Safeguards Implementation in Switzerland: Past, Present and Future

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Abstract

The current status of Safeguards implementation in Switzerland, its evolution during the last 25 years and possible future developments are addressed. Switzerland's Comprehensive Safeguards Agreement (CSA) is in force since 1978 and its Additional Protocol (AP) since 2005. Switzerland is one of the few states in Europe with a significant nuclear program that is not member of EURATOM. Hence, it is subject to Safeguards by the International Atomic Energy Agency (IAEA) only. Among others, this aspect allowed the IAEA the opportunity to test and implement new Safeguards approaches in a faster and less bureaucratic way. Switzerland was the first state in the world to implement remote data transmission (RDT) from nuclear power plants on an operational basis. The experience gained by the IAEA was of good value to implement RDT during the following years in other states as well. The implementation of RDT in Switzerland had also the effect to diminish gradually the verification efforts in the field. The Broader Conclusion by the IAEA for Switzerland was drawn for the first time for 2015 and the new State Level Approach (SLA) is implemented since 2018. In 2016 Switzerland also took over the responsibilities for reporting and verification activities required under the CSA and its AP for the Principality of Liechtenstein. Liechtenstein's Broader Conclusion was drawn for the first time in 2017 and the new State Level Approach is implemented since 2019. The human resources allocated for Safeguards purposes in Switzerland increased dramatically during the last 15 years. This was the result of a successful IAEA State Systems of Accounting for and Control of Nuclear Material advisory service mission (ISASS) conducted in 2007. Adequate resources enabled in the following years the necessary improvements in quality of reporting and verifications and allowed the IAEA to draw the Broader Conclusion. The Swiss Federal Office of Energy (SFOE) is taking measures to ensure knowledge transfer for keeping the current good quality of Safeguards implementation, at the regulator level as well as at nuclear facilities and locations outside facilities.

1. Introduction

This paper presents an overview of Safeguards implementation in Switzerland and in the Principality of Liechtenstein. By describing the historical development of Safeguards at facility level as well as at the State level beginning from the '90s, it outlines the period, when on a technical level, Remote Data Transmission (RDT) was tested and implemented, and on a legal level the Additional Protocol (AP) was introduced. It also shows the build-up in personnel at the Swiss Federal Office of Energy (SFOE) enabling Switzerland to fully comply with its obligations under the CSA and AP, which finally led to the International Atomic Energy Agency (IAEA) drawing the Broader Conclusion[3] on Switzerland and Liechtenstein and the application of a State Level Approach[4] (SLA) to both states.

[1] Deputy Head of Safeguards.
[2] Head of Safeguards.
[3] No indication of the diversion of declared nuclear material from peaceful nuclear activities, and no indication of undeclared nuclear material or activities.
[4] Approach for each state on the basis of a structured, technical method used to analyse the plausible paths by which nuclear material suitable for use in a nuclear weapon or other nuclear explosive device could be acquired.

2. Overview of the nuclear landscape in Switzerland

Nuclear facilities and locations outside facilities (LOFs[5]) under IAEA Safeguards at the end of 2020:

- 4 nuclear power plants (NPPs): 1 site with two reactors; one NPP is in definitely shut down
- 1 research reactor in operation
- 1 research reactor in decommissioning
- 2 interim storages for spent fuels (one of these stores also waste from reprocessing)
- 1 interim storage for radioactive waste (incl. nuclear material) from research, industry and medicine
- 1 storage at the European Organization for Nuclear Research (CERN)
- 1 nuclear laboratory with hot cells
- 1 special laboratory as single LOF at CERN
- 1 catch-all LOF with 38 holders of small quantities of nuclear material

Currently Switzerland does not consider nuclear energy as a source for future electricity generation in Switzerland. The Swiss Energy Strategy 2050 foresees the phase out of nuclear energy although existing NPPs may operate as long as they are safe. The forecast sees the shutdown of the last NPP between 2035 and 2045 (50-60 years of operation). However, even the possibility to operate some of the existing NPPs beyond 60 years might be envisaged.

In Switzerland, for many years, there were no possibilities to obtain a bachelor's or master's degree in nuclear engineering. From 2008, the two Federal Institutes of Technology together established a master course for this subject. However, since nuclear energy does not seem to have a long-term future in Switzerland, maintaining the knowledge in the nuclear engineering domain is becoming very difficult.

3. Legal basis for Safeguards implementation in Switzerland and Liechtenstein

All agreements concerning Safeguards are in force for both Switzerland and Liechtenstein: the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) [1], the Comprehensive Safeguards Agreement (CSA) [2][3] and the Additional Protocol to the CSA (AP) [4][5]. See Table 1 for dates of entry into force.

In Swiss legislation, a subject is regulated by an act and corresponding ordinance(s). An act decrees the obligations and responsibilities in a general way. The ordinance is the legislation document that enables the implementation of the act into practice since it describes obligations, responsibilities and procedures in detail. Ordinances are legally binding as the acts themselves. This legislation system allows for an easier and faster update of an ordinance without modifying the act.

The Safeguards Ordinance [6] regulates all Safeguards requirements resulting from the CSA and AP. This ordinance is bound to the Nuclear Energy Act (NEA) [7]. The Safeguards Ordinance entered into force on 1 February 2005for the first time. Since then two major revisions took place, one in 2012 and the latest in 2021. Such revisions, in a relatively short time, became necessary due to several reasons such as recognised loopholes or inconsistencies in the implementation of Safeguards, and the different definitions of nuclear material between the Nuclear Energy Ordinance [8] and the IAEA statutes. In addition, in Switzerland, there are two different authorities that grant licenses for the use of nuclear material: one for nuclear material used in nuclear activities and the other for nuclear material utilized in non-nuclear applications. Between 1979 and 2005 (time interval between entry into force of the CSA and the Safeguards Ordinance), there was no national legislation regulating Safeguards. However, the legal system in Switzerland allows international law to be applied directly without having it explicitly formulated in the national legislation if the level of detail is sufficient. Therefore, for several years, Safeguards matters were regulated from the legal point of view directly under the CSA. In 2017, SFOE

[5] Location Outside Facilities, see IAEA Safeguards Glossary [11] for definition.

released two non-legally binding Guidelines [9] [10] that are intended to facilitate the implementation of Safeguards at nuclear facilities. These two guidelines are currently under review following the latest general revision of the Safeguards Ordinance.
The Safeguards Ordinance addresses, among others, the implementation of Safeguards regulations at nuclear facilities[6]. These regulations require approval by SFOE before their application. SFOE has to approve the designated Safeguards responsible persons at the nuclear facilities on the basis of their knowledge, experience and skills as described in the Safeguards ordinance.

Table 1 Dates of entry into force or implementation dates of agreements and/or legislation

	Entry into force / implementation	
Agreement type, act or similar	**Switzerland**	**Liechtenstein**
NPT	9 Mar. 1977	20 Apr. 1978
CSA	6 Sep. 1978	4 Oct. 1979
AP	1 Feb. 2005	25 Nov. 2015
Safeguards Ordinance[7] (first version)	1 Feb. 2005	yes[8]
First Broader Conclusion	2015	2017
Integrated Safeguards[9]	2018	2019
State Level Approach (SLA)	2018	2019

4. Safeguards at the state and facility level

SFOE has always been in charge of Safeguards implementation in Switzerland. Currently, the Safeguards tasks are under the responsibility of its Safeguards section. Until 2008, SFOE held also the responsibility for the implementation of physical protection at nuclear facilities. The section dealing with physical protection was transferred at the beginning of 2009 to the Swiss Federal Inspectorate for Nuclear Safety (ENSI). ENSI, formerly HSK, was administratively linked to SFOE until 2008. In 2009 ENSI became a completely independent inspectorate, reporting directly to the Federal Council. Since then, from time to time, discussions about which agency of the Swiss administration is the most appropriate for implementing Safeguards are rekindled.

4.1 Functions

About 75-80% of the available resources in the Safeguards section are dedicated directly or indirectly to the implementation of Safeguards. Safeguards activities include participation in all IAEA inspections (required by the legislation), compilation and checks of accounting reports submitted by the nuclear facilities and LOFs before transmittal to the IAEA, collection and collation of data for compiling AP declarations, updates of the Safeguards legislation and related guidelines, independent inspections at facilities. Other significant tasks cover the domain of export control. Although the section itself does not grant licenses[10] for the export of nuclear material and nuclear goods, it is deeply involved in the evaluation of export applications. The remaining tasks refer to national obligations, coordination with other authorities and so on. These last activities do not affect human resources significantly and only take place sporadically.

4.2 State Safeguards Resources

Until 2008, the human resources dedicated to Safeguards implementation were insufficient to achieve timeliness, correctness and completeness of reporting to the IAEA. From the end of the ‘80s until 2002 only one full-time position (FTE) was available for Safeguards, occasionally staff

[6] Locations Outside Facilities excluded.
[7] The last version of the Safeguards Ordinance entered into force on 1st July 2021.
[8] The government of Liechtenstein, on a 6 months cycle, decides which new or updated Swiss legislation will be applicable also on the territory of the Principality.
[9] For Switzerland and Liechtenstein the Integrated Safeguards step coincided with the implementation of the SLA.
[10] Besides export licenses for nuclear material for non-nuclear use.

from other sections relieved the burden by participating in some IAEA inspections. Unfortunately, that Safeguards officer got ill and passed away. With this situation, handover to the new Safeguards colleagues was not possible; even the software used for the national nuclear material accounting was completely lost. Nowadays, it looks inconceivable that such situation could have occurred, taking into account that the Office director at that time was a supporter of nuclear energy. The two new Safeguards officers (now two FTEs) in 2002 started almost from scratch. It was quite evident that two FTEs were not sufficient anyway, also considering the entry into force of the AP in 2005. To assess the level of resources dedicated to Safeguards, SFOE requested an ISASS[11] mission from the IAEA. The mission took place in 2007 and the most important outcome was the conclusion that the number of staff dedicated to Safeguards was inadequate for fulfilling Switzerland's legal obligations under the CSA and AP. The SFOE management became aware that it could not neglect Safeguards implementation in Switzerland any longer. Starting in 2008 two additional positions for Safeguards officers were granted. During the revision of the Safeguards ordinance in 2012, the Federal Council could be convinced to increase the resources again with two additional FTEs. Since then the staffing in the Safeguards section remained unchanged with six officers (5.6 FTEs) including the section head.

It must be noted that for several years the work-related interaction between the Swiss and the IAEA Safeguards personnel was tense. The Swiss officer(s), overburdened with work, could barely cope with providing the basic Safeguards reporting, even less with additional requests made by the IAEA that on its side did not recognize the need to provide the assistance and support necessary for a smooth implementation of Safeguards.

Recent years showed that good communication and cooperation between SFOE and IAEA at the managerial level as well as at the working level are of paramount importance to achieve a smooth and unproblematic implementation of Safeguards. A prerequisite is in any case adequate staffing.

4.3 Safeguards culture at nuclear facilities

For the reasons mentioned above it was impossible until 2008 to foster Safeguards culture and knowledge at the facility level besides the basic Safeguards requirements. Safeguards activities were very poorly known to the facilities' high level management and were considered just as an additional nuisance. As a consequence not always the most appropriate persons for Safeguards implementation were appointed or the resources (time and support) allocated to fulfil the Safeguards obligations were not adequate. Since 2012, nuclear facilities have to implement specific Safeguards regulations and SFOE has to approve them as well the new nominated Safeguards officers at the facilities[12] who have to fulfil specific requirement. Another measure taken by SFOE to improve the quality of Safeguards deliverables[13] by the facilities, was the introduction of the so-called Safeguards Indexing. Each facility is evaluated on an annual basis against the quality[14] of the reporting, of inspections' preparation and support and adequate communication. Every year, at each facility, officers of the Safeguards section meet with the facility Safeguards officers to identify areas of improvement and discuss non-compliances or reporting issues.

5. Evolution of Safeguards implementation at the facility level

The IAEA 93+2 Programme[15] formulated Safeguards measures, which would have allowed the IAEA to verify the compliance of a non-nuclear weapon State with its NPT obligations with more confidence and knowledge. These measures were divided into categories, Part 1 and Part 2. Part 1 measures could be applied immediately under the legal framework of the CSA, whereas Part 2 measures would need an extended legal framework. Most of Part 2 measures were implemented

[11] IAEA SSAC Advisory Service, see https://www.iaea.org/services/review-missions/iaea-ssac-advisory-service.
[12] These two aspects do not concern LOFs.
[13] Accounting reports, AP declarations, notifications, etc.
[14] Timeliness, correctness, completeness.
[15] See e.g. The IAEA's Programme '93+2' [12] for an overview.

later under the AP. One of the Part 1 measures envisaged was the possibility to take environmental samples (swipe samples) inside nuclear facilities to confirm the correctness of the declared materials. The first swipe samples in Switzerland were taken 1996 at a research laboratory with hot cells. Another Part 1 measure was the introduction of unannounced inspections at some type of facilities, allowing a more effective verification scheme and in some cases resulting in an overall reduction of verification efforts in the field.

Another technical measure that the IAEA started to test in the mid-'90s, aiming to reduce verification activities in the field, was the introduction of Remote Data Transmission (RDT). Switzerland was a pioneer in the implementation of such novel technology. During '95-'96 extensive RDT testing was performed at specific key measurement points at two research reactor facilities. The feasibility of using satellite communication systems, specifically addressing data encryption, authentication, and digital transmission were thoroughly tested. The telephone system via PSTN/ISDN as back-up was also incorporated in the later stage of the test. This comprehensive and extensive testing took place only in Switzerland. The expected outcome was essential to identify the remote system hardware and communication services that will achieve data integrity and confidentiality, while meeting the safeguards technical objectives, for States where RDT was foreseen. Switzerland was chosen to be the "guinea pig" for this RDT test following the suggestion of the DDG[16] Safeguards at that time a Swiss fellow (Mr. Pellaud) and former vice-director of SFOE.

RDT was officially introduced in Switzerland by a memorandum of understanding signed in 1998 between the IAEA and SFOE representatives. It covers the implementation of remote monitoring systems at all NPPs and at a storage vault. The proposed verification approach under the remote monitoring (RM) regime expects the incorporation of unannounced inspections. Altogether, the new inspection regime would have allowed a significant reduction of verification activities in the field and implementation costs, improved timeliness of containment and surveillance data, increase inspector efficiency, etc. The facility operators, with this perspective in mind, were very cooperative and presented no objection for the installation of all the equipment needed. In reality, it took several years to achieve the expected verification savings. At the storage vault (now decommissioned), containing direct use nuclear material, the standard inspection regime comprised twelve inspections per year including the PIV. The RM regime involved seven inspections and eventually, a further reduction depending on the experience gained. The introduction of the seven inspections per year regime took place only more than ten years later, just a couple of years before this facility was decommissioned. In addition, three of the five nuclear power reactors utilised at that time MOX[17] fuel. As fresh MOX fuel contains direct use material, the physical presence of the IAEA inspector was necessary for almost every movement of such fuel elements. Therefore, RM was not making a significant difference as expected. Other reasons for the delay in fully implementing the RM regime were the following: reliability problems of the RDT equipment during the first years, the acceptance and confidence of such verification tools by the IAEA's management, and the insufficient support (due to lack of resources) by the State authority.

The operational experience gained by the IAEA using RDT in Switzerland demonstrated that such verification method could be applied as a standard Safeguards measure all around the world. In retrospect, states and the IAEA have very much benefited from this verification tool as proven with several years of implementation. The extraordinary event of the COVID-19 pandemic demonstrated how such technology could keep continuity of knowledge despite many restrictions or delays of verifications in the field.

[16] Deputy Director General.
[17] Mixed Oxide nuclear fuel (reprocessed uranium and plutonium).

Although, Switzerland had to wait a long time (more than the average) between the ratification of the AP in 2005 and the drawing of the Broader Conclusion[18] by the IAEA in 2015, the level of the verification regime was already for several years similar to the ones in states having Integrated Safeguards[19] in place. In comparison with other European states the evolution of Safeguards implementation in Switzerland was very gradual for over more than twenty years.

6. Safeguards implementation in Liechtenstein

6.1 Background

The Principality of Liechtenstein is a small sovereign State (area 160 km^2, inhabitants: 38'000) locked between Switzerland and Austria. It has a highly-developed industrial sector. No nuclear activities or nuclear research take place there. Since 1924, Liechtenstein and Switzerland form a customs union with a single customs territory.
Due to this customs union treaty and other close ties, especially in the economic and infrastructure sectors, Switzerland supports Lichtenstein in fulfilling some of its obligations not only at the national but also at the international level. Liechtenstein adopts the Swiss Franc as its official currency and implements directly a large part of the Swiss legislation.

6. 2 CSA and AP

At the end of the '70s, when both Switzerland and Liechtenstein were ready to conclude the CSA with the IAEA there was already the intention that SFOE would take over the responsibilities for implementing Safeguards in Liechtenstein. For the reason of compatibility and procedural easiness, Liechtenstein concluded a CSA with the IAEA like Switzerland and not a Small Quantity Protocol agreement, which would have been more appropriate, considering the very small quantities of nuclear material used in the Principality.

However, even if at that time formal instruments were signed between Switzerland and Liechtenstein, full Safeguards implementation in Liechtenstein was not achieved until the end of 2015. Due to the very limited human resources for Safeguards at SFOE for many years, nobody was interested to take up additional responsibilities. On the other hand, the IAEA seemed not to be very interested in Liechtenstein either. Only in the middle of the '2000s, when Switzerland and Liechtenstein were preparing for the ratification of the AP, the IAEA became concerned with the "non-implementation" of Safeguards in the Principality of Liechtenstein. Irrespective of this situation, Switzerland ratified the AP in 2005. The government of Liechtenstein didn't have objections to ratifying the AP, however it became aware of a possible problem in its implementation. Indeed Article 2a.(ix) of the AP requires the notification of exports concerning nuclear goods. According to the customs union treaty, movements of goods between Switzerland and Liechtenstein are legally not considered as exports or imports but simply transfers. Hence, there is only one export control authority responsible for both States. In practice, this is a non-issue. Since Liechtenstein has no nuclear activities, no transfers of nuclear goods are taking place from Switzerland to Liechtenstein. Very few companies in Liechtenstein have included nuclear goods in their product catalogues. Those are not utilised anyway in Switzerland. Despite this, Lichtenstein decided to ratify the AP only after this export notification question was resolved. Between 2005 and 2015, prior to the AP ratification, the customs union issue escalated; several bilateral and trilateral meetings with the IAEA took place and even a visit of the DDG[20] Safeguards to Liechtenstein was organised in 2015. In the first place, Switzerland and Liechtenstein tried to negotiate with the IAEA for a small change in the text of the AP that would take into account the customs union. Whereas at some point one of the former DDG Safeguards was open for discussions of amendments to the text of the AP, the next DDG Safeguards refused any concessions in this regard. The IAEA wanted to avoid precedent; consequences of text changes in the AP may be unpredictable. On the other hand, concessions were made in the past in

[18] The reason for the delay in getting the Broader Conclusion are detailed in chapter 6.
[19] Optimization of Safeguards implementation with states having CSA and AP in place.
[20] Deputy Director General Safeguards.

both texts of the CSAs[21] recognising that transfers of nuclear material between both states are not considered as international exports. In 2015 representatives from both states met to find a solution that would satisfy all parties. At the end of the same year, Liechtenstein ratified the AP. In 2016 a bilateral agreement was implemented between Switzerland and Liechtenstein to regulate Safeguards implementation in the Principality. Since then the Safeguards section at SFOE is also responsible for Safeguards matters regarding Liechtenstein. The IAEA drew the Broader Conclusion for Liechtenstein in 2017 and applied the SLA in 2019.

Noteworthy in this context is that this AP issue between Switzerland and Liechtenstein prevented the IAEA to draw the Broader Conclusion for Switzerland at an earlier stage (4-5 years earlier). The Swiss Safeguards officers did not realize at that time that the IAEA considered this issue very fundamental not only from the legal aspect but also from the implementation point of view.

7. Broader Conclusion and SLA in Switzerland

The resolution of the AP issue described in the previous section, triggered the drawing of the Broader Conclusion by the IAEA for Switzerland almost immediately. This fact indicated that there were no verification issues preventing the Broader Conclusion but just one legal aspect that needed to be resolved. The IAEA developed the "new" SLA which was presented to Switzerland at the beginning of 2018. Some clarifications and consultations took place but at the end of 2018, the SLA was fully implemented.

Now some digressions are needed to explain what the IAEA nowadays means with the SLA. In 2001, the IAEA started developing and implementing State level safeguards approaches (SLAs) for states for which the IAEA had drawn a Broader Conclusion. An SLA is a customized approach for the implementation of safeguards in an individual state. For such states, the IAEA began to implement integrated safeguards[22]. However, these first SLAs didn't really consider the state as a whole, but more or less as the sum of single (Safeguards) components as in the "traditional"[23] Safeguards. To take advantage of all information received from the states and the uses of technical means (such as RDT with surveillance, seals, etc.) the IAEA took a step forward considering each state more holistically to improve or keep the same effectiveness as before but analysing the relationship among facilities and movements of nuclear material. In 2013 the IAEA presented the "new" SLA in GOV/2013/38 [13] where such approach was described.

Whereas the traditional Safeguards approach is "bottom-up" (arithmetically summing of all Safeguards components), the new SLA from the theoretical point is more "top-down" (holistic consideration of all Safeguards aspects). Even though no revolution was expected, the outcome from the SLAs was for many states including Switzerland quite disappointing. The differences in verification activities before and with SLA were minimal. How can quite different approaches produce almost the same results? Some adjustments in Switzerland looked more justifications for the new approach than the result of a new methodology. For sure, in some types of facilities in Switzerland, like NPPs, the level of verification in the field was already optimized and no big changes have been expected there. However, the authors believe that if the SLA would consider more consequently in a holistic way all Safeguards aspects in a state, more improvement could be achieved, one example is the transfer of spent fuel from NPPs to interim and/or final storages.

7.1 Summary of the current status of SLA in Switzerland

At NPPs, besides the Physical Inventory Verification (PIV, once every 12 months), the former unannounced inspections (once per NPP per year) were replaced by Announced Supporting Inspections (ASI). In reality this type of inspections was already in place some years before the SLA but in the foresight of its future application. The NPPs and one storage facility for spent fuel provide three potential dates during a calendar year for performing ASIs. The IAEA announces

[21] Switzerland and Liechtenstein.
[22] Optimization of all Safeguards measures within a state.
[23] Safeguards implementation before RDT and AP.

one week in advance should it intend to carry out such an inspection. Currently, 2-3 ASIs in total are foreseen to be carried out per year. Activities during an ASI include mainly checking and maintaining RDT and other containment and surveillance (C/S) equipment. At the research laboratory the semi-annual announced inspection was replaced with one unannounced inspection per year for design information verification purposes. This change was also possible due to the reduction of direct use material in the inventory.

For the only remaining research reactor the frequency of the PIV changed from one every two years to one every three years.

The IAEA Safeguards verification activities during transport of spent fuel to the interim storages, are the least affected by the SLA. Indeed, since the transfers started at the beginning of the '2000s not much improvement in methodologies and verifications could be noted. Each transfer comprises at least 2-3 inspections at the NPP and up to three inspections at the storage facility. The authors would welcome the IAEA to consider new methodologies and verification tools for the Safeguards aspects involving transfers of spent fuel. For these activities considerable verification efforts in the field could be saved.

Switzerland is also dealing with one storage facility and a separate LOF (laboratory) at CERN. Here the difficulty lies in the legal status of CERN which is a recognized international organisation. The CSA and AP don't foresee such special situations, this aspect leads to different interpretation of responsibilities. However, from the implementation and verification point of view until now, no real issues were encountered.

There seems to be a tendency by the IAEA in recent years to put more effort in non-nuclear or non-nuclear fuel cycle activities performed by some holders of small quantities of nuclear material. Indeed, to get an overview of state activities some endeavour should be devoted evaluating the technical capabilities not exclusively the quantities and quality of nuclear material of a state. However, the authors have difficulties in some cases to understand this disproportionate interest. The reasons of this increased interest by the IAEA in Switzerland and in other countries is not really comprehensible.

As observed in other states with the AP in force, the number of Complementary Accesses (CAs) decreased over the years. Once inconsistencies and discrepancies and the past state's nuclear activities are clarified to the IAEA, there shouldn't be the need[24] anymore, besides isolated or new issues, to perform CAs. At least this is one possible interpretation of Article 4 of the AP. In Switzerland between 2005 and 2011 sixteen CAs were performed (2.3 as average per year), none between 2012 and 2016 and once a year since 2017. In the last years there was often no real issue that to the opinion of the authors warranted the conduct of a CA. The justification in the announcement of some of the last CAs was sometimes vague. The premises to be inspected were also not clearly specified and the announced activities kept on a very general level. The authors suspect that the SLA for Switzerland envisage at least one CA per year even if no real issues are identified. Should this be the case, the spirit of the AP on this matter was on our opinion reinterpreted.

8. Comparison of some aspects of the Swiss and other SLAs in some European states

Although the SLA is tailored to the specificities of a state, the Safeguards goals for the IAEA are always the same. Therefore, it is also expected that the verification tools are in some way standardized, among others the types and frequency of inspections. As described in the previous chapter at Swiss NNPs and at one storage facility, to complement PIVs the inspection type called ASI is implemented. To our knowledge nowhere is Europe, if not in the world, such type of inspection type exists. To complement PIVs at NPPs and other nuclear facilities in some European

[24] See Article 4 of the AP about justification for performing a CA.

states SNRIs (Short Notice Random Inspections) are in place. However, whereas SNRIs are almost a duplicate of the PIVs, the ASIs deal almost exclusively with C/S measures.

Another difference noted is that in some states the PIVs at NPPs include core verification[25] and in others not. Core verification per se is not very cumbersome but its scheduling is for sure. Usually this means keeping IAEA inspectors in the country for a longer time (stand-by time).

A tendency noted in some states, including Switzerland, is the growing interest of the IAEA in small holders of nuclear material even if its use is for non-nuclear purposes. Whether the IAEA is more interested in the material, in the activities using it or both is unclear. Information about activities of small holders could be acquired through open sources or through the state authorities. Verifications in the field would be necessary only in very few cases.

It is not the intention here to evaluate the effectiveness or efficiency of these different Safeguards approaches. The use of different tools set, depending on the state, reduces however the comprehensibility of the whole Safeguards system. A state can now only trust the IAEA that its SLA was developed in a reasonable way, but it cannot check any plausibility. Another point that the new SLA concept never addressed, at least officially, was the interval between PIVs, which is remained unchanged since the times of the traditional Safeguards when the verification regime was dictated solely by the Safeguards Criteria. Those criteria were clear but inflexible. The introduction of RDT and other C/S measures and as well the implementation of the AP, helped in introducing flexibility in shaping new inspection regimes with reductions of verifications in the field but at the expense of transparency.

9. Future of Safeguards in Switzerland

Due to the age structure of the Safeguards section at SFOE, in about 3-5 years there will be nearly a complete generational change. One of the major goals in the medium term is therefore the preservation and the handover of institutional knowledge. Although since 2008 most documents are in digital form and easy to find, the daily operation is not described in sufficient detail. One measure taken to overcome this shortcoming is writing all procedures down in a quality management manual. The process has already started and in the end will allow shortening the job training for the new generation of Safeguards colleagues and maintaining the quality of the deliverables at the current level. Indeed the resources required by this project are often in conflict with the demands of daily tasks and the progress is not as fast as desired.

Another aspect is the preservation of the level of human resources necessary to continue operation without compromising quality. In recent years the pressure to reduce the number of employees in the Federal Administration has increased. The reduction of employees could affect any branch of the administration. The advantage of the Safeguards section is that the requirements for the SSAC[26] are not negotiable. Even if the phasing out of nuclear energy has already begun, it is not foreseeable that in the next 15-20 years the Safeguards activities will decrease significantly in Switzerland. The last NPP will probably shut down in 2045 and for the first years of decommissioning all nuclear facilities will still have nuclear fuel on their site. Furthermore, around 2030, Switzerland will start the construction of a geological repository and its associated encapsulation plant for spent fuel and other types of radioactive waste.

10. Conclusions

Regarding the implementation of Safeguards, the authors would welcome if the SLA would take into account state's specificities in a better way, e.g. nuclear fuel cycle activities and their evolution. In particular, a reduction of verifications in the field related to the transport of spent fuel from NPPs to the interim storages would be welcome. This goal could be achieved by

[25] Verification of fuel elements' IDs in the core before restarting operation.
[26] State System of Accounting for and Control of nuclear material, Art. 31 and 32 CSA [2].

optimizing the verification procedures and as well by the introduction of specific and new surveillance and containment technologies.

On the other hand, the SLA should be made more transparent for the state concerned, some measures currently in place seem not really necessary (or excessive) for deterring to proliferation of nuclear weapons.

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