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REVISITING THE PRACTICES AND TECHNICAL OBJECTIVE OF SAFEGUARDS

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ABSTRACT

With the expected expansion in nuclear programs, the IAEA will face many safeguards challenges in the coming decades due to increasing numbers of facilities and new types of facilities. Change and expansion will require the IAEA to plan carefully, both to ensure its effort is focussed on areas of greatest proliferation risk and to make optimal use of scarce safeguards resources.

The IAEA's safeguards system has evolved considerably since the 1960s, but some elements have remained unchanged. Continuing some of these traditional safeguards practices and approaches in a new and resource constrained safeguards environment may not be practicable or even desirable.

It is important to recall the technical objective of safeguards, i.e. "… *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, paragraph 28). While nuclear materials accountancy is a key safeguards measure, it is not the only, or even a necessary, measure for the IAEA to fulfil its technical objective.

It is important that process (i.e. nuclear materials accountancy) not be a distraction from the goal (i.e. achieving the technical objective). For example, the current safeguards system maintains a strong reliance on independent verification of declared inventories, a verification concept that arose in a time when inventory verification was the entirety of the IAEA safeguards effort. A back to basics review of the allocation of IAEA safeguards effort may determine that these measures are not the best way to achieve the technical objective.

This paper will revisit the concepts contained in the standard form comprehensive safeguards agreement and explore possibilities for achieving the technical safeguards objective without depending on detailed nuclear materials accountancy in its current form.

1. INTRODUCTION

The International Atomic Energy Agency's nuclear non-proliferation safeguards system is continually being re-designed and re-engineered to meet the changing needs and expectations of the international community. The interpretation of the IAEA's traditional safeguards instrument, INFCIRC/153, in terms of implementation and expectations has evolved over time and continues to do so. The system is robust and effective, but is constantly subject to new challenges at the diplomatic, legal, administrative and technical levels.

Under the terms of the NPT, each non-nuclear-weapon state party accepts "the Agency's safeguards system". It is important to note that INFCIRC/153 does not represent the full extent

of the IAEA's verification mandate, as evidenced by the facts that: when the NPT was concluded INFCIRC/153 did not exist, so NPT states parties were committing to a systems that was then undefined; and, the term "safeguards system" does not appear in the title or in any part of INFCIRC/153[1]. But more importantly, the IAEA's safeguards system has evolved since the 1970s, and the fact that this evolution has been on the whole accepted by states demonstrates implicit acceptance that the safeguards system referred to in the NPT is not fixed.

Apart from INFCIRC/153, other major elements of the safeguards system include Board of Governors decisions, the IAEA's Safeguards Manuals, Safeguards Criteria, the integrated safeguards conceptual framework and associated documentation, etc. The point is, there is considerable flexibility in "the Agency's safeguards system", so the Board of Governors and the Secretariat are able to adapt the system to meet changing circumstances. This adaptability is a key strength, essential to maintaining and improving the effectiveness of the safeguards system.

With the predicted increase in the number of nuclear facilities around the world, the IAEA will need to safeguard both increasing numbers of facilities of existing types and entirely new classes of facilities. Change and expansion will require the IAEA to plan carefully, both to ensure that its effort is focussed on areas of greatest proliferation risk and to make optimal use of scarce safeguards resources. The IAEA will operate in an environment of expanding demands but limited resource growth (not simply financial resources, but also human resources). The scale and complexity of the international nuclear fuel cycle will leave the IAEA with no choice but to continue to adapt to new realities and practicalities.

In order to meet these challenges strategically it may be necessary for the IAEA to adapt the underlying assumptions of its safeguards system – to clearly distinguish between those matters which are vital to achieving the objectives of the safeguards system and those matters of process that are merely instrumental in such efforts. The current safeguards system maintains a strong reliance on independent verification of declared inventories. The approaches built around these verification concepts arose in a time when inventory verification was the entirety of the IAEA safeguards effort. Do these measures remain the most efficient and effective way for the IAEA to achieve its technical objective?

This paper seeks to highlight the primacy of the technical objective of safeguards, as set out in INFCIRC/153 paragraph 28 – deterrence through risk of early detection – and identifies areas in which existing matters of process can be revisited.

2. IMPORTANCE OF MATERIAL ACCOUNTANCY AND VERIFICATION

The IAEA's verification of declared inventories of nuclear material has been the back-bone of the safeguards system since its inception. Facility operators maintain a system of records which are reported to the IAEA by the state in accordance with the relevant form of Code 10 of the state's Subsidiary Arrangements. Reconciliation of these facility records and state reports with physical inventories of nuclear material at facilities represents the great bulk of the verification effort by the IAEA.

To many safeguards practitioners, a safeguards approach built on a solid foundation of nuclear materials accountancy with related IAEA inventory verification still maintains its primacy in the IAEA's verification toolkit. Efforts to improve effectiveness and efficiency have strongly maintained the importance of independent inventory verification and nuclear materials accountancy. For example, while the introduction of integrated safeguards[2] has generally led to a reduction in IAEA inspections at each facility, verification activities at facilities still retain a strong element of following safeguards criteria[3] for inventory verification.

In spite of the close relationship and historic importance of accountancy and inventory verification, it is important to recognise that these activities only address a part of the IAEA's safeguards mandate. Materials accountancy defines and delineates the declared inventories of nuclear material in peaceful uses in the state and the IAEA's independent verification efforts confirm these declarations. Inventory verification does not directly assist the IAEA in its efforts to derive credible assurance that there are no undeclared nuclear materials or activities of safeguards significance in a state.

When considering a new facility or class of facilities, it is important to ensure that all credible pathways for removal of fissile material from the facility are covered and that the IAEA can access facility inventories for the purposes of inventory verification. In a similar fashion, when the IAEA is evaluating the effectiveness of the safeguards measures that have been applied to a facility during a material balance period, the evaluation criteria are largely based on the coverage of potential diversion paths and the proportion of material inventories verified.

It is important to understand that access to nuclear material for verification purposes and assessment of diversion pathways are not objectives in and of themselves. Rather, these are processes in support of the safeguards objective. Does the consideration of broader-based methods to achieve the safeguards objective need to rely on maintaining the long-established processes of inventory verification?

With the introduction of new types of nuclear fuel cycle facilities (such as electro-metallurgical processing) and the revolutionary reactor types envisaged under the Generation IV initiative, the traditional model of independent IAEA verification of declared inventories may no longer be applicable. Some of the new fuel cycle approaches envisaged would render large inventories of fissile material inaccessible for the purposes of IAEA verification.

Some safeguards practitioners and analysts consider the lack of access, for the purposes of independent verification, to present a significant problem with the safeguardability of the new facility types. Rather than concentrate on maintaining a particular process (in this case, access to all nuclear material) in support of the overall safeguards objective, it is the contention of the authors that the IAEA could explore methods of maintaining and attaining an equivalent degree of assurance without independent inventory verification.

The technical objective of safeguards for these facilities (indeed for all facilities) 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....*" As for what measures should be used to achieve this objective, paragraph 29 of INFCIRC/153 states that "*material accountancy shall be used as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures*".

Clearly material accountancy has an important role, but since the adoption of INFCIRC/153 other tools, such as the IAEA's state-level approach implemented through information-driven safeguards, have also taken on a fundamental, if not greater, importance in achieving the safeguards objective. And in the spirit of adapting the safeguards system to maximise its effectiveness, paragraph 29 need not lock in material accountancy as operating in the same way as has traditionally been the case. What other possibilities exist for detection by the IAEA of the diversion of significant quantities of nuclear material?

3. THE PHYSICAL MODEL AND INFORMATION DRIVEN SAFEGUARDS

The IAEA, working in cooperation with its various member state safeguards support programs, has developed the "Physical Model" (PM) which identifies, describes and characterises every

stage of the nuclear fuel cycle, and how it could be used for converting source material to weapon-usable material, identifying indicators for each process. The underlying philosophy of the PM is that each activity that could contribute to the diversion of material or the clandestine production of material gives rise to indicators that can be separately identified. Within the PM, these indicators have been assessed for their strength of association with particular declared and clandestine activities. In large part the PM was developed to guide the IAEA's processes of information collection, review and evaluation, but the utility of the PM has been more broadly recognised by the IAEA and it serves major roles in the state evaluation and in the design information analysis processes.

In the case of new facility types the PM would of course be expanded to identify, describe and characterise indicators of misuse of these facilities. Indicators are currently used to prepare for design inventory verification activities under INFCIRC/153 and complementary accesses under the Additional Protocol (AP). If nuclear material is less accessible for verification in new facility types, then inspectors could instead shift effort that would otherwise be used for inventory verification to more actively search for PM indicators during verification activities.

4. NEW CHALLENGES AND PROCESSES REQUIRE NEW WAYS OF THINKING

The international safeguards system has of course a finite budget and the IAEA has been held to strong budget discipline by its member states. If the predicted expansion of nuclear power eventuates it will generate new pressures on the safeguards system, and existing safeguards methodologies and processes will face further re-examination. While it is difficult make any predictions about the future in general it seems safe to predict that the human and financial resource base of the IAEA will not expand at a rate sufficient to maintain current safeguards approaches and philosophies.

The IAEA has an established history of adapting verification methodologies to changing needs. For example, it has taken a series of very important steps in its re-thinking of safeguards approaches with the introduction of integrated safeguards and the move towards use of the State Evaluation Report/State-Level Approach/Annual Implementation Plan approach to safeguards for all states. These measures provide the IAEA with a significantly enhanced degree of flexibility in its dealings with member states but they do not represent the limits of what the IAEA can achieve under its existing legal authority.

As noted above, for new technologies and facilities where the existing model of independent verification of inventories cannot apply, greater use could be made of active searches for Physical Model indicators, augmented by the State-Level Approach. If the IAEA and member states were to accept that this model could apply to new technologies and facility types, there is no in principle reason that this cannot be extended to existing facilities.

5. WHAT MIGHT REPLACE INVENTORY VERIFICATION?

There are a number of possibilities for within the IAEA's existing legal authority for alternatives to inventory verification. The IAEA is already empowered to make use of the findings of the State System of Accountancy and Control (SSAC). The IAEA could move to a situation in which it devotes a proportion of the resources currently devoted to independent verification to auditing and reviewing the findings of the SSAC. Such a change would not be trivial as it would depend on the technical capabilities and capacities of the SSAC, and it would need to be arranged in such a way as to maintain the credibility and independence of IAEA safeguards.

Paragraphs 7 and 31 of INFCIRC/153 allow for the IAEA to verify the findings of the SSAC in achieving its safeguards objective. Limited use has been made of these provisions by the IAEA

– traditionally there has been concern that reliance on the SSAC will impair the independence of the IAEA's conclusions. In order for the IAEA to maintain independence of its conclusions while still ensuring a state's declarations were verified, it would need to be able to independently confirm that the findings of the SSAC are accurate and reliable e.g. by performing parallel verifications of a random subset of the findings declared by SSAC. The inspection resources freed up by such an approach could be used for the purposes of information-driven review and evaluation, including, as described above, actively searching for Physical Model indicators.

Alternatively the IAEA could largely replace existing regular inspections with fewer but more intrusive inspections on a basis that would not be predictable to the inspected state. In order to avoid problems with the preparedness of facility records or facility equipment necessary for the inspection, the IAEA could provide a date for inspection but not specify which of the state's facilities would be inspected. Each of the facilities would need to go through all of the necessary preparatory steps but only some subset of facilities would actually be inspected. Due to intrusiveness of the inspections such inspections would have a high deterrent value for diversion, but due to their reduced numbers the overall cost to the IAEA is likely to be far lower than for the existing inventory driven model.

6. CHANGING THE SAFEGUARDS SYSTEM

While the safeguards system has adapted over time, the system has a lot of internal inertia. This inertia arises from:

- the legal limitations imposed upon the IAEA by its members states (inter alia, via the Statute, the NPT and the various safeguards agreements);
- the expectations of the member states as expressed through the decisions of the Board of Governors and the resolutions of the General Conference;
- the management vision of the Director General, the Deputy Director General for Safeguards, and the various Safeguards Division Directors;
- the day to day approaches of the Section Heads, their senior inspectors, country officers, facility officers and inspectors in the field.

Each contribution to the inertia of the system adapts to changing circumstances in different ways and with different characteristic response times. The development, introduction and adoption of the strengthened safeguards system serves as a useful illustrative example of this inertia.

In the 1990s, when the strengthened safeguards system was being developed, the international community responded as quickly as it was able. The Board of Governors agreed a series of measures to reassert the authority of the Secretariat to seek information on both the correctness and the completeness of states' declarations. Once the need for complementary legal authority for some necessary measures was recognised, the international community was able to negotiate the text for a model Additional Protocol (AP) for states to adopt. The time period from recognition of the problem to the introduction of the model AP was approximately five years (which was made up of a diagnostic period of roughly three years followed by a negotiating period of roughly two years).

Once the AP was completed its adoption by the broad international community was a process characterised by delays and reluctance. In some cases the delays were largely procedural (e.g. the EU's decision to have the AP come into force for all of its non-nuclear-weapon states on the

same date) but other cases reflected a degree of reluctance to grant the IAEA the additional authority that it needed to fulfil its mandate.

The slow rate of adoption of the AP by member states meant that the Operations Divisions of the Safeguards Department had to deal with a system in which states in their areas of responsibility could have substantively different safeguards obligations. It has also led to the situation in which inspectors regularly found that they had very different tool-sets available to them when considering two otherwise equivalent states. The slow and uneven decline in the use of the traditional "safeguards criteria"-focussed system meant that inspectors that had been trained under the system of traditional safeguards were able to continue to do their work under such systems. A valuable opportunity to re-engineer the safeguards system was delayed by working arrangements that kept both systems in parallel.

The persistence of traditional practices and ways of thinking in parallel with the new represented a substantial organisational inertia that has worked to slow efforts to fully optimise the safeguards system. With the introduction of integrated safeguards, intended as the optimal combination of available safeguards measures, the IAEA Secretariat published a guiding document titled "*The Conceptual Framework for Integrated Safeguards*" GOV/2002/8 (8 February 2002). In this important document, the IAEA noted that "…*Under integrated safeguards, nuclear material accountancy will continue to be the basis for deriving a conclusion on the non-diversion of declared nuclear material in a State*. …"

To move beyond the primacy of nuclear material accountancy in integrated safeguards, the IAEA would need to reconsider its historic attachment to independent inventory verification and concentrate instead on ensuring that the technical objective of safeguards is achieved in the most cost effective and efficient means possible.

7. CONCLUSIONS

Over its some fifty year history, the IAEA has adapted its safeguards system to new technologies, new demands and new facility types. The future will bring new challenges and the IAEA will need to continue this practice of adaption in order to optimise its use of available resources. The particular challenges presented in this paper are those that would arise for new types of facilities, such as electro-metallurgical processing, or reactors considered under the Generation IV initiative. For these facilities the traditional model of independent IAEA verification of declared inventories may no longer be applicable, as the design of some of these facilities may render large inventories of fissile material inaccessible for the purposes of verification.

In designing safeguards approaches to meet these challenges, material accountancy and inventory verification are not objectives in and of themselves, rather these are only one set of tools for achieving the safeguards objective of "*the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of … nuclear explosive devices or for purposes unknown …*". Over the last twenty years the primacy of material accountancy and inventory verification has been reduced, in favour of a state-level approach implemented through information-driven safeguards, but material accountancy and inventory verification still form a significant component of safeguards efforts. This paper has presented for consideration ideas for shifting the balance from inventory verification, while still achieving the technical objective of safeguards, such as: more active searches for Physical Model indicators; auditing and reviewing the findings of the SSAC; fewer but more intrusive inspections.

The ideas presented in this paper are not new. Furthermore, the implementation of these ideas, and determining their potential impacts on achieving the safeguards objective, are not trivial matters, so careful assessment and planning would first be required. However, in the spirit of encouraging continuous innovation of safeguards approaches to meet future challenges before they arise, the authors consider it timely to draw attention to some alternative approaches, and encourage debate.

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1. By contrast, the pre-NPT facility-specific IAEA safeguards agreement, INFCIRC/66, is titled "The Agency's Safeguards System".
2. The optimum combination of all safeguards measures under comprehensive safeguards agreements and the Additional Protocol to achieve maximum effectiveness and efficiency.
3. The IAEA documents which specify the scope, normal frequency and extent of the verification activities required to achieve the IAEA's inspection goals under traditional safeguards