Addressing Safeguards Challenges for the Future

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1. Introduction

IAEA safeguard system is considered the corner stone of the international nuclear nonproliferation regime. Effective implementation of this legal instrument enables the IAEA to draw a conclusion with a high degree of confidence on the peaceful use of nuclear material and activities in the state.
This paper aims to provide an opportunity to address various challenges encountered by IAEA. Strengthening safeguards system for verification is one of the most urgent challenges facing the IAEA. The IAEA should be able to provide credible assurance not only about declared use of nuclear material and facilities but also about the absence of undeclared material and activities.

2. Safeguards challenges

Global nuclear energy is growing, even after the Fukushima accident, with 438 reactors operating at the end of 2014 in about 30 countries. About the same number are working actively or planning to develop nuclear power as a newcomer [1]. Of the 30 operating countries, 13 are either constructing new plants or actively completing previously suspended construction projects, and 12 are planning to either construct new plants or to complete suspended construction projects.

2.1 Challenges in the current system

With the increase in the use of nuclear power, safeguards responsibilities continue to increase rapidly. However the budget for international safeguards is not commensurate with this increased demand. As of the end of 2014, safeguards were applied to 180 member states, including approximately 1,300 nuclear facilities and 190,000 significant quantities nuclear material [2].
Nuclear power reactors are being modernized and becoming more complex. New fourth generation reactors and small modular reactors are expected to be in operation in the future. New innovations such as the use of laser for enrichment and pyroprocessing for the spent fuel have also become realized during the past decade [1].
The expansion of international trade and nuclear cooperation between states are intensifying. The erosion of border between countries and availability of internet facilitate illicit trafficking of sensitive nuclear technology (Know- how) [1,2]. These lead to the possibility of increasing the covert supply of nuclear related technology, equipment, and materials, which in turn introduce additional burden on safeguards.
The emergence of number of outstanding cases (past and current) in breaking international commitments under the non-proliferation treaty (NPT) and safeguards agreements raises the fear of proliferation and security concerns and poses major challenges to strengthening the international safeguards system. These cases illustrate that there should be increased focus on the importance of robust safeguards in the nuclear industry to verify correctness and completeness and be able to provide reasonable assurance about the declared and undeclared activities by the state. There also exist difficulties in the implementation of the IAEA activities. Some of these difficulties are: timeliness and detection of illicit activities; and non-compliance and loop holes in the NPT. All of these factors, recently, have challenged IAEA's ability to carry out its safeguards mission effectively and efficiently [2].

3. Suggestions to address safeguards challenges

To prepare for the future, IAEA has taken several efforts to strengthen the effectiveness and improve the efficiency of safeguards. The safeguards department long–term strategic plan 2012–2023 addresses the conceptual framework for safeguards implementation, legal authority, technical capabilities (expertise, equipment and infrastructure) and the human and financial resources necessary for Agency's verification activities [3]. Through its international project on innovative nuclear reactors and fuel cycles and the Generation IV International Forum, IAEA has held technology meetings, worked on assessments of proliferation resistant nuclear energy systems and contributed to the development of safeguards by design guidance. IAEA has been working to employ more efficient and effective ways of implementing safeguards, with a focus on sustaining quality workforce, strengthening quality management and performance measurement and improving information security. IAEA is trying to optimize safeguards processes in a resource constrained environment into the future by making better use of modern technology and by enhancing cooperation with State and regional

authorities in the implementation of safeguards. Continued success will need member states' political, technical and financial support [4]. Examples of such support include the USA next generation safeguards initiative (NGSI) aimed at promoting and strengthening nuclear safeguards worldwide, and the support programs provided by different member states.

3.1 Addressing the problem with timeliness and detection

IAEA's timeliness detection goal, Paragraph 28 of INFCIRC/153, is used for establishing the frequency of safeguards inspections and activities at a facility to verify that no diversion has occurred. Under this agreement the state is committed to provide the agency with access to nuclear facilities and information about nuclear material and related facilities at high degree of transparency, and makes every possible effort to facilitate IAEA's regulatory role [5].

Timeliness criteria depend on the form of the nuclear material and IAEA's access rights. If the Iran case is an example, then it is clear that the IAEA does not always have the ability to detect the misuse of nuclear activities and material in a timely manner. Since verification activities require extended periods of time, the threat of timely detection of illicit activities remains, mainly with countries without additional protocol (AP) in force or under small quantity protocol (SQP) such as the Syrian case.

There are additional potential gaps which may challenge IAEA's timely detection goal such as:

- IAEA concerns over political instability in many countries and threats of nuclear terrorism, the control of some of the armed groups (terrorist or extremist) at some places that may contain nuclear activities.
- Tremendous technological advances over the past years, with respect to the hardware and communication technology and the world of the Internet, it become possible for any country, regardless of its economic status from obtaining nuclear technology(Know How).

These terrorist or extremist groups have military and technical capabilities and human resources, with the availability of information about nuclear weapons or explosive devices manufacturing.

3.2 Addressing the problem with noncompliance and the loopholes in the NPT

Article X of the NPT states that any states party to the treaty has the right to withdraw from it with three month notice. This easy exit process raises the concern that countries might withdraw from the NPT once they gained the nuclear weapon capability. This occurred when the DPRK announced in 2003 that it was withdrawing from the treaty. Likewise, the situation in Iran poses the question whether breaches of safeguards agreements or refusal to cooperate with the IAEA can be considered as non-compliance [6].

The application of safeguards promotes international confidence in peaceful uses of nuclear energy and establishes a mechanism for member states to make judgments regarding compliance through the IAEA Board of Governors and the UN Security Council. This mechanism must be revisited to give the power and momentum to IAEA to take action against any states violating their obligations through the use of coercive measures such as economic sanctions. IAEA member states should strengthen safeguards measures by creating binding legal requirements to maintain safeguards, to any nuclear material and equipment, even after a state exercise its right to withdraw from the NPT**.**

3.3 Utilizing regional regulatory system to better safeguards facilities

According to the comprehensive safeguards agreement (CSA), IAEA shall envisage "the use of nuclear material accountancy as a safeguards measure of fundamental importance with containment and surveillance as important complementary measures" and (para. 31 INFCIRC/153) encourages the Agency to "make full use" of state systems of accounting for and control (SSAC) and to "avoid unnecessary duplication of the state's accounting and control activities". This means that the information provided by SSACs would be sufficient to IAEA verification activities in drawing the final conclusion.

This indicates the need to enhance the cooperation between the agency and the states represented by the regulatory authorities (SSAC) to ensure that their State system of accounting for and control of nuclear material (SSAC) has the necessary legal authority, and enhance capacity building available to them through their rehabilitation and training.

Efforts may be made to find new initiatives to encourage cooperation among the states to create regional regulatory systems (RSSAC) [6]. For example, EU states and Argentina and Brazil have created regional organizations (EURATOM and ABACC). EURATOM and ABACC are party to the relevant safeguards agreement and both of them delegated most SSAC functions/responsibilities to the respective states. These regional systems will help to reassure countries that their neighbors are neither diverting nuclear material from peaceful purposes to nuclear weapon programs nor engaging in undeclared nuclear activities. This reassurance promotes the principle of transparency between countries and achieves efficiencies and effectiveness by utilizing these systems either through reports sent by the (RSSAC) or joint inspection of these systems. The resulting efficiency and financial savings

helps IAEA to direct its efforts focused on hot spots and outstanding issues.

3.4 *Use of advanced technologies and Safeguards approaches for facilities*

New technology developments in nuclear safeguards can play an important role in detecting diversion at declared facilities and to aid in the detection of undeclared activities. New safeguards technologies include technologies that: (1) increase the speed of nuclear measurements and improve the precision and; (2) can perform real-time process monitoring and surveillance in unattended mode [5].
Nuclear facilities have multiple potential diversion pathways. Therefore, the effective implementation of safeguards by design (SBD) and assessments of proliferation resistant nuclear energy systems can help to avoid costly and time consuming retrofits to nuclear facilities and increase both effectiveness and efficiency by identifying potential improvements and evaluating safeguards approaches [7]. In order to advance this process IAEA needs to draft new general and facility specific safeguards by design (SBD) guidance in close cooperation with nuclear facility designers and the IAEA member states to ensure optimum utilization of the resources of the IAEA to develop and apply new safeguard technologies. In this respect, availability of modern and secure remote monitoring systems will make IAEA work more effective and efficient by using these next generation surveillance systems. They allow easy record keeping and authenticated data storage, and timely data transmission to IAEA headquarter. The use of remote monitoring technologies can reduce verification efforts in the field, for example, the implementation of short notice random inspections.

3.5 Safeguards and Non-proliferation culture development:

Literature on the topic of safeguards culture is limited compared with the internationally accepted definitions of safety and nuclear security culture. Development of a new safeguards culture concept is needed. Exploration of safeguards culture should begin with achieving an international consensus on definition for the concept. Conceptual development of a clear definition for safeguards culture, considers aspects for identifying indicators of safeguards culture and establishing the link between safeguards actions, beliefs, attitude, behaviors [8]. This should be followed by development of methodologies and approaches that will benefit IAEA and member states missions and enhance the nonproliferation regime.
Establishing 3S culture would provide long term commitment to safeguards, safety, and security of nuclear materials and technologies and promote good practices that improve performance. Safeguards culture starts in the initial phases of infrastructure planning and must be integrated into the process of developing a responsible nuclear energy program. In addition to that, complying with international nuclear safeguards, promotes safeguards culture

4. Conclusion

Implementation of IAEA safeguards continue to play a vital role within the nuclear non-proliferation regime. IAEA safeguards have evolved over the years through, for example, the development and implementation of the State-level concept, improved safeguards approaches for facilities, and use of advanced technologies (e.g., remote monitoring and information technology). IAEA must move towards more enhanced safeguards system that is driven by the full use of all the safeguards available relevant information. Safeguards system must be responsive to evolving challenges and continue innovation through efficient implementations of more effective safeguards.

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