

September 6, 2013

## IAEA SAFEGUARDS SYSTEM: CONCEPTUAL EVOLUTION\*

Valery Bytchkov\*\*

Historically, the system under study has been called “the IAEA safeguards system”; however, as it is shown below, it would be more appropriate to call it “the IAEA verification system”. At present, the system serves the purpose of verification of States’ compliances with their international undertakings concerning peaceful use of nuclear energy. It comprises safeguards agreements between the Agency and the States, procedures for implementing provisions of the agreements, and human, technical and financial resources necessary to implement the procedures.

The current stage of the system’s evolution is associated with the so-called *State-Level Concept*<sup>1</sup>. In the framework of this concept, the result of Agency’s verification activity is the safeguards conclusion concerning the fulfillment of a State’s obligations under the Safeguards Agreement. In the early stages of safeguards development, which we associate with a *Facility-Level Concept*, the safeguards conclusion related to the non-diversion from peaceful activity of a nuclear facility, material or equipment placed under the Agency’s safeguards. This conceptual difference resulted from the system’s evolution over the past several decades. In spite of the fact that some elements of the *State-Level Concept* have been used by the Agency since the beginning of 2000, the concept has not yet been satisfactorily documented.

There are a number of publications describing the evolution of the Agency’s safeguards<sup>2</sup>. The existing publications, while addressing historical, political, legal, and technical aspects of that evolution, contain little information about the system’s underlying principles or concepts. However, analysis of these principles is important for achieving a proper understanding of how the system functions and what potential it has for further development. The present article attempts to address these issues and to describe the contemporary concept of safeguards implementation.

Methods of analogy and modeling are often used for investigation of various systems. In order to stress the importance of the evolution process, analogy is made in this paper between the safeguards system and a biological system. It is known that genes play an important role in the evolution of any biological system. In the safeguards system, the principles laid down in its fundamental documents play the role of genes that control and influence the system’s evolution. The safeguards agreements and the safeguards procedures, being implemented by the Agency and the States, constitute the system’s body. And finally, the international community, the nuclear industry, and major political events which have taken place during the time period being discussed, play the role of the environment.

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\* The article is based on the report prepared by the author for the Nuclear Club journal (№1-2, 2013).

\*\* Valery **Bytchkov** is an independent expert. He has worked at the IAEA Department of Safeguards for 25 years (1981-1985; 1987-2007), including as the Head of Operations Sections and the Head of Section for Effectiveness Evaluation.



The IAEA safeguards system has been evolving since it was first designed in 1961. The key milestones of that evolution are reflected in the Agency's Information Circulars: INFCIRC/26, INFCIRC/66, INFCIRC/153 and INFCIRC/540<sup>3</sup>. Throughout this paper we will be referring to these documents simply by giving the number of the corresponding Information Circular, e.g. '66' will mean INFCIRC/66/Rev2 (the latest revision).

### **Origin of the term “Safeguards” and creation of the IAEA**

According to David Fisher<sup>4</sup>, who had been working for the IAEA in various capacities for more than 40 years, the term “nuclear safeguards” was first publicly proposed in November 1945 by the heads of the three allied States: the USA, the UK and Canada. The three allies said that they would be willing to proceed with the exchange of fundamental scientific information about atomic energy - but only upon establishment of conditions that would prevent non-peaceful use of that energy. These conditions were described in the declaration as “reciprocal and enforceable safeguards acceptable for all nations”. The latter could be interpreted as an international regime of preventing any military use of atomic energy, which would be based on mutual obligations of the States and include enforcement measures.

In 1946 the USA proposed a plan for eliminating the threat posed by nuclear weapons known as “the Baruch plan”<sup>5</sup>. The plan contained proposals for establishing an International Atomic Development Authority (IADA), with the following mandate:

1. Managerial control or ownership of all nuclear activities potentially dangerous for world security.
2. Power to control, inspect and license all other nuclear activities.

Under that plan, the national nuclear authorities would be subordinated to the IADA.

The plan could not be implemented due to political constraints, but the idea of establishing an international organization for nuclear energy development and control began to gain traction.

In 1953 President Eisenhower made a less radical proposal for promoting peaceful use of nuclear energy, which is known as the Atoms for Peace program<sup>6</sup>. It contained the following plan:

- 1) to create an International Atomic Energy Agency under the aegis of the UN<sup>7</sup>;
- 2) for governments “principally involved”, to make joint contribution of nuclear material from their stockpiles to the IAEA;
- 3) for the IAEA, to devise methods for ensuring that nuclear material which it supplies to other States serves only peaceful purposes.

Eisenhower's proposal formed the basis for the Statute of the IAEA, which entered into force in 1957<sup>8</sup>.



In the Statute, among other responsibilities, the Agency was entrusted with the following task: “To establish and administer safeguards designed to ensure that special fissionable and other materials<sup>9</sup>, 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...” (IAEA Statute, article III, A.5.).

This phrasing reflected the idea of the Baruch plan and of Eisenhower’s proposal that the newly established international organization would control the supplies of nuclear items. However, the expectation that the Agency would be in control of nuclear supplies proved to be unrealistic. In the late 1950s a number of non-nuclear States began to receive nuclear material and facilities from the States that possessed nuclear technology without any involvement of the Agency. The Agency needed therefore a mechanism through which it could apply safeguards in cases where nuclear transfers were made without the Agency’s involvement. That need was addressed by giving the Agency the mandate “...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” (IAEA Statute, article III, A.5.).

### **Establishment and administration of IAEA safeguards**

The first outlines of the Agency’s safeguards system were described in INFCIRC/26 under the title “The Agency’s Safeguards System (1961)”. The document was approved by the Agency’s Board of Governors in 1961. It was further fleshed out in INFCIRC/66; the document was entitled “The Agency’s Safeguards System (1965)”. These two documents established the conceptual basis for the Agency’s safeguards system; the post-1965 revisions of INFCIRC/66 did not change this basis: they merely specified the safeguards procedures for various types of nuclear facilities. INFCIRC/26 contained special safeguards procedures only for research reactors with an output of less than 100 MW(t). INFCIRC/66/Rev.2 document contained special safeguards procedures for all reactors, as well as for the reprocessing, conversion and fuel fabrication plants. Thus, the system had taken shape on a conceptual level by 1965; further principal changes were introduced only in documents ‘153’ and ‘540’, in 1971 and in 1997, respectively.

Two important issues were to be addressed in the process of designing the safeguards system:

- I. What do safeguards mean in technical terms? In other words, what measures should be introduced in order to ensure that nuclear and other materials, services, equipment and information are not used in such a way as to further any military purpose?
- II. How to administer safeguards, i.e. how to put safeguards measures in place in a sovereign State?

In resolving the first issue, one had to overcome the following fundamental difficulty: any nuclear fuel cycle facility - be it, for instance, a nuclear reactor or a fuel



fabrication plant - can be used for peaceful as well as military purposes. An energy reactor can be used for the generation of electricity in a civilian program – but it can also be used for the production of plutonium for a nuclear bomb as part of a military program. The same reactor can be used for both purposes: for the generation of electricity for peaceful use, and for the production of plutonium for military use. Likewise, a fuel fabrication plant can manufacture fuel assemblies for a civilian reactor producing electricity, and for a military reactor producing plutonium for a nuclear bomb.

That problem was addressed by the introduction of two principles: (a) the requirement for the recipient State to declare the intended peaceful use of the items placed under safeguards, and (b) the requirement that the nuclear material and facilities which come into contact with the safeguarded nuclear material and facilities also become subject to safeguards. Thus, the plutonium that has been produced through irradiation of nuclear fuel in a safeguarded nuclear reactor also becomes subject to safeguards. The Agency can ascertain that this plutonium is not being used for military purposes through verification of the continued validity of nuclear fuel inventory at the reactor. That is, the Agency confirms that the material remains within the declared peaceful activity.

The resolution of the second issue, i.e. the administration of safeguards, was achieved through concluding safeguards agreements between the Agency and the State or States. Such an agreement gives the Agency the right to implement safeguards measures by inspecting nuclear facilities in the State. According to Paragraph 4 of Document 26, a safeguards agreement should specify:

- The principles that are to be followed by the Agency..., and
- The procedures to implement these principles.

This generic structure was followed later in all ‘66’- and ‘153’-type safeguards agreements.

In order to continue our analysis of the evolution of safeguards, we need to consider the terminology of fundamental safeguards documents. That terminology also evolves in line with the general trend of the system’s evolution. In this paper we highlight such terms in *italics*.

A State, in fulfilling the provisions of its safeguards agreement, undertakes not to use *items* placed under safeguards for military purposes. The definition of *items* includes nuclear material, special non-nuclear materials, equipment and facilities which are specified in the safeguards agreements. While undertaking such an obligation, the State declares that the *items* placed under safeguards will be used exclusively for peaceful nuclear activities. To emphasize this, Document 26 uses the terms *peaceful nuclear material* and *peaceful nuclear facility* for nuclear material and facilities placed under safeguards. These terms later evolved into the term *peaceful nuclear activities*; the latter is used in a similar context in Document 153.



The term *principal nuclear facility* used in ‘26’ and ‘66’ corresponds to the term *facility* which is used in ‘153’. The latter means any nuclear fuel cycle facility, with the exception of uranium mining facilities. There are small differences between the definitions of these terms in the three documents, but these differences are not important for our analysis in this paper. Later in this paper we will be using simply the term *facility*. The concept of *facility* plays a central role in the safeguards system described in ‘66’: most of its safeguards procedures are focused on a *facility*. Accordingly, conclusions on safeguards implementation results are drawn at the level of *facility*. That is why we associate the 1965 safeguards system with the “facility-level concept”, while the system which has been formed by mid-2000 is associated with the “State-level concept”.

Document 26 uses the term *attachment of safeguards* which is defined in paragraph 19 as “the requirement to apply appropriate safeguards procedures”. Later on, in ‘66’ and in ‘153’, this term was replaced by the term *subject to safeguards*, which has the same meaning, that is: subject to safeguards procedures. Likewise, *application of safeguards* means the implementation of appropriate safeguards procedures.

“Agency safeguards” is defined in paragraph 18 of ‘26’ as follows: ““Agency safeguards” means the measures pursuant to the Statute to prevent loss or diversion of materials, specialized 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...”

This definition of “Agency safeguards” reflects the idea of the Baruch plan that the Agency would have managerial control or ownership of nuclear activities in each State. In such a case the Agency would have been able to prevent any loss or diversion of *items* placed under safeguards. However, the real situation was different: these *items* were under the managerial control or ownership of the State, and the Agency was in a position to verify only that these *items* remained within their declared use at the safeguarded *facility*. The absence of the *items* would mean their possible diversion from peaceful nuclear activity.

The continued evolution of the system has led to the recognition that the Agency and the States are equal actors in the implementation of the Agency’s safeguards system. The States are responsible for physical protection of safeguarded *items* and for the provision of necessary information and access to the Agency, while the Agency is responsible for verification that the safeguarded *items* have not been diverted from the declared use. Accordingly, the original definition of safeguards, which was given in paragraph 18 of ‘26’, was not included in ‘66’. The latter document gives the following definition of the purpose of IAEA inspections: “The purpose of safeguards inspections shall be to verify compliance with safeguards agreements and to assist States in complying with such agreements...” (paragraph 46).

Article XII.1. of the IAEA Statute provides for the Agency’s right to examine the design of specialized equipment and *facilities*, including nuclear reactors, and to



approve it only from the view-point of assuring that it will not further any military purpose and that it will permit effective application of safeguards. That provision could not be implemented, either. Although it was included in '26' (paragraph 40(a)), the final text of '66' does not contain this provision. It is interesting to note that the idea of reflecting in *facility* design various technical recommendations for effective implementation of safeguards (the so-called principle of "safeguards by design") is presently under discussion<sup>10</sup>.

Summing up this chapter, we note the conceptual evolution of the safeguards system during the period from 1961 to 1965. The 1961 design was made on the assumption that the role of the Agency in global development of nuclear energy would be close to what was envisaged in the Baruch plan, while the 1965 system was brought in line with the real situation in which the Agency and the State are equal partners in safeguards implementation.

### **The IAEA safeguards system established by 1965**

In this chapter we will analyze the conceptual basis of the Agency's safeguards system that had been established by 1965. To that end we will look closely at the text of '66'.

According to paragraph 15 of '66' there are three mechanisms for concluding safeguards agreements:

- The Agency concludes with the State a *project agreement* with the aim, for example, of assisting the State in establishing a research reactor project; such an agreement provides for the application of safeguards;
- The State is party to a bilateral or multilateral arrangements regarding materials, services, equipment, facilities or information with another State(s), and all the parties have requested the Agency to administer safeguards; the Agency concludes the necessary safeguards agreement with the State;
- The State has requested the Agency to safeguard certain nuclear activities under the State's jurisdiction; the Agency concludes the necessary safeguards agreement with the State.

A State, in its INFCIRC/66-type safeguards agreement with the Agency, undertakes an obligation that the *items* subject to safeguards will not be used in order to further any military purpose, or for the manufacture of nuclear weapons, or for the manufacture of any nuclear explosive devices<sup>11</sup>. The objective of the Agency's inspection activities is the verification of the State's compliance with this obligation.

The Safeguards agreement determines the principles, or provisions, to be followed by the Agency and the State. It also contains procedures for the implementation of these provisions. The State ensures the implementation of accounting procedures at the safeguarded *facilities* and submits to the Agency design information on safeguarded *facilities*. The Agency, for its part, analyses and verifies the design information and inspects the *facilities* and nuclear material placed under safeguards<sup>12</sup>.



In the event of detection of any non-compliance by a State with its safeguards undertakings, the Agency may take the measures set forth in Articles XII.A.7 and XII.C of the Statute. The former provides for the suspension or termination of assistance and withdrawal of any materials and equipment made available by the Agency or a member in furtherance of the project. This enforcement measure can be applied only under a *project agreement*. The latter Article, which is applicable to any type of safeguards agreement, provides for reporting the non-compliance to the Security Council and the General Assembly of the United Nations.

The use of safeguarded *items* for “furthering any military purpose” would mean non-compliance by the State with its safeguards agreement. In practice, however, there is a conceptual difficulty with detecting the misuse, because the term “furthering any military purpose” is not defined in technical terms. This difficulty has been addressed by the introduction of the principle of detecting diversion of safeguarded *items* (that is, their physical removal from a *facility*). At the same time, there is a need to confirm that the safeguarded *facility* itself remains in peaceful use, i.e. that it is not being misused. Document 66 stipulates that this objective is achieved by undertaking a review and verification of *facility* design information, examination of the equipment and the *facility* and check of the *facility's* operations. However, in the absence of a definition of “furthering any military purpose”, we can hardly regard this objective as fully achievable. A more successful attempt to resolve this issue has been made in ‘153’, in which the IAEA objectives are specified in a more precise way: “...detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons...”

Summing up this chapter, we note that under the ‘66’-type safeguards agreement, the State undertakes that the *items* placed under safeguards are not used for military purposes. However, there is no similar undertaking in respect of the non-safeguarded nuclear activities in the State. This fact reduces the effectiveness of the 1965 safeguards system. Indeed, several States which had concluded only ‘66’-type safeguards agreements with the Agency were able to acquire nuclear weapons using the nuclear material and activities which were not placed under the Agency’s safeguards.

### **NPT and Comprehensive Safeguards Agreement**

The system described in ‘66’ was created on the assumption, which existed in the late 1940-es and in the early 1950-es, that establishing control over transfers of nuclear material, technologies and knowledge to non-nuclear States would prevent a proliferation of nuclear weapons. However, within two decades after the first nuclear detonation some developed countries had acquired the knowledge and technologies necessary to build nuclear weapons. The Caribbean crises of 1962 had demonstrated a real threat of a nuclear war. A potential proliferation of nuclear weapons would significantly increase that threat. A new political approach was needed, which would strengthen trust between States and remove the incentive for States to acquire nuclear weapons. Important steps in this direction included the creation of Nuclear Weapons Free Zones (the first treaty on establishing a NWFZ in Latin America and the



Caribbean was opened for signature in 1967) and the entry into force in 1970 of the Non-Proliferation Treaty (NPT).

The NPT addressed the situation with nuclear weapons that existed at that time. The States, that had manufactured and exploded a nuclear weapon or other nuclear explosive device by 1 January 1967 were placed into the category of Nuclear Weapon States (NWSs). All the other States, members of the NPT, were placed into the category of Non-Nuclear Weapon States (NNWSs). The NNWSs undertook not to acquire nuclear weapons or any other nuclear explosive devices; they also undertook to conclude Comprehensive Safeguards Agreements (CSAs) with the Agency. The NWSs undertook not to transfer nuclear weapons to any recipient and not to assist any NNWS in acquiring nuclear weapons.

The structure and content of a Comprehensive Safeguards Agreement are described in '153'. In accordance with this type of agreement, safeguards measures are applied to all nuclear material in all peaceful nuclear activity of a NNWS. Document 153 serves also as a basis for a Voluntary Offer (VO) safeguards agreement between the Agency and a NWS; however, there is no undertaking by NWS to place all their nuclear material under safeguards.

We will now analyze the post-1970 safeguards system, which was formed upon the entry into force of the NPT and the implementation of CSA and VO agreements. We will first discuss the principal changes that have occurred, or, in our analogy, the changes at the "genetic level", and then the changes resulting from the evolution of the established procedures, i.e. the changes in the system's "body". We will do this mostly by analyzing Document 153. We note that, in accordance with the principle established in '26', Document 153 consists of two parts: Part I containing principles (provisions, in the document's language), and Part II containing procedures for implementing the provisions of Part I. We will discuss only those provisions and procedures which we regard as key to our analysis of the system's evolution.

### **The key provisions of '153'**

Paragraphs 1 and 2 in Part I specify the undertakings by the State and the obligations of the Agency:

- The State undertakes to accept safeguards on all nuclear material in all peaceful nuclear activities within its territory, under its jurisdiction or control;
- The Agency has the right and obligation to ensure that safeguards are applied to all nuclear material in all peaceful nuclear activities of the State for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

The above provisions should be seen in the context of Article II of the NPT, pursuant to which the State undertakes "... not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices".





These provisions are of the utmost importance for the development and implementation of safeguards procedures. Although the term *peaceful nuclear activities* is not explained in '153', we assume, taking into account the definitions given in '26', that these are the activities at *Facilities* and Locations outside *Facilities* (LOFs) which are to be declared to the Agency and placed under safeguards. The Agency's task is to develop and implement procedures to verify that safeguarded nuclear material remains in the declared peaceful activities at *facilities* and LOFs. In this regard, the effectiveness and efficiency of the procedures which were developed earlier in the framework of the 1965 safeguards system are significantly improved due to the more concrete definition of the detection goal. The goal is to detect a diversion of nuclear material from peaceful nuclear activities to the manufacture of a nuclear explosive device. The fact that the manufacture of a nuclear explosive device requires a certain amount of nuclear material of a certain quality is taken into account in the development of the procedures.

In the safeguards system resulting from the implementation of NPT provisions the role of State has been further enhanced. Paragraph 3 of '153' calls for cooperation between the Agency and the State to facilitate the implementation of safeguards. The preamble of the NPT states that the Parties to the Treaty express their support for research, development and other efforts to further, within the framework of the IAEA safeguards system, the principle of safeguarding *nuclear material flow* through the use of instruments and other techniques at certain strategic points. Such efforts have been undertaken in the framework of national support programs concerning the IAEA safeguards. These programs provide support to the IAEA not only for the development of methods for *flow* verification but also for the development of safeguards measures in general.

In the concept of 1965 safeguards the notion of a *nuclear material flow* did not exist. a *Facilities* were addressed outside the nuclear fuel cycle, and safeguarded nuclear material was considered as a static inventory item rather than a "flow"<sup>13</sup>. However, in the framework of the Comprehensive Safeguards Agreement, safeguards measures apply to all nuclear material in all peaceful nuclear activities of a State. The scope of verification includes not only inventories of nuclear material at nuclear fuel cycle *facilities*, but also *nuclear material flows* between *facilities* and *flows* related to export and import. The possibility of a full-scale verification of *flows* and inventories is provided by the concept of nuclear material accountancy adopted in '153'. The concept is based on the establishment, for each *facility* and LOF, of Material Balance Areas and the Key Measurement Points for *flows* and inventories.

Paragraph 7 requires each State to establish and maintain a State System of Accounting for and Control (SSAC) of all nuclear material subject to safeguards. Such a system is based on the aforementioned concept of accountancy. As part of its inspection activities the Agency verifies the findings of the SSAC, taking into account its effectiveness. Provisions of Paragraph 7 determine one of the most important functions of the State in safeguards implementation, and enable the Agency to optimize its verification activity.

In recognizing the role of States in strengthening the non-proliferation regime in general and in strengthening the safeguards system in particular, we should emphasize the importance of the systems of nuclear export control (e.g. the activities of the Zangger Committee<sup>14</sup> and of the Nuclear Suppliers Group<sup>15</sup>).

Unlike '66', '153' does not use the term "non-compliance" – it uses a softer language in Paragraphs 18 and 19. According to these paragraphs, if the Board decides that action by a State is essential and urgent in order to verify non-diversion of nuclear material *subject to safeguards*, the Board shall call upon the State to take the required action. If the Board finds that the Agency is unable to verify that there has been no diversion of nuclear material placed under safeguards, then it may take measures specified in Article XII.C of the Statute.

Summing up, the phrasing of the purpose of safeguards under '153' differs from the one given in '66'. In Document 153 the essence of the phrasing is to ensure that all nuclear material in the State is placed under safeguards for the purpose of verifying that it is not diverted from peaceful use to the manufacture of nuclear weapons or other nuclear explosive devices. The purpose of safeguards under a Voluntary Offer agreement with a NWS is also phrased differently. Thus, at the current stage in the development of the IAEA safeguards system we need a phrasing that would be common for all types of safeguards agreements. The objective could be phrased as "verification of a State's compliance with its undertakings under the safeguards agreement". Consequently, it would be more appropriate to describe the existing safeguards system as "the IAEA verification system" (i.e. a system for verification of international obligations concerning peaceful use of nuclear energy).

At this stage, the Agency is not in a position to guarantee that nuclear material in a State is not being used for military purposes. This task is being addressed by the international community by signing international treaties and agreements, and by implementing enforcement measures. In this "international system of nuclear safeguards" the Agency fulfills the task of independent verification of States' compliance with their obligations under the safeguards agreements.

### **The key procedures of '153'**

In this chapter we will briefly discuss the procedures which we consider important in view of the analysis of safeguards implementation under a CSA.

In accordance with the safeguards agreement, the State submits to the Agency the "initial report on all nuclear material which is to be subject to safeguards thereunder" (paragraph 62). The State also submits information on the design of *facilities* and information with regard to LOFs. Thus, the State essentially provides a declaration of its peaceful nuclear activities<sup>16</sup>.

The Agency examines the information provided by the State and carries out inspections at *facilities* and LOFs in order to verify the veracity of the State's declaration. In order to fulfill the provisions of paragraph 2 of '153', i.e. to make sure



that safeguards are being applied to all nuclear material in all peaceful nuclear activities of the State, the Agency also needs to verify the completeness of the declaration. However, part II of '153' does not explicitly specify the procedures to be applied in order to fulfill this task, with the exception of "special inspection" (paragraph 73). The issue of strengthening the Agency's safeguards through providing the Agency with additional instruments for verifying the completeness of the States' declarations was raised after the events in Iraq in 1991. We may conclude, using our analogy with a biological system, that the provision to ensure the completeness of the States' declarations was a "sleeping gene" which was "woken up" only by the 1991 events in Iraq.

The procedures contained in '153' apply to nuclear material at the *facilities* and LOFs which have been declared by the State (or in other words, have been placed under safeguards). That is why there is a conceptual similarity between these procedures and the procedures of the 1965 system. At the same time, the more precise technical phrasing of the objective of the procedures in '153' has enabled a significant enhancement of their effectiveness and efficiency.

Paragraph 28 of '153', contains the definition of the "objective of safeguards". However, it would be more appropriate to call it "the objective of safeguards procedures", the way it was done in the model CSA<sup>17</sup>. The model agreement contains the following equivalent of paragraph 28 of '153': "The objective of the safeguards procedures set forth in this part of the Agreement 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...".

The procedures are based on the principle of independent verification by the Agency of the findings of the SSAC. These include measurements of nuclear material *flows* and inventories, and also the implementation of containment and surveillance measures, i.e. the use of seals, video systems and radiation monitors. These procedures give the Agency a means to detect inconsistencies or anomalies in a State's accounting data which may indicate diversion of nuclear material from peaceful activities. However, the Agency would hardly be able to determine the exact purpose of such diversion: that is why the wording "diversion ... for purposes unknown" is included in the above phrasing of the objective of the safeguards procedures.

Summing up this chapter, let us emphasize that although Part I of CSA contains the provision about the Agency's obligation to ensure the completeness of the State's declaration, Part II does not provide a sufficient set of procedures that would enable the Agency to fulfill this task. This issue was addressed in "Program 93+2" on strengthening the safeguards system, which was initiated in 1993. One of the results of the Program was the drafting of a Model Additional Protocol (INFCIRC/540) to the safeguards agreement.

## The IAEA safeguards system in 1971-1990

The period between 1971 and 1990 was marked by two important developments. First, a large number of States where the Agency's safeguards had been originally applied under the *item specific* ('66'-type) agreements joined the NPT and concluded CSAs with the Agency. Second, rapid development of safeguards procedures and techniques had taken place during these years. A significant contribution to that development was made by the States' support programs. Following our analogy, we may conclude that evolving during this period was the system's body, while the genetic basis, which was established in '26', '66' and '153', remained unchanged.

During that period, the Agency had been applying safeguards under the three types of agreements: the CSAs, the *item specific* agreements and the Voluntary Offer (VO) agreements. States' obligations under each type of the agreement are different:

- In the framework of CSA: non-diversion of nuclear material from a State's peaceful nuclear activities to the manufacture of nuclear weapons or other explosive devices,
- In the framework of an *item specific* agreement: the non-misuse of *items* placed under safeguards, and
- In the framework of a VO agreement: the non-withdrawal of nuclear material from the selected civilian *facilities*.

However, in spite of the different undertakings by States, the "facility-level concept" had enabled the Agency to implement a uniform approach to safeguards in States with different types of agreements.

This approach was based on a standard set of verification procedures developed for each type of *facility* handling nuclear material subject to safeguards. The objective of the procedures was a timely detection of diversion of a significant quantity of nuclear material from any given *facility* type. The "significant quantity" was defined as the amount of nuclear material necessary for the manufacture of one nuclear explosive device. In addition, it was postulated that a State may have unsafeguarded nuclear installations, which can be used by the State in order to upgrade the diverted material to the extent that it could be used for the manufacture of a nuclear explosive device. This postulate gave a possibility to develop a standard set of procedures for each type of *facility*. Such a set of procedures could be used, in principle, under each of the three types of safeguards agreements. Of course, the efficiency of the implementation of this approach in the framework of CSA was not optimal, as there was no mechanism to take into account specific features of the nuclear fuel cycle in every particular State. The grounds for such consideration appeared only in the State-level concept.

Thus, the approach taken to the implementation of safeguards during the period of 1971 – 1990 was a superposition of the provisions and procedures contained in '66' and '153', and was based on the *facility-level concept*. For the facilities inspected in the framework of *item-specific* agreements, the standard set of procedures contained



additional verification procedures with regard to non-nuclear materials and equipment placed under safeguards.

Conceptually, this approach was based on the provisions of paragraph 28 of '153' which defined the safeguards objective as "timely detection of diversion of significant quantities of nuclear material..." In reality, however, as it was already pointed out, this paragraph defines the objective of safeguards procedures described in '153' which rely, according to paragraphs 29 and 30, on the nuclear material accountancy measure supported by containment and surveillance measures. The real objective of safeguards, in the framework of any safeguards agreement concluded with the IAEA, is the verification of a State's compliance with its obligations under the agreement.

### **Safeguards evolution in 1991-2012; Additional Protocol, Integrated Safeguards and State-level Concept**

A number of important political events occurred in the post-1990 period. The crucial one was the discovery, as a result of the first war in the Gulf, of clandestine nuclear weapons program in Iraq. That discovery was a serious blow to the world's confidence in the Agency's safeguards. However, for those familiar with the safeguards system, it was clear that the Agency's inspectors were not to be blamed for the failure to detect the Iraqi nuclear weapons program: the safeguards procedures at that time simply were not designed to detect clandestine nuclear activities carried out outside the declared *facilities*. The Agency's secretariat, under the leadership of Hans Blix, the then Director-General of the IAEA, promptly reacted to this situation and requested that the inspectors be given additional access to information and locations in order to be able to detect undeclared nuclear material and activities. This idea of additional access to information and locations was implemented later in the Additional Protocol to safeguards agreement ('540').

In 1993 the Agency launched its Program 93+2, aimed at strengthening the effectiveness and enhancing the efficiency of the Agency's safeguards. The Program was implemented in two Parts. Part I comprised safeguards measures which 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 540.

Following our analogy, it can be said that Program 93+2 and the Additional Protocol triggered the development mechanism of the safeguards system at the genetic level. The changes affected mostly the safeguards implementation in the States with CSAs. The most important measures for strengthening the system were those aimed at ensuring the completeness of a State's declaration. To this end, the Agency was to be able to detect *undeclared nuclear material and activities*. This new term means nuclear material and *facilities* or LOFs that the State was supposed to declare in accordance with its obligations under CSA, but for some reason did not do so. The Additional Protocol contains procedures for detecting *undeclared nuclear material*



*and activities*. In accordance with the Protocol, the State submits to the Agency information on its nuclear fuel cycle, which is additional to the information declared under the agreement. The Agency also obtains the right of access to the locations where nuclear fuel cycle-related activities take place.

The implementation of the Additional Protocol revealed the need to formulate verification objectives at the State level. Initially, this was done within the frameworks of *Integrated Safeguards* applied in States with CSAs and Additional Protocols in force<sup>18</sup>. The purpose of the implementation of '540' measures was to enhance the Agency's confidence that there are no *undeclared nuclear material or activities* in the State. This enhanced confidence would allow the Agency to reduce its inspection activities at *facilities* and LOFs.

However, the integration of measures of '153' and '540' could not be fully completed in the framework of *Integrated Safeguards*. The reason was that the State-level objectives were not brought into correlation with the facility-level objectives. As a result, the individual features of any particular State's nuclear fuel cycle could not be taken into account. Consequently, the optimization of the IAEA verification activities at facilities could be done only on formal grounds through the introduction of a standard set of rules. Another limitation was that the *Integrated Safeguards* did not apply to the States with CSA but without the Additional Protocol.

In fact, the *Integrated Safeguards* were part of a more general *State-level concept*, which had been formed as a result of the system's evolution by the mid-2000s.

This concept can be described as follows:

- The purpose of the Agency's verification activity is to verify that States comply with their undertakings made in the corresponding safeguards agreements;
- The objectives of verification procedures are formulated according to the provisions of the safeguards agreement; they differ depending on the type of the agreement;
- Safeguards conclusion is drawn for each individual State pursuant to the provisions of the safeguards agreement and taking into account all the information available to the Agency.

The conceptual evolution of safeguards can be observed when reviewing the Agency's safeguards statements published in the IAEA annual Safeguards Implementation Report<sup>19</sup>.

A typical Safeguards Statement reported in the SIR during the period of 1980 – 1990 looks as follows: "The Secretariat ... did not detect any indication of the diversion of nuclear material placed under Agency safeguards or the misuse of facilities, equipment or non-nuclear material placed under safeguards. On this ground, the Secretariat concludes that nuclear material and other items under Agency safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for."



This Statement corresponds to the *facility-level concept*. In the framework of this concept, the Secretariat, having drawn conclusions about non-diversion for each safeguarded *facility* and LOF, accumulates them into one common Statement for all the nuclear material and *items* under safeguards.

In the beginning of 2000 the Statement contained, in addition to a common safeguards conclusion (common for all nuclear material placed under safeguards), separate conclusions drawn for States with Integrated Safeguards; these conclusions were formulated for each State as a whole. Separate conclusions were also drawn for the States in which undeclared nuclear material and activities were detected (e.g. for the DPRK, Iran and Libya).

The Safeguards Statement for the year 2003 was for the first time consistently formulated at State level in accordance with the provisions of each of the three types of agreement; for the States with CSA the formulation depended also on the status of the implementation of the Additional Protocol. Further development of the model Safeguards Statement was completed in the Report for the year 2005. In the chapter called “Background to the Statement” the principles of drawing conclusions in accordance with each of the three types of agreement were explained. This model of Safeguards Statement continues to be used, and the Report contains relevant data for each State with a safeguards agreement.

Below is an example of safeguards conclusion for States with CSA and Additional Protocol: “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”. In States with CSA but without the Additional Protocol, the Secretariat cannot implement the entire set of procedures for the verification of the completeness of the State’s declaration. The safeguards conclusion for these States applies only to the declared nuclear material.

Below we analyze the implementation of the contemporary safeguards concept in the States with CSA.

The Agency’s task is to detect any diversion of nuclear material from peaceful nuclear activities to the manufacture of a nuclear explosive device. The State, in carrying out such a diversion, would need to establish a certain plan for acquiring nuclear material required for the device. We call this plan an “acquisition path”. An acquisition path could involve declared nuclear material, unreported production or processing of nuclear material at declared *facilities* and LOFs, *undeclared nuclear material and activities*, or any combination of these.

The Agency, in order to be able to detect a diversion, designs and implements a State-Level approach for the State as a whole<sup>20</sup>. Such approach defines inspectors’ activities on the compilation and analysis of available information and on carrying out inspections and complementary access (in States with Additional Protocol) for achieving the following objectives:



- To detect *undeclared nuclear material and activities* anywhere in the State;
- To detect undeclared production or processing of nuclear material at the declared *facilities* or LOFs;
- To detect any diversion of declared nuclear material.

We note that the objective “to detect any diversion of declared nuclear material” is similar to the objective described in paragraphs 28-30 of ‘153’, and is achieved by independent verification of the SSAC findings.

The Agency analyses the acquisition paths of any given nuclear fuel cycle in order to optimize its verification activity by focusing its attention on the “sensitive” aspects of the State’s nuclear program. These aspects include uranium enrichment activity and the reprocessing of irradiated nuclear fuel.

Thus, the contemporary safeguards concept has a significant potential for enhancing the effectiveness and efficiency of the Agency’s verification activity. However, the process of adapting this concept to the Agency’s practical work has not been fully completed. One of the remaining issues is the implementation of verification activities on a non-discriminatory basis. For this, one would need a set of common criteria - or at least a set of criteria that would be acceptable to the majority of the States – for determining the intensity of the Agency’s verification activity in a State. Although this issue is being widely discussed in safeguards publications and at various forums, there is no final decision yet. Resolving this issue will probably require further efforts on ensuring the transparency of the Agency’s publications on safeguards implementation, and particularly of the annual Safeguards Implementation Report.

## **Conclusion**

Presently, the IAEA safeguards system represents an instrument of international controls over States’ compliance with their obligations undertaken with regard to peaceful use of nuclear energy. This system is an important component of the nonproliferation regime, the cornerstone of which is the Non-Proliferation Treaty.

The 1945 declaration of the three states (mentioned at the beginning of this article) outlines the condition necessary for preventing any destructive use of atomic energy. The condition was phrased as “reciprocal and enforceable safeguards acceptable to all nations”. This may be interpreted as an international regime for preventing the use of atomic energy for military purposes. The existing nonproliferation regime only partially meets the goals set out in that declaration. Those goals could be achieved by resolving the current issues facing the nonproliferation regime. These issues relate to further progress in nuclear disarmament (Article VI of the NPT) and to the obligations of the States which possess nuclear weapons but are not members of the NPT. The direction of further evolution of the IAEA safeguards system will largely depend on the way these issues are eventually resolved.

The conclusion above concerns only the political conditions affecting further evolution of the safeguards system. But there are also technical aspects - which,





however, cannot be considered outside the political context. Such aspects include the increasing accessibility of nuclear technologies, especially sensitive technologies. This problem is attracting a lot of attention in the international community. There are ongoing discussions about the concept of international or multilateral operation of the sensitive parts of the nuclear fuel cycle. In this regard, Russia has proposed and implemented an important initiative to establish the International Uranium Enrichment Center in Angarsk, which has been placed under the IAEA safeguards.

The present concept, which regards the safeguards system as a system of verification of compliance with international agreements, ensures the possibility of that system being adapted to new directions in the global development of nuclear energy.

## Notes

<sup>1</sup> The term “State-level concept” has been used in some of the IAEA safeguards documents since 2005; other terms, which have been used at various stages of the development of this concept, are: “State-level approach”, “Integrated Safeguards”, “Information-driven Safeguards”, etc.

<sup>2</sup> See, for example: “The evolution of IAEA safeguards”, International Nuclear Verification Series No.2, IAEA, Vienna, 1998. Official Website of International Atomic Energy Agency. [http://www-pub.iaea.org/MTCD/publications/PDF/NVS2\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/NVS2_web.pdf); J. Carlson, V. Bragin, J. Bardsley and J. Hill “Viewpoint: Nuclear safeguards as an evolutionary process”, the Nonproliferation Review/winter 1999. Official Website of James Martin Center for Nonproliferation Studies. <http://cns.miis.edu/npr/pdfs/bragin62.pdf>; J. Carlson “Safeguards in a changing environment”, INMM annual meeting, Nashville, July 2008. Official Website of Department of Foreign Affairs and Trade, Australian Government. [http://www.dfat.gov.au/asno/publications/safeguards\\_changing\\_env.html](http://www.dfat.gov.au/asno/publications/safeguards_changing_env.html) (Retrieved on September 2, 2013).

<sup>3</sup> IAEA Information Circulars (INFCIRCs): INFCIRC/26. The Agency’s Safeguards. <http://www.iaea.org/Publications/Documents/Infcircs/Others/inf26a1.shtml>; INFCIRC/66. The Agency’s Safeguards System. <http://www.iaea.org/Publications/Documents/Infcircs/Others/inf66r2.shtml>; INFCIRC/153. The structure and content of agreements between the Agency and states required in connection with the Treaty on the Non-proliferation of nuclear weapons. <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc153.pdf>; INFCIRC/540. Model protocol additional to the agreement(s) between state(s) and the International Atomic Energy Agency for the application of safeguards. <http://www.iaea.org/Publications/Documents/Infcircs/1997/infirc540c.pdf> (Retrieved on September 2, 2013).

<sup>4</sup> David Fisher. Nuclear Safeguards: The First Steps. IAEA Bulletin. 2007, September. Official Website of International Atomic Energy Agency. <http://www.iaea.org/Publications/Magazines/Bulletin/Bull491/49103480711.pdf> (Retrieved on September 2, 2013).

<sup>5</sup> The Baruch Plan. The United Nations Atomic Energy Commission. 1946, June. NUCLEARFiles.org, Project of the Nuclear Age Peace Foundation. [http://www.nuclearfiles.org/menu/key-issues/nuclear-weapons/issues/arms-control-disarmament/baruch-plan\\_1946-06-14.htm](http://www.nuclearfiles.org/menu/key-issues/nuclear-weapons/issues/arms-control-disarmament/baruch-plan_1946-06-14.htm) (Retrieved on September 2, 2013).

<sup>6</sup> Address by President Eisenhower to the 470-th Plenary Meeting of the UN General Assembly. Official Website of International Atomic Energy Agency. [http://www.iaea.org/About/atomsforpeace\\_speech.html](http://www.iaea.org/About/atomsforpeace_speech.html) (Retrieved on September 2, 2013).

<sup>7</sup> Abbreviation IAEA was not used in Eisenhower’s speech and was introduced into lexicon later.

<sup>8</sup> Statute, International Atomic Energy Agency (as amended up to 1 June 1973), Vienna, 1980. <http://www.iaea.org/About/statute.pdf> (Retrieved on September 2, 2013).

<sup>9</sup> “Nuclear material” is defined in the Agency’s documents as any “source” or “special fissionable” material. “Special fissionable” material means plutonium-239, uranium-233, uranium enriched in the isotopes 235 or 233, and any material containing one or more of these materials. “Source” material means uranium containing a mixture of naturally occurring isotopes; uranium depleted in the isotope



235; thorium; any of the aforementioned materials in the form of metal, alloy, chemical compound, or concentrate.

<sup>10</sup> See, for example: Trond Bjornard, et al. Safeguards-by-Design: Early Integration of Physical Protection and Safeguardability into Design of Nuclear Facilities. Proceedings of Global 2009 – The Nuclear Fuel Cycle: Sustainable Options and Industrial Perspectives. Paris, France. 2009, 6-11 September. Paper 9518. <http://www.inl.gov/technicalpublications/Documents/4384039.pdf> (Retrieved on September 2, 2013).

<sup>11</sup> There is no model for the text of a ‘66’-type agreement. An example of the text of one of the latest such agreement can be found in document INFCIRC/754. Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities. <http://www.iaea.org/Publications/Documents/Infcircs/2012/infirc754a4.pdf> (Retrieved on September 2, 2013).

<sup>12</sup> Small quantities of nuclear material placed under safeguards may be located in *locations outside facilities* (LOFs).

<sup>13</sup> INFCIRC/66/Rev.2 includes annexes which contain special safeguards procedures for reprocessing plants and for conversion and fuel fabrication plants. These procedures use the notions of “annual throughput” and “annual input” but only with the aim of determining the intensity of the Agency’s inspection activity.

<sup>14</sup> The Zangger Committee was created in 1971 to develop a mechanism for the implementation of the provisions of Paragraph 2 Article III of the NPT. The list of non-nuclear material and equipment subject to export controls, as maintained by the Committee, is given in INFCIRC/209. Communications of 15 November 1999 received from member states regarding exports of nuclear material and of certain categories of equipment and other material. <http://www.iaea.org/Publications/Documents/Infcircs/2000/infirc209r2.pdf> (Retrieved on September 2, 2013).

<sup>15</sup> The Nuclear Suppliers Group (London club) was created in 1975 in order to strengthen the export control mechanisms suggested by the Zangger Committee. The relevant guidance is given in INFCIRC/254. Communication received from the Permanent Mission of the United States of America to the International Atomic Energy Agency regarding certain Member States’ Guidelines for the Export of Nuclear Material, Equipment and Technology. <http://www.iaea.org/Publications/Documents/Infcircs/2012/infirc254r11p1.pdf> (Retrieved on September 2, 2013).

<sup>16</sup> Provision on non-application of safeguards to nuclear material to be used in non-peaceful activities (INFCIRC/153 paragraph 14, P. 5, <http://www.iaea.org/Publications/Documents/Infcircs/Infcirc153.pdf>) is not discussed in this article as it does not change the essence of the agreement and, moreover, it has never been implemented in practice.

<sup>17</sup> Model CSA on the basis of ‘153’ was issued in 1974 in GOV/INF/276. Because the latter has limited distribution, an example of the text of paragraph 28 of ‘153’ can be found in any actual agreement; see, for example, paragraph 27 of INFCIRC/495. Agreement of 14 April 1995 between the Republic of Belarus and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons. <http://www.iaea.org/Publications/Documents/Infcircs/1996/inf495.shtml> (Retrieved on September 2, 2013).

<sup>18</sup> *Integrated Safeguards* were defined as the optimum combination of all safeguards measures available to the Agency under comprehensive safeguards agreements and additional protocols to achieve the maximum effectiveness and efficiency in fulfilling the Agency’s right and obligation in paragraph 2 of INFCIRC/153.

<sup>19</sup> The IAEA Safeguards Implementation Report has limited distribution. The safeguards statements were reproduced in the past in the Agency’s Annual Reports, which are available to the general public. IAEA Annual Report for 2012. P.75-83. [http://www.iaea.org/Publications/Reports/Anrep2012/anrep2012\\_full.pdf](http://www.iaea.org/Publications/Reports/Anrep2012/anrep2012_full.pdf) (Retrieved on September 2, 2013).

<sup>20</sup> Jill N. Cooley, “Progress in evolving the State-level Concept”, presentation at the seventh INMM/ESARDA Joint Workshop: Future directions for Nuclear Safeguards and Verification, Aix-en-Provence, France, 17-20 October 2011.



**Center for Energy  
and Security Studies**  
www.ceness-russia.org

Mailing address: Mosfilmovskaya, 42, bldg. 1,  
office 55, Moscow, 119285, Russia  
Tel.: +7 (499) 147-5192, +7 (495) 227-0829  
Fax: +7 (499) 147-5192  
E-mail: ceness@ceness-russia.org

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