

# IAEA Safeguards Criteria

*Everything You Might Like to Know but Didn't Know Who to Ask*

**James Larrimore, IAEA Safeguards, Retired**

## Abstract

The IAEA *Safeguards Criteria 1991-1995* started their life in 1991, initially for a five-year period. As it turned out, the Safeguards Criteria continued in use. Their success brought criticism. With the Iraq, DPRK and Iran earthquakes in the nonproliferation world, it became clear that the Safeguards Criteria were suited to States that wanted to and were abiding by their NPT obligations but not enough for noncompliance cases. This paper explains why and how the Safeguards Criteria came into being, counters criticisms of them, and suggests how they might be relevant for today's and future safeguards. Using a question-and-answer format, topics addressed are:

*Aren't the Safeguards Criteria too inflexible; with the increased focus on providing assurance of the absence of undeclared nuclear material and activities, how can the Safeguards Criteria apply; in the Iran case with the JCPOA, aren't the Safeguards Criteria irrelevant; how were the Safeguards Criteria developed, who was involved, how long did it take; were any new safeguards verification measures introduced; what was the most difficult decision during the development of the Safeguards Criteria; were the Safeguards Criteria updated to take account of developments in nuclear facilities; and, with the introduction of Integrated Safeguards and then the State Level Approach, what is the relevance of the Safeguards Criteria today?*

## Introduction

The Safeguards Criteria are currently defined by the IAEA Department of Safeguards as “A set of nuclear material verification activities, and their frequency and intensity, for each facility type and for Locations Outside Facilities (LOFs) based on the associated quantity and type of nuclear material.”<sup>1</sup>

Why were they developed and how did that take place? Those questions are addressed in this paper.

In the Spring of 1988, the IAEA Department of Safeguards initiated a project to develop and document unified criteria to govern all safeguards implementation and evaluation activities. The resulting Safeguards Criteria were developed in the context of the requirements for adaptability and flexibility as safeguards would evolve over time, maintaining the all-important requirement of credibility through practical and consistent safeguards practices.

Prior to introduction of the Safeguards Criteria, there were annual revisions of the evaluation criteria to take into account improvements in safeguards practices, procedures and technology. That gave the impression that Agency safeguards were a moving target and thus was an undesirable basis for planning and managing safeguards for state authorities and for the IAEA Operations Divisions.

The Safeguards Criteria were to be used for the planning of safeguards implementation activities in the field and at agency headquarters for all facilities and LOFs covered by safeguards, as well as for the evaluation of safeguards implementation at facilities and at the state level.

The IAEA Safeguards Criteria went into force in 1991. They were initially called the *Safeguards Criteria 1991-1995*. That was intended to leave open the possibility to modify or even stop their use

after a five-year period. As it turned out, the Safeguards Criteria worked well and were in use for a long period, evolving along the way.

Their success, not surprisingly, brought about criticism and eventually some opposition. More important were the earthquakes in the nonproliferation world, starting with Iraq's attempt to develop a nuclear weapon capability clandestinely. Then, the DPRK unfortunate case, that continues up to today. And, regrettably, the long-drawn-out case of Iran. It was clear that the Safeguards Criteria were suited to most States that wanted to and were abiding by the obligations they had voluntarily taken by signing and ratifying the NPT. But for noncompliance cases, an individually crafted verification and monitoring approach was needed. And the IAEA Department of Safeguards has shown itself well qualified to deal with those cases.

In this paper, I will explain why and how the Safeguards Criteria came into being, counter criticisms of them, and suggest how they might be relevant for today's and future safeguards implementation. I have adopted a question-and-answer format, in line with the title chosen for this paper.

**Question 1.** *The Safeguards Criteria are criticized as being too fixed and not able to be implemented flexibly. Was that understood from their beginning?*

**Answer.** That is indeed the most general and common criticism. And, in my view, it is off base. NPT safeguards under INFCIRC/153 is focused on nuclear material and must inherently be quantitative. The objective of safeguards is to detect the diversion of one significant quantity of nuclear material. And that is to be done by the Agency performing a material balance evaluation for each Material Balance Area (MBA) in a nuclear facility<sup>2</sup>. That fundamental requirement, in its essence, requires the so-called "fixed" or "rigid" provisions of the Safeguards Criteria. In that sense, yes, the intention was from the beginning for the Safeguards Criteria to set out how to meet that requirement. The safeguards criteria do it by treating the facility types one-by-one, to take into account differences in how material balance verification can be carried out.

**Question 2.** *With the increased focus on providing assurance of the absence of undeclared nuclear material and activities after Iraq, how can the Safeguards Criteria apply?*

**Answer.** There is perhaps some misunderstanding here. The possibility of a clandestine nuclear weapon program was, of course, always understood. The preparers of INFCIRC/153 acknowledged that the Agency could find an indication of undeclared nuclear activities, and they provided special inspections as a means for investigation<sup>3</sup>. As we all know, the special inspection provision has been used very sparingly. The Safeguards Criteria do address one type of undeclared activity, the misuse of a declared facility for purposes related to nuclear weapon development. An example would be using a reactor for undeclared irradiation experiments related to nuclear weapon development.

But the Safeguards Criteria did not change what the founding safeguards technical gurus had decided. They had considered how to implement the objective of safeguards in INFCIRC/153, agreed by states for the implementation of NPT safeguards agreements, the timely detection of diversion of significant quantities of nuclear material<sup>4</sup>. They decided that "timeliness goals" should be utilized by the Secretariat to accomplish "timely detection" of diversion. But how should timeliness goals be set? They decided that, although the Agency would of course be looking for undeclared nuclear material and activities, it could not be expected to detect preparations we now call "weaponization" using the inspector access that states had accepted in INFCIRC/153 and with the tools available at the time (no environmental sampling, no satellite imagery, etc.). Therefore, in setting timeliness goals it was assumed *"that the diversion was part of a planned sequence of*

*actions chosen to give a high probability of success in manufacturing one or more nuclear weapons with minimal risk of discovery until at least one weapon is manufactured. Therefore, it was assumed that all necessary conversion and manufacturing facilities exist, that processes have been tested, and that non-nuclear components of the device have been manufactured, assembled, and tested.”*<sup>5</sup> Those assumptions about weaponization activities were accepted in preparing the Safeguards Criteria. There was no basis for changing those assumptions at that time. Only after the Iraq case did the Agency’s capabilities to provide assurance of the absence of undeclared nuclear material and activities move to center stage.

The Iraq case woke up the Secretariat and Member States. DG Blix stated that, to avoid another such case, the Agency needed more information, more access, and more involvement of the UN Security Council. Member States agreed and worked with the Secretariat to develop the Model Protocol Additional to INFCIRC/153 Safeguards Agreements, INFCIRC/540, commonly called the Additional Protocol. With INFCIRC/540’s introduction and implementation, the Agency was looked to, and it accepted, to provide assurance beyond nondiversion, to attempt to provide assurance of the absence of activities the state has not declared. As a result, the Agency’s safeguards conclusion has developed into two-parts, one part addressing assurance of nondiversion of declared nuclear material, the other addressing assurance of the absence of undeclared nuclear material and activities. The Safeguards Criteria continued to be the basis for the nondiversion safeguards conclusion.

**Question 3.** *The Safeguards Criteria came out in 1991. Surely, they need updating to take account of developments in nuclear facilities since that time. How has that been handled?*

**Answer.** It was understood from the start that it would be necessary to review actual implementation experience so that appropriate refinements could be made based on experience. A midterm review was carried out during the 1991-1995 period which confirmed the success of the Safeguards Criteria, while allowing some changes to be introduced, often through footnotes to deal with a special facility situation.

Then, to establish this review process on a continuing basis, a Criteria Working Group (CWG) was set up, staffed with senior, experienced inspectors and other department staff. The CWG dealt with detailed particularities of operation at a facility, often through the introduction of criteria Footnotes. With their general success, the Department decided to continue to use the now called Safeguards Criteria.

**Question 4.** *With the introduction first of Integrated Safeguards and then the State Level Approach, what is the relevance of the Safeguards Criteria today?*

**Answer.** First, for a State for which a State Level Approach has not been applied, safeguards approaches are based primarily on the Safeguards Criteria<sup>6</sup>, and the safeguards effectiveness evaluation includes the quantitative findings from implementation of nuclear material verification activities as prescribed by the Safeguards Criteria<sup>7</sup>.

More generally, when an Agency inspector goes to a nuclear facility to perform a PIV or a timely detection inspection, he/she needs to know what has to be done and to what extent in order for their verification results to meet the desired level of confidence that diversion of 1 SQ has not taken place. That is what the Safeguards Criteria lay out – what to do and with what intensity. Call them something else if desired. One way or another, those instructions continue to be needed.

**Question 5.** *In the Iran case, an additional verification and monitoring arrangement, the JCPOA<sup>8</sup>, has been introduced. Aren't the Safeguards Criteria irrelevant in that case?*

**Answer.** The Iran case is an excellent example of the importance of the Safeguards Criteria and how they can and should be applied flexibly. The Agency carries out and reports on its verification of Iran's nuclear program in two parts: verification under Iran's INFCIRC/153 safeguards agreement<sup>9</sup>; and additional verification and monitoring of Iran's nuclear activities as specified by the JCPOA. After Iran stopped applying provisionally the Additional Protocol, as included in the JCPOA, and stopped implementing the other JCPOA provisions, the principal pillar of safeguards implementation in Iran is the Safeguards Criteria. As Iran has increased the enrichment level of its uranium enrichment above 20%, the intensity of verification increased in accordance with the Safeguards Criteria to meet the shorter timely detection goal. The Agency continues to perform activities to provide assurance that undeclared nuclear activities are not taking place, as it does for all States.

**Question 6.** *What is the background on why the Safeguards Criteria were developed? Who was involved; how long did it take?*

**Answer.** That is an interesting and surprisingly complex question. When we started in 1987, I was just two years into safeguards and didn't fully understand the reasons. In retrospect, I believe there were two main drivers (Other old timers may have other views.) Jon Jennekens became DDG-SG in 1987. One objective he brought with him from his back-home safeguards experience was consistency in implementation, to assure that safeguards measures being applied in his home country were being equally applied in other countries. Discrimination in safeguards implementation between States under IAEA safeguards was not acceptable; differentiation, OK; discrimination, No<sup>10</sup>. Perhaps to his surprise, Jon Jennekens found that the Directors of the three Operations Divisions, who reported directly to him, were not fully in charge of their divisions. That was in the hands of three highly experienced and strong safeguarders, with the title of Divisional Coordinator<sup>11</sup>. In order to achieve the consistency he was aiming at, Jennekens wanted the Division Directors more fully in charge of their Divisions. Something had to be done about the Coordinators, who indeed were implementing good safeguards in their domains, but pretty much as they saw fit. Consistency was indeed a good goal at that time.

Jennekens was aided by the fact that those Coordinators were unhappy with the dominant position of the Section Head for Safeguards Effective Evaluation (SEE), a very capable Russian<sup>12</sup>, who was responsible for the reporting each year in the Safeguards Implementation Report (SIR) on how well the Operations Divisions had done in meeting SEE's evaluation criteria, including "*attainment*", "*partial attainment*" or "*failure*" to meet specific inspection goals. Naturally, Safeguards Authorities - and Operations Division Coordinators - did not like to see "*failure*" associated with the safeguards in their State. Operations wanted more say on how verification requirements were specified and evaluated.

DDG-SG Jennekens demonstrated his leadership ability in how he resolved those situations. He eliminated the Coordinator positions and assigned the three persons to head up new tasks. One Coordinator, Dimitri Perricos, he assigned to head a Safeguards Criteria Project with the task of developing what became the Safeguards Criteria<sup>13</sup>. The importance of the Safeguards Criteria Project was recognized throughout the Department. Senior, experienced inspectors were assigned to work on the project.

Under the leadership of Dimitri Perricos, *the Safeguards Criteria would be developed for inspectors by inspectors*. It was clear to Perricos that inspectors on the ground were the fundamental element in achieving effective safeguards. Within a State, inspectors went to declared facilities<sup>14</sup> to carry out inspections to verify that there was no diversion of a significant quantity of nuclear material, their mandate defined in the legally governing safeguards agreement between the State and the IAEA<sup>15</sup>. The inspectors' in-field activities were at facilities. Therefore, Dimitri knew from the start that he wanted to use facility type as the major structural feature of the new criteria. The evaluation criteria, developed by SEE, had used nuclear material as the top structural level.

Dimitri said the Safeguards Criteria Project would develop criteria that inspectors could use directly to perform their on-site inspections at facilities. There would be criteria for light water reactors (LWRs), for on-load reactors (OLRs), for research reactors, for enrichment plants, for fuel fabrication plants, for reprocessing plants, for storages, and more.

What the criteria would look like, we had no idea at the start. We began to prepare a section for LWRS, and used that section to decide on the format, the language, and many other details of the structure. Then we moved on to other facility types. At appropriate points, drafts were prepared and put out for review internally, and also by some interested States. The whole process took two-and-a-half years of continuous effort, week-by-week, to finally produce a reviewed and ready product in mid-1990. The criteria were to come into effect in 1991, to give the Operations Divisions time to prepare for the changes in in-field activities that were involved. Initially, the criteria were to be in use for five years, so the first issue was titled *Safeguards Criteria 1991-1995*. The experience in the first two years was publicly reported in 1993.<sup>16</sup>

To illustrate the depth and complexity of the Safeguards Criteria, let me give some details.

- The criteria covered all types of safeguards agreements: INFCIRC/153-type, INFCIRC/66-type as well as agreements with nuclear weapon states (“voluntary offer”).
- The criteria initially had sections for 11 facility types, for LOFs and for entire states. Each section contained paragraphs which detail the safeguards implementation activities relevant to that facility type (see listing of the paragraphs in the Annex).
- The safeguards criteria cover safeguards approaches, technical capabilities, facility practice, safeguards measures, inspection procedures and effectiveness evaluation.
- The safeguards criteria defined for all facilities and locations the normal frequency of inspection.
- The criteria distinguish nuclear material in three ways, by category, type and stratum. Nuclear material categories (unirradiated direct-use, irradiated direct-use, indirect use) are used primarily in specifying detection probabilities and timeliness goals. Nuclear material types (Pu, >20% U-235, <20% U-235, Th) are used in defining significant quantities. Strata (groups of items having similar physical or chemical properties, e.g. UO<sub>2</sub> powder,) are used in verification activities.
- For a facility type and a specific inspection activity, the criteria specify for each stratum the necessary and sufficient verification measurements: the detection probability to be achieved and the defect tests (gross, partial, bias) to be performed. These were based on credible diversion scenarios, the attractiveness of the material and whether the verification is for material balance, timely detection or remeasurement.
- Levels of verification detection probability used are: high (90%), medium (20%) and low (20%), plus 10% for remeasurement of material under C/S. A general principle was to require

one level less of detection probability and defect tests for timely detection than for the PIV. This was based on the consideration that the multiple timely detection verifications during a material balance period gave an accumulation of assurance and an increase in confidence level for timely detection conclusions.

- An example of a criterion for application in an INFCIRC/153-state is: *For natural UO<sub>2</sub> powder at a physical inventory verification (PIV), verification measurements must be performed with medium detection probability for gross and partial defects.* In an INFCIRC/66 state, high detection probability is required.
- In each facility section, verification measurements were connected with recommended instruments through a table. These tables were reviewed and updated annually to incorporate newly approved instruments.
- Eight annexes to the criteria present definitions and special criteria. One annex defines how C/S is to be applied and the requirements for remeasurement and reverification. One annex addresses verification of difficult to access material, which is one of several verification procedures that require specific approval.

**Question 7.** *Did the Safeguards Criteria introduce any new safeguards verification measures?*

**Answer.** Yes, some new measures were introduced. But the main objective of the Safeguards Criteria was achieving consistency in safeguards verification around the world. When a modified or new safeguards measure was to be introduced, the Operations Division Director wanted to be able to say to the State's safeguards authority that the same measure was being implemented around the world.

An important example of a new measure in the area of containment and surveillance was the dual C/S concept, which soon came into widespread application. Others were the zone approach; reverification of nuclear material under C/S, and "difficult to access" nuclear material.

**Question 8.** *What was the most difficult decision during the development of the Safeguards Criteria?*

**Answer.** One decision was left to the very end of the preparation of the Safeguards Criteria by the Project Head. That was whether surveillance of spent fuel storage ponds at LWRS should be required. At most LWRs, the spent fuel inventory can be verified by visual inspection during the PIV (or at another time if needed), and inspectors are present during core reloading. At some LWRs, pin replacement in the spent fuel pond was being contemplated when a fuel pin leak occurred; those activities could be verified by appropriate measures when and as required. It was recognized that provision of continuous surveillance of LWR spent fuel ponds involved a lot of equipment and inspector effort. *Was that necessary to provide the desired level of assurance that undeclared activities were not taking place with the spent fuel?* That was debatable. The decision had to be made based on judgment.

Perricos submitted the final Safeguards Criteria to the DDG-SG for approval including the requirement for LWR spent fuel pond surveillance, but he left to the DDG-SG the decision as to whether that requirement should be included or removed. The DDG-SG, John Jennekens, who had had extensive safeguards experience in Canada, decided that the requirement should be included. And it remains today.

## Conclusions

The IAEA Safeguards Criteria grew out of the fertile earth of two decades of safeguards inspection experience. They blossomed and served the IAEA Secretariat, Member States and the world well for many years, specifying the safeguards activities considered necessary to draw safeguards conclusions in States with all forms of safeguards agreement. The Safeguards Criteria continue to serve as a reference for nuclear material verification activities for all States, and they continue to be directly used for some States.

## Annex: Safeguards Criteria Facility Section Structure

Each facility section in the Safeguards Criteria contains the relevant following paragraphs that detail safeguards implementation activities for that facility type:

- auditing of records and reports
- physical inventory verification (PIV)
- verification of domestic and international transfers
- verification of other inventory change
- verification at other strategic points
- confirmation of the absence of unreported production of direct-use material
- confirmation of the absence of nuclear material borrowing
- material balance evaluation
- verification at interim inspections for timely detection purposes
- anomaly follow-up
- verification of design information
- verification of operator's measurement systems
- confirmation of transfers
- verification of small inventories (<1 SQ)
- activities related to non-nuclear material under safeguards
- activities related to equipment and facilities under safeguards
- activities related to inventories and lists of information.

---

<sup>1</sup> IAEA Safeguards Glossary, 2022 Edition, para 3.10, p 28

<sup>2</sup> INFCIRC/153 (Corrected), para 29. "...the technical conclusion of the Agency's verification activities shall be a statement, in respect of each material balance area, of the amount of material accounted for over a specific period..."

<sup>3</sup> INFCIRC/153 (Corrected), para 73. "...the Agency may make special inspections..."

<sup>4</sup> INFCIRC/153 (Corrected), para 28. "...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..."

<sup>5</sup> IAEA Safeguards Glossary, 1987 Edition, para 105. Conversion time, p 23

<sup>6</sup> IAEA Safeguards Glossary, 2022 Edition, para 3.4, p 26

<sup>7</sup> IAEA Safeguards Glossary, 2022 Edition, para 11.30, p 119

<sup>8</sup> UN Security Council Resolution S/RES/2231(2015) (20 July 2015), Annex A, Joint Comprehensive Plan of Action (JCPOA), Vienna, 14 July 2015

<sup>9</sup> INFCIRC/214 (Dec 13, 1974)

<sup>10</sup> This statement is premature for 1987. The catchy phrase "differentiation without discrimination" was invented by Slava Pouchkarev and myself in preparing the initial report on integrated safeguards in the year 2000.

---

<sup>11</sup> The Coordinators, Sven Thorstenson, Lesley Thorn and Dimitri Perricos happened to come from the outskirts of Europe – Norway, UK and Greece, respectively.

<sup>12</sup> Vladimir Fortakov

<sup>13</sup> Jennekens also solved his desire to move me out of his DDG-SG office by making me the Secretary of the Safeguards Criteria Project

<sup>14</sup> And to locations outside facilities, LOFs.

<sup>15</sup> Regarding inspectors looking for facility misuse or undeclared activities, at that time it was common to talk about the “inspector’s nose”; later that would become the ‘inquisitive inspector’.

<sup>16</sup> James A. Larrimore, IAEA, “IAEA Safeguards Criteria,” INMM Journal, Vol XXI, Number III, May 1993, p 19-23