of the kind considered in the diversion hypo thesis had occurred.

Technical Objectives of IAEA Safeguards

For practical purposes it is necessary to go beyond the general concepts discussed in this paper and to define more specifically the technical objectives of IAEA safeguards. This objective is stated explicitly in [153/para.28]:

> “. . . 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 explosives or for purposes unknown...” [6]/

Detection Goals

For the careful planning of safeguards implementation and for objective performance evaluation, it is necessary to quantify the terms used in the above quotation. The various numerical parameters (significant quantity, detection time, detection probability), together with a further parameter known as the false alarm probability, constitute the so-called detection goals. These parameters cannot be deduced solely from physical and technical axioms and reasonable values have been selected on the basis of technico-political judgement and consensus. The present detection goals were discussed in detail and numerical values were given in other presentations at this Seminar.

The significant quantity (SQ) is defined as the approximate quantity of nuclear material in respect of which, taking into account any conversion process involved, the possibility of manufacturing a nuclear

5/ Examples of anomalies might be: nuclear material or equipment missing, inaccessibility of nuclear facilities, IAEA seals tampered with, inconsistencies in documents, etc.

6/ The inclusion of the expression “for purposes unknown” is very important for the practical application of safeguards, because 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 nuclear material is diverted to the manufacture of nuclear weapons or other nuclear explosive devices.

explosive device cannot be excluded. Typical values of an SQ (not to be confused with critical mass) range from 8 kg of plutonium to 20 t of thorium.

The second parameter, detection time, should correspond in order of magnitude to the conversion time, estimated as the time necessary to convert different forms of nuclear material to the metallic components of a nuclear explosive device. Conversion time values used at present range from 7 to 10 days for metallic plutonium to one year for natural uranium.

Inspection Goals

In planning the inspection regime for particular nuclear facilities, the detection goals are not used in a purely mechanical way; they are not interpreted as rigid requirements but as guidelines to be used in designing safeguards approaches and establishing inspection goals. The latter reflect actual conditions at the facility, the requirements of the safeguards agreement, the limitations of measurement methods, and the effectiveness of given safeguards procedures and techniques. They are thus performance targets adopted for a given facility and provide a basis for designing the appropriate safeguards approach. Inspection goals are established with their attainability in mind and are in fact, as the records show, attained at most facilities of various types. The achievement of goals in other, more difficult, cases will depend, inter alia, on the resources available to the IAEA.

The accountancy verification goal (AVG) is the minimum quantity of nuclear material which, if diverted at a facility, should (to the required degree of probability) be detected by the application of nuclear material accountancy measures along with a low risk of false alarm. In the case of item facilities, the goal is equal to one SQ of nuclear material, including that which might be produced as a result of unreported irradiation. In the case of bulk handling facilities, the goal depends, inter alia, on the nature of the facility, the quantities of material handled, and the effect of measurement uncertainties. For most current bulk handling facilities it is also possible to set the accountancy verification goal equal to one SQ or less.

The timeliness goal is a parameter derived by adapting the detection time guidelines to the specific conditions at a facility. It also reflects the available safeguards resources. The timeliness goals currently used for determining the frequency of inventory verification and containment and surveillance activities (video/film evaluation, seals examination, etc.) at facilities handling one SQ or more of nuclear material range from up to four weeks for material containing high enriched uranium (HEU) or plutonium in non-irradiated form to twelve months for low enriched uranium (LEU) or natural uranium.

It must be emphasized that detection goals are only one of several factors determining the inspection goals. The use of inspection goals which in some cases do not meet detection goals should not be seen as a failure of safeguards. Inspection procedures aiming at an inspection goal of more than one SQ still provide a possibility of timely detection of the diversion of one SQ or less, but with a lower probability.

The successful implementation of safeguards and the extent to which inspection goals can be achieved depend largely on the degree of co-operation offered by the State and the facility operator concerned and on the availability of manpower, safeguards equipment and inspection support services. The extent to which Subsidiary Arrangements made under safeguards agreements provide the IAEA with the necessary rights is also an important factor.

Co-operation with the State

Effective implementation of safeguards requires co-operation between the IAEA and the State concerned. To this end, agreements of the [153] type require that the State shall establish and maintain a system of accounting for and control of nuclear material subject to safeguards (SSAC). They prescribe that the system shall be based on a structure of material balance areas (MBAs) and shall provide for the establishment of a measurement system, a records and reports system, procedures for taking physical inventories, and provisions to ensure that the accounting procedures and other arrangements are being correctly operated [I 53/para.32]. This should enable the IAEA to verify the findings of the SSAC. In performing its verification, the IAEA takes due account of the technical effectiveness of the SSAC [153/para.7].

Document [153] requires that the State make information available to the Agency. Specifically, they require the State to:

- Provide the IAEA with information in respect of facility design features and other information relevant to safeguards

- Arrange for the keeping of records for each facility or MBA

- Provide the IAEA with reports in respect of nuclear material, based on the records kept.

On the basis of co-operation with the State concerned, the verification process involves three main areas of inspection activity:

(1) The examination of the information provided by the State, including:

- Design information
- Accounting and operating reports, and special reports
- Amplification and clarification of reports
- Advance notification of international transfers.

(2) The collection of information by the IAEA through:

- Visits for the verification of design information
- Ad hoc and routine inspections
- Special inspections.

(3) The evaluation of the information provided by the State and collected during inspections for the purpose of determining the completeness, accuracy and validity of this information.

The results of inspections performed under [153]-type agreements are reported by the IAEA to the State concerned in the form of a statement which identifies the inspection and the detailed activities carried out. Also noted are any discrepancies and anomalies, together with their significance and the results of an investigation into their cause. This kind of statement is of a preliminary nature because evaluation activities may still be under way and usually more than one inspection is made before a conclusion is drawn.

After the physical inventory taking (PIT) by the plant operator and the physical inventory verification (PIV) by the IAEA, a second type of statement is sent to the State, containing the conclusions drawn from the safeguards activities performed. This includes a statement in respect of each MBA of the amount of material unaccounted for (MUF) over a specific period (the material balance period, MBP) for each category of nuclear material [153/para.90]. The statement shows whether the material subject to safeguards has been satisfactorily accounted for during the period between PIVs. If the IAEA is not satisfied with the results obtained during inspections, further investigation is called for and the State is requested to examine the causes of any inadequacy and undertake the necessary remedial steps.

METHODOLOGY

Safeguards Measures

According to paragraph 29 of [153], nuclear material accountancy (NMA) is a safeguards measure of fundamental importance, with containment and surveillance (C/S) being important complementary measures. The reliance on NMA and C/S does not exclude the application of other objective measures, such as the use of conclusions drawn from verification of the operational status or the design reverification of a facility. IAEA verification activities can be carried out in practice only with the substantial co-operation of the facility operator and the State concerned. This co-operation is necessary for implementation of the following basic concepts (see [153/paras 6, 7, 72, 74, 75, 79, 90]):

- The independent verification by the IAEA of the entire State accountancy system for nuclear material by means of document audits, item counting and identification, observation, chemical analysis and nondestructive measurements, seal verification, etc.

- The periodic closing of material balances by the taking of physical inventories by the operator and their verification by the IAEA

- The effective monitoring by the IAEA of the flow of nuclear material through the use of instruments and other techniques at key measurement points and other strategic points

- The use of C/S as important complementary measures.

Nuclear Material Accountancy (NMA)

Nuclear material accountancy relies on the principle of conservation of matter. Any changes to the inventory of material present in a defined area must be equal to the net production or loss of such material within the area plus the inward flow of such material from outside, minus the flow out of the area. Effective verification based on this principle requires knowledge of the flow and inventory of the nuclear material and the compilation of periodic nuclear material balances. Areas defined in nuclear facilities for application of the conservation principle are called material balance areas (MBAs). Their delineation takes account of the specific technical aspects of the nuclear facility and their boundaries are chosen to facilitate the measurement of all nuclear material transfers across the boundaries and the establishment of the inventory within the MBA. Measurements are made at certain strategic points (SP), called key measurement points (KMP). KMPs are locations where information on flow and inventory can be gathered and verified and at which nuclear material appears in a form in which it may be measured. An NMA cycle starts with the determination by the operator and verification by the IAEA of the physical inventory for an MBA. The operator maintains a book inventory based on the initial physical inventory, adding increases (e.g., receipts) and deducting decreases (e.g., shipments). [7]/ The NMA cycle is closed by an ending PIV and by evaluation of the material balance for the period considered by the operator. Both are verified by the IAEA.

7/ The accounting activity of the operator is to be documented in accounting records and operating records, complemented by supporting documents such as measurement results, irradiation data, shipping documents, etc.

The analysis of nuclear material samples taken at the facility is a vital part of the verification process. Some analyses are carried out during IAEA inspections without physically affecting the item under examination, i.e., by non destructive assay (NDA). Some samples have to be measured by 'destructive' techniques, such as chemical and other analyses. This is done in the IAEA Safeguards Analytical Laboratory.

For facilities handling identifiable 'items' containing nuclear material (e.g., fuel assemblies or sealed containers), the integrity of which can be considered as preserved during the NMA period, no difference between the updated book inventory and the ending physical inventory is normally to be expected. For facilities with nuclear material in unsealed bulk form (powder, pellets, solutions, scrap, etc.), there is always some difference between the book inventory and the physical inventory because of the unavoidable limitation on the exactness of measurements. There may also be discrepancies for other reasons, e.g., failure to measure parts of the inventory, unmeasured loss of material and, conceivably, diversion. The difference between the book inventory and the physical inventory represents the material unaccounted for (MUF). Because MUF is a quantity derived from measurements, it may be used as an indicator in evaluating the possibility of diversion.

On the basis of operators' NMA activities, the State submits periodic accounting reports to the IAEA, namely:

- Inventory Change Reports (ICR), which describe each increase and decrease of nuclear material in each MBA since the last report; and

- Material Balance Reports (MBR), accompanied by Physical Inventory Listings (PIL) submitted after each physical inventory and containing the MUF analysis.

On the basis of these reports, the IAEA maintains a set of accounts parallel to that of the State, and subjects the facility records and State reports to audit and comparison with its own records.

Containment and Surveillance (C/S)

Containment and surveillance measures are widely used in IAEA safeguards to complement and support NMA. It is the purpose of C/S measures to provide information on movements of nuclear material or on the integrity of equipment, verified data, etc. In many instances they cover the periods when the inspector is absent and thus contribute to cost-effectiveness. Containment and surveillance measures are for instance applied to:

- ensure during flow and inventory verification that each item is inventoried without duplication and that the integrity of samples is preserved

- ensure that IAEA instruments, devices, working papers and supplies are not tampered with

- reduce the need for repeating full verification of previously verified items or of containers the integrity of which has not been changed

- cover specific safeguards situations. [8]/

8/ Examples might be: on-load refueled reactors, where the fuel m the core is not routinely accessible for inventory taking, and situations where a safeguarded nuclear reactor is routinely supplied from an unsafeguarded fuel fabrication plant.

Containment measures take advantage of existing structural features, such as containers, tanks, pipes, or substantial walls, to establish the physical integrity of an area or item by preventing the undetected access to or movement of nuclear material, or interference with equipment or data.

Surveillance refers to both human and instrumental observation aimed at indicating the movement of nuclear material, or interference with containment or IAEA equipment. It thus serves to assure the integrity of containment. Surveillance may also be used for observing various operations or obtaining relevant operational data. It may involve, for example, the checking of tamper-indicating seals and the use of automatic surveillance systems, such as camera or closed circuit TV systems, or radiation monitors applied by the IAEA. IAEA inspectors may fulfill similar assignments continuously or periodically at strategic points.

The C/S techniques used by the IAEA are carefully designed and implemented to avoid imposing any unnecessary physical restrictions on facility operations or movements or access to materials which are in accordance with the design information and which are duly recorded and reported. Nevertheless, they must provide the IAEA with credible information on whether unreported movement or access might have occurred or whether the integrity of data might have been impaired. The detection of an anomaly relating to C/S measures does not necessarily by itself indicate that material has been removed. The ultimate resolution of C/S anomalies (e.g., broken seals) is provided by NMA measures (e.g., the reverification of the material under seal). If any C/S measure has been, or may have to be, breached, the IAEA must be notified by the fastest means available. Examples might be: seals which have been broken - inadvertently or in an emergency; or, seals for which the possibility of removal after advance notification to the IAEA has been agreed between the IAEA and the operator.

INSPECTIONS

The key to verification by the IAEA is the right to conduct on-site inspections. Three types of inspections are involved: routine, special inspections and ad hoc inspections in accordance with [153].

Visits and initial inspections are made under agreements of the [153] type, to verify the facility design information submitted by the State.

The majority of the inspection effort is expended on *routine inspections* [153/para.72]. The purpose of the routine inspections is to verify that the information contained in reports submitted by the State is consistent with the accounting and operating records kept by the facility operator, to verify the location, identity, quantity and composition of safeguarded materials, and to verify information about the causes of shipper/receiver differences, book inventory uncertainties, and MUF.

Ad hoc inspections are made to verify the initial report or changes in the situation since the initial report was made, and to identify and verify the nuclear material involved in international transfers [153/para.71].

Under [153]-type agreements, *special inspections* are made under [153] in addition to routine inspections to verify information presented in special reports or to collect additional information when the IAEA considers the information provided by the State or obtained through routine inspections to be inadequate for it to fulfil its responsibilities.

Activities carried out by the IAEA during inspections and in connection with them are described in more detail below.

INSPECTION ACTIVITIES

The activities of IAEA inspectors during and in connection with a visit to or inspection of a nuclear facility have been described in general terms above. Such activities depend to a certain extent on the particular situation (type of agreement and facility, number of inspections per year, etc.). Certain of these activities, however, have common features independent of the specific circumstances. In order to avoid repetition in the subsequent discussion of safeguards approaches for various facility types, a brief description of characteristic activities is first given here.

Safeguards implementation starts at a facility coming under safeguards with an initial visit [153] by IAEA inspectors. The purpose of this is to verify the accuracy and completeness of the design information on the facility which the State has to submit to the IAEA as early as possible before nuclear material is first introduced. This information (describing the facility and in particular its design features, operation modes and procedures relevant to safeguards) is examined by the IAEA prior to the initial visit for the purpose of developing an appropriate safeguards approach. The initial visit is also used to consider the conclusions of the design examination, to collect any necessary additional information and to prepare the Subsidiary Arrangements.

Routine inspections

As stated above, IAEA verification essentially means testing diversion hypotheses. The purpose of the following activities, performed during or in connection with routine inspections, is to carry out such tests. Each of these activities has the potential to disclose one or more anomalies corresponding to specific elements in the diversion hypotheses. If any anomaly is found, its cause has to be ascertained immediately.

In the following list, the nature of each activity, i.e., whether it is related to NMA or C/S, is indicated in parentheses.

Follow-up actions (NMA and C/S)

Individual inspections are not usually independent of each other. It may be necessary to complete actions which were started during the previous inspection(s) and to resolve problems which have been identified in the meantime.

Accounting records examination (NMA)

The purpose of this activity is to establish for the MBA by independent audit a correct set of data upon which physical verification can be based. It should also enable an assessment to be made of the quality of the operator's system of accounting records. The examination is carried out with respect to the completeness, internal consistency and arithmetic correctness of the data and includes the checking of supporting documents and, if relevant, confirmation from operating records.

Finally the book inventory totals are checked and - in the case of PIT - the physical inventory totals are recorded. The examination is usually carried out in connection with one or more of the NMA activities.

Operating records examination (NMA)

A correct set of facility operating data is in many cases necessary for comparison with accounting records or for deriving additional data or conclusions. The operating records include:

- operating data used to establish changes in the quantity, composition and location of nuclear material

- data obtained from calibration, sampling and analyses

- information on procedures for controlling the quality of measurements, and on the evaluation of the results

- information on the preparation for a physical inventory taking

- information relating to the cause and magnitude of any accidental or unmeasured loss.

The examination is also used as an opportunity to assess the quality of the operator's system of operating records and to offer advice if requested

Reconciliation of accounting and operating records (NMA)

The purpose of the reconciliation is to identify and clarify any inconsistency between the accounting and operating data. Examples might be the comparison of recorded fuel assembly movements or loading patterns with accounting entries, or the analysis of a reactor operating history (operation time, power output) in relation to nuclear material production and nuclear
loss.

Comparison of records and reports (NMA)

This activity consists in making a correlation between the relevant facility accounting and operating records on the one hand, and the State reports (ICR, MBR, PIL) on the other in order to determine their completeness, internal consistency and arithmetic correctness.

Updating of the book inventory (NMA)

An important step in NMA consists in establishing the amount of nuclear material that should be present at the facility the book inventory at the date or near the date of inspection. The updating is based on the book inventory established at the previous inspection and uses facility records and supporting documents covering the intervening period. At times of physical inventory verification (PIV) the relevant book inventory may be used for the preparation of preliminary sampling plans.

Inventory change (flow) verification (NMA)

This activity involves verification of important components of the material balance, namely:

Increases: such as imports from abroad, domestic receipt, nuclear production, de-exemption, etc.

Decreases: such as exports, domestic shipment, nuclear loss, transfer to retained waste exemption, etc.

In addition to the document audits, the following activities may be carried out:

- removal of seals and/or verification of receipts

- verification and sealing of shipments (e.g., partially filled irradiated fuel assembly casks)

- verification at other MBAs of matching receipts/shipments

- verification of shipper/receiver differences

- calculations for assessing nuclear loss and production (also in connection with physical inventory verification).

Inventory verification (NMA)

The inventory verification is carried out to confirm the operator's recorded book inventory of nuclear material present at a given time within an MBA. There are two types of inventory verification:

- the PIV which follows closely on or coincides with the PIT by the operator and closes the material balance period;

- and the interim inventory verification, which does not coincide with the closing of a material balance period and during which part or all of the inventory is verified. An interim verification is made if only part of the inventory is accessible or if the action is required in order to attain IAEA timeliness goals.

The basis for a PIV is an itemized inventory list prepared by the operator and organized by location (KMP) and material type, or some such equivalent documentation. In the case of items, the PIV is carried out by item counting, item identification and 'attribute tests' (NDA applied to a random sample of the items in order to detect dummies or other anomalies if present). For bulk material, 'variables tests' are made in addition to the above activities in order to determine the amount and isotopic composition of the material present (e.g., weighing, radiation measurement or chemical analysis of random samples) The verification results are compared with the physical inventory listings submitted by the State.

Verification at special strategic points (various measures)

The list of verification activities above is not exhaustive. One example of a different category is the special arrangement foreseen for the cascade hall of enrichment plants. Another example would be reprocessing plants. Here, special arrangements define the access to the various instrument readings and measurements or calibrations which are used by the operator to identify nuclear material or to provide information on the quantity, quality and location of nuclear material.

Application and use of surveillance (C/S)

Surveillance is used to detect possible movements of nuclear material and production of special fissionable material which, contrary to agreed procedures, has not been recorded or reported, falsification of information on the location, composition and quantity of nuclear material, unreported changes of the facility design, or any tampering with containment or IAEA safeguards devices. Automatic film cameras and closed-circuit TV systems are the most frequently used types of surveillance measures

The installation of an surveillance unit requires careful analysis of the location (in the containment, along routine paths followed by nuclear material, etc.) and proper positioning. During maintenance, the integrity of the containment (signs of modification) and of the indications of interference are checked. The characteristics of the system may be such that the frequency of maintenance (change of films, batteries, tapes, etc.) coincides with timeliness requirements, so that maintenance can be carried out when surveillance records have to be evaluated. The evaluation of exposed films (video tapes) involves checking on significant events, e.g., number of appearances or disappearances of spent fuel casks, and their correlation with the operator’s accounting and reporting records.

Application and use of seals (C/S)

Seals are tamper-indicating devices used to join movable segments of a containment structure in such a manner that access to a sealed item becomes impossible without opening of the seal or other obvious interference with containment integrity. Seals are used, for example, at the following locations:

- shields covering reactors
- channel gates, doors and other access possibilities
- fresh fuel racks, stacks of spent fuel, fuel assemblies
- spent fuel casks and other containers
- valves, levers, instruments
- IAEA equipment and other items (samples, standards, documents) stored at the facility.

Seals have to be verified at specified intervals on the spot. The intervals are usually related to the timeliness requirements. Additionally, samples of the most commonly used metal seals are checked at IAEA Headquarters. All data related to seals are recorded. Under certain conditions (aging of seals, doubts as to the integrity of seals or containment), follow-up actions may include remeasurement of the nuclear material involved. Radiation monitors are used in a manner similar to seals: they indicate for example whether or not spent fuel has passed an access port or a containment penetration.

Verification of adequacy of the operator’s measurement system

According to paragraph 81 of [153], the extent to which an SSAC has fulfilled the various requirements of paragraph 32 of that document has to be taken into account in the determination of the Average Routine Inspection Effort (ARIE). In this context, verification of the functioning and calibration of relevant instruments is necessary, together with an evaluation of the precision and accuracy of the operator’s measurements in relation to international standards.

Other inspection activities

The typical inspection activities mentioned in this paper are not exhaustive. Special technical or legal situations may require other kinds of activity. Furthermore, IAEA safeguards approaches are still evolving and new developments may lead to changes in implementation practice.

THE SAFEGUARDS CONCLUSIONS

In 2000 as it has been in the past, the Agency concluded that in the 140 States (and in Taiwan, China), which have safeguards agreements in force, nuclear material and other items placed under safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for. This conclusion derives from the evaluation of all information acquired in implementing safeguards agreements and from other information available to the Agency, in particular for the 70 States with significant nuclear activities and for Taiwan, China. In the course of such evaluation the Agency found no indication of diversion of nuclear material placed under safeguards or of misuse of facilities, equipment or non-nuclear material placed under safeguards.

The Agency, however, is still unable to verify the correctness and completeness of the initial report of nuclear material made by the Democratic People's Republic of Korea and is, therefore, unable to conclude that there has been no diversion of nuclear material in that State.

From 1991 to 1998, the Agency's safeguards obligations in Iraq were implemented under the United Nations Security Council resolution 687 and related resolutions. However, since December 1998, the Agency has not been in a position to implement its mandate under those resolutions and, therefore, still cannot provide any assurance that Iraq is in compliance with its obligations under those resolutions. Given the requirements of its safeguards system, and pursuant to its safeguards agreement with Iraq, the Agency was, however, able to conduct a physical inventory verification of the nuclear material under safeguards and located at the Tuwaitha storage facility in January 2000. Agency inspectors were able to verify the presence of the nuclear material in question.

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