Conceptualisation in the IAEA safeguards system and the formation of safeguards culture

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Contents	Page

Executive summary

This paper discusses the role of conceptualisation in International Atomic Energy Agency (IAEA) safeguards in the formation of safeguards culture. The object of this study is the IAEA safeguards system. This system was created in the mid-1960s on the basis of the IAEA Statute. In the 1970s the safeguards system was adapted for the purposes of the Nuclear Non-Proliferation Treaty (NPT). The safeguards system was strengthened during the post-1991 period, and its evolution remains ongoing.

The paper comprises two parts: a main part and an Annex. The main part contains major outcomes of the study: the three implementation concepts inherent in the safeguards system, the mechanism of safeguards culture formation, and the evolution of safeguards terms and notions. The Annex contains five parts, each describing an important milestone in the evolution of the IAEA safeguards system: (1) Conceptual development of the IAEA safeguards system in the pre-NPT period; (2) Adaptation of the IAEA safeguards system for the NPT; (3) Further development of the safeguards system; (4) Introduction of the additional protocol and development of the concept of integrated safeguards; and (5) Development of the State-level concept.

Safeguards conceptualisation

The authors postulate that there have been three major implementation concepts over the whole history of safeguards implementation: the **Facility-level** concept, which has been used since the time of the design of the IAEA safeguards system; the **integrated safeguards** concept, which was developed around 2000; and the **State-level** concept, which was introduced in 2004. The paper analyses these using three characteristics of each implementation concept: the formulation of safeguards and technical objectives; the development of verification activities (safeguards approaches); and the formulation of safeguards conclusions.

The paper contains several important outcomes of this analysis. One outcome is that the safeguards system is essentially a verification system: the IAEA verifies compliance of a State with its undertakings under its safeguards agreement. In particular, under the comprehensive safeguards agreement (CSA) the Agency verifies the compliance of non-nuclear-weapon States parties to the NPT with their obligations under the Treaty. Another outcome of this analysis is the importance of distinguishing between the safeguards objective, which is a formulation of the purpose of the safeguards agreement, and the technical objective, which is a formulation of the objective of the verification procedures implemented to detect an indication of non-compliance. In the case of the CSA, the safeguards objective is formulated in article 2 of the model agreement and the technical objective is formulated in article 28 of that agreement.

The formulation of safeguards conclusions reported in the IAEA's annual Safeguards Implementation Report depends on the type of safeguards agreement, including protocols to the agreement, and on the safeguards and technical objectives.

The study reveals the difficulties with the safeguards terminology of the CSA, discussed in section D on the evolution of safeguards terms and notions. The authors believe these difficulties originated from the process of adaptation of the original safeguards system, designed in the mid-1960s, for the purpose of the NPT.

Formation of safeguards culture

The authors see safeguards culture as the manifestation of the political, ethical, legal, and technical achievements of human society in ensuring the peaceful use of nuclear energy. They identify three basic levels of the IAEA safeguards system: the **foundation** level (established by the conclusion of international treaties and safeguards agreements); the level of **operation design** (development of verification concepts and safeguards approaches); and the **implementation** level (implementation of safeguards approaches and associated safeguards activities in the field and at headquarters, and the drawing of safeguards conclusions).

Associated with these basic levels are three principal components of the system: a State's undertakings under its safeguards agreement; the safeguards and technical objectives and the means to attain them; and safeguards findings and safeguards conclusions. These components have been used to analyse the main stages of the evolution of the IAEA safeguards system: the initial development of the system; the adaptation of the system for the NPT and pre-1991 safeguards; the implementation of the integrated safeguards concept; and the implementation of the State-level concept.

The analysis has shown the role of the evolution of the IAEA safeguards system and of its conceptualisation in the formation of safeguards culture. The most significant changes in the safeguards system have occurred in the post-1991 period. These changes affected, to a great extent, the work of the IAEA Secretariat and also the work of State nuclear regulators and other stakeholders. They have changed the verification philosophy and the verification activities of IAEA inspectors. At the same time, they have greatly enhanced the effectiveness and efficiency of IAEA safeguards. These developments are continuing and require further effort with safeguards conceptualization for the system to remain robust to meet future challenges.

The evolution of safeguards terms and notions

The evolution of the IAEA safeguards system brought about the evolution of safeguards terms and notions. As a result of this, some safeguards terms have more than one meaning; a concrete meaning depends on the type of safeguards agreement implemented and on the implementation concept used. The authors discuss the most important terms and notions used in the comprehensive safeguards agreement, which include:

- Safeguards; application or implementation of safeguards;
- Nuclear material required to be safeguarded; nuclear material subject to safeguards;
- Nuclear material placed under safeguards; safeguarded facilities;
- Undeclared nuclear material and activities;
- Diversion;
- Non-compliance.

Conclusion

The paper concludes that safeguards culture should not be organisation-based (that is, a separate culture for each organisation or entity), but rather, should be approached as a shared endeavour involving collaboration at all levels – multilateral, national, industry and individuals. After all, the underlying principle, the peaceful (or non-explosive) use of nuclear energy, does not depend primarily on IAEA safeguards (the IAEA is only the verifying agency) but on the commitment of each State. Safeguards culture, therefore, should emphasise international collaboration. Formally recognising the role of safeguards culture would not only

lead to better performance in conceptualisation and implementation, but would also help strengthen safeguards as a global discipline.

A. Introduction

Conceptualisation plays an essential role in the development of any system of rules and procedures, and this is especially the case with a unique and innovative system like IAEA safeguards. This paper discusses how the development of safeguards has been influenced by the concepts that have been applied at different times, and how the resulting safeguards approaches and practices have influenced ongoing safeguards culture. To date the existence of a "safeguards culture" has not been formally recognised. As we have discussed elsewhere[1], there would be advantage in promoting safeguards culture as a positive influence in the further evolution of the safeguards system.

There are several publications on the subject of safeguards culture.[2] Some authors see safeguards culture through the prism of the theory of "organisational culture", others see safeguards culture as a general notion. We consider a broader notion of safeguards culture, which applies to all the actors of the non-proliferation regime: the IAEA, governments, the nuclear industry, and civil society.

The development of the concepts that guide the work of an organisation is an essential part of culture. We have considered the evolution of safeguards concepts and culture in the context of the major evolutionary stages of the IAEA safeguards system, namely:

- The pre-NPT (Nuclear Non-Proliferation Treaty) safeguards system;
- The adaptation of this system for the NPT, and implementation of the system up to 1991 (the discovery of Iraq's nuclear weapon program);
- The strengthening of safeguards post-1991 – Programme 93+2 and the integrated safeguards concept;
- The State-level concept.

From the pre-NPT period up to around 2000 (i.e. including the adaptation of the safeguards system for the NPT, and subsequently the initial development of strengthened safeguards), safeguards guidelines, norms and assumptions were shaped by the **Facility-level concept** of safeguards implementation. The major part of the safeguards culture of that time was represented by the Safeguards Criteria[3] and associated documents. These formed the

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1. J. Carlson and V. Bytchkov, "Reflections on Safeguards Culture", NTI/CENESS, May 2022.
2. Trevor Findlay in "Nuclear Safeguards Culture: The IAEA's Nuclear Safeguards Culture: 'Candy Concept' or Powerful Prism?", Belfer Center, 2014, https://www.belfercenter.org/publication/iaeas-nuclear-safeguards-culture-candy-concept-or-powerful-prism; Stephen Mladineo and Sarah Frazar, "The Importance of Safeguards Culture", 2013, http://dx.doi.org/10.1080/10736700.2013.853937, and Trevor Findlay, *op.cit*. and "Transforming IAEA Safeguards Culture", presented to the INMM/ESARDA Joint Annual Meeting, 23 August-1 September 2021.
3. The 1991-95 Safeguards Criteria contain condensed information necessary for practical implementation of IAEA safeguards. In particular, the Criteria encompass: verification activities to be performed in the field and evaluations to be performed in headquarters; types of destructive and non-destructive measurements to be applied depending on nuclear material category and the associated measurement devices; principles for

safeguards culture of the IAEA Secretariat, of the State nuclear regulator, and of the facility operator.

The situation started to change around 2000 with the introduction of the results of Programme 93+2 for the strengthening of safeguards, including the additional protocol and integrated safeguards. The major focus was developing the capability to detect undeclared nuclear material and activities in States with comprehensive safeguards agreements (i.e. non-nuclear-weapon States parties to the NPT). This necessitated going beyond the Facility-level concept, and led to the development of the **State-Level Concept** (SLC) and replacement of the Safeguards Criteria by **State-level approaches** (SLAs).

The introduction of the SLC and SLAs caused significant change in safeguards culture, mainly in the areas of safeguards operation design and implementation. In particular, the old philosophy of verification, which was essentially based on verification of the **correctness** (accuracy) of State accounting reports, has been extended to include additional measures to detect indications of undeclared nuclear material and activities, an objective that came to be referred to as verifying the **completeness** of State declarations (i.e. that **all** nuclear material required to be declared has actually been declared). The old, mostly **quantitative**, verification procedures have been complemented by new procedures for analysing the entire scope of safeguards-related information, which provide **qualitative** results. Accordingly, a new stage of safeguards culture is under formation.

In summary, the safeguards culture of an IAEA inspector in the pre-1991 period could be attributed to the inspector's knowledge of the Safeguards Criteria and the associated procedures. This was based on the Facility-level verification concept. The influences on the safeguards culture of an inspector in 2024 are much more complex: the inspector's culture is influenced by the Facility-level concept, the integrated safeguards concept and the State-level concept. The inspector should understand the new verification concepts and should be contributing to the development of the verification procedures in State-level approaches and annual implementation plans. The process of forming a contemporary safeguards culture is well underway. We consider it important to address the issues which influence the formation of contemporary safeguards culture, such as the evolution of the safeguards system and its conceptualization.

Conceptualisation is a prerequisite to the process of culture formation. A clear and consistent set of terms and notions is an important attribute of any culture. The same is true with regard to safeguards culture. This paper outlines the results of our efforts aimed at further clarification of safeguards terms and notions. This clarification comes from an elaboration of the evolution of the IAEA safeguards system.

A note on the organization of this paper

The conceptualisation process discussed in the paper underscores the characteristics of the IAEA safeguards system. These characteristics as we describe them might be perceived by some safeguards experts as unexpected and difficult to accept because they seem to contradict the old ideas and notions to which the safeguards community is accustomed. Being aware of this possibility, we decided to write a comprehensive paper which provides a solid

application of containment and surveillance measures; and principles for evaluation of the results of safeguards implementation. The Criteria had been developed taking into account the provisions of the three types of safeguards agreements, experience gained until 1990, and the contemporary level of science and technology.

basis for the outcomes (conclusions) of this conceptualisation process. But in order to discuss conceptualization we also need to analyse the historical evolution of the safeguards system. Being aware also of the fact that such a voluminous paper would be difficult to read and comprehend, we have chosen a structure for the paper comprising: (a) a main part, discussing the outcomes of our analysis; and (b) an Annex describing the major milestones in the evolution of the IAEA safeguards system. The logic of this structure is that a reader who is knowledgeable about the historical background can read our discussion without needing to read the Annex. A reader who is less familiar with this background, however, will benefit from reading the Annex first, to better understand the points made in the discussion. Unfortunately, this structure causes some repetitions in the text of the paper; we hope the readers will forgive us for this inconvenience.

The main part contains major outcomes of the process: the three implementation concepts inherent in the safeguards system, the mechanism of safeguards culture formation, and the evolution of safeguards terms and notions. The Annex contains five parts, each describing an important milestone in the evolution of the IAEA safeguards system: (1) Conceptual development of the IAEA safeguards system in the pre-NPT period; (2) Adaptation of the IAEA safeguards system for the NPT; (3) Further development of the safeguards system; (4) Introduction of the additional protocol and development of the integrated safeguards concept; and (5) Development of the State-level concept. The analysis performed in parts 2, 4, and 5 is essential for understanding the process of formation of the contemporary safeguards culture.

In order to facilitate the reading of the paper we have provided, where appropriate, cross-references between the main part of the paper and the Annex.

B. Safeguards conceptualisation

Safeguards implementation concepts

Speaking about conceptualisation[4], our understanding is that there have been three major implementation concepts over the whole history of safeguards implementation: the **Facility-level** concept, which has been used since the time of the design of the IAEA safeguards system; the **integrated safeguards** concept, which was developed around 2000; and the **State-level** concept, which was introduced in 2004.[5] All three concepts use a common verification hypothesis: a State's non-compliance with its obligations under its safeguards agreement will

4. By conceptualisation we mean the process of clarification, within the legal framework of the safeguards system, of the safeguards objectives, and of the underlying principles and assumptions used to develop verification measures necessary to meet the objectives.

5. As we will discuss further, the Facility-level concept was applied under all three types of safeguards agreement; the integrated safeguards concept can be applied only in States with a CSA and AP; and the State-level concept can be applied under all three types of safeguards agreement. The current official definition of the SLC, i.e. "the general notion of implementing safeguards in a manner that considers a State's nuclear and nuclear-related activities and capabilities as a whole, within the scope of the State's safeguards agreement", may lead to a perception that this concept is applicable only under the CSA. However, this is not true: the SLC is also applicable under the other two types of safeguards agreement; such an application simply requires the formulation of generic State-level technical objectives specific for each agreement type.

generate indications (anomalies[6]) in the physical and informational spheres, that Agency inspectors should be able to detect. If no such indications (anomalies) have been detected, the Agency may conclude that the State is in compliance with its obligations under its safeguards agreement. The State's obligations depend on the type of safeguards agreement concluded; the credibility of the Agency's conclusion depends on the effectiveness of the verification concepts and verification measures applied.

The key characteristics of the above-mentioned implementation concepts are: the formulation of safeguards and technical objectives; the development of verification activities based on safeguards approaches at State- and facility-levels; and the formulation of safeguards findings and conclusions. We consider these below with regard to safeguarding nuclear material.

(a) Facility-level concept

The following analysis is based on the content of Parts 1, 2 and 3 of the Annex to this paper.

The original safeguards system was facility oriented: documents INFCIRC/26 and INFCIRC/66 contain safeguards procedures specified per facility type. In other words, we may refer to the implementation concept of the original system as the Facility-level concept.

The original safeguards objective given in the IAEA Statute may be expressed, in simple terms, as: "to confirm that the items placed under safeguards are not used in such a way as to further any military purpose". This original formulation has undergone changes as the safeguards system has evolved. New formulations of safeguards objectives were given in paragraphs 2 and 28 of INFCIRC/153. As we discuss in Parts 2 and 3 of the Annex, the "safeguards objective" formulated in paragraph 28 of INFCIRC/153 related to the timely detection of diversion (undeclared withdrawal) of nuclear material from peaceful nuclear activities. This objective served, at the same time, as a technical objective of safeguards procedures, as stated in the Model Agreement (GOV/INF/276, Annex A). In safeguards implementation practice of the pre-1991 period the paragraph 28 formulation was referred to as the safeguards objective for implementing all three types of safeguards agreement ("item-specific" agreements, "comprehensive" agreements and "voluntary offer" agreements, discussed further in Part 3 of the Annex). Thus, under the Facility-level concept, there was no clear distinction between the safeguards objective (the purpose of implementing the safeguards agreement) and the technical objective (the objective of verification procedures). With our present understanding of the evolution of the safeguards system, we may conclude that the objective "to detect diversion from peaceful activities" represented a technical objective derived from the original safeguards objective "to confirm that the items placed under safeguards are not used in such a way as to further any military purpose".

From a technical point of view, the formulation of paragraph 28 is not sufficiently accurate.[7] In order to be implemented in practice, this technical objective was re-formulated as the

6. The IAEA's 2022 Safeguards Glossary gives the following definition of an anomaly "An unusual observable condition which might result from diversion of nuclear material or misuse of safeguarded items, or another safeguards implementation issue which frustrates or restricts the ability of the IAEA to draw a safeguards conclusion for a State pursuant to its relevant safeguards agreement".

7. A historical account of the paragraph 28 formulation is given in Part 2 of the Annex to this paper. Although originally intended to serve as a **technical** objective, this paragraph also sets out a broader **safeguards** objective because it manifests one of the purposes of the agreement, namely "… deterrence of such diversion by the risk of early detection". In order to conclude that the term "nuclear material" in this paragraph refers to

ability of the inspector to detect, in a timely manner, diversion of one **significant quantity** of safeguarded nuclear material from a facility or from a "location outside facilities" (LOF). This formulation served as the basis for developing the Safeguards Criteria. Verification activities to achieve this objective were established on the basis of safeguards approaches developed for each type of facility. Such an approach considers all plausible ways of undeclared withdrawal of at least one significant quantity of nuclear material from the facility. Concealment methods which the facility operator may use to hide the diversion (for example, "diversion into material unaccounted for (MUF)") were taken into account. The safeguards approaches developed for each type of safeguarded facility served as a basis for the inspection activities listed in the Safeguards Criteria document.

A safeguards conclusion was drawn at the facility level, for each material balance area established in the facility, in accordance with paragraph 30 of INFCIRC/153. The Safeguards Statement reported in the IAEA's Safeguards Implementation Report (SIR) contained the conclusion in respect to the entire amount of nuclear material placed under safeguards in accordance with all types of safeguards agreements: "nuclear material placed under safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for". This formulation of the safeguards conclusion was consistent with the "safeguards objective" as it was understood at that time (timely detection of diversion of safeguarded nuclear material from peaceful use). This objective was used for implementing all three types of safeguards agreement.

(b) Integrated safeguards concept

The following analysis is based on the content of Part 4 of the Annex.

This concept was developed in order to implement the additional protocol. The additional protocol was developed as part of strengthening the ability of the IAEA to detect undeclared nuclear activities and materials. Integrated safeguards represented the first formal step towards the State-level concept. The new technical objective: "to detect undeclared nuclear material and activities" was set out at the State level. This new, State-level technical objective was derived from that part of the safeguards objective formulated in paragraph 2 of INFCIRC/153, which related to ensuring the **completeness** of safeguards coverage. At the same time, the old technical objective at Facility-level (to detect diversion of declared nuclear material from a facility) was used to develop the so-called "Integrated Safeguards Criteria" to be applied in declared facilities. No clear distinction between safeguards and technical objectives was made at that time. The notions of Facility-level and State-level concepts also did not exist at that time. It was assumed that integrated safeguards represented a new form of safeguards while the previous form of safeguards was referred to as "traditional" safeguards.

Integrated safeguards were intended to be the optimum combination of all safeguards measures available to the Agency under comprehensive safeguards agreements (CSAs) and additional protocols which achieves the maximum effectiveness and efficiency within available resources. The rationale was that, if a particular "acquisition path" that a State might follow to obtain nuclear material for nuclear weapon use included both declared facilities and possible undeclared facilities, then verification activities that provided assurance of the

"nuclear material subject to safeguards" (that is, nuclear material subject to accountancy and routine inspection procedures), one needs to analyse paragraphs 28, 29, and 30 in combination.

absence of undeclared facilities could justify some reduction in safeguards activities at declared facilities on the same acquisition path. For example, if the Agency were able to establish sufficient assurance of the absence of an undeclared reprocessing plant, this would enable a reduction in safeguards effort to verify non-diversion of spent fuel.

Verification activities to achieve the State-level objective "to detect undeclared nuclear material and activities" were established on the basis of consideration of the State's nuclear program and its nuclear fuel cycle, taking into account what additional capabilities the State would require to produce weapon-usable material and the possible indicators for the existence of such capabilities. Verification activities to achieve the Facility-level objective were taken from the "Integrated Safeguards Criteria".

A safeguards conclusion was drawn at the State level for each State where the integrated safeguards concept was implemented. The original formulation of the safeguards conclusion reflected the underlying idea of the concept: implementing measures of the CSA and additional protocol to confirm the completeness of the State's declaration and implementing verification activities of the "Integrated Safeguards Criteria" to confirm that declared nuclear material remained in peaceful nuclear activities or was otherwise adequately accounted for.

(c) State-level concept

The following analysis is based on the content of Part 5 of the Annex.

The main underlying idea of this concept was that the new State-level technical objective "to detect undeclared nuclear material and activities", which was derived from the safeguards objective formulated in paragraph 2 of INFCIRC/153, was applicable to all CSA States, irrespective of whether the State had concluded an additional protocol. However, this objective cannot be fully achieved in a State with no additional protocol. Therefore, under this implementation concept, the status of the additional protocol in the State affects the formulation of the safeguards conclusion for this State. The so-called "broader conclusion", that all nuclear material in the State[8] remained in peaceful activities, can be drawn only for States with the additional protocol. Thus, an important distinction was made under this concept between a safeguards objective and a technical objective.

Another idea under this concept was to develop verification activities for the State as a whole based on the analysis of acquisition paths relevant for the State. As noted above, the notion of the acquisition path already existed in integrated safeguards, but the necessary implementation procedures had not been developed. To implement it, technical objectives should have been formulated at State level. Accordingly, three technical objectives, which were named "generic State-level objectives", were formulated under the State-level concept. Verification activities under each generic objective cover generalised components of any acquisition path, such as: the use of declared nuclear material; the use of declared facilities for undeclared purposes; and the use of undeclared nuclear material and activities.

The first of these three objectives, to detect diversion of declared nuclear material, actually represented the objective of the Safeguards Criteria expanded to cover all the declared facilities in the State. Under the SLC, in order to achieve this generic objective it is not always

8. For convenience this paper refers to nuclear material and nuclear activities "in the State", but it should be kept in mind that the obligations of a non-nuclear-weapon State under the NPT and the CSA apply to all nuclear material in all peaceful nuclear activities within the territory of the State, under its jurisdiction, or carried out under its control anywhere.

necessary to perform all the verification activities of the Criteria for all the declared facilities in the State. It is sufficient to perform only selected activities at selected facilities. The activities and facilities are selected based on the analysis of the acquisition paths.[9]

The second objective, to detect undeclared production or processing of nuclear material at declared facilities (in other words, to detect misuse of facilities) also originated from the Safeguards Criteria. Although the Criteria did not contain a precise formulation of such an objective, there were activities prescribed in the Criteria which corresponded to such an objective. These were the activities to detect "unrecorded production of direct-use material from nuclear material subject to safeguards" (the term "undeclared" did not exist at the time of the Criteria development). The activities and facilities to achieve this objective are selected based on the analysis of the relevant acquisition paths.

The third objective, to detect undeclared nuclear material and activities, was reflected in the Integrated Safeguards concept. However, while under Integrated Safeguards the verification activities to achieve this objective are established based on a formal guideline, under the State-level concept they are established based on acquisition path analysis.

In the process of acquisition path analysis the three generic state-level objectives are reflected in more detailed technical objectives. Safeguards measures and verification activities to achieve the technical objectives are listed in State-level approach and annual implementation plan documents prepared for a given State.

The safeguards conclusion is drawn at the State level and depends on the status of the additional protocol. For a State without an additional protocol, all going well the Agency is able to draw the conclusion that **declared** nuclear material remained in peaceful activities. For a State with the additional protocol, the Agency is able to draw the conclusion that **all** nuclear material in the State remained in peaceful activities.

Introduction of new implementation concepts in the post-1991 safeguards system – a historical overview

The post-1991 evolution of the safeguards system was influenced by the development and implementation of new safeguards implementation concepts, such as the integrated safeguards (IS) concept and the State-level concept (SLC). The importance of conceptualisation when implementing new ideas for enhancing safeguards effectiveness and efficiency was not fully recognised at the beginning of the post-1991 period.

Only around 2000, when the Agency began to implement the provisions of the additional protocol (INFCIRC/540), did the need for development of a new implementation concept become evident.

9. For example, verification activities required by the Safeguards Criteria for light water reactors include annual closure of the nuclear material balance and annual conclusion of non-diversion and non-misuse. The most efficient approach to closing the balance and drawing conclusions would be to do these when the reactor is refuelled. However, the time interval between consecutive refuelling of a reactor normally exceeds the 12-month interval required by the Criteria for timely performance of these verification activities. The Agency may take the approach of performing this activity only upon the reactor refuelling if it is satisfied with the effectiveness of its verification activities associated with the other steps of the plutonium acquisition path. Such other steps involve the State's capabilities to manufacture reactor fuel or irradiation targets, and to separate plutonium from irradiated fuel or targets.

While the IS concept was described in several internal IAEA documents (GOV/INF/2000/4, GOV/INF/2000/26, and GOV/INF/2002/8), there was no comprehensive description of the SLC, except for a very brief outline in the Safeguards Implementation Reports for 2004 and 2005. In 2012 several States objected to the implementation of the SLC on the ground that the concept had never been properly reviewed and approved by the Board of Governors. The IAEA General Conference requested the Director General to report to the Board on "the conceptualisation and development of the State-level concept for safeguards". In response, two such reports were issued: "The conceptualisation and development of safeguards implementation at the State level" (GOV/2013/38) and "Supplementary document to the report on the conceptualisation and development of safeguards implementation at the State level" (GOV/2014/41).

The first report contained an explanation of the limitations of the IS concept and of the reason for developing the SLC. It stated that in the State-level approaches developed under the IS concept the primary basis for verification activities at declared facilities remained the Safeguards Criteria. The Criteria were adjusted to take into account the "broader conclusion" for such States.[10] The report explained that the term "State-level concept" was introduced to describe safeguards implementation that is based on State-level approaches developed using safeguards objectives common to all States with CSAs. Further, the report elaborated on generic safeguards objectives and on the processes, within the Secretariat, supporting safeguards implementation.

However, some States continued to be concerned that State-level approaches might be discriminatory and might allow for the use of political, rather than technical, factors. There was also a lack of understanding of such notions as "generic State-level objectives" and "technical objectives" and their relation to the "safeguards objective" formulated in paragraph 28 of INFCIRC/153. In the second report, the so-called "supplementary document", such issues were addressed in greater detail. This report clarified that the purpose of Agency safeguards was to verify States' undertakings under their respective agreements with the Agency. It meant that the safeguards objective was to verify a State's compliance with its obligations under the applicable safeguards agreement. Further, the report elaborated on the State-level objectives and on the development of State-level approaches under the three existing types of safeguards agreements.

The 2014 General Conference adopted a resolution where it welcomed "the clarifications and additional information provided by the Director General in the Supplementary Document to the Report on the conceptualisation and development of safeguards Implementation at the State level (GOV/2014/41, and its Corrigenda) taken note of by the Board of Governors in September 2014, following the intensive consultation process undertaken over the past year".

Those events highlighted the importance of safeguards conceptualisation. Despite the significant effort and time invested so far in the development and implementation of the SLC, the conceptualisation process has not been yet completed. This means that the process of safeguards culture formation continues. The Agency's work on the explanation of safeguards terms in the Safeguards Glossary reflects this situation. The 2001 edition of the Glossary reflected the updating of safeguards terminology following the development of safeguards strengthening measures during the last decade of the last century. However, when the Agency

10. The original formulation of the "broader conclusion" included a statement of the absence of undeclared nuclear material and activities in the State.

started to implement these strengthening measures, it appeared that the conceptualisation of the new ideas required updating of the 2001 safeguards terminology. The 2014 "supplementary document" included a "Glossary of Key Terms" which was, in fact, a partial update of safeguards terminology established in the 2001 Safeguards Glossary. The new, 2022, edition of the Glossary contains the latest update of safeguards terminology. However, more attention is needed to appropriately update safeguards terminology. Current problems with regard to several important safeguards terms are discussed in section D of the present paper.

Current outcomes of the conceptualisation process

The following understanding of the purpose, evolution, and function of the contemporary IAEA safeguards system comes out of the conceptualisation process. In this conceptualisation process, a number of issues have been identified which need to be followed up. Most of these relate to safeguards terminology.

The safeguards system is essentially a verification system; the CSA is applied to verify the compliance of the non-nuclear-weapon States parties to the NPT with their obligations under the Treaty. Article III.1 of the NPT provides that a non-nuclear-weapon State accepts safeguards "… for the exclusive purpose of verification of the fulfilment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices."[11] The safeguards objective is formulated in paragraph 2 of INFCIRC/153, while the technical objective is formulated in paragraph 28. The formulation of these objectives was influenced by the adaptation, by the drafters of INFCIRC/153, of the original safeguards system described in INFCIRC/26 and INFCIRC/66. The original system contained safeguards procedures to detect diversion of nuclear material from a principal facility or from a location outside principal facilities, and to detect the misuse of other items placed under safeguards. This was the verification tool available at that time.[12] When adapting this tool for the purpose of INFCIRC/153, the emphasis was made on the principle of detecting diversion of nuclear material. To apply this principle under the CSA, all nuclear material subject to safeguards in the State was to be "placed under safeguards" in facilities or in locations outside facilities where nuclear material was customarily used. Nuclear material which was "placed under safeguards" was subjected to the verification procedures established in the original safeguards system and further developed in INFCIRC/153. The term "application of safeguards" was used in the sense of "application of safeguards procedures" specified in the agreement.

The safeguards objective given in paragraph 2 contains, in fact, two components: first, to ensure that safeguards are applied to all nuclear material in all peaceful nuclear activities in the State, and second, to verify that such nuclear material is not diverted to nuclear weapons. The technical objective formulated in paragraph 28 relates to the second component of the safeguards objective, while no technical objective was formulated which would relate to the first component of the safeguards objective. Such technical objective was formulated for the first time in the framework of the integrated safeguards concept. The two-component

11. For convenience, in most places this paper refers only to "nuclear weapons", but the NPT and safeguards obligations apply also to "other nuclear explosive devices".
12. The term "principal facility" used in INFCIRC/66 was replaced by the term "facility" in INFCIRC/153.

structure of the CSA safeguards objective has been reflected in the logic of the IS concept and in the initial structure of the safeguards conclusion drawn under this concept.

The SLC was developed with the understanding that "diversion to nuclear weapons" means a realisation by the State of an "acquisition path(s)" to obtain "weapon-usable material". Three generic State-level technical objectives have been formulated, which have been further reflected in "technical objectives" of verification activities. Verification activities under each generic objective cover generalised components of an acquisition path, such as the use of declared nuclear material, the use of declared facilities for undeclared purposes, and the use of undeclared nuclear material and activities.

The above considerations can be illustrated by safeguards implementation in States with a Small Quantity Protocol (SQP). For a State with an SQP based on the model set out in GOV/INF/276, Annex B issued in 1974, implementation of safeguards procedures prescribed in Part II of the CSA is held in abeyance as long as the quantity of nuclear material subject to safeguards in the State does not exceed the specified limit and there is no nuclear material in a facility in the State. In 2005, the Board of Governors approved the modified text of an SQP. The modified text makes an SQP unavailable to a State with an existing or planned facility.

As we noted earlier, implementing safeguards in the context of INFCIRC/153 means implementing safeguards procedures specified in Part II of the document, the key procedures being those of nuclear material accountancy and routine inspections. Under the Facility-level concept, this leads to the situation that if there is no declared nuclear material in the State, IAEA safeguards are not implemented in the State: no IAEA inspections are performed and no safeguards conclusions are drawn. This was the case of the pre-1991 safeguards system, where the Agency did not perform verification activities and did not draw safeguards conclusions for the SQP States. Implementation of safeguards strengthening measures, including the additional protocol and the modified SQP, has changed the situation. However, the most appropriate treatment of this case, consistent with the State's obligation under the NPT and the CSA, became possible with the implementation of the State-level concept. Under the SLC, appropriate safeguards measures are applied in a State to verify its compliance with its safeguards agreement irrespective of whether there is nuclear material placed under safeguards in the State. The safeguards objective for an SQP State is to confirm the completeness of its declaration that it has only a small amount or no nuclear material subject to safeguards, and the technical objective is to detect any undeclared nuclear material and activities.

However, the situation with the formulation of safeguards conclusions for SQP States is still not fully satisfactory. In particular, the standard conclusion that "declared nuclear material remained in peaceful activities" is not sufficiently accurate in the case where there is no declared nuclear material in the State. This problem is further discussed below.

These conceptual developments reveal the difficulties we have with the safeguards terminology of INFCIRC/153. These difficulties are discussed in section D on the evolution of safeguards terms and notions. These difficulties originated from the process of adaptation of the original safeguards system, which was described in INFCIRC/26 and INFCIRC/66, for the purpose of the NPT. The idea to formulate the CSA safeguards objective in terms of verifying non-diversion of nuclear material from peaceful nuclear activities was used following the verification concept of the original system. Consequently, "safeguards" under the CSA apply to all nuclear material in all peaceful activities in the State, but do not apply routinely to

nuclear material declared to be in a non-proscribed military activity. This situation creates difficulties with the term "diversion from peaceful activities to nuclear weapons" since possible paths to acquire weapon-usable material may involve material which is not in a declared peaceful activity or material which is in a declared non-proscribed military activity.

For the sake of discussion of possible ways of resolving this situation, we may consider a hypothetical case of re-formulating the safeguards objective under the CSA. Following the wording of the IAEA Statute and that of the NPT, the CSA safeguards objective could hypothetically be formulated as: "to verify that nuclear material in the State is not used for manufacturing nuclear weapons". To facilitate the attainment of this objective, the State's obligations under the agreement should include declaration of all its nuclear activities both in civil and military areas. Consequently, technical objectives and safeguards procedures should be formulated separately for civil and military areas.[13] The technical objectives should include detection of undeclared nuclear activities. The additional protocol should be universally implemented.

The safeguards conclusion should be formulated in terms of confirmation that the State is in compliance with its safeguards agreement. Where the Agency is unable to reach such a conclusion, the reason for this should be explained.

C. Formation of safeguards culture

We see safeguards culture as the manifestation of the political, ethical, legal, and technical achievements of human society in ensuring the peaceful use of nuclear energy. In our effort to understand the process of safeguards culture formation, we identify three basic levels of the IAEA safeguards system: the **foundation** level (established by the conclusion of international treaties and safeguards agreements); the level of **operation design** (development of verification concepts and safeguards approaches); and the **implementation** level (implementation of safeguards approaches and associated safeguards activities in the field and at headquarters, and the drawing of safeguards conclusions).

Associated with these basic levels are the following principal components of the system: the State's undertakings under the safeguards agreement; the safeguards and technical objectives and the means to attain them; and safeguards findings and safeguards conclusions. We use these three principal components of the IAEA safeguards system to analyse its conceptual evolution and formation of safeguards culture.[14]

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13. Safeguards procedures in the military area are those which are meant under the term "arrangement" in paragraph 14 of INFCIRC/153 and under the term "special procedures" in Article 13 of the safeguards agreement between Argentina, Brazil, ABACC, and the IAEA.

14. The theory of organisational culture recognises three major attributes of organisational culture:

(a) underlying assumptions – beliefs, perceptions, feelings, habits;
(b) espoused values – strategies, goals, philosophies;
(c) artefacts - visible organisational structures and processes.

There are differing views on how to apply this framework to safeguards culture. We have looked at this broadly, in terms of the factors that determine the development and evolution of the safeguards system. Accordingly, in our view:

(a) The **underlying assumption** is the principle of the peaceful use of nuclear energy (or to be more precise, that nuclear material should not be used to produce nuclear weapons). This principle is reflected in the basic undertaking under a CSA;

The stages of the evolution of the IAEA safeguards system which we consider here are: the initial development of the system; the adaptation of the system for the NPT and pre-1991 safeguards; the implementation of the integrated safeguards concept; and the implementation of the State-level concept.

The initial development of the safeguards system

(a) The State's undertakings under its safeguards agreement

The principle of the peaceful use of nuclear energy is a cornerstone of the IAEA Statute. Article II of the Statute provides that the Agency should ensure that assistance provided by it "is not used in such a way as to further any military purpose". The formula "not to further any military purpose" with regard to items placed under safeguards was used in the original design of the safeguards system, to formulate the State's undertakings under the safeguards agreement. Although politically this formula sounded very attractive, technically it required a clarification between "military" and "peaceful" purposes. Later, this problem was made more pronounced by India's so-called "peaceful nuclear explosion".

(b) Safeguards and technical objectives

Although these notions were not used in the original design of the system, we may use them for the purpose of this analysis with the understanding that "safeguards objective" relates to the purpose of a safeguards agreement and "technical objective" relates to the objective of safeguards procedures applied to fulfill the "safeguards objective". The formulation of "safeguards objective" was based on the IAEA Statute: "to confirm that the items placed under safeguards are not used in such a way as to further any military purpose". There were two safeguards implementation concepts available to fulfill this objective: to detect a misuse of a safeguarded item; or to detect a diversion of a safeguarded item from peaceful nuclear activities.

Thus, we can formulate two "technical objectives" with regard to these implementation concepts: "to detect a misuse of a safeguarded item" and "to detect a diversion of a safeguarded item from peaceful nuclear activities". To implement the first objective, we must identify all possible military applications of the item including the indicators of each military application, while to implement the second objective, we should simply monitor the presence of the item in the declared peaceful activity at a nuclear facility. Undeclared withdrawal of the item from peaceful activities at a facility would mean possible diversion of the item from peaceful activity. The technical objective "to detect diversion of nuclear material from peaceful activities" became a fundamental objective of safeguards implementation. The safeguards measure to attain this objective, nuclear material accounting, became a fundamental safeguards measure.

(c) Safeguards findings and conclusions

(b) Regarding **espoused values**, a detailed analysis would consider a range of factors such as the attitudes underlying the way staff approach their tasks, but for the purpose of this paper we take **espoused values** to be primarily those reflected in the safeguards objectives and the technical objectives;

(c) Regarding **artefacts**, a detailed analysis would consider a range of factors including legal instruments, planning and evaluation processes, implementation procedures, etc., but for this paper we focus on safeguards findings and conclusions, as these reflect the culmination of these various aspects.

By “safeguards findings” we mean the results of verification activities, including the detected indications (anomalies) which could be associated with non-compliance of the State with its safeguards agreement. In the case where no such indications are detected, the Agency draws the conclusion of compliance. The Agency started to formulate such conclusions with the issuance of the annual Safeguards Implementation Report (SIR). The first such conclusion, issued for 1976, was related to non-diversion: “From the analysis of the Agency's safeguards activities during 1976, the Secretariat has concluded that in none of the 41 States in which inspections were carried out was there any diversion of a significant quantity of safeguarded nuclear material…”.

The adaptation of the system for the NPT and pre-1991 safeguards

(a) The State’s undertakings under its safeguards agreement

In the NPT, the emphasis is placed on the non-proliferation of nuclear weapons, while the use of nuclear material in a “non-proscribed military activity” (that is, a non-explosive use) is permitted. This is reflected in paragraph 14 of INFCIRC/153. No list of such “non-proscribed military activities” is available; a common understanding, discussed during the NPT negotiations, is that it includes nuclear propulsion of military vessels, e.g. nuclear submarines. The use of nuclear energy by non-nuclear-weapon States for “peaceful nuclear explosions” is proscribed. Still, there can be difficulties with distinguishing between “military” and “peaceful” purposes of nuclear activities. The use of nuclear energy for production of heat and electricity in nuclear reactors has a clearly “peaceful” purpose. The other facilities of the nuclear fuel cycle used to produce fuel for the reactors can be also considered to have a “peaceful” purpose. However, in reality any nuclear fuel cycle facility could also be used for a **proscribed** military purpose if the nuclear material it produces or processes is intended for manufacturing nuclear weapons. Therefore, the key factor in ensuring the peaceful use of nuclear energy is the State’s undertaking not to use nuclear material for nuclear weapons. Under the NPT each non-nuclear-weapon State party undertakes not to manufacture or otherwise acquire nuclear weapons.

(b) Safeguards and technical objectives

The safeguards documents of that time did not make a sufficiently clear distinction between safeguards and technical objectives. However, based on a comprehensive analysis of INFCIRC/153 as well as implementation practice, we conclude that the safeguards objective is formulated in paragraph 2 of INFCIRC/153 while the technical objective is formulated in paragraph 28. Indeed, the corresponding paragraph of the Model Agreement (paragraph 28 of GOV/INF/276, Annex A) is formulated as the objective of **safeguards procedures**, i.e. the technical objective. The safeguards objective of paragraph 2 has two components: to confirm the completeness of safeguards coverage, and to confirm the absence of diversion from peaceful activities. The technical objective addresses only the second component of the safeguards objective. The verification procedures to attain the technical objective are included in Part II of INFCIRC/153.

Based on the technical objective of paragraph 28, an inspection goal was formulated: “to detect, in a timely manner, diversion of one significant quantity of safeguarded nuclear material from a facility”. The inspection goal has two components: the **quantity** component, associated with detection of **protracted** diversion, and the **timeliness** component, associated

with the detection of **abrupt** diversion. Verification activities to attain the inspection goal are listed in the Safeguards Criteria document. The Safeguards Criteria apply to the implementation of safeguards under each of the three types of safeguards agreements.[15] The essence of the verification activities included in the Criteria is the verification of the **correctness** of the State's declarations concerning inventories and flows of nuclear material and the maintenance of this knowledge through applying containment and surveillance measures. The Safeguards Criteria and the associated documents both reflected and influenced the safeguards culture of that time, in particular, the safeguards culture of the IAEA Secretariat and of the State regulator.

(c) Safeguards findings and conclusions

A conclusion of compliance has two parts: the preamble part that no indications of non-compliance have been found, and the concluding part that the State is in compliance with its obligations under the applicable agreement. However, as the Facility-level implementation concept was used in the pre-1991 safeguards system, safeguards conclusions were drawn at facility level, without referring to the State's obligations under the agreement. Safeguards conclusions reported in the SIRs during the pre-1991 period reflected the above structure. The last SIR issued during the pre-1991 period, the SIR for 1990, contained the following Safeguards Statement:

> In carrying out the safeguards obligations of the Agency in 1990, the Secretariat, as in previous years, did not detect any event which would indicate the diversion of a significant amount of safeguarded nuclear material - or the misuse of facilities, equipment or non-nuclear material subject to safeguards - for the manufacture of any nuclear weapon, or for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown. It is considered reasonable to conclude that the nuclear material under Agency safeguards in 1990 remained in peaceful nuclear activities or was otherwise adequately accounted for. This statement is based on all the information available to the Agency, including information derived from safeguards activities conducted in the field and at Headquarters and information provided in reports submitted by States.

This statement contains a conclusion covering all nuclear material and specified items placed under safeguards in accordance with all types of safeguards agreements. The last sentence refers to evaluation of all the information available to the Agency. Later, in the post-1991 safeguards system, this measure was further developed and became a measure of high importance. Under the SLC, it is referred to as "State evaluation".

Implementation of the integrated safeguards concept

(a) The State's undertakings under its safeguards agreement

The integrated safeguards concept has been implemented in those States with both a comprehensive safeguards agreement and an additional protocol, for which the Agency has drawn the broader conclusion that all nuclear material in the State is in peaceful use. These States have an obligation under the CSA not to divert nuclear material from peaceful use to manufacture of nuclear weapons. Indirectly, this formulation of the State's obligation is based

15. "Item-specific" agreements, "comprehensive" agreements and "voluntary-offer" agreements.

on the assumption that all nuclear material in the State, with the exception of the material referred to in paragraph 14 of INFCIRC/153 (if any), has been in peaceful nuclear use.

(b) Safeguards and technical objectives

The integrated safeguards concept represented the first formal step from the Facility-level concept towards the State-level concept. Still, no clear distinction was made under integrated safeguards between safeguards and technical objectives. A new State-level technical objective "to detect undeclared nuclear material and activities" was introduced in order to verify the first part of the safeguards objective of paragraph 2 of INFCIRC/153, related to confirming the **completeness** of safeguards coverage. To verify the second part of the safeguards objective, related to confirming non-diversion, the Facility-level technical objective used in the Safeguards Criteria was adopted. For this purpose, the "Integrated Safeguards Criteria" were developed.

In the process of developing and implementing the integrated safeguards concept, emphasis was placed on the purpose of this concept. Apart from the main idea to strengthen the effectiveness and enhance the efficiency of safeguards, the goal was to achieve an optimised balance between the measures of the safeguards agreement and of the additional protocol. The promotion of this goal facilitated the acceptance of the additional protocol and the acceptance of the integrated safeguards concept.

(c) Safeguards findings and conclusions

The process of inclusion in the Safeguards Statement of safeguards findings for individual States and, since 1999, of the results of integrated safeguards implementation, resulted, in the SIR for 2003 and the SIRs that followed, in a new structure for the Safeguards Statement. In this new structure, safeguards conclusions were drawn at the State level and with regard to compliance of each individual State with its obligation under the type of safeguards agreement concluded with the IAEA. This reporting reflected the trend of the evolution of the IAEA safeguards system – from the Facility-level to the State-level concept.

The Safeguards Statement for 2000 contained the following conclusion on the results of integrated safeguards Implementation in seven States:

> … for seven States, each of which has a comprehensive safeguards agreement and an additional protocol in force or being provisionally applied, the Agency concluded that all nuclear material in those States had been placed under safeguards and remained in peaceful nuclear activities or was otherwise adequately accounted for.

The latter conclusion was supported by the confirmation that

> … the Agency found no indication of diversion of nuclear material placed under safeguards or of the presence of undeclared nuclear material or activities in these States.

This formulation of conclusion reflected the logic of the integrated safeguards concept.

Implementation of the State-level concept

(a) The State's undertakings under its safeguards agreement

The State-level concept was developed with the understanding that the purpose of the IAEA safeguards system was to verify compliance of a State with its obligations under the safeguards agreement concluded with the Agency. The State's obligations concerning the peaceful use of nuclear energy are formulated differently, depending on the type of safeguards agreement. The SLC can be applied in any State irrespective of the type of safeguards agreement concluded. The important condition of such application is the formulation of State-level generic technical objectives with regard to each type of safeguards agreement.

(b) Safeguards and technical objectives

Three levels of objectives are considered in the SLC. The safeguards objective is formulated in each type of safeguards agreement. The State-level generic technical objectives are formulated depending on the safeguards objective. Therefore, the generic technical objectives are common for all States with the same type of safeguards agreement. The generic objectives are further divided into technical objectives. Under the CSA, technical objectives are established based on the analysis of acquisition paths relevant for a State. Verification activities under each generic objective cover generalised components of any acquisition path, such as: the use of declared nuclear material; the use of declared facilities for undeclared purposes; and the use of undeclared nuclear material and activities. Verification measures and activities to be applied in a State are listed in the corresponding State-level approach and annual implementation plan documents.

In some official IAEA documents, the SLC is referred to as "the general notion of implementing safeguards in a manner that considers a State's nuclear and nuclear-related activities and capabilities as a whole, within the scope of the State's safeguards agreement" (GOV/2014/41).

(c) Safeguards findings and conclusions

Safeguards conclusions of compliance are formulated in respect of each type of safeguards agreement in accordance with the State's obligations under the agreement. Under the CSA, the safeguards conclusion depends on the status of the additional protocol. For a State without an additional protocol, the Agency is able to draw the conclusion that declared nuclear material remained in peaceful activities. For a State with the additional protocol, the Agency is able to draw the broader conclusion that all nuclear material in the State remained in peaceful activities.

Since 2005, the broader conclusion has been formulated as follows:

> … the Secretariat found no indication of diversion of declared nuclear material and no indication of undeclared nuclear material and activities. On this basis, the Secretariat concluded that … all nuclear material remained in peaceful activities.

In the Safeguards Statement for 2022, this formulation has been modified with regard to the preamble part of the conclusion:

> … the Secretariat found no indication of the diversion of declared nuclear material from peaceful nuclear activities, no indication of undeclared production or processing

of nuclear material at declared facilities and LOFs, and no indication of undeclared nuclear material or activities. On this basis, the Secretariat concluded that, for these States, all nuclear material remained in peaceful activities.

This formulation more accurately reflects the role of State-level generic technical objectives in implementing the CSA.

To conclude, we may say that the above analysis illustrates the role of the evolution of the IAEA safeguards system and of its conceptualisation in the formation of safeguards culture. In this analysis we did not consider technical aspects of safeguards evolution. This subject deserves separate consideration. We decided to concentrate on what we considered the most important factors of safeguards culture formation – the conceptual evolution of safeguards. The most significant changes in the safeguards system have occurred in the post-1991 period. These changes affected, to a great extent, the work of the IAEA Secretariat and of the States' nuclear regulators, and of the other stakeholders. They have changed the verification philosophy and the verification activities of the IAEA inspectors. At the same time, they greatly enhanced the effectiveness and efficiency of the IAEA safeguards. These developments are continuing and require further effort for safeguards conceptualisation and for clarification of contemporary safeguards terminology.

D. Evolution of major safeguards terms and notions

As we have discussed in the previous sections, the evolution of the IAEA safeguards system inevitably brought about the evolution of safeguards terms and notions. As a result of this, some safeguards terms have more than one meaning; a concrete meaning depends on the type of safeguards agreement implemented and on the implementation concept used. In this section we discuss the most important terms and notions used in the comprehensive safeguards agreement (CSA). These include the following:

- Safeguards; application or implementation of safeguards;
- Nuclear material required to be safeguarded; nuclear material subject to safeguards;
- Nuclear material placed under safeguards; safeguarded facilities;
- Undeclared nuclear material and activities;
- Diversion;
- Non-compliance.

What does the term "safeguards" mean in the CSA context?

While the term "safeguards" is the most frequently used term in the field of IAEA safeguards implementation, the term is not clearly defined. Non-experts associate it with safety or security measures and intuitively believe that they understand what the term means. However, the situation is not that simple.

We understand "implementing safeguards" to refer to the implementation of a safeguards agreement between the IAEA and a State(s). In the context of the CSA, the original notions of "safeguards" and "application of safeguards" mean the application of safeguards procedures, specified in the agreement, to nuclear material which is "subject to safeguards". "Nuclear material" means "source material" or "special fissionable material", as defined in Article XX of

the IAEA Statute. Paragraph 2 of INFCIRC/153 requires that "safeguards" (in our understanding: safeguards procedures) apply, in accordance with the terms of the agreement, to all source or special fissionable material in all peaceful nuclear activities in the State. At the same time, the agreement uses such terms as "nuclear material required to be safeguarded" and "nuclear material subject to safeguards". There is no precise definition of these two terms in the agreement. The INFCIRC/153 negotiating record shows that the negotiators considered these two terms had the same meaning. They saw an essential aspect of these terms as emphasising the obligation to accept safeguards on all nuclear material in all peaceful uses **regardless of whether reported by the State**.[16]

Under the CSA, "safeguards" (that is, the safeguards procedures specified in the agreement) need not apply to nuclear material in a non-proscribed military activity, provided the IAEA and the State agree on an appropriate arrangement to apply to the material concerned while it is in such use. This material is not "subject to safeguards" under the CSA while it is in such use. At the same time, the use of such material for manufacturing nuclear weapons would constitute a violation of the NPT and non-compliance with the agreement. As we have concluded in our section on adaptation of the original IAEA safeguards system for the NPT (Part 2 of the Annex), such situation has arisen because of the mechanistic transfer of the safeguards principles and procedures of INFCIRC/66, which were developed for application to the well-defined scope of items placed under safeguards, to INFCIRC/153 for verification of nuclear material, which flows through nuclear fuel cycle facilities, and which is required to be safeguarded "while it is being produced, processed or used at any principal nuclear facility or is outside any such facility" (NPT Article III).

Paragraph 34 distinguishes between nuclear material which has reached the stage of the nuclear fuel cycle where it is suitable for fuel fabrication or isotopic enrichment, for example, uranium dioxide or uranium hexafluoride, and nuclear material which is before this stage, for example, "yellow cake". Nuclear material after this stage is subject to the entire scope of safeguards procedures, the most important of which are procedures of nuclear material accountancy and routine inspection.[17] Nuclear material before this stage is subject to only a few safeguards procedures, such as provision of information to the Agency on export or import of such material and, since the introduction of the additional protocol, relevant provisions in that document.

In the pre-1991 safeguards system, the application of "safeguards" in the context of the CSA meant the application of the entire scope of safeguards procedures specified in the agreement to nuclear material which has been declared by the State and "placed under safeguards" in accordance with the subsidiary arrangements concluded between the Agency and the State. The procedures specified under the CSA cease to apply when nuclear material has been exempted from "safeguards" or when "safeguards" on it have been terminated.[18] However,

16. See the negotiation history prepared by International Energy Associates Limited (IEAL) for the US Arms Control and Disarmament Agency in 1984 (document IAEL-275), https://nationalsecuritytraining.pnnl.gov/fois/doclib/IAEA_153_Negotiating_History.pdf, page 35.
17. The agreement provides for special, ad hoc, and routine inspections. Special inspections are used to resolve special situations, ad hoc inspections are used to verify the initial report on nuclear material "subject to safeguards", and routine inspections apply after the initial report has been verified and nuclear material placed under safeguards in declared facilities and LOFs (and Facility Attachments have been agreed).
18. In States with an additional protocol such material is subject to certain procedures of the AP.

the State's obligation not to use this material for manufacturing nuclear weapons continues to apply.

In the post-1991 safeguards system, characterised by the introduction of safeguards strengthening measures, the notion "safeguards" has been extended. Application of the new procedures, additional to those specified in Part II of the CSA, is also regarded as implementation of safeguards. Thus, the contemporary notion "safeguards" is broader than the one used in INFCIRC/153. The magnitude of the problem associated with the ambiguity of the term "safeguards" could be reduced if we understand the meaning of the term "safeguards" used in the CSA as primarily the application of nuclear material accounting and routine inspection procedures, complemented by containment and surveillance. Consequently, the terms "exemption from safeguards" and "termination of safeguards" used in INFCIRC/153 would mean "exemption from accounting and routine inspection procedures" and "termination of accounting and routine inspection procedures". But relevant procedures of the additional protocol are applicable to such material, which means that "safeguards" in a broader sense are still applied to this material.

The understanding that the original meaning of the term "safeguards" in the CSA is the application of the procedures specified in Part II of the agreement explains the controversy of the text of paragraph 28 in INFCIRC/153 as compared with the relevant text of the Model Agreement (GOV/INF/276). In the former document, the objective described in that paragraph is referred to as the "safeguards" objective, while in the latter document it is referred to as the objective of safeguards procedures specified in Part II. The above understanding, that "safeguards" in the CSA context means application of the CSA Part II procedures, resolves this problem.

In conclusion, we may state that the meaning of the term "safeguards" depends on the context under which it is used. Based on a comprehensive analysis of INFCIRC/153, we conclude that, in that document, the term "safeguards" means the application of the procedures specified in Part II of the document. In the post-1991 safeguards system, the meaning of the term "safeguards" has been extended to include new procedures of strengthened safeguards, such as the procedures of the additional protocol.

Nuclear material "subject to safeguards"

As discussed above, an essential aspect of the term "nuclear material subject to safeguards" is to emphasise the obligation, under a CSA, to accept safeguards on all nuclear material in all peaceful uses regardless of whether reported by the State.[19]

Under the "item-specific" type of safeguards agreement, safeguards are applied to concrete items which are well established in the agreement. Under the CSA, where safeguards are applied to nuclear material which flows through nuclear fuel cycle facilities, it is necessary to identify the stage of the fuel cycle where certain safeguards procedures start to apply. Consequently, in addition to the old terms, such as "nuclear material subject to safeguards" and "safeguarded nuclear material", the authors of INFCIRC/153 introduced a new term: the "starting point of safeguards". At this point, the flow of nuclear material subject to only export/import notifications changes to the flow of nuclear material subject to the full range

19. As noted earlier, obligations under a CSA apply to all nuclear material in all peaceful nuclear activities within the territory of the State, under its jurisdiction, or carried out under its control anywhere.

of safeguards procedures. Uranium ore concentrate, such as “yellow cake”, becomes nuclear material which can be used for isotopic enrichment or reactor fuel production, such as uranium hexafluoride or uranium dioxide. Such a transition takes place at conversion facilities.

Nuclear material which is subject to the entire scope of safeguards procedures is referred to in INFCIRC/153 as “nuclear material subject to safeguards” (paragraphs 7, 8, 35, 37, 41, 54, 59, 61, 62, 71, 72, 74, and 81). This material is also referred to as “nuclear material required to be safeguarded”. As we discuss below, this material is “placed under safeguards” through the subsidiary arrangements concluded between the IAEA and the State. These arrangements allow Agency inspectors to draw, based on their verification activities, the technical conclusion about the correctness of the State’s declarations regarding each material balance area established in the subsidiary arrangements. As required by paragraphs 30 and 90(b) of INFCIRC/153, these conclusions relate to nuclear material balances and values of nuclear material unaccounted for.

As regards uranium ore concentrate, no material balance areas are established, and no technical conclusions are drawn. However, this material is subject to procedures that support safeguards implementation (namely, export/import notifications in accordance with paragraph 34(a) and (b), and provisions of the additional protocol), and it is subject to the NPT obligation, repeated in the CSA, to accept safeguards on all source or special fissionable material. So uranium ore concentrate can be regarded as being subject to safeguards in the specific sense discussed here.

In conclusion, we may state that in the term “subject to safeguards” which is used in the context of the CSA, the original meaning of the notion “safeguards” was: application of the entire set of procedures specified in Part II of the agreement. We may clarify that “subject to safeguards” in the CSA context means “subject to accountancy and routine inspection procedures, supplemented by containment/surveillance measures”. The meaning of the term “safeguards” has been extended with the introduction of safeguards strengthening measures including the additional protocol.

Nuclear material placed under safeguards

The term “placed under safeguards” does not appear in INFCIRC/153; it is rather used when discussing practical implementation of a safeguards agreement. For example, the Safeguards Statement for 1991 contained reference to the failure by Iraq “to declare certain … nuclear activities and place all relevant nuclear material under safeguards”.[20]

According to paragraph 8 of INFCIRC/153, the State shall provide the IAEA “with information concerning **nuclear material** subject to safeguards under the Agreement and the features of **facilities** relevant to safeguarding such material”. The State submits this information to the Agency in the form of the initial report “on all **nuclear material** which is to be subject to safeguards” (paragraph 61 of INFCIRC/153), and in the form of design information of facilities and information about locations outside facilities where nuclear material is customarily used. Thus, the State’s nuclear activities to be declared to the IAEA involve the nuclear material which is “subject to safeguards” and the facilities and locations outside facilities where such material is produced, processed, or stored.

20. IAEA Safeguards Implementation Report for 1991.

To specify how the procedures laid down in the agreement are to be applied in practice, the Agency and the State conclude subsidiary arrangements to the agreement. The arrangements include communication channels between the IAEA and the State, reporting specifications, and facility attachments. The facility attachments are developed based on the design information as provided by the State and verified by IAEA inspectors. Material balance areas, established within each facility, key measurement points, where the inspectors can measure the inventories and flows of nuclear material "subject to safeguards", and strategic points where the inspectors can apply containment and surveillance measures constitute essential parts of a facility attachment.

Development and implementation of a facility attachment concludes the process of placing nuclear material under "safeguards" at a declared facility. This process is just an initial phase of "safeguards" implementation. The actual amount of safeguarded nuclear material at the facility can be calculated at any given time based on the initial accounting report and all the accounting reports that followed. Through the verification of nuclear material flows and inventories at declared facilities IAEA inspectors verify, in fact, the correctness of the State's accounting reports.

We note that a State also provides to the IAEA information on material containing nuclear material which has not reached the stage of the nuclear fuel cycle defined in paragraph 34(c). Such information is provided in accordance with the provisions of the safeguards agreement and additional protocol. However, no facilities, material balance areas and key measurement points are established for such material; and, therefore, no safeguards conclusion required by paragraphs 30 and 90(b) can be drawn for such material. Under the SLC, such information is used in safeguards evaluation and verification activities aimed at detecting the presence of undeclared nuclear material and activities.

The Safeguards Implementation Report contains statistics on the amount of safeguarded nuclear material and the number of safeguarded facilities as of the end of each calendar year. Under comprehensive safeguards agreements, "safeguarded facilities" were initially defined as "facilities containing safeguarded nuclear material". Statistics on "facilities containing safeguarded nuclear material" were important to analyse inspection effort spent during the year and to forecast the amount of effort, in terms of person-days of inspection, required in future.

In the post 2001 safeguards system, it was clarified that under the CSA inspectors will also perform technical visits to verify design information before the new facility received nuclear material, and during the process of facility decommissioning, after nuclear material has been shipped out from the facility. Accordingly, the term "facilities containing safeguarded nuclear material" was replaced by "facilities under safeguards". This resulted in the increase in statistics on facilities under safeguards reported in the SIR.

In conclusion, the term "facilities containing safeguarded nuclear material" has been replaced in the post-2001 safeguards system by the term "safeguarded facilities" or "declared facilities".

Undeclared nuclear material and facilities

The term "undeclared nuclear material and activities" appeared following the discovery in Iraq of nuclear material and facilities which were not placed under IAEA safeguards although they

were required to be safeguarded in accordance with the safeguards agreement. A precursor of this term was the term “unsafeguarded nuclear facilities”.

The verification concept used by the IAEA before 1991 included the assumption of the possible existence in a State of unsafeguarded nuclear facilities where nuclear material diverted from a safeguarded facility could be further processed to produce weapon-usable material. The concept, however, did not include a verification objective to detect such unsafeguarded nuclear facilities and activities. Introduction of such an objective required general support from IAEA member States and also required a new, State-level verification concept. Such international support was given following the events of 1991. Under the new State-level concept, the Agency now confirms the completeness of the State’s declaration through applying verification procedures aimed at detection of undeclared nuclear material and activities.

The term “declaration” is presently used in respect of provision by the State of information required by the safeguards agreement and additional protocol. We should, however, separate two different aspects of the use of this term.

The first aspect is associated with the provision of accounting reports on nuclear material which is “subject to safeguards” and of design information of the facilities where such material is produced, processed, or stored. The Agency verifies the correctness of this information and uses its verification results to draw safeguards conclusion of “non-diversion of declared nuclear material”. This verification activity relates to verification of the correctness of the State’s declaration. The relevant safeguards conclusion can be formulated as follows: “the declared nuclear material has been adequately accounted for” or “the declared nuclear material remained in peaceful nuclear activities or was otherwise adequately accounted for”. Here, the term “declared” is associated with the original meaning of nuclear material “subject to safeguards” in the context of the CSA.

The second aspect of the use of the term “declaration” is associated with the provision of additional information which the Agency uses in the process of “State evaluation”. This evaluation activity has the objective of establishing a transparent picture of the State’s nuclear fuel cycle and its nuclear program. The associated verification activities of IAEA inspectors are aimed at confirming that there are no nuclear activities in the State which are required to be safeguarded but have not been declared to the Agency and therefore have not been placed under safeguards. Nuclear activities involved in this declaration include activities related to uranium ore concentrate, material exempted from safeguards, and material on which safeguards have been terminated; such material is not subject to accounting procedures and State accounting reports.

In conclusion, there are two aspects of the use of the term “undeclared nuclear material and activities”: one is associated with nuclear material “subject to safeguards” and the other is associated with nuclear material which does not fall into that category. These two aspects have an impact on the notion “non-compliance” which will be discussed below.

Diversion

In the original design of the IAEA safeguards system, the Agency’s task was defined as to confirm that the items placed under safeguards “are not used in such a way as to further any military purpose”. This task was fulfilled through the conclusion, between the IAEA and a

State, of an "item-specific" agreement, where the State undertakes that the items placed under safeguards are used only for peaceful purposes. Nuclear material placed under safeguards in accordance with such an agreement is processed or stored in a principal nuclear facility such as a reactor, conversion, fuel fabrication or reprocessing plant. Nuclear activities at such facilities are regarded as peaceful nuclear activities. In order to use the material placed under safeguards for any military purpose the State would have to "divert" the material from the declared peaceful activities. Physically this means that the State transfers the material from the facility where it is safeguarded to an unsafeguarded facility where the material can be used for a military purpose. The Agency can satisfy itself that the items placed under safeguards are not used for a military purpose as long as it can verify that these items **remain in the declared use**, i.e. remain in the safeguarded facility.

Accordingly, in the original design of the system, the objective of the Agency's verification was to detect a "diversion" of safeguarded nuclear material from peaceful use at the safeguarded facility. In practical terms this means a detection of an anomaly which indicates that the safeguarded nuclear material, or part of it, could have been withdrawn from the facility. The essence of this idea of "diversion" was **diversion from the declared peaceful use** under the assumption that among the purposes of diversion could be furtherance of a military purpose.[21] There was no elaboration, in the original design of the system, of possible military purposes - it was sufficient to design means to confirm that the safeguarded items remain in peaceful use.

When adapting the original safeguards system for NPT purposes, the drafters of INFCIRC/153 used the term "diversion" in a different way: the **diversion of nuclear material from peaceful use to manufacture of nuclear weapons**. That is, the purpose of diversion was well defined. This new meaning of the term "diversion" was used in paragraphs 1 and 2 of INFCIRC/153. However, the safeguards procedures defined in Part II of INFCIRC/153 were based on the old idea of detecting a withdrawal of nuclear material from the declared use at a safeguarded facility. The objective of the verification procedures defined in Part II was therefore formulated as the timely detection of a "diversion" of significant quantities of nuclear material from peaceful use to manufacture of nuclear weapons or "for purposes unknown". This reflected the assumption that, in the absence of information to the contrary, a "diversion" (withdrawal) of nuclear material from a safeguarded facility could be for the purpose of manufacturing nuclear weapons at unsafeguarded facilities. At the same time, the requirement of paragraphs 1 and 2 that the verification purpose is the detection of diversion to manufacture of nuclear weapons, allowed the IAEA to define the quantity and timeliness goals for verification purposes taking into account the amount of nuclear material required for a nuclear explosive device and the conversion time necessary.

In the post-1991 safeguards system, however, it was clarified that the State's obligation under the CSA is to declare all nuclear material "subject to safeguards" and all the facilities and locations outside facilities processing or storing such material. A new verification objective "to detect undeclared nuclear material and activities" had been adopted. This invoked a new, broader, interpretation of the term "diversion" being an extended process during which the

21. "Agency safeguards" are defined in paragraph 18 of INFCIRC/26 as: "… the measures pursuant to the Statute to prevent loss or diversion of materials, specialised equipment or principal nuclear facilities". Paragraph 17 of the same document defines "diversion" as: "… the use by a recipient State of fissionable or other materials, facilities or equipment supplied by the Agency so as to further any military purpose …"

State runs a clandestine nuclear weapons program. Such a program may involve not only secret, undeclared nuclear activities but also nuclear material and facilities which have been declared and placed under safeguards. Such a "diversion process" has its beginning, that is the State's decision to launch a nuclear weapon program, and its end, that is the creation of a nuclear weapons arsenal. We should also bear in mind that the State may decide to terminate its nuclear weapons program before completing it. In practice, the Agency considers the possibility of such a "diversion process" through analysing the acquisition paths available for a State with certain nuclear fuel cycle and technical capabilities. It is also important to note that Article III of the NPT requires each non-nuclear-weapon State to accept safeguards "… with a view to preventing diversion …". This means that the Agency aims to detect the "diversion process" before it has been completed.

This new, extended interpretation of the notion "diversion" highlights another semantic problem: an acquisition path in a State could be based entirely on undeclared nuclear material and activities, thus there would be no "diversion from the declared peaceful use." John Carlson addressed this issue in the paper "IAEA safeguards - Reflections on the meaning of 'diversion' and 'non-compliance'".[22] This paper concluded it is not necessary to show that nuclear material was physically taken from a peaceful use and moved to a proscribed use. In a State that has a CSA **all** nuclear material should be in peaceful use (or in non-proscribed military use under appropriate arrangements), so any use for a proscribed purpose represents a change from that which is legally permitted. Accordingly, diversion should be understood to mean use of nuclear material that is subject to a commitment to use only for peaceful purposes (or, under agreed arrangements, a non-proscribed non-peaceful purpose) for a proscribed purpose, that is, a purpose prohibited by the applicable agreement – namely, in the case of the NPT and comprehensive safeguards agreements, the manufacture of nuclear weapons.

This problem of terminology is partly resolved in the text of the comprehensive safeguards agreement concluded between Argentina, Brazil, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Material (ABACC) and the IAEA (referred to as the Quadripartite Agreement).[23] Argentina and Brazil have agreed that naval propulsion is a **peaceful** activity.[24] Consequently, certain articles of this CSA are formulated differently as compared to INFCIRC/153 and GOV/INF/276. Article 1 of the agreement requires that the States Parties accept safeguards on all nuclear material in **all nuclear activities.** Article 2 requires that the Agency ensures safeguards will be applied on all nuclear material in **all nuclear activities** in the State concerned. Article 13 is drafted in terms of "**special procedures**" to be applied to "non-proscribed nuclear activity as agreed between the State Party and the Agency".[25]

Thus, the agreement avoids the usage of the wording "non-application of safeguards", which requires definition of the term "safeguards". It also does not use the wording "a non-proscribed military activity" which would also need a definition. Instead, it speaks about a

22. VCDNP, June 2022, https://vcdnp.org/iaea-safeguards-diversion-and-non-compliance/.
23. INFCIRC/435, https://www.iaea.org/sites/default/files/infcirc435.pdf.
24. 1991 Guadalajara Agreement. See also Article 5 of the Tlatelolco Treaty.
25. This approach was devised to avoid a potential inconsistency between the Quadripartite Agreement and the Tlatelolco Treaty (to which both States are parties) with regard to non-proscribed military use (namely, naval propulsion). As discussed elsewhere in this paper, the standard CSA provides for use of nuclear material in non-proscribed "non-peaceful purposes". However, the Tlatelolco Treaty permits use only for peaceful purposes – hence naval propulsion is permitted only if it is considered a peaceful purpose.

"non-proscribed nuclear activity as agreed between the State Party and the Agency". This language resolves also another conceptual problem of INFCIRC/153, namely the problem with the term "diversion from peaceful nuclear activity".

To conclude, the meaning of the term "diversion" depends on the context in which the term is used. For example, in the first of the three generic objectives under the State-level concept, "to detect diversion of declared nuclear material", the term "diversion" means undeclared withdrawal of declared nuclear material from a declared facility or location outside facilities. An alternative formulation of this objective would be: "to verify that declared nuclear material has been adequately accounted for". The interpretation of the notion "diversion" is very important when dealing with the notion "non-compliance".

Non-compliance

The notion "non-compliance" is very important not only in view of the implementation of the IAEA safeguards system, but also in view of ensuring the sustainability of the NPT. The subject of "non-compliance" with regard to the implementation of comprehensive safeguards agreements has been addressed in several publications.[26]

The primary meaning of "compliance", as regards CSAs, is the State's compliance with conditions prescribed in the agreement between the IAEA and the State concerned.[27] The conditions of the CSA reflect the State's undertakings under the NPT, "not to manufacture or otherwise acquire nuclear weapons" (Article II), and to accept safeguards, as set forth in a safeguards agreement (a CSA) to be concluded with the IAEA, to verify the State's fulfilment of its obligations assumed under the NPT with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons (Article III.1). The Basic Undertaking under the CSA (paragraph 1 of INFCIRC/153) is for the State to accept safeguards on all its nuclear material in all peaceful nuclear activities in accordance with NPT Article III.1.

It is important to note that INFCIRC/153 does not use the notion "non-compliance", but contains two paragraphs, 18 and 19, which can be associated with this notion. Paragraph 18 provides that if the Board, upon report of the Director General (DG), decides that, in order to ensure verification that nuclear material is not "diverted" to nuclear weapons, an action by the State is essential and urgent, the Board may call upon the State to take the action. Paragraph 19 provides that if the Board, upon examination of the DG's report, finds that the Agency is not able to verify that there has been no "diversion" of nuclear material to nuclear weapons, it may take the measures provided for in Article XII C. of the Statute. These measures include reporting to the Security Council and General Assembly of the UN. We may conclude that these paragraphs deal with a State's "compliance" with its obligation to accept safeguards, that is to fulfil those provisions of the agreement that enable the Agency to draw a conclusion of "diversion" or to confirm the absence of "diversion". In this regard, the

26. Pierre Goldschmidt, "Exposing nuclear non-compliance", Survival, Vol.51. No 1, 2009; John Carlson, "IAEA safeguards - Reflections on the meaning of 'diversion' and 'non-compliance'", VCDNP June 2022, https://vcdnp.org/iaea-safeguards-diversion-and-non-compliance/; Valeri Bytchkov "The IAEA verification activity", Pathways to peace and security, №2 (63), Fall-winter 2022, Moscow, IMEMO, ISSN 2307-1494.
27. See Article XII.A.6 of the IAEA's Statute. This Article also refers to compliance with the undertaking against use of safeguarded material and items in furtherance any military purpose, but this undertaking applies only in the case of "project agreements".

essential obligations of the State are: to provide the information and access specified in the safeguards agreement, and to cooperate with the IAEA in implementing safeguards.

In order to elaborate on the notion "non-compliance", we should clarify what we mean by the wording "diversion of nuclear material to manufacture of nuclear weapons". In accordance with our elaboration above on the notion "diversion", this wording means an extended process during which the State runs a clandestine nuclear weapons program. The Agency, through its verification activity, is able to detect indications, or anomalies, such as problems with nuclear material accounting reports, denial of access or undeclared nuclear material and activities. However, such findings of the Agency might not be sufficient to prove that the State is in the process of diverting nuclear material to the manufacture of nuclear weapons. In the past, the evidence of a State being in the process of such a "diversion" was obtained either through the State admitting it had a nuclear weapon program (Libya, Romania), or through obtaining documentary and other evidence of a weaponisation program in a State (Iraq).

The above considerations help us to understand the nexus between Article III of the NPT and document INFCIRC/153. Article III sets out the State's obligation to accept IAEA safeguards for the purpose of verifying the fulfilment of its obligations, that is, not to manufacture or otherwise acquire nuclear weapons, with a view **to preventing** "diversion" of nuclear energy from peaceful use to such weapons. Thus, the end goal of implementing safeguards under the NPT is **to prevent** the "diversion", that is, to detect the "diversion process" before it is completed with the creation of nuclear weapons. Paragraphs 1 and 2 of INFCIRC/153 specify the objective of safeguards under this type of safeguards agreement as: "verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices".

Paragraph 28 speaks about "timely detection"; we may interpret this timeliness requirement as to detect the "diversion process" before it has been completed. This interpretation is in line with the objective of providing deterrence of such "diversion" as mentioned in paragraph 28.

These considerations mean that, in general, the term "non-compliance" may involve two situations: (a) a major safeguards violation, such as diversion; or (b) the Agency is unable to verify that there has been no diversion, for instance due to a refusal of cooperation, and determines there are sufficient grounds to warrant reporting as non-compliance. In case (b), the Board needs to take account of all the information available to it, as well whether the State has taken actions required of it, provided necessary reassurances, and cooperated fully to resolve the situation. If, after this, the Board determines there are sufficient grounds to conclude that diversion is the most likely explanation, it may decide to report the situation as non-compliance. Alternatively, the Board may decide to regard the matter as less serious, an anomaly to be resolved with the State. It is also open to the Board to report the matter to the UN Security Council under Article III.B.4 of the Statute (where in connection with the activities of the Agency questions have arisen that are within the competence of the Security Council).

To conclude, our understanding is that the term "non-compliance" may involve two situations: (a) a major safeguards violation, such as diversion; or (b) the Agency is unable to verify that there has been no diversion, and determines there are sufficient grounds to warrant reporting as non-compliance with the safeguards agreement.

E. Conclusion

Initially the conceptual thinking that influenced the development of the safeguards system reflected the culture of the organisations from which the key safeguards personnel were drawn. The focus on verifying the correctness of State declarations reflected the practice of nuclear material accountancy that had been developed at the national level.

When the NPT was concluded, the broader requirement inherent in this treaty, to establish a process for verifying that **all** a State's nuclear material was placed under safeguards (completeness), was not given adequate attention, partly because the necessary methodologies had not been developed, and partly due to the rapidly growing workload faced by the IAEA. Cultural factors were also important, particularly the common view at that time that States would not accept inspectors going beyond routine inspections at declared sites.[28]

Subsequent events demonstrated the need for the IAEA to change focus from individual facilities to the State as a whole. This involved a whole new way of thinking, about the role of the Agency and about the methodologies and technologies needed to meet the Agency's responsibilities. A cultural shift was required, from a quantitative approach to a more qualitative one in which expert judgment has a key role. This has involved major challenges, including how to ensure non-discrimination and how to provide the transparency necessary to maintain the confidence and support of Member States. Safeguards culture thus has to broaden from realising technical objectives and methodologies to recognising the international political objectives that the international community seeks to achieve with the help of treaties and safeguards agreements.

This leads in the direction that safeguards culture should not be organisation-based (a separate culture for each organisation or entity), but rather, should be approached as a shared endeavour involving collaboration by all levels – multilateral, national, industry and individuals. After all, the underlying principle, the peaceful (or non-explosive) use of nuclear energy, does not depend primarily on IAEA safeguards (the IAEA is only the verifying agency) but on the commitment of each State. Safeguards culture, therefore, should emphasise international collaboration; one where States and the IAEA Secretariat work in collaboration to provide credible assurances of States' compliance with their obligations concerning the peaceful use of nuclear energy. Formally recognising the role of safeguards culture would not only lead to better performance in conceptualisation and implementation, but would also help strengthen safeguards as a global discipline.

28. CSAs provide for "special inspections", but these were considered to be available only for exceptional circumstances.

Annex

Part 1 Conceptual development of the IAEA safeguards system in the pre-NPT period

Part 2 Adaptation of the IAEA safeguards system for the NPT

Part 3 Further development of the safeguards system: new types of safeguards agreements, Safeguards Implementation Report and Safeguards Criteria

Part 4 Introduction of the additional protocol and development of the concept of integrated safeguards

Part 5 Development of the State-level concept

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1. Conceptual development of the IAEA safeguards system in the pre-NPT period

Introduction

The concept of nuclear "safeguards" was set out in the Agreed Declaration Relating to Atomic Energy issued by the leaders of the United States, United Kingdom, and Canada in November 1945. This declaration emphasised the need to devise "effective enforceable safeguards against [the] use [of atomic energy] for destructive purposes." The declaration called for the establishment of an Atomic Energy Commission to make proposals, inter alia, for "effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions."

It took over a decade to develop thinking and reach agreement on the establishment of an international body to apply safeguards as proposed in this declaration. The "Atomic Energy Commission" became the International Atomic Energy Agency (IAEA), established in 1957. With respect to safeguards, the IAEA's Statute authorised the Agency:

> To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy.[29]

Thus, three situations where safeguards would be required were envisaged in the Statute:

(a) Where nuclear material, services, equipment, facilities and information were made available by or under the supervision or control of the IAEA (essentially, Agency projects);

29. IAEA Statute, Article III.A.5.

(b) Where the parties to a bilateral or multilateral arrangement requested the application of safeguards;

(c) Where a State requested the application of safeguards.

The system to implement this task was developed by the IAEA, in cooperation with its member States, beginning in the 1960s and was described in IAEA documents INFCIRC/26 and INFCIRC/66, including several revisions of these documents. We will analyse these documents with emphasis on the conceptual aspects of the system's development.

Initial development of IAEA safeguards

The development started on the basis of the IAEA Statute, which contains the fundamental principles of the application of the Agency's safeguards. In accordance with these principles, the IAEA has the following rights and responsibilities:[30]

(a) To send inspectors into the territory of a State to verify the State's compliance with the undertaking against use of materials or items required to be safeguarded in furtherance of any military purpose and compliance with any other conditions prescribed in the agreement between the Agency and the State;

(b) To examine the design of specialised equipment and facilities and to approve it only from the viewpoint of assuring that it will not further any military purpose, and that it will permit effective application of safeguards;

(c) To require the maintenance and production of operating records to assist in ensuring accountability for nuclear materials required to be safeguarded;

(d) To obtain progress reports and to access all places and data as necessary to verify nuclear material accountancy for nuclear material required to be safeguarded.

It is important to note that these rights and responsibilities are not "self-executing" but need to be set out in a safeguards agreement with the State concerned.

These provisions created the ground for the establishment and future development of the basic inspection activities of the IAEA: inspections on the territory of State(s), examination and verification of design information, examination and verification of operating records and examination and verification of nuclear material accountancy.

In addition, the Statute provides the Agency with the right of access to enforcement measures:

(a) If in connexion with the activities of the Agency there should arise questions that are within the competence of the Security Council, the Agency shall notify the Security Council;[31]

(b) The inspectors shall report any non-compliance to the Director General who shall transmit the report to the Board of Governors. The Board shall report the non-compliance to all members and to the Security Council and General Assembly of the UN;[32]

30. IAEA Statute, Article XII.A.
31. IAEA Statute, Article III.B.4.
32. IAEA Statute, Article XII.C.

(c) The Board may take the following measures: direct curtailment or suspension of assistance provided by the Agency and call for the return of materials and equipment made available to the recipient State(s).[33]

Also, in developing IAEA safeguards, the developers took into account the experience that had been gained by States under bilateral arrangements for control of nuclear exports. Particular States exporting nuclear materials and technology – research reactors and other facilities, nuclear components, and so on – required importing States to declare that the imported items were intended for exclusively peaceful use. Some exporting States sent national inspectors to confirm that the supplied items were indeed being used for peaceful purposes.

The foundation for safeguards was seen as nuclear material accountancy, taking advantage of an important property of nuclear material, radioactivity, which enables nuclear material to be detected and characterised. Monitoring the presence of safeguarded nuclear material at a "peaceful nuclear facility" is possible through verifying the inventory of safeguarded material and applying containment and surveillance measures. Taking nuclear material accountancy as a starting point, implementation of safeguards required the development of new concepts such as timeliness and quantity goals and goals for detection probability. This required analysis of the time required to convert different categories of nuclear material to weapon-usable form, and the quantities of material needed for this purpose.

INFCIRC/26 and INFCIRC/66

The initial design of the IAEA safeguards system, carried out in response to the Agency's mandate "to establish and administer safeguards" was described in INFCIRC/26, approved by the Board on 31 January 1961. This document contained the principles to be followed by the Agency "in determining safeguards", and the procedures to implement these principles. The "administration of safeguards" was to be governed by a safeguards agreement between the Agency and the State or States concerned.

The drafters of INFCIRC/26 used the terms and notions which later evolved together with the evolution of the safeguards system, especially with the introduction of INFCIRCs '66', '153', and '540'. We will perform the analysis of the system using the contemporary safeguards terms, but to begin with we will establish the correspondence between the old and the new terms.

- The term "attachment of safeguards", was used to define the items and materials required to be covered by the Agency's safeguards. This term was subsequently replaced with the term "subject to safeguards".
- The term "principal nuclear facility" was used to define the types of nuclear facilities for which INFCIRCs '26' and '66', including their revisions, contain safeguards procedures. This term has been replaced with the term "facility".
- The terms "peaceful nuclear material" and "peaceful nuclear facilities" were used to refer to the materials and facilities placed under safeguards. These terms are important for understanding the notion "diversion" which will be discussed below. INFCIRC/153 uses a similar term, "peaceful nuclear activities".

33. Ibid.

- The terms “purpose of safeguards” and “objective of safeguards” were not used in INFCIRCs ‘26’ and ‘66’, they appeared only in INFCIRC/153. These terms are very important, and we will discuss them below.

INFCIRC/26 contained the initial version of the IAEA safeguards system. The document dealt primarily with general principles, but set out specific provisions applying to reactor facilities (initially research reactors). It was envisaged that further documents would be issued for expansion of the safeguards system to further facility types. The first such expansion was INFCIRC/26/Add.1, issued in 1964 to cover large reactor facilities. The safeguards system’s development continued with the issuance in 1965 of INFCIRC/66 entitled: “The Agency’s safeguards system”, which was extended to include procedures in connection with reprocessing, conversion, and fuel fabrication (INFCIRC/66/Rev.2).

The purpose of INFCIRC/66 according to paragraph 2 of the document was “… to establish a system of controls to enable the Agency to comply with its statutory obligation with respect to the activities of Member States in the field of the peaceful uses of nuclear energy …”. Further, paragraph 4 of the document States, that “Provisions of this document … will only become legally binding upon the entry into force of a safeguards agreement.” Thus, the IAEA safeguards system is a verification system which is applied in a State through the conclusion of a safeguards agreement between the Agency and the State(s). It was foreseen, in paragraph 15 of INFCIRC/66, that there could be various types of safeguards agreements: an agreement concluded in connection with a project agreement between the Agency and the State[34]; an agreement concluded in connection to a bilateral or multilateral arrangements involving several parties; or an agreement concluded at the request of a State.

In further discussion, we will refer to the system described in INFCIRC/66 Rev.2 as the initial version of the IAEA safeguards system. This initial version evolved with time reacting to the internal and external challenges. In the initial version of the safeguards system, the purpose or the objective of IAEA safeguards was “to ensure that the materials and items subject to safeguards are not used in such a way as to further any military purpose.” Safeguards agreements with this type of objective are normally referred to as “item-specific” agreements, because safeguards apply only to the materials or items specified under the agreement. The agreement does not apply to any other nuclear materials or facilities the State may have had. This formulation of the safeguards objective, which was taken from the IAEA Statute, has evolved with time.[35] Importantly, under comprehensive safeguards agreements, described in INFCIRC/153, the safeguards objective is expressed in terms of the non-diversion of nuclear material from the State’s peaceful activities to nuclear weapons.

34. A project agreement applies to "Agency projects", where nuclear material or other material, equipment, facilities etc are made available by the IAEA or under its supervision or control – see Article XI of the IAEA Statute.

35. Since 1975, the new formulation of the safeguards objective is: “to ensure that nuclear material, facilities and other items specified under the safeguards agreement are not used for the manufacture of any nuclear weapon or to further any other military purpose, and that such items are used exclusively for peaceful purposes and shall not be used for the manufacture of any nuclear explosive device.” This change was in reaction to India’s testing of a “peaceful nuclear explosion” in 1974.

The initial safeguards system: major issues

The initial version of the safeguards system was essentially a **facility-oriented** system: it contained procedures for the application of safeguards for several types of nuclear fuel cycle facilities. The system contained the principles and rules which provided for the continuation of safeguards with respect to nuclear material produced or processed in a safeguarded nuclear facility, or produced in or by the use of safeguarded nuclear material, or substituted for safeguarded nuclear material. The system also contained the principles and rules for termination of safeguards, suspension of safeguards and exemption from safeguards. Using these rules and the rules defining what materials and items are subject to safeguards, the Agency and the State have the possibility to establish, at any point in time, the inventories of safeguarded materials and items.

The next task was to develop means by which the Agency could ensure that safeguarded materials and items are not used so as to further any military purpose. The difficulty was the ambiguity of the term "to further any military purpose": in order to prevent the use of safeguarded materials, facilities and other items from "furthering any military purpose" one should establish an exhaustive list of such proscribed uses, as well as a list of detectable indicators of the proscribed uses. We may list just a few of such examples: apart from the obvious example of producing nuclear weapons, these could include the use of natural or depleted uranium in military munitions; the use of a material-testing research reactor for testing materials used in military applications; and the operation of naval propulsion reactors.

Analysing this problem, we may conclude that the basic objects we should address are: the peaceful use of nuclear energy; and the peaceful use of nuclear material (source and special fissionable material) which is the potential source of nuclear energy. Further, we should concentrate on preventing the most devastating military use of nuclear energy: a nuclear explosive device (nuclear weapon). The manufacture of nuclear weapons requires weapon-usable nuclear material - high enriched uranium or separated plutonium.[36] In order to produce such materials a State needs nuclear fuel cycle facilities such as enrichment plants and/or reactors, fuel fabrication plants, and reprocessing plants. Each of these nuclear fuel cycle facilities could be used for peaceful, as well as for military purposes (such as producing or processing nuclear material intended for manufacture of nuclear weapons). Therefore, the State must undertake that a nuclear facility placed under safeguards will be used only for peaceful purposes. Consequently, nuclear and non-nuclear materials and equipment in the facility are also to be used only for peaceful purposes. In this regard, INFCIRC/26 uses the terms "peaceful nuclear material" and "peaceful nuclear facility".

An important term introduced by INFCIRC/26 was "diversion". This term was given two meanings: the use by a State of safeguarded materials, facilities or equipment: (a) so as to further any military purpose; or (b) in violation of any other condition prescribed in the agreement. In regard to (b), undeclared removal of safeguarded nuclear material from a facility is clearly a fundamental violation of the agreement. Such removal could indicate the material has been "diverted" from peaceful to proscribed use, but the IAEA might not have sufficient

36. Nuclear weapons can also be produced with neptunium or americium. In 1999 the IAEA Board of Governors considered whether to add these materials to the definition of "nuclear material" for safeguards purposes. The Board concluded these materials presented limited proliferation risk while only small quantities exist in separated form in non-nuclear-weapon States, and introduced a reporting system so the situation could be kept under review.

information to conclude this is the case. Diversion from safeguards will frustrate the objective of the agreement, to provide assurance that the material is not used for a proscribed purpose.[37] In practical implementation the notion "diversion" is associated only with safeguarded nuclear material, while the use of safeguarded facilities and equipment for a proscribed purpose (such as processing of undeclared nuclear material) is termed "misuse".

At the early stages of the development of the safeguards system, the examination and approval of the facility design was considered to be a measure to prevent the possible misuse of a facility.[38] It was, however, recognised that in the majority of safeguards agreements the Agency will not have legal authority to approve the design of a facility placed under safeguards. Moreover, as stated above, any nuclear facility could be misused as part of the production or processing of nuclear material intended for the manufacture of nuclear weapons. Neither INFCIRC/26 nor INFCIRC/66 provides any concrete example of the misuse of a nuclear facility or equipment, nor do they explain how this could be detected by the Agency. In principle, IAEA inspectors could use such verification activities as the examination and verification of design information and the examination and verification of facility's operating records for detecting misuse, however these measures remain ineffective unless detectable indicators of the facility's misuse have been established.[39]

The issuance in September 1968 of INFCIRC/66 Rev.2 crowned the efforts in developing the initial IAEA safeguards system. This document recorded the development steps as follows:

- The first version, to cover small research reactors, published in INFCIRC/26 (1961);
- The 1961 system extended to cover large reactor facilities, published in INFCIRC/26 Add.1 (1964);
- The revised system, published in INFCIRC/66 (1965);
- The revised system with additional provisions for reprocessing plants, published in INFCIRC/66 Rev.1 (1966);
- The revised system with provisions for safeguarding nuclear material in conversion plants and fabrication plants, published in INFCIRC/66 Rev.2 (1968).

Summing up

We conclude that the purpose of the IAEA safeguards system as developed by 1968 was to verify the fulfilment by a State of its undertakings under the safeguards agreement concluded with the Agency. A safeguards agreement specifies the obligations of a State regarding the peaceful use of nuclear material, facilities and other items placed under safeguards and the obligation of the Agency to verify the State's compliance with the safeguards agreement. The system includes two verification concepts: detecting any misuse of safeguarded facilities and other items; and detecting any diversion of safeguarded nuclear material from safeguarded

37. The term "diversion from safeguards" is sometimes used in safeguards literature; it corresponds to the meaning "diversion from declared peaceful use" or diversion through the failure to declare.
38. According to paragraph 40 (a) of INFCIRC/26: "The Agency shall examine the design and approve it only from the viewpoint of assuring that it will not further any military purpose and that it will permit effective application of Agency safeguards."
39. The Safeguards Criteria require the following verification activity under "item-specific" agreements to verify that a nuclear reactor is not misused: "Comparison of the consistency of operating reports, accounting reports and facility records with facility historical data and data on similar activities conducted elsewhere."

facilities or from other locations containing safeguarded material. Detecting diversion is the easiest concept to address. The system contains basic verification procedures which include inspections, examination and verification of a facility's design information, examination and verification of a facility's operating records, and examination and verification of accounting records. In the event of any detected non-compliance by a State with a safeguards agreement, the Agency may take the enforcement measures set forth in Articles XII.A.7 and XII.C of the Statute. The system evolves through responding to internal and external challenges.

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2. Adaptation of the IAEA safeguards system for the NPT

The negotiation of the NPT began in 1965. During the negotiations the IAEA agreed to accept the verification responsibilities envisaged under the treaty. The NPT was concluded in 1968 and entered into force in 1970. Following the NPT's entry into force, the IAEA embarked on a process of extending and adapting the Agency's safeguards system to meet the new responsibilities required by this treaty. The Board of Governors established a Safeguards Committee for this purpose (Committee 22).

The NPT brought about a fundamental change in the scope of IAEA safeguards. For non-nuclear-weapon States (NNWS) party to the treaty, the requirement to accept IAEA safeguards expanded from specified items and materials to the entirety of the State's nuclear materials and activities. This new form of safeguards — applying to **all** the nuclear material of a State (in peaceful use – see below) — was termed "full-scope safeguards" (today known as "comprehensive safeguards"). This change in safeguards scope had major implications, not fully appreciated at the time, for the IAEA's verification responsibilities. As will be discussed, the issue of "completeness", how to establish that a State had declared all its nuclear material and activities, would come to dominate safeguards development – but this lay many years ahead.

The NPT's safeguards provisions

Each NNWS party to the NPT undertakes not to manufacture or otherwise acquire nuclear weapons (NPT Article II). Further, each NNWS undertakes (NPT Article III.1):

> … to accept safeguards as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agency's safeguards system …

The exclusive purpose of this undertaking by the State is to enable:

> … verification of the fulfilment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.

The safeguards required by the NPT:

> … shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.

The safeguards agreement developed in accordance with the provisions of Article III of the NPT is referred to as a "comprehensive" safeguards agreement and is described in IAEA document INFCIRC/153 (Corrected). This document was developed by the Safeguards Committee in 1970-71.

The development of a new type of safeguards agreement – the "comprehensive" safeguards agreement – effectively meant the adaptation of the initial version of the IAEA safeguards system for the purpose of the NPT. A valuable discussion of the INFCIRC/153 negotiation history was published in document IAEL-275[40], a report prepared by International Energy Associates Limited (IEAL) for the US Arms Control and Disarmament Agency in 1984. The goal of this report was to facilitate understanding of INFCIRC/153.

According to the report, the following two objectives were pursued by the Committee:

1. To preserve the integrity and effectiveness of the IAEA safeguards system and the maintenance of the principle of independent verification by the IAEA.
2. To make the NPT more acceptable by appropriate simplifications and rationalisation of safeguards to be applied under the Treaty.

The report contains a very clear statement of the adaptation of the safeguards system described in INFCIRC/66 for the development of the safeguards agreement required by the NPT:

> … the development of INFCIRC/153 was specifically undertaken (GOV/INF/222) not to establish a new system distinct from that of INFCIRC/66, but rather to determine the content of safeguards agreement with NPT parties. It is for this reason that INFCIRC/153 is entitled: "The structure and content of agreement …" rather than the "Agency safeguards system" for NPT parties. Thus, INFCIRC/153 did not formally supersede or displace the "Agency safeguards system" for NPT parties, but merely adapted it for this use.

The authors of the report pointed out that INFCIRC/153 was a product of compromises reached during the negotiation process: "Parts of the document reflect carefully drawn compromises of conflicting views among the participants." This fact explains the inconsistencies between different parts of the document and the lack of technical precision of the text of certain paragraphs. We will discuss these inconsistencies and ambiguities below.

Another important observation of the authors of the IEAL report was that INFCIRC/153 inherited certain features of the earlier phases of IAEA safeguards system evolution:

> The development of INFCIRC/153 had its explicit beginning in the negotiation and conclusion of the NPT, and the decision of the IAEA to adapt its safeguards system for application to Treaty parties. The development, however, cannot be isolated from the earlier phases in the evolution of the Agency's safeguards system.

Indeed, INFCIRC/153 uses terms and notions of the initial version of the safeguards system; some of them, for instance, "diversion" of nuclear material, nuclear material "subject to safeguards", and nuclear material "exempted from safeguards" have meanings which differ from those of INFCIRC/66. This issue has an impact on the development of modern safeguards culture, and is discussed in detail in section D.

40. https://nationalsecuritytraining.pnnl.gov/fois/doclib/IAEA_153_Negotiating_History.pdf.

We will start with the explanation of what we mean by the adaptation of the initial version of the IAEA safeguards system for use as the NPT control mechanism. The system is applied through the conclusion and implementation of safeguards agreements between the IAEA and States. INFCIRC/66 does not contain a model of a safeguards agreement; it rather provides basic principles and procedures for developing a safeguards agreement. These main principles and procedures are:

- The formulation, in a safeguards agreement, of the State's obligation concerning the peaceful use of nuclear energy;
- The formulation, in a safeguards agreement, of the IAEA's verification obligation, or, in other words, the formulation of the safeguards objective;
- The definition of the scope of the materials and items subject to safeguards;
- The verification concept;
- The safeguards procedures.

We discuss these principles and procedures below, comparing an "item-specific" agreement, which is based on the principles and procedures of INFCIRC/66, and a "comprehensive" agreement, where those principles and procedures had been further developed.

The formulation, in a safeguards agreement, of the State's obligation concerning the peaceful use of nuclear energy

First, we shall consider the State's obligation under an "item-specific" agreement. We take as an example the agreement concluded between India and the IAEA as recorded in INFCIRC/754. The State's obligation, formulated in paragraph 1 of the agreements, is:

> India undertakes that none of the items subject to this Agreement, as defined in paragraph 11, shall be used for the manufacture of any nuclear weapon or to further any other military purpose and that such items shall be used exclusively for peaceful purposes and shall not be used for the manufacture of any nuclear explosive device.

Paragraph 11 of the agreement defines facilities, nuclear material and heavy water which are subject to safeguards. This paragraph provides that in addition to the facilities and nuclear material placed under safeguards pursuant to a bilateral or multilateral arrangement to which India is a party, any nuclear material produced, processed or used in or by the use of a safeguarded facility or of any safeguarded materials or other safeguarded items become subject to safeguards (the principle of "contamination by safeguards"). Further, paragraph 12 states that the scope of the agreement is limited to the items subject to the agreement as defined in paragraph 11.

In the case of INFCIRC/153, the State's obligation was formulated on the basis of Article III of the NPT. According to the IAEL report, the IAEA initially objected to providing in INFCIRC/153 any reference to the NPT. It argued that "The agreement should constitute a self-contained legal instrument, since the Agency is not a party to NPT…" The original proposal by the IAEA Director General concerning State's basic undertaking was:

> The agreement should contain an undertaking that nuclear material within the State's territory, under its jurisdiction or under its control anywhere, shall not be diverted from peaceful uses to nuclear weapons or other nuclear explosive devices.

That was a clear formulation of the State's obligation, including the issue of "completeness": safeguards were to be applied to all nuclear material in the State. The final formulation of paragraph 1 of INFCIRC/153, which resulted from the negotiation process, was:

> The Agreement should contain, in accordance with Article III.1 of the Treaty on the Non-Proliferation of Nuclear Weapons, an undertaking by the State to accept safeguards … on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere …

In this formulation, the prime undertaking is "to accept safeguards on … material in all peaceful activities", while the obligation not to divert nuclear material is addressed only indirectly: "for the exclusive purpose of verifying that such material is not diverted …"

This formulation has an impact on the "non-compliance" issue. We may conclude that there could be a "non-compliance with the safeguards agreement" (failure to accept safeguards in accordance with the terms of the agreement), and a "non-compliance with the NPT" (diversion of nuclear material to manufacture of nuclear weapons).

Comparing these two obligations of the State under the "item-specific" and the "comprehensive" agreements, we come to the following observations.

Under an "item-specific" agreement, the facilities, materials and other items subject to safeguards are well defined and the list of safeguarded items can be easily maintained with time. Placement of these items under safeguards means the State undertakes not to use them to further any military purpose. At the same time, the State may have nuclear material and facilities outside safeguards; such unsafeguarded nuclear activities may be used by the State for military purposes.

Under a "comprehensive" agreement, all nuclear material in peaceful nuclear activities within the territory, jurisdiction or control of the State is subject to safeguards. Although the emphasis in this formulation is given to nuclear material, facilities also become subject to certain safeguards procedures, such as verification of facility design and examination of operating records, as nuclear material is stored or processed in nuclear facilities. The stipulation concerning "nuclear material in peaceful nuclear activities" was obviously introduced to allow for **non-proscribed** military activities as elaborated in paragraph 14 of the agreement. This situation causes some difficulties in the interpretation of the meaning of the term "subject to safeguards" under the "comprehensive" agreement, which we discuss in section D.

The formulation, in a safeguards agreement, of the safeguards objective

Again, we shall start with the consideration of safeguards objective as formulated in the "item-specific" agreement concluded with India. Paragraph 2 of this agreement states that:

> The Agency undertakes to apply safeguards, in accordance with the terms of this Agreement, to the items subject to this Agreement, as defined in paragraph 11, so as to ensure, as far as it is able, that no such item is used for the manufacture of any nuclear weapon or to further any other military purpose and that such items are used exclusively for peaceful purposes and not for the manufacture of any nuclear explosive device.

This formulation refers, indirectly, to a certain verification concept: that whether the safeguarded items are misused can be determined by whether indicators of misuse are detected; and if no such indicators are detected it can be concluded the items concerned have not been misused. In the practical implementation of such agreements, the Agency verifies that safeguarded nuclear material is not diverted from peaceful use, and verifies that safeguarded facilities and other safeguarded items are not misused. This can be seen from the typical safeguards conclusion, under this type of agreement, published in the contemporary Safeguards Implementation Reports:

> For these States, the Secretariat found no indication of diversion of nuclear material or of misuse of the facilities or other items to which safeguards had been applied. On this basis, the Secretariat concluded that, for these States, nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities.

In the case of INFCIRC/153, the situation with the formulation of the safeguards objective is more complex. Paragraph 2 of the document provides for the Agency's right and obligation

> … to ensure that safeguards will be applied … on all source or special fissionable material in all peaceful nuclear activities within the territory of the State … for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

There are two important aspects in this provision: the aspect of ensuring **completeness** (the application of safeguards to all nuclear material in all peaceful activities within the territory, jurisdiction or control of the State), and the aspect of verification that nuclear material is **not diverted** to nuclear weapons.

There is also a second formulation of "safeguards objective", given in paragraph 28 of INFCIRC/153:

> … the objective of safeguards is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.

This formulation differs from the one given in paragraph 2 in several aspects: (a) it does not address precisely the subject of safeguards completeness; (b) in addition to diversion to nuclear weapons, it refers to diversion "for purposes unknown"; and (c) it includes notions of timeliness and significant quantities.

The IEAL report sheds some light on the cause of this problem of two different formulations of safeguards objective. Initially, paragraph 28 was formulated as a technical objective, that is the objective of verification procedures, and related to the measurement of the amount of material unaccounted for.[41] The negotiation process ended, however, with formulating the so called "objective of safeguards":

> The objective of safeguards as set forth in paragraphs 28 and 29 emerged as the timely detection of diversion instead of a more limited earlier version of measurement of material unaccounted for.

41. Material unaccounted for (MUF) is the fundamental parameter of nuclear material accountancy at a facility; it is defined as the difference between the amount of material recorded in operator's accounting books and the amount actually measured during the material inventory taking.

The report contains an explanation of this decision: “Detection of diversion was preferred as a more general notion, which could be achieved with procedures other than ‘nuclear material accounting’.” That is, diversion indicators can be detected by containment and surveillance measures as well. Also, there is an opportunity for the introduction of future measures for detecting diversion as agreed by the Board and by States.

It is important to note that the formulation of paragraph 28 was later referred to in the Model Safeguards Agreement (GOV/INF/276) as the objective of **safeguards procedures** contained in the agreement. This means there are two different objectives formulated in the comprehensive agreement: the **safeguards objective** in paragraph 2 and the **technical objective** (the objective of safeguards procedures) in paragraph 28. This important issue will be further discussed under the sub-title “The safeguards procedures” below.

Definition of the scope of materials and items subject to safeguards

“Subject to safeguards” is a term applying to the materials and items that the State is legally obligated to place under safeguards. As will be discussed, the scope of materials and items subject to safeguards differs depending on whether the relevant safeguards agreement is item-specific or comprehensive.

Under an “item-specific” agreement the scope of the materials and items subject to safeguards is well defined. For example, in case of the agreement with India, the materials and items subject to safeguards are defined with help of the principles and procedures listed in paragraph 11 of that agreement. These materials and items are placed under safeguards. The placement under safeguards – or application of safeguards - means: (a) India undertakes that these materials and items will not be used for any proscribed purpose – namely, the manufacture of any nuclear weapon or to further any other military purpose; (b) India and the IAEA apply to these materials and items the safeguards procedures which are provided in the safeguards agreement, in order to enable the IAEA to verify compliance of India with its undertaking in (a). In accordance with the agreement, certain materials or items can be exempted from safeguards or safeguards on them can be terminated. In such a case, condition (b) ceases to apply.

The situation with INFCIRC/153 is more complex. Similar to the above discussion, application of safeguards to nuclear material under the comprehensive agreement should mean: (a) the State undertakes that this material shall not be diverted to nuclear weapons; (b) the State and the IAEA apply to this material the safeguards procedures provided in the agreement, in order to enable the IAEA to verify compliance of the State with its undertaking in (a). However, as we can see in paragraph 14 of INFCIRC/153, safeguards under the agreement do not apply to nuclear material in **non-proscribed military activity**. At the same time, paragraph 14 requires that during the period of non-application of safeguards the nuclear material in question shall not be used for the production of nuclear weapons. We conclude therefore, that the terms “subject to safeguards” and “application of safeguards” mean, under the comprehensive agreement, only the application of certain safeguards procedures and do not determine the scope of the undertaking described in (a) above, which is derived directly from the NPT.[42] The same conclusion can be drawn when analysing paragraphs 33 - 37 of INFCIRC/153.

42. To clarify this statement, we may imagine the situation where the term “subject to safeguards” means the obligation of the State not to use the material in non-proscribed military activity for nuclear weapons. Then

Paragraphs 33 and 34 describe the "starting point of safeguards". These paragraphs reflect the understanding that safeguards apply to the dynamic scope of nuclear material which flows through the facilities of the nuclear fuel cycle: from uranium mining to manufacturing reactor fuel, burning the fuel in reactors, reprocessing the spent fuel and managing the waste. It was decided, in the course of developing the document, that the entire scope of safeguards procedures, the most important of which are procedures of nuclear material accountancy and routine inspection[43], will apply only to that nuclear material which has reached the stage, or is at a later stage, of the nuclear fuel cycle where it is suitable for fuel fabrication or isotopic enrichment. This material is referred to in the agreement as the material "subject to safeguards" (paragraphs 7, 35, 37, 41, 54, 59, 62, 71, 72, 74, and 81).

In accordance with the above rules, material which has not reached the condition where it is suitable for fuel fabrication or isotope enrichment is not "subject to safeguards"[44]; however, this does not free the State of the obligation not to divert such material to nuclear weapons (though this type of material is not directly usable for weapons, the "diversion process" must include upgrading to make the material "weapon-usable"). Further, paragraphs 35 – 37 provide for termination of safeguards on certain categories of nuclear material and exemption of certain categories of nuclear material from safeguards. Such termination or exemption means only that safeguards procedures involving accountancy and routine inspection cease to apply; it does not, however, mean that the State's obligation not to divert this material to nuclear weapons no longer applies.

Most probably, such situation has arisen because of the mechanistical transfer of safeguards principles and procedures of INFCIRC/66, which were developed for the application on the well-defined scope of items placed under safeguards, to INFCIRC/153 for verification of nuclear material, which flows through the nuclear fuel cycle facilities, and which is required to be safeguarded "while it is being produced, processed or used at any principal nuclear facility or is outside any such facility" (NPT Article III.1).

Verification concept

We will discuss the verification concepts used in "item-specific" and "comprehensive" agreements. These concepts are: the **detection of misuse** of a facility and other items, and the **detection of diversion** of nuclear material from peaceful activities (diversion from safeguards).

Under an "item-specific" agreement, the simplest situation is the placement of one facility, for instance a power reactor, under Agency safeguards. The scope of items subject to safeguards under the agreement are: the reactor facility; and the nuclear material present at the facility.

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paragraph 14 would have been written in a different way: the material in question would be subject to safeguards, but safeguards procedures, which include accountancy and routine inspection, would be non-applicable during the period when the material is in that activity.

43. The agreement provides for special, ad-hoc, and routine inspections. Special inspections are used to resolve special situations, ad-hoc inspections are used to verify the initial report on nuclear material "subject to safeguards", and routine inspections apply after the initial report has been verified and nuclear material placed under safeguards in declared facilities and LOFs.

44. We should clarify, that uranium ore concentrate, for instance, "yellow cake", belongs to the category of material which has not reached this condition but still some safeguards procedures apply to this material; however, because the accounting and routine inspection procedures do not apply to this material no safeguards conclusion required by paragraphs 30 and 90(b) of the agreement can be drawn by the Agency for this material.

The objective of safeguards is to ensure that the safeguarded items (the reactor and the nuclear material) are not used for any military purpose including manufacture of nuclear weapons. To achieve this goal, the IAEA applies the hypothesis that, in the case of misuse of the items, there will be detectable indicators of such misuse. Further, the Agency will consider the possible cases of misuse that could arise, identify the detectable indicators of such misuse and implement verification procedures to detect these indicators. If no indicators of misuse were detected, the Agency may conclude that the safeguarded items remained in peaceful use.

The main example of a reactor's misuse would be the production of plutonium for a nuclear explosive device. To separate plutonium from spent fuel, the State would need to transfer the spent fuel to a reprocessing plant. Where nuclear material subject to safeguards is transferred to a reprocessing plant, the reprocessing plant would become subject to safeguards in accordance with the principle of "contamination by safeguards".[45] However, if the State has secretly withdrawn spent fuel, or part of it, from the safeguarded reactor and transferred it to an unsafeguarded reprocessing plant, the IAEA is not able practically to apply safeguards there. In this case, the violation which safeguards aim to detect is the diversion of nuclear material from safeguards or, in practical terms, the diversion of nuclear material from the safeguarded facility.

In order to detect indicators of misuse and diversion, the IAEA requests the State to provide the reactor's design information and operating records. In addition, the IAEA requests the State to provide the nuclear material accounting records. If the IAEA has performed its verification activities (examination of records and physical measurements) and did not find indications of misuse or diversion, it concludes that the reactor and the nuclear material remained in peaceful activities.

Under a "comprehensive" agreement, all nuclear material in all peaceful nuclear activities in the State should be covered by Agency safeguards. The verification concept used in this agreement type is the detection of diversion of nuclear material from peaceful activities. The Agency's obligation (the objective of safeguards) is to ensure that safeguards are applied to all nuclear material (in peaceful use) and to verify that such material is not diverted to nuclear weapons. To achieve this goal, the agreement requires that the State establishes a national system of accounting for and control of nuclear material, which generates accounting and operating records and reports.

The agreement provides that accountancy and routine inspection procedures will apply depending on the quality of nuclear material, according to established criteria. Such material is processed or stored in "facilities" or locations outside of facilities (LOFs). The term "facility" applies to those installations of the nuclear material fuel cycle which store or process nuclear material of a quality that meets the established criteria[46] (material "subject to safeguards", according to the language of the agreement). The notions of "facility" and "LOF" are important for implementing the provision of the NPT that nuclear material is required to be safeguarded "while it is being produced, processed or used at any principal nuclear facility or is outside any such facility" (NPT Article III). This provision enabled the Agency to implement, under the

45. Due to the presence of nuclear material that is subject to safeguards.

46. For example, an installation that only produces "yellow cake" from uranium ore does not fall into the category of a "facility".

comprehensive agreement, the verification concept of detecting diversion of nuclear material from a “facility” or “LOF”, which was developed in the initial version of the safeguards system.

In order to place nuclear material “subject to safeguards” under the Agency’s verification procedures, including accountancy and routine inspections, the State is required to submit an initial report which contains all the facilities and LOFs with nuclear material “subject to safeguards”.[47] For each such facility or LOF, the report contains the amount of nuclear material present (the nuclear material inventory).

The IAEA verifies the initial report. The inventory of nuclear material which is subject to accountancy and routine inspection procedures is established and maintained on the basis of the initial and consecutive accounting reports (State declarations) and the results of the IAEA verification. For each declared facility, the IAEA develops a safeguards approach based on consideration of all possible diversion scenarios. Through the implementation of these approaches the IAEA is able to establish the absence of diversion of nuclear material which has been declared and placed under safeguards.

The safeguards procedures

The safeguards procedures required in order to enable the Agency to detect diversion of nuclear material “subject to safeguards” from declared facilities or LOFs, as described in the comprehensive safeguards agreement, have been significantly developed as compared with the initial safeguards system described in INFCIRC/66. The new aspect which had to be addressed in the comprehensive agreement was the continuing flow of nuclear material through the facilities of the nuclear fuel cycle. By comparison, in the initial safeguards system the scope of safeguarded items was relatively stable.

To address this difference, further development of nuclear material accountancy procedures was needed. An essential concept in this development was the **material balance area** (MBA), an area in which transfers of nuclear material in and out, and the physical inventory of nuclear material present, can be determined. One or more MBAs are established for each facility as necessary. Starting from the known initial inventory of nuclear material in the MBA, one can maintain the balance of nuclear material in the MBA taking into account flows into and out of the MBA. The established balance can be verified during the nuclear material inventory taking, which is performed roughly, once a year. The Agency’s inspectors verify the nuclear material accounting records and reports submitted by the State and the facility operator. A serious anomaly in accountancy detected by the inspector serves as an indicator of possible diversion.

The technical objective (the objective of verification procedures) is the same for each safeguarded facility and LOF and has been formulated by the Agency based on paragraph 28 of INFCIRC/153. This technical objective is: to be able to detect, in a timely manner diversion of one significant quantity of safeguarded nuclear material from the facility or LOF. One significant quantity is taken to be the amount of nuclear material required to manufacture one nuclear explosive device. The timeliness aspect means that the inspector must be able to detect diversion within the time span equal to the amount of time required to convert the diverted material into weapon-usable form (conversion time).

47. In States with developed nuclear fuel cycle, nuclear material permanently flows through the facilities; therefore, the initial report represents just a snap-shot of this flow at a given point of time.

Summing up

The NPT brought about a fundamental change in the scope of IAEA safeguards. For a non-nuclear-weapon State party to the treaty, the requirement to accept IAEA safeguards expanded from specified items and materials to the entirety of the State's nuclear materials and activities. This change in safeguards scope had required the development of a full-scope (now comprehensive) safeguards agreement. The agreement was developed by the Safeguards Committee which adapted for this purpose the original version of the safeguards system described in INFCIRC/66.

The comprehensive agreement described in INFCIRC/153 uses terms and notions of the initial version of the Agency's safeguards system; some of them, for instance, "diversion" of nuclear material, nuclear material "subject to safeguards", and nuclear material "exempted from safeguards," have meanings which differ from those of INFCIRC/66. Most probably, this situation has arisen because of the mechanistic transfer of safeguards principles and procedures of INFCIRC/66, which were developed for application to the well-defined scope of items placed under safeguards, to INFCIRC/153 for verification of nuclear material which flows through the nuclear fuel cycle facilities, and which is required to be safeguarded "while it is being produced, processed or used at any principal nuclear facility or is outside any such facility" (NPT Article III).

Under the "item-specific" safeguards agreement the term nuclear material "subject to safeguards" means both the undertaking by the State not to use this material for proscribed purposes and the application to this material of safeguards procedures provided in the agreement. Under the comprehensive safeguards agreement it means only the application to this material of safeguards procedures as provided for in the agreement – the fundamental undertaking not to divert nuclear material to nuclear weapons is derived directly from the NPT itself. Similarly, the term nuclear material "exempted from safeguards", means under the comprehensive agreement only that the safeguards procedures provided in Part II of the agreement cease to apply to this material. The prohibition of diversion to nuclear weapons continues to apply. While these terminology problems did not affect practical implementation of the safeguards system until 1991, they became pronounced with the implementation of safeguards strengthening measures including the additional protocol to the agreement.

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3. Further development of the safeguards system: new types of safeguards agreements, Safeguards Implementation Report and Safeguards Criteria

Implementation of INFCIRC/153 influenced further development of the IAEA safeguards system. In addition to the "item-specific" type of safeguards agreement, two new agreement types were implemented: the "comprehensive" agreement applied in the non-nuclear-weapon States (NNWSs) parties to the NPT, and the "voluntary offer" agreement applied in the nuclear-weapon States (NWSs) parties to the NPT. Cooperation between States and the IAEA played a major role in the further development of the safeguards system, including development of the principles of nuclear material accountancy. The annual Safeguards

Implementation Report (SIR) prepared by the Secretariat and submitted to the Board played an important role in informing States about the safeguards implementation results and the implementation problems that occurred. Safeguards Criteria were developed to evaluate the effectiveness of safeguards implementation and to consolidate safeguards approaches for a given type of facility.

The three types of safeguards agreements

Development of the principles and procedures contained in INFCIRC/66 influenced, first of all, the structure and content of safeguards agreements. For the first type of safeguards agreement implemented by the Agency, the "item-specific" agreement, there was no model setting out a standardised text. Originally the texts of these agreements were drafted on the basis of the principles and procedures contained in INFCIRC/66 Rev.2. The agreements evolved further in the course of implementing the safeguards system, and today "item-specific" agreements contain standardised formulations of the State's and the Agency's undertakings under such agreement. These standardised formulations were influenced by the text of INFCIRC/153 in the part related to "the manufacture of any nuclear weapon" and "the manufacture of any nuclear explosive device". Now, the standard formulation of the Agency's obligation (the safeguards objective under this type of agreement) is:

> The Agency undertakes to apply safeguards, in accordance with the terms of this Agreement, to the items specified in this Agreement so as to ensure, as far as it is able, that no such item is used for the manufacture of any nuclear weapon or to further any other military purpose and that such items are used exclusively for peaceful purposes and not for the manufacture of any nuclear explosive device.

As far as the "comprehensive" safeguards agreement is concerned, there is not only a well-structured and technically sound content of such an agreement given in INFCIRC/153, but also a model agreement, issued as document GOV/INF/276, Annex A, putting the content of INFCIRC/153 into agreement form. As discussed in Part 2 of the Annex, the major difference between the model agreement and INFCIRC/153 is the formulation of paragraph 28 of INFCIRC/153 as compared to the corresponding paragraph of GOV/INF/276. It is important to emphasise that in all the "comprehensive" and "voluntary offer" agreements concluded by the Agency the text of this paragraph is identical to the text of GOV/INF/276.

A CSA consists of Part I, Part II and Definitions. Part I contains general provisions, such as the State's and the Agency's obligations specified in paragraphs 1 and 2; Part II describes the procedures for implementing those provisions. The objective of the safeguards procedures set forth in Part II (paragraph 28) is:

> … the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices, or for purposes unknown, and deterrence of such diversion by the risk of early detection.

INFCIRC/153 was taken as a basis for writing "voluntary offer" agreements concluded by the Agency with the five NWSs parties to the NPT. The formulation of the State's undertaking under the agreement differs from State to State, but the principal undertaking is the same; this fact allows all five agreements to be treated as belonging to the same type of safeguards agreement. The five States are formally recognised under the NPT as nuclear-weapon States,

therefore the State's obligation as specified in INFCIRC/153 does not apply to them. The purpose of a "voluntary offer" agreement, as stated, for example, in the preamble of the agreement between the Agency and the USA, is: "encouraging widespread adherence to the Treaty by demonstrating to non-nuclear-weapon States that they would not be placed in a commercial disadvantage by reason of the application of safeguards pursuant to the Treaty". An additional purpose, as stated, for example, in Article 3(d) of the agreement concluded with the USSR, is "the objective of ensuring the further development and improvement of safeguards techniques".

Under a "voluntary offer" agreement, the State provides the Agency with a list of facilities that it makes eligible for the application of safeguards. The Agency applies safeguards to nuclear material in those facilities that it selects from the State's list of eligible facilities in order to verify that the material is not withdrawn from peaceful activities except as provided for in the agreement. The procedures to attain this objective are the same as those in the "comprehensive" agreements.

It became clear in the course of evolution of the safeguards system that the Agency and the State are partners in implementing the safeguards agreement concluded between them. Paragraph 3 of INFCIRC/153 states that the Agency and the State shall cooperate to facilitate the implementation of the safeguards agreement. Both the State and the Agency have their responsibilities in implementing the agreement. The major responsibilities of the State are: to provide information specified in the agreement; to provide access for on-site verification; and to support the verification activities of IAEA inspectors. The major responsibilities of the Agency are: to perform independent verification of the State's compliance with its undertakings under safeguards agreement; and to draw a safeguards conclusion based on the verification activities performed. Paragraphs 30 and 90(b) of INFCIRC/153 provide for such conclusions.

Safeguards Implementation Report

The purpose of the annual Safeguards Implementation Report is to inform the international community of the results of the Agency's implementation of safeguards in States with safeguards agreements, including an analysis of safeguards operations and any problems encountered. The first such report, the Special Safeguards Implementation Report (SSIR) covering the Agency's safeguards activities in 1976, was prepared by the IAEA Secretariat in 1977 in accordance with the recommendations provided by the Standing Advisory Group on Safeguards Implementation (SAGSI). The report contained the following Safeguards Statement:

> From the analysis of the Agency's safeguards activities during 1976, the Secretariat has concluded that in none of the 41 States in which inspections were carried out was there any diversion of a significant quantity of safeguarded nuclear material and the Secretariat is confident that in these States there was no diversion at all.

The next report, issued in 1978, and all the consecutive reports were entitled "Safeguards Implementation Report" (SIR) and contained a Safeguards Statement and an analysis of the verification activities on which the statement was based. While the Safeguards Statement in the SIRs for 1976 to 1979 referred only to "diversion" of safeguarded nuclear material, the Safeguards Statement of the SIR for 1980 referred to both "diversion" and "misuse":

> In 1980, as in previous years, the Secretariat, in carrying out the safeguards programme of the Agency, did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material - or the misuse of facilities or equipment under certain agreements - for the manufacture of any nuclear weapon, or to further any other military purpose, or for the manufacture of any other nuclear explosive device. The Secretariat therefore considers it reasonable to conclude that the nuclear material under Agency safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for.

The above statement reflects the verification concept used by the Secretariat. The core of the concept is the hypothesis that in case of a "diversion" or a "misuse" there will be indications (anomalies) detectable by the inspectors. If no such anomalies were detected, the Secretariat concludes that the safeguarded nuclear material remained in peaceful nuclear activities or was otherwise adequately accounted for. The wording "or was otherwise adequately accounted for" was included in the statement because a certain fraction of the material placed under safeguards (in the sense of having been placed under the accounting procedures) could have been taken out of safeguards due to legally sound processes, such as nuclear consumption, nuclear decay, or exemption from safeguards in accordance with the terms of safeguards agreement.

The credibility of the above statement depends on the effectiveness of the verification procedures applied by the Secretariat. In order to make it possible for the member States to assess the effectiveness of the verification activities implemented, the Secretariat developed an effectiveness evaluation methodology. In this methodology, the effectiveness of the implementation of the safeguards approaches designed per facility type is evaluated with the help of "performance indicators", or the "safeguards criteria." This methodology is discussed in the "Safeguards Criteria" chapter below.

The last SIR issued for the pre-1991 period, the SIR for 1990, contained the following Safeguards Statement:

> In carrying out the safeguards obligations of the Agency in 1990, the Secretariat, as in previous years, did not detect any event which would indicate the diversion of a significant amount of safeguarded nuclear material - or the misuse of facilities, equipment or non-nuclear material subject to safeguards - for the manufacture of any nuclear weapon, or for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown. It is considered reasonable to conclude that the nuclear material under Agency safeguards in 1990 remained in peaceful nuclear activities or was otherwise adequately accounted for. This statement is based on all the information available to the Agency, including information derived from safeguards activities conducted in the field and at Headquarters and information provided in reports submitted by States.

There was a footnote to this statement: "In the case of voluntary-offer agreements with nuclear-weapon States, nuclear material subject to safeguards was not withdrawn from safeguards except in conformity with these agreements."

As this was the last Safeguards Statement for the period considered, we shall analyse it in detail. The statement reflects the generic concept of safeguards implementation used in the period considered. This concept, which we refer to as the "Facility-level concept" - to differentiate it from the concept of safeguards implementation based on the State as a whole -

was inherited from the principles and procedures described in INFCIRC/66. According to the "Facility-level concept", the Agency verifies that nuclear material placed under safeguards in a facility or LOF is not diverted for the manufacture of nuclear weapons or for purposes unknown. Such diversion can be detected through implementing nuclear material accounting measures supported by containment and surveillance measures. This concept was directly applicable to the implementation of "item-specific" and "voluntary offer" agreements, as safeguards under such agreements apply to nuclear material in specified facilities or LOFs. Under the "comprehensive" agreements, safeguards were applied to nuclear material in facilities and LOFs declared by the State - the objective to verify the **completeness** of the State's declarations was not included in the "Facility-level" concept.

The objective described in paragraph 28 of INFCIRC/153 was taken as the objective of IAEA safeguards procedures under each of the three types of safeguards agreement. The peculiarities of the other two types of agreements were taken into account by referring to the "misuse of items" in case of the "item-specific" agreements and by clarifying that the term "diversion" was used in lieu of the term "withdrawal" in case of the "voluntary-offer" agreements. The Safeguards Statement addressed, therefore, the entirety of the nuclear material placed under safeguards under all types of safeguards agreements. The fact that the State's undertakings are different, depending on the type of safeguards agreement concluded, was reflected in the Safeguards Statement only when implementing the post-1991 safeguards system.

Safeguards criteria

Safeguards criteria were developed by the IAEA Secretariat for the purpose of reporting in the SIR on the effectiveness of safeguards implementation. The initial set of safeguards criteria (the evaluation criteria) represented the performance indicators of major inspection activities implemented at reactor-type facilities and at facilities other than reactors. As the generic objective of inspection activities was taken to be **the timely detection of diversion of one significant quantity of nuclear material from a facility or LOF**, two components of the inspection goals, the **quantity** and the **timeliness** components, were evaluated.

- The quantity component was regarded as fully attained if all the inspection activities necessary to verify the declared amount of Material Unaccounted For (MUF) had been adequately performed. In other words, these were the inspection activities necessary to detect a protracted diversion.
- The timeliness component was regarded as fully attained if all the inspection activities necessary for detecting an abrupt diversion had been adequately performed.

Examples of safeguards criteria (performance indicators) were:

- at least one physical inventory at the facility during the year must be carried out;
- the probability of detecting diversion of nuclear material must correspond to the requirements established for a given category of nuclear material, e.g. 90% for direct-use material;
- the time interval between the inspections for timely detection purpose must not exceed the conversion time parameter established for a given category of nuclear material.

Safeguards criteria evolved further from the minimum set of performance indicators, used in connection with the preparation of the SIR, to the implementation and evaluation criteria known as the "1991-95 Safeguards Criteria". The 1991-95 criteria specified, for major types of facilities under safeguards, the scope, the normal frequency and the quality of the verification activities which were considered necessary for fulfilling the Agency's responsibilities under safeguards agreements.

The 1991-95 criteria contained, for each type of nuclear facility, a set of major verification activities to be carried out during a **material balance period** (the time period between two consecutive physical inventory takings):

- Audit of facility accounting and operating records and examination of the State's accounting reports;
- Verification of nuclear material inventories and, under "item-specific" agreements, inventories of non-nuclear material and equipment;
- Verification of nuclear material flow including transfers between the facilities and transfers within the facility;
- Application of containment and surveillance measures;
- Verification of facility design information;
- Verification of the operator's measurement system;
- Evaluation of material balances and drawing safeguards conclusions over the material balance period, as required by paragraphs 30 and 90(b) of INFCIRC/153.

The evolution process involved not only the criteria but also the reporting and evaluation procedures, in particular, a new revision of the computerised inspection report which was introduced in 1991.

The SIR process included not only the evaluation of the inspection goal attainment but also an analysis of the reasons for failure to fully attain the goal, and the formulation of generic problems affecting the implementation of IAEA safeguards. These problems were dealt with on a routine basis by the Secretariat in collaboration with the member States, with the aim of further increasing the effectiveness and efficiency of safeguards implementation. The process of identifying safeguards implementation problems through the evaluation of inspection goal attainment, and resolving them in cooperation with States, was summarised, for the period 1982-1991 in an article published in the IAEA Yearbook 1991.[48] The major outcomes of this process were listed as follows:

- Lack of adequate method to verify spent fuel.
    - A considerable advance in the problem solution was the development of the Cerenkov glow viewing device (night vision device) which effectively came into use over the period 1984-86 and the development of an improved device capable of operating in normal facility lighting. A new piece of equipment, the spent fuel attribute tester, was introduced around 1990.
- Lack of adequate equipment to verify fuel assemblies at fabrication plants.

48. A.S.Adamson, V.M.Bychkov, "IAEA safeguards experience in the last ten years (1982-1991)", IAEA Yearbook 1991.

- Equipment capable of verifying finished assemblies to an acceptable accuracy, the “Neutron Collar”, was developed and introduced for practical use at a number of facilities.

- Lack of methods or arrangements to verify in-process material in large facilities.
  - A study was carried out to ensure that the Agency had available adequate techniques and practical procedures. A combined effort by the Agency, State authorities and operators to resolve the problem was very effective. During the period from 1985 to 1989 the problem had been practically solved.

- Lack of methods or procedures to be applied to difficult-to-access nuclear material.
  - The principal problem was that surveillance systems covering difficult-to-access material were insufficiently reliable and reverification of nuclear material after loss of continuity of knowledge was difficult or impossible. Major advances took place in the development of dual containment and surveillance systems. The dual systems do not have a common mode of failure and, where they could be applied, had solved the problem.

- Lack of standardised systems for recording, processing and storing inspection data and lack of standardised inspection procedures.
  - The introduction of computer systems was influential in the creation, in 1983-84, of computerised inspection data processing. The development of the comprehensive 1991-95 Safeguards Criteria resulted in standardised verification procedures for facilities of the same type.

Safeguards progressed steadily over the ten year period under discussion. The principles had been clearly stated and there was considerable evidence of the desire of both member States and the Secretariat to ensure these principles were attained in practice. Problems did exist but could be solved. The safeguards system demonstrated its ability to meet challenges and to advance with changing requirements. Substantial contributions to safeguards development were provided through national programs, committees and other regular forms of contact between the Agency and member States.

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4. Introduction of the additional protocol and development of the integrated safeguards concept

A new stage in the evolution of the IAEA safeguards system started in 1991 following the discovery in Iraq of a clandestine nuclear weapons program. UN Security Council resolution 687 (1991) required Iraq to reaffirm unconditionally its obligations under the NPT and to submit to the IAEA a declaration of the locations of all means and materials which could be used for the manufacture of nuclear weapons. Iraq was required to destroy all of its chemical, biological and nuclear weapons capability and to allow verification by inspectors from the UN Special Commission (UNSCOM) and the IAEA.

IAEA inspectors were entrusted with important tasks: to verify the completeness of Iraq’s nuclear declaration and to confirm that all the nuclear capabilities created for nuclear weapons

purposes had been destroyed or made inoperable. To fulfill the first task, the IAEA had to implement new measures which had not been used by the Agency before: analysis of all available information including data on import of dual-use technology, intelligence information from other States, satellite imagery, environmental sampling, and other measures. The second task required IAEA inspectors to independently observe the removal from Iraq of relevant material, the conversion, where possible, of nuclear and nuclear-related installations from serving a military purpose to peaceful purposes, and the destruction of these installations. A useful summary of the results of the IAEA's verification activity under UNSC resolution 687 was presented by Jacques Baute, the former head of the IAEA's Iraq Nuclear Verification Office, in an article published in the IAEA Bulletin.[49]

Based on its activities under UNSC resolution 687, the IAEA concluded that Iraq was not in compliance with its obligations under its safeguards agreement:

> Inspection activities carried out pursuant to United Nations Security Council resolution 687 revealed that Iraq had not complied with the obligations under its safeguards agreement to declare certain nuclear activities and place all relevant nuclear material under safeguards.[50]

The case of Iraq revealed that the IAEA safeguards system had serious shortcomings:

> … owing to limitations in the information available to the Agency and in the existing safeguards practices, non-compliance with agreements could occur without detection by the Agency, particularly at non-declared facilities.[51]

The need to strengthen the IAEA safeguards system was evident. Prompted by the situation in Iraq, as well as the revelation of South Africa's nuclear weapon program (developed prior to South Africa joining the NPT), and problems emerging in the implementation of the CSA in the DPRK[52], the IAEA took a number of decisions aimed at strengthening the safeguards system. In particular, in early 1992 the Board of Governors re-affirmed that IAEA safeguards apply to **all** nuclear material in **all** nuclear activities. It also made clear that safeguards are applicable to States' nuclear activities anywhere. The Board also reiterated the Agency's right to undertake special inspections. Another important step was the Board's decision calling for the early provision of facility design information. At this time the Agency initiated a study into the scope of its existing safeguards authority and consideration of possible strengthening measures.

In 1993, the Standing Advisory Group on Safeguards Implementation (SAGSI), acting on a request by the Director General, submitted recommendations for strengthening the safeguards system. Based on SAGSI's recommendations, the IAEA launched a program (named "Programme 93+2") to strengthen the effectiveness and enhance the efficiency of the safeguards system. The main task of this Programme was to develop measures to ensure the **completeness** of a State's declaration in the framework of its comprehensive safeguards agreement. One of the principal focuses of this Programme was on the evaluation of all safeguards-related information about a State with a view to treating the State as a whole, rather than evaluating information on a facility-by-facility basis. The practical implementation

49. Jacques Baute, "Timeline Iraq, Challenges and lessons learned from nuclear inspections", IAEA Bulletin 46/1, June 2004.
50. IAEA Safeguards Implementation Report for 1991, the Safeguards Statement.
51. Ibid.
52. Democratic People's Republic of Korea.

of this idea required the development of new verification concepts, which emerged over the following years.

The results of Programme 93+2 were summarised in two Parts. Part I comprised safeguards measures that the IAEA had the authority to implement within the framework of existing CSAs. Part II comprised those safeguards measures for the implementation of which the IAEA would need additional legal authority. This additional legal authority took the form of a "Model Additional Protocol", approved by the Board in 1997 and published as document INFCIRC/540 (corrected). The safeguards measures resulting from the Programme 93+2 were described in a comprehensive article by the Deputy Director General, Department of Safeguards, Pierre Goldschmidt.[53]

The stated purpose of the "Model Additional Protocol" was to strengthen the effectiveness and improve the efficiency of the safeguards system as a contribution to global nuclear non-proliferation objectives. This model is to be used as a standard for additional protocols concluded by States parties to comprehensive safeguards agreements with the Agency. Additional protocols with regard to other types of safeguards agreements were to be negotiated between the State and the IAEA, incorporating those measures which the State was prepared to accept. The conclusion of an additional protocol (AP) was described as being "voluntary", but it was expected that a State adhering to the objective of strengthening the non-proliferation regime would do so.

The "Model Additional Protocol" extended the scope of information to be provided by the State to the IAEA and gave IAEA inspectors additional access to locations in the State related to nuclear fuel cycle activities. New verification measures included consistency analysis of all safeguards-related information available to the Agency and complementary access to locations beyond the KMPs and strategic points defined under the CSA. The purposes of such access are those defined in the AP, i.e. to assure the absence of **undeclared nuclear material and activities** in a specified location, to resolve an inconsistency or a question related to the information provided under Article 2 of the AP, or to confirm the declared decommissioned status of a facility or LOF.

In order to implement measures of the AP in States with comprehensive safeguards agreements, the Agency developed a new implementation concept termed "integrated safeguards". The concept was described in internal IAEA document GOV/2002/8, "The Conceptual Framework for Integrated Safeguards". A description of integrated safeguards can also be found in open media.[54]

The stated purpose of integrated safeguards was to use the "optimum combination" of all safeguards measures available to the Agency under comprehensive safeguards agreements and additional protocols in such a way as to achieve the maximum effectiveness and efficiency within available resources in achieving the safeguards objective stated in paragraph 2 of INFCIRC/153. The way of achieving this objective was through the establishment of two goals for the Agency's verification activities: (a) to provide credible assurance of the non-diversion of nuclear material from declared activities; and (b) to provide credible assurance of the absence of undeclared nuclear material and activities in the State as a whole. These assurances

53. Pierre Goldschmidt, "The IAEA safeguards system moves into the 21st century", Supplement to the IAEA Bulletin, vol.41, No.4/December 1999.
54. Jill Cooley, "Integrated nuclear safeguards: genesis and evolution", Verification Yearbook 2003, Center for Security studies, ETH Zurich.

(safeguards conclusions) were to be provided by the Agency on the basis of its verification activities aimed at: (a) detecting indications of diversion of declared nuclear material from declared facilities and LOFs; and (b) detecting indications of existence in the State of undeclared nuclear material and activities. It was understood, however, that the absence of detected indications did not prove with absolute certainty that no diversion had occurred or there were no undeclared nuclear material and activities (the absence of evidence is not evidence of absence).

It was further assumed, under this concept, that the Agency's ability to draw a conclusion of the absence of undeclared activities in the State would provide a rationale for reductions in verification effort on those categories of nuclear material which require further processing to produce weapon-usable material (the prescribed verification effort was based on the assumption that undeclared facilities for such further processing could exist). In the "integrated safeguards approaches for facilities" to be implemented for attaining the goal (a) above, this enabled a reduction in the frequencies and intensities of inspection activities as compared with the performance targets of the Safeguards Criteria.

Integrated safeguards were to be implemented in a State with a comprehensive safeguards agreement and an additional protocol in two stages. During the first stage, which could take several years, the Agency would perform all the evaluation and verification activities which it considered necessary for drawing the initial conclusion of the non-diversion of declared nuclear material and of the absence of undeclared nuclear material. Following the drawing of this conclusion, the second stage would start with the implementation of a "State-level approach" which contained measures for the attainment of goals (a) and (b) described above.

Starting with the Safeguards Implementation Report (SIR) for 1991, the Safeguards Statement, which is given on the first page of each SIR, included two components. The first component related to the conclusion that all the nuclear material and items placed under safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for. The second component related to the IAEA findings in individual States. The 1991 Statement contained the IAEA findings of undeclared nuclear material and activities in Iraq. In its 1992-97 Safeguards Statements the IAEA reported on its findings in the DPRK; in the SIR for 1992 the IAEA stated that it could not confirm the completeness and correctness of the DPRK's initial report under the CSA concluded with the Agency. This was followed by the Statement in the SIR for 1993 that the IAEA was unable to conclude there had been no diversion of nuclear material subject to safeguards in the DPRK.

This process of inclusion in the Safeguards Statement of the IAEA findings for individual States and, since 1999, of the results of additional protocol implementation, resulted, in the SIR for 2003 and the SIRs that followed, in a new structure for the Safeguards Statement. In this new structure, safeguards conclusions were drawn at the State level and with regard to compliance of each individual State with its obligation under the type of safeguards agreement concluded with the IAEA. This reporting reflected the conceptual evolution of the IAEA safeguards system – from the level of facilities to the level of the State as a whole.

In the SIR for 1999, the Agency reported that it was in the early stages of implementing additional protocols. The report stated that:

> For two States, each of which has a comprehensive safeguards agreement and an additional protocol in force, the Agency was able to draw a further conclusion relating to the absence of undeclared nuclear material and activities in the State as a whole.

The Safeguards Statement continued its evolution and in the SIR for 2000 the two components of the Statement were more pronounced. First, the Statement contained a conclusion 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.

Second, it concluded that:

> … for seven States, each of which has a comprehensive safeguards agreement and an additional protocol in force or being provisionally applied, the Agency concluded that all nuclear material in those States had been placed under safeguards and remained in peaceful nuclear activities or was otherwise adequately accounted for.

The latter conclusion was supported by the confirmation that:

> … the Agency found no indication of diversion of nuclear material placed under safeguards or of the presence of undeclared nuclear material or activities in these States.

The formulation of safeguards conclusion for the seven States with a CSA and additional protocol, referred above, reflects the early stage of conceptual development towards the future State-level concept. The idea of Integrated safeguards had originated from the IAEA's experience in Iraq: starting from 1991 IAEA verification activities in Iraq under the CSA had been subsumed under the activities pursuant to UNSC resolution 687. The Agency returned to routine implementation of the CSA only when it was possible to conclude that there were no remaining undeclared nuclear material and activities in Iraq. Similarly, the conceptual basis of integrated safeguards was: first to arrive at the conclusion relating to the absence of undeclared nuclear material and activities in the State as a whole, and then to implement a State-level approach which contains the optimised set of safeguards measures available under the CSA and additional protocol. The initial conclusion of no diversion of declared material and no undeclared nuclear material in the State is referred to as the "broader conclusion". The ability of the Agency to continue to draw the "broader conclusion" on an annual basis is maintained through the implementation of the SLA.

With the implementation of integrated safeguards, the IAEA's safeguards implementation was divided into two parts: so-called "traditional safeguards" (implementation of all types of safeguards agreement under the Facility-level concept) and Integrated safeguards (implementation of the CSA and additional protocol for the States for which the IAEA has drawn the broader conclusion). While implementation of "traditional safeguards" was governed by the Safeguards Criteria, implementation of Integrated safeguards was governed by the SLAs developed for each individual State. The distinction between Integrated safeguards and traditional safeguards may have given the impression that the IAEA has the right to verify the absence of undeclared nuclear material and activities only in those CSA States that have concluded an additional protocol. The problem of this incorrect perception was resolved under the State-level concept: it was confirmed that the technical objective "to detect undeclared nuclear material and activities" arises from the legal authority of the CSA (Article II of the agreement) and is therefore applicable to all CSA States.[55] The additional protocol simply provides additional technical means to fully achieve this objective.

55. Paragraph 6 of the IAEA Safeguards Implementation Report for 2005.

The concept of integrated safeguards was an important milestone in the evolution of the IAEA safeguards system. It ended the predominance of the old Facility-level concept and ensured further movement towards the State-level concept.

At the same time, the concept of integrated safeguards had several shortcomings:

- An SLA developed under this concept was applicable only for States with a CSA and an additional protocol, and only for those of them for which the broader conclusion had been drawn; the concept was not applicable to other States with a CSA;
- While means for drawing a conclusion of **no diversion of declared nuclear material** could be based on Facility-level approaches developed in line with the Safeguards Criteria, the means for drawing a conclusion of **no undeclared nuclear material and activities** had not been sufficiently developed; and sufficient transparency for the process of drawing the initial broader conclusion was lacking;
- The Facility-level approaches had been developed with the assumption that the State could have undeclared facilities to convert diverted nuclear material into weapon-usable form; the initial conclusion of **no undeclared nuclear material and activities** invalidates this assumption;
- It was understood, in the course of implementing integrated safeguards, that the Agency cannot conclude, with absolute certainty, that there **is no diversion of declared material** and **no undeclared nuclear material and activities** in the State: the only certain Statement the Agency can make is that it did not detect possible indicators of such events; a question remains: what should be the intensity and the frequency of verification activities in the State in order that the Agency can make the initial broader conclusion and maintain this on an annual basis?

These shortcomings have been mostly overcome in the process of developing the State-level concept, which is discussed in Part 5 following.

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5. Development of the State-level concept

Development of the State-level concept (SLC) was the most controversial part of the post-1991 evolution of the IAEA safeguards system. This concept was mentioned specifically for the first time in the Safeguards Implementation Report (SIR) for 2004.[56] The concept was being developed mostly by the IAEA Secretariat with some external input from SAGSI and other expert groups. Because development was ongoing, only limited information on the SLC was given officially until 2012, when a number of member States began to question how the concept was being applied in practice. In 2012 and 2013 the subject was intensively discussed

56. Quotation from the SIR-2004: "The Department of Safeguards further developed the safeguards effectiveness evaluation process. By the end of 2004, it adopted a State-level concept for implementation and evaluation of safeguards. This concept is now being implemented for the States with integrated safeguards and will be extended for all the other States with comprehensive safeguards agreements. Under this concept, safeguards implementation and evaluation are based on a State-level approach developed for each individual State. State-level approaches are developed on non-discriminatory basis using safeguards verification objectives which are common to all the States."

at Board meetings and the General Conference; the Secretariat also arranged a series of technical meetings for member States in an attempt to clarify the issues involved. These efforts resulted in two reports by the Director General to the Board on the conceptualisation of safeguards implementation at the State level.[57] A useful study of this subject has been published by Noah Mayhew.[58] This study analysed, "through the lens of safeguards language", the most significant points of disagreement on the SLC and its outstanding issues. Indeed, insufficiently developed safeguards terminology contributed to the problems of comprehension and acceptance of the SLC.

In this part of the Annex, we undertake to answer the following questions:

- What were the reasons for the introduction of the SLC?
- What role has the SLC played in further conceptualisation of the safeguards system?
- What is the impact of the SLC on contemporary safeguards terminology?

Reasons for the introduction of the SLC

As stated in the SIR for 2004, the Secretariat adopted the SLC when further developing its safeguards effectiveness evaluation process. There was a need to evaluate[59] the effectiveness of implementing integrated safeguards. Traditional evaluation methodology was based on assessment of the extent to which the implementation of safeguards was able to achieve the applicable safeguards objectives. The Safeguards Criteria, which were used for practical evaluation of safeguards effectiveness, were based on the technical objective formulated at facility level and related to the inspector's ability to detect, in a timely manner, a diversion of one significant quantity of nuclear material from a facility. The formulation of this objective was based on paragraph 28 of INFCIRC/153. The Safeguards Criteria listed the inspection activities which were considered necessary to attain this objective.

Under the integrated safeguards concept, **two technical objectives** were introduced: the old one, formulated at the **facility level** related to detecting diversion of declared nuclear material from a declared facility; and the new one, formulated at the **State level**, related to detecting undeclared nuclear material and activities in the State as a whole. This second objective originated from the requirement of paragraph 2 of INFCIRC/153 for **completeness**. In order to address completeness, a new concept of safeguards effectiveness evaluation was required. This new concept needed to be formulated at the State level and to include appropriate new safeguards objectives.

Pursuing this task further, it was necessary to develop the verification activities needed for the attainment of the stated technical objectives. The vehicle for determining State-level verification activities already existed in integrated safeguards, namely, a State-level approach

57. "The Conceptualisation and Development of Safeguards Implementation at State level", GOV/2013/38, 12 August 2013, and "Supplementary Document to the Report on The Conceptualisation and Development of Safeguards Implementation at the State Level", GOV/2014/41.
58. Noah Mayhew, "A lexical history of the State-level concept and issues for today", VCDNP, Occasional Paper, December 2020.
59. A distinction should be made between the two different processes: (a) the "State evaluation" process to evaluate all safeguards-related information for consistency and for identifying possible indicators of non-compliance, and (b) the safeguards effectiveness evaluation process to ensure that safeguards conclusions are sound and credible.

(SLA) coupled with an Annual implementation plan (AIP).[60] Such a SLA, developed for each individual State, replaces the former Safeguards Criteria. And the new concept for the evaluation of safeguards effectiveness, termed the State-level concept, becomes, as a matter of fact, the concept for safeguards implementation and evaluation.

The new State-level objective to detect undeclared nuclear material and activities was derived from Article 2 of the CSA. This meant this objective is applicable to all States with CSAs irrespective of whether they have concluded an additional protocol to their safeguards agreement. This fact was clarified in the SIR for 2005. In the "Background to the Safeguards Statement" this SIR said:

> While the Agency's authority to verify the correctness and completeness of a State's declarations under its comprehensive safeguards agreement derives from the agreement itself, the tools available to the Agency to do so under such an agreement are limited. The Model Additional Protocol … equips the Agency with important supplementary tools which address these limitations by providing the Agency with broader access to information and locations.

Initially, the SLC was developed to cover safeguards implementation and evaluation in all States with CSAs. For this purpose, three generic State-level objectives[61] were formulated:

(a) To detect diversion of declared nuclear material;[62]

(b) To detect undeclared production or processing of nuclear material at declared facilities;

(c) To detect undeclared nuclear material and activities.

These objectives cover all the activities which a State, if it is in the process of diverting nuclear material to the manufacture of a nuclear weapon, might undertake. An undeclared chain of such activities would constitute an "acquisition path" used by the State to acquire weapon-usable nuclear material. Analysing the plausible "acquisition paths" that a State with a given nuclear fuel cycle might undertake, the inspector can identify the indicators of the "diversion process" and implement the verification activities necessary to detect these indicators.

The SLC resolved the shortcomings of integrated safeguards identified in Part 4 of this Annex:

- The SLC was applicable to all States with CSAs, not only those for which the broader conclusion had been drawn;
- There was no requirement, under the SLC, to draw a conclusion of the absence of undeclared nuclear material and activities in the State; this requirement was replaced with the verification objective to detect those indicators of undeclared activities which belong to a plausible acquisition path for a State with a given nuclear fuel cycle;

60. Very little information is available on how the IAEA Secretariat derives the Annual Implementation Plan from the State-level approach. For the sake of simplicity, we will skip consideration of the AIP in further discussion and deal only with the SLA.

61. Initially there was a fourth State-level objective - to resolve anomalies, questions and inconsistencies - but this is incidental to the three primary objectives and was not included separately in the final version of this list of objectives.

62. The term "diversion" was used here in the sense of "undeclared withdrawal" from the facility. An alternative formulation of this objective is: "to verify whether declared nuclear material has been adequately accounted for".

- Under the SLC, the intensity and the frequency of verification activities in the State are established on the solid basis of an acquisition path analysis.

The ideas of the SLC influenced further development of integrated safeguards. The initial State-level IS approaches (SLISAs), which consisted, in part, of the Facility-level integrated safeguards approaches translated into the so-called "Integrated Safeguards Criteria", have been gradually replaced with SLAs developed on the basis of acquisition path analysis (APA). The formulation of the safeguards conclusion was modified as discussed below.

Role of the SLC in further conceptualisation of the safeguards system

The SLC was introduced at the time when the Agency was in the process of modifying the structure of its Safeguards Statement reported in the SIR. This process resulted in a new structure for the Statement in the SIR for 2003, and in the SIRs that followed. The Statement was broken out into the three main groups of States in accordance with the three types of safeguards agreements concluded with the IAEA.[63] In addition, a fourth group was included, comprising States parties to the NPT which had not yet concluded a CSA with the IAEA.

The group of States with a CSA was further broken out into three sub-groups:

- States with a CSA and an additional protocol for which the broader conclusion had been drawn;
- States with a CSA and an additional protocol for which the broader conclusion had not yet been drawn; and
- States with a CSA which had not concluded an additional protocol.

The main conceptual characteristic of the SLC is the formulation of the safeguards objective at the State level, in accordance with the State's obligations under the safeguards agreement it has concluded. Originally the SLC was introduced for implementing and evaluating safeguards in those States with a CSA. Later it was expanded to all other States with safeguards agreements.

Two important safeguards terms have been clarified in the process of development of the SLC:

- The term "diversion" has different connotations depending on the implementation concept; under the Facility-level concept it means undeclared withdrawal of nuclear material from a facility; under the State-level concept "diversion to nuclear weapons" means a chain of undeclared activities by the State which is aimed at acquiring weapon-usable material and includes withdrawal of declared material from declared facilities; misuse of declared facilities; and use of undeclared material and activities.
- The term "safeguards objective" also has different connotations. First, it relates to the objective of the implementation of a safeguards agreement by the parties to the agreement, namely, the State and the IAEA, and such a "safeguards objective" is described in paragraphs 1 and 2 of INFCIRC/153. Second, it relates to the objective(s) of the IAEA verification activities: such a "safeguards objective", which is also referred to as "technical objective", is described in paragraph 28 of INFCIRC/153.

63. CSAs, item-specific safeguards agreements and voluntary offer agreements.

The next task in developing the SLC was to formulate a safeguards conclusion under the CSA which would be consistent with safeguards and technical objectives under this type of safeguards agreement.

The Safeguards Statement of the SIR for 2003 had a new structure that was consistent with the understanding that the Agency verifies the compliance of a State with its obligations under the safeguards agreement it has concluded. The Secretariat stated in particular that only for those States with both a CSA and an additional protocol were Agency safeguards able "to provide credible assurance not only regarding the non-diversion of nuclear material but also regarding the absence of undeclared nuclear material and activities." For these States, the Secretariat reported that it:

> … found no indication of the diversion of nuclear material placed under safeguards and no indication of undeclared nuclear material or activities for the State as a whole. On this basis, the Secretariat concluded that all nuclear material within the territories of those States, under their jurisdiction or under their control anywhere had been placed under safeguards and remained in peaceful nuclear activities or was otherwise adequately accounted for.

The conclusion that all nuclear material in those States "had been placed under safeguards" was based on the fact that the Secretariat found no indication of undeclared nuclear material or activities in those States. And the conclusion that all nuclear material "remained in peaceful nuclear activities or was otherwise adequately accounted for" was based on the fact that the Secretariat found no indication of diversion (no indication of undeclared withdrawal) of nuclear material placed under safeguards. The chain of logic of this conclusion followed, therefore, the internal logic of the integrated safeguards concept.

The wording "remained in peaceful nuclear activities or was otherwise adequately accounted for" requires further elaboration. The statement that nuclear material "was otherwise adequately accounted for" might seem to imply that the material did not remain in peaceful nuclear activities. The original meaning of this statement was that part of the material placed under safeguards did not remain under safeguards due to legitimate reasons, such as nuclear decay, consumption, exemption from safeguards or termination of safeguards. Therefore, the implication that this material did not remain in peaceful nuclear activities is incorrect. In the case of nuclear material which has decayed or been consumed (e.g. through nuclear fission), such material no longer exists. In the case of nuclear material which has been exempted from safeguards or for which safeguards have been terminated, this material still exists and may remain within the State. Measures of the additional protocol can be applied to such material in order to verify whether it remains in peaceful activities or is involved in a diversion process through a possible acquisition path.

A new formulation of the safeguards conclusion for States with a comprehensive safeguards agreement and an additional protocol was used in the SIR for 2005 and in the SIRs that followed. This conclusion was formulated in accordance with the SLC logic and stated that:

> … the Secretariat found no indication of the diversion of declared nuclear material from peaceful nuclear activities and no indication of undeclared nuclear material or activities. On this basis, the Secretariat concluded that, for these States, all nuclear material remained in peaceful activities.

The term “diversion” is used here in the sense of “undeclared withdrawal” of nuclear material from a facility. The actual meaning of the first sentence is that the Secretariat found no indication of a diversion process aimed at acquisition of weapon-usable material which could be used for the manufacture of nuclear weapons. This formulation of the safeguards conclusion is in line with the safeguards objective specified in Article 2 of the CSA.

Impact of the SLC on safeguards terminology

The SLC was the product of a further conceptualisation of the safeguards system. In the process of safeguards conceptualisation, the IAEA must ensure that safeguards terminology is precise and unambiguous. The introduction of the SLC highlighted several problems with safeguards terms which need to be resolved. While these terminology problems did not affect practical implementation of the safeguards system until 1991, they became pronounced in the post-1991 safeguards system. A number of such problems, in particular the definition of “safeguards objective”, have been identified during the SLC development. Some of these problems are discussed in Part 2 of the Annex, “Adaptation of the IAEA safeguards system for the NPT”.

In the 2022 edition of the Safeguards Glossary the IAEA Secretariat made some progress in further clarification of safeguards terms. This work will continue. Terms which require clarification include: “diversion”, “safeguards objective”, “technical objective”, “starting point of safeguards”, “nuclear material placed under safeguards”, “exemption from safeguards”, “termination of safeguards” and “non-compliance”. We address this issue in section D of this paper, on the evolution of safeguards terms and notions.

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