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The Impact of the State-Level Concept on "Newcomers": A Case Study of the Kingdom of Saudi Arabia

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Abstract

The International Atomic Energy Agency's (IAEA) latest reports indicate a growing number of states (newcomers) considering the deployment of nuclear energy programs. In developing nuclear infrastructure, newcomers have to employ the prevailing standards to deploy the nuclear program in a secure, safe, and sustainable manner. State-Level Concept (SLC) refers to a comprehensive approach that uses information about a state's nuclear facilities and capabilities to implement safeguards within the scope of the state's safeguards agreement. SLC focuses on strengthening the effectiveness and improving the efficiency of the safeguards system considering the State as whole. SLC has been implemented in 53 states, and the IAEA is encouraging other states to implement SLC. This paper investigates the influence of SLC on newcomers, with the Kingdom of Saudi Arabia (KSA) as a case study. The investigation approaches SLC from the newcomer's perspective, with the aim of determining critical factors impacting newcomers' successful implementation of SLC. KSA has in force, the Nuclear Non-Proliferation Treaty (NPT), Comprehensive Safeguards Agreement (CSA) with no Additional Protocol (AP), and Small Quantities Protocol (SQP) and has a small unit for the State System of Accounting for and Control of nuclear material (SSAC). Critical looks at State-level objectives and State-specific factors are employed to reconcile KSA's outlook with the IAEA's safeguards framework/agreements. The factors impacting SLC include sufficient cooperation between the IAEA and newcomer states, raised confidence in sensitive nuclear plant management, higher transparency of the civilian nuclear energy program, and improved capabilities of SSAC. For KSA to achieve its initial nuclear capacity (18 GWe) by 2032–40, it is recommended that KSA improve and expand its SSAC to adequately meet safeguard responsibilities. In addition, KSA is encouraged to sign the AP, which enables the IAEA to draw broader safeguard conclusions on nuclear materials and activities. This will foster transparency and long-term nuclear cooperation between KSA and developed states.

Keyword: State-Level Concept (SLC), Newcomer States, Safeguards Evolution, Broader Safeguards Conclusion, Nuclear Transparency

1. Introduction

The International Atomic Energy Agency's (IAEA) latest reports indicate a growing number of "newcomer" states considering the deployment of nuclear energy programs. The states look to nuclear technology to address increasing electricity demand driven by population growth and limited energy resources.[1] The expected projections in nuclear energy demand are 1) 17% if the current market remains and few changes in resources and technology occur, 2) 94% if the rate of electricity demand and economies continue to grow.[1] The consideration of civilian nuclear power programs comes with the necessity of having acceptable safeguards protocols in place before deployment. The types of safeguards commitments and agreements reflect on the state-level nuclear transparency and the confidence of the international nuclear community, especially during the sensitive stages of the nuclear fuel cycle. Development in nuclear safeguards has continued since the creation of the IAEA in 1957, as well as the establishment of the nuclear non-proliferation treaty (NPT) and comprehensive safeguards agreement (CSA) in the 1970s.[2,3] The CSA, based on INFCIRC/153 criteria, “called traditional safeguards”, was proven to have limitations that prevent the IAEA from carrying out its duties sufficiently and effectively.[2-4] The discovery of the clandestine Iraqi nuclear weapon program in the 1990s triggered the alarm for strengthening the effectiveness and improving the efficiencies of the safeguards system.[3,5] Many lessons were learned in the Iraqi case – and subsequently in DPRK, Libya and Iran – that pushed for continuous evolution of the safeguards system.[2] Since then, the IAEA has been giving greater consideration to the state as a whole. The Additional Protocol (AP) was adopted in 1997.[6] AP equipped the IAEA with the needed tool (broader information, wider environmental sampling, complementary access, and short notice) to verify, deter by timely detection, and provide assurances of the absence of undeclared nuclear activities.[3-6] Moreover, AP allowed the IAEA to draw broader safeguards conclusions.[2,3] Consequently, the ratification of NPT along with maintaining acceptable safeguards commitments and agreements were considered as important factors for the successful development of civilian nuclear power programs.[7]

1.1. SLC Development and Methodology

The integrated safeguards (IS) and state-level concept (SLC) were the concepts developed by the IAEA for the consideration of the state as whole.[4] The IS refers to the best combination of safeguards measures that is available to the IAEA under CSA and AP.[4] The implementation of IS is achieved only once the IAEA has drawn the broader safeguards conclusion of the absence of undeclared nuclear material, facilities, and activities in the concerned state.[4] The IAEA can draw the broader safeguards conclusion only if both CSA and AP are in force.[8,9] Thus, IS is limited to the type of safeguards agreements. The implementation of IS is achieved if all the needed evaluations have been completed. SLC was introduced for the first time in safeguard implementation report (SIR) 2004.[8] Since then, SLC has played an important part in strengthening the effectiveness and improving the efficiency of the safeguards system.[8,9] As defined by the IAEA, SLC refers to the implementation of safeguards in a manner that considers a state’s nuclear and nuclear-related activities and capabilities as a whole, within the scope of the state’s safeguards agreement [GOV/2013/38 and GOV/2014/41].[8,9] SLC does not present any additional rights or obligations to the party states of NPT and CSA and no modification in the existing rights and obligations.[8,9] SLC is applicable to states with all different types of safeguards agreements. SLC considers the capability of the state’s nuclear fuel cycle, the technical capability of the state/regional system of accounting for and control of nuclear material (SSAC/RSAC), all safeguards relevant information, and the nature of safeguards conclusion.[8,9] Additionally, SLC is not used to rate or grade states and is not a substitute for AP. SLC has been implemented in 53 states, and the IAEA is encouraging other states to join.[8]

SLC involves development of the state-level approaches (SLA). SLA addresses the generic safeguards objectives common to all states with CSA agreements while taking into account the state-specific factors.[8,9] In addition, SLA addresses the state-level objectives developed for the concerned state. The generic state-level objectives for states with CSA agreement, included: [8,9]

1) The detection of any undeclared nuclear material and activities in the state as a whole,
2) The detection of any undeclared production or processing of nuclear material in declared facilities or in location outside facilities (LOF),
3) The detection of any diversion of declared nuclear materials in declared facilities or LOFs.

The determination of state-level objectives is based on conducting diversion/acquisition path analysis that takes into account the state-specific factors.[8,9] The state-specific factors include:[8,9]

1) The type of safeguards agreement in force and the nature of the safeguards conclusion drawn by the IAEA;
2) The nuclear fuel cycle and related technical capabilities of the state;
3) The technical capabilities of SSAC/RSAC;
4) The IAEA's ability to implement certain safeguard measures in the state;
5) The nature and scope of the cooperation between the IAEA and the state;
6) The IAEA experience in implementing safeguards in the state.

The various aspects involved in the development of SLC positively impact the effectiveness and efficiencies of safeguards implementation. Newcomers must recognize the importance of developing SLA and SLC in early stages of nuclear infrastructure development. Thorough collaboration is required between the IAEA and the state in order to elevate nuclear transparency. The technical capabilities of SSAC/RSAC in the development of SLC allow for tight cooperation and improve the newcomer's SSAC/RSAC. Another benefit of the SLC is the building of confidence in the state's sensitive nuclear facilities through the concentration of the safeguards effort on key areas.

2. Scope of Work: Justification and Significance

The goal of this paper is to investigate the SLC's impacts on newcomer states, with KSA as a case study. Critical looks at state-level objectives and state-specific factors are employed in reconciling KSA's current outlook with the IAEA's safeguards framework/agreements. The implementation of SLC has not been addressed in details since such details must involve IAEA and KSA. The review is mainly concerned with the factors considered as positive influences that ultimately strengthen the effectiveness and improve the efficiency of safeguards, as demonstrated by previous implementation of SLC. This is due to the fact that SLC is already governed by existing safeguards commitments, "CSA and AP if applicable", and it neither introduces new rights and obligations nor involves new interpretation of existing authorities. It should be noted that IAEA has addressed discriminatory and/or political (i.e. negative) factors that may lead to objection to SLC in IAEA documents GOV/2013/38 and GOV/2014/41.

3. KSA's Proposed Civilian Nuclear Power Program

The Gulf States, namely, Kingdom of Saudi Arabia (KSA), United Arab Emirates (UAE), Kuwait, Bahrain, Qatar, and Oman, are considering the deployment of civilian nuclear power programs.[10] The countries' different interests lead to separate efforts to seek civilian nuclear power programs.[10] In 2010, KSA officially announced its consideration of a civilian nuclear power program along with the creation of King Abdullah City for Atomic and Renewable Energy (KACARE), KSA's representative to the IAEA.[11] KACARE's responsibilities include the planning, formation and deployment of the KSA civilian nuclear power program along with other renewable resources.[11]

Table 1: Specifications of the Proposed KSA Civilian Nuclear Power Program

KSA	Parameter Specifications	
Nuclear Capacity	**Electricity Production (GWe)**	**Number of Nuclear Power Reactors**
	17–18	16
Reactor Types	**Name-Characterization**	**Electricity Production (MWe)**
	EPR- Power Reactor	1600
	AP1000-Power Reactor	~1000
	SMART-Research Reactor	90–100
	CAREM-Research Reactor	~ 25
Nuclear Fuel Cycle	**Options or Scenarios**	
	1—The nuclear fuel will be imported	
	2—The nuclear fuel will be manufactured	
	3—A combination of both	
Nuclear Non-Proliferation Activities[a]	**Agreement Name**	**Signature or Ratification Date**
	NPT	1988
	SQP	2005
	CSA	2009
	AP[b]	-

Source: World Nuclear Association. 2016. *Nuclear Power in Saudi Arabia*.[11]

[a], Non-Proliferation activities are limited, list does not include all conventions.

[b], KSA has not yet signed the AP.

KACARE has been involved in various international agreements for evaluating and planning the deployment of a civilian nuclear power program.[11] KACARE has concluded agreements with the following entities: 1) Areva, France in 2011; 2) Investigación Aplicada (INVAP), Argentina in 2011; 3) South Korea Atomic Energy Research Institute (KAERI), South Korea in 2011 and 2015; 4) China Nuclear Engineering Corporation (CNEC), China in 2012; 5)

Finnish Radiation and Nuclear Safety Authority (STUK), Finland in 2014; 6) Rosatom State Nuclear Energy Corporation, Russia in 2015; and 6) Hungary in 2015.[11] In terms of nuclear capacity, KACARE announced the projection of 16 power reactors.[11] The proposed numbers of power reactors will provide at least 17 to 18 GWe by 2032–40 (see Table 1).[11] In KACARE's initial plan, the first two power reactors will start operation by 2022, followed by one or two reactors subsequently added each year until the complete deployment of 16 reactors.[11] To date, there is no official announcement of a type of power reactor, but the Evolutionary Power Reactor (EPR), a 1600 MWe, and AP1000, a 1000 MWe, have been proposed (see Table 1).[11] The considered research reactors are System-integrated Modular Advanced Reactor (SMART) and CAREM for the purpose of human capabilities development as well desalination.[11]

The KSA has no nuclear fuel cycle capabilities.[11] The proposed KSA nuclear fuel cycle may involve three options: 1) importation of nuclear fuel, which does not involve building a local fuel fabrication and enrichment plant, 2) local manufacturing of nuclear fuel, which involves obtaining a local fuel fabrication and enrichment plant, and 3) a combination of both options (see Table 1). It should be noted that KSA signed NPT in 1988, SQP in 2005 and CSA in 2009, and has not sign AP (see Table 1).

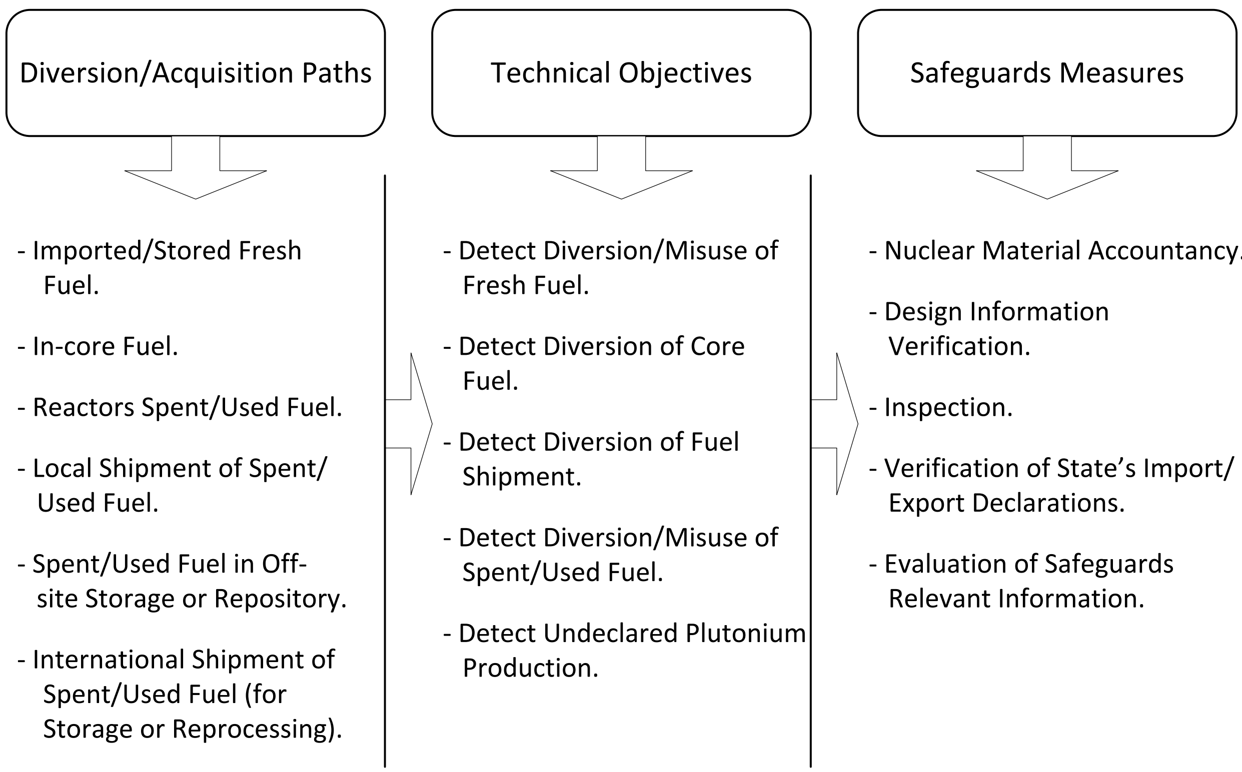
4. Towards Implementation of SLC in KSA

Newcomer states like KSA must maintain appropriate safeguard agreements to provide the IAEA with the needed tools for appropriate safeguards verification. The generic safeguards objective remains the same for all states with CSA agreements. However, SLA will depend i.a. on the fuel cycle option and facilities in the concerned state. Under the implementation of KACARE's planned nuclear power plant deployment, the required nuclear fuel must be initially imported because of the long-term investment required to manufacture nuclear fuel. Considering the above circumstance, an example of SLA for KSA's current outlook is illustrated in Fig. 1. The diversion/acquisition path analysis is primarily determined by detecting all plausible paths of diversion or misuse (of declared and undeclared nuclear material, activities, and facility or LOF).

The determination of the diversion/acquisition paths analysis for KSA is based on the planned nuclear power facilities, or LOF that the nuclear materials may be shipped to and stored, processed, and used. Thus, the diversion/acquisition paths analysis should include, but not limited to: 1) imported/stored fresh fuel; 2) in core fuel; 3) reactors spent fuel; 4) spent fuel shipped to or stored in local repository; 5) spent fuel shipped for outside reprocessing. After the determination of diversion/acquisition paths analysis, the technical objectives are established and prioritized to identify the applicable safeguards measures. The technical objectives include, but are not limited to the detection of diversion/misuse of fresh/spent fuel, undeclared plutonium production in the reactor, and diversion of core fuel (see Fig. 1). The identified safeguards measures include, but are not limited to the nuclear material accountancy, design information verification, inspection, evaluation of safeguards relevant information (which includes information from the state itself, IAEA safeguards activities, open sources and third parties), and verification of state's import/export declaration.

Based on the developed SLA, the safeguards activities would be planned, conducted, and evaluated. Once IAEA completes the necessary safeguards measurements and evaluations, the safeguards conclusion can be drawn. This will also enable IAEA to ascertain that the declared nuclear materials remain dedicated to peaceful nuclear activities after the needed measurements and evaluations have been completed. For the completeness of state declarations and to provide credible assurances of the absence of undeclared nuclear materials and activities, the IAEA will be required to seek clarification from the state to draw a sound safeguards conclusion. For the broader safeguards conclusion of the absence of undeclared nuclear activities, KSA is encouraged to conclude AP with the IAEA because it provides the IAEA with broader access and information. This will foster KSA-level nuclear transparency and attract and secure long-term nuclear cooperation between KSA and developed states, which is essential for successful deployment of civilian nuclear power programs. However, if KSA considers manufacturing the nuclear fuel, the development of SLA must be expanded to include all of the involved fuel manufacturing plants, for example conversion, enrichment, and fuel fabrication plants.

Figure 1: An Example of SLA for KSA's Current Outlook.*



*, Diversion/Acquisition Path Analysis, Technical Objectives, and Safeguards Measures are limited.

As part of a successful deployment of SLC, KSA has the responsibility to cooperate with IAEA and foster transparency with IAEA as well as the nuclear community. When KSA's first reactors are operational, KSA will be required to have an adequate SSAC in place to carry out safeguards declarations. Therefore, it is recommended that KSA improve and expand its SSAC to adequately meet safeguards responsibilities. The structure of KSA's nuclear program places the responsibility with KACARE. The function of KSA's SSAC should be performed by KACARE. Adequate employees of KACARE should be trained extensively in nuclear materials accountancy. Such train would be performed through IAEA and it will improve technical capabilities of KSA in SSAC/RSAC. The employees involved could be responsible for reporting small quantities of nuclear material to the IAEA prior to full deployment of the KSA nuclear program.

5. Conclusion

The goal of this work is to investigate the influence of SLC on newcomers, with KSA as case study. The investigation approaches SLC from the newcomer's perspective, with a view to determine critical factors impacting newcomers toward successful implementation of SLC. Critical looks at the development of SLA with its involved aspects (such as state-level objectives and state-specific factors) are employed to reconcile KSA's outlook with the IAEA's safeguards framework/agreements. SLC refers to implementing safeguards in a manner that considers a state's nuclear and nuclear-related activities and capabilities as a whole, within the scope of the state's safeguards agreement [GOV/2013/38 and GOV/2014/41]. SLC involves developing the SLA, which mainly addresses the generic safeguards objectives common to all states with CSA agreements as well as the state-level objectives. The state-level safeguards objectives are established on the basis of paths determined by performing the diversion/acquisitions path analysis considering the state-specific factors.

The impact of SLC implementation on newcomer states include sufficient cooperation between the IAEA and the newcomer states, greater confidence specifically regarding sensitive nuclear plants (such as conversion, enrichment, and fuel fabrication plants), higher state-level of nuclear transparency, and improved capabilities of SSAC. The implementation of SLC helps build confidence through greater transparency, specifically in sensitive nuclear plants. KSA plans to add at least 18 GWe through nuclear technology by 2040. KSA should improve and expand its SSAC to meet the new safeguards responsibilities. The type of safeguard agreements in place will eventually impact safeguards verifications performed by the IAEA, and will be reflected in the nature of the drawn safeguards conclusion. Thus, KSA must maintain appropriate safeguard agreements to provide the IAEA with the needed tools for appropriate safeguards verification. For a broader safeguards conclusion, KSA is encouraged to sign the AP to equip the IAEA with the needed tool of broader access and information. This will foster state-level nuclear transparency as well as long-term nuclear cooperation between KSA and developed states, both of which are essential for successful deployment of its civilian nuclear power program.

One of the keys for successful implementation of a civilian nuclear power program is compliance with acceptable safeguards commitments. Therefore, KSA must develop its nuclear infrastructure considering the latest developments to maintain the highest level of safeguards, security, and nonproliferation. KSA must also raise the confidence of the international nuclear community in its planned program through nuclear transparency. The implementation of SLC is a good start towards the necessary safeguards compliance and nuclear transparency.

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