STUK-YTO-TR 167 August 2000

INTEGRATED SAFEGUARDS PROPOSAL FOR FINLAND

Final report on Task FIN C 1264 of the Finnish Support Programme to IAEA Safeguards

Markku Anttila
VTT Energy

In STUK this study was supervised by **Matti Tarvainen**

STUK • SÄTEILYTURVAKESKUS • STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

The conclusions presented in the STUK report series are those of the authors and do not necessarily represent the official position of STUK.

ISBN 951-712-408-2
ISSN 0785-9325

Oy Edita Ab, Helsinki 2000

ANTTILA Markku (VTT Energy). Integrated Safeguards proposal for Finland. Final report on Task FIN C 1264 of the Finnish Support Programme to IAEA Safeguards. STUK-YTO-TR 167. Helsinki 2000. 17 pp + Appendices 2 pp.

ISBN 951-712-408-2
ISSN 0785-9325

Keywords: safeguards, state-level evaluation, integrated safeguards proposal

ABSTRACT

The IAEA has requested several member states to present their proposal of the application of the Integrated Safeguards (IS) system in their nuclear facilities. This report contains a IS proposal for Finland prepared under the Task FIN C 1264 of The Finnish Support Programme to IAEA Safeguards.

The comprehensive safeguards system of the International Atomic Energy Agency (IAEA) has been one of the main tools in the fight against nuclear proliferation since the entry-into-force of the Nuclear Non-proliferation Treaty three decades ago. In the 1990s some of the inherent weaknesses of this so-called traditional safeguards system were revealed first in Iraq and then in North Korea. Therefore, the member states of the IAEA decided to give the Agency additional legal authority in order to make its control system more effective as well as more efficient than before. This was accomplished by the approval of the so-called Model Additional Protocol (INFCIRC/540) in 1997.

Straightforward implementation of new safeguards measures allowed by the Additional Protocol (INF-CIRC540) without careful review of the old procedures based on INFCIRC153 would only result in increased costs within the IAEA and in the member states. In order to avoid that kind of outcome the old and new means available to the Agency shall be combined to form an optimised integrated safe-guards (IS) system. When creating an effective and efficient system a necessary approach is a state-level evaluation, which means that each state shall be assessed by the IAEA separately and as a whole. The assessment of a country's nuclear field shall result in credible assurance of the absence of diversion of declared nuclear materials to prohibited purposes and of the absence of clandestine nuclear activities, facilities and materials. Having achieved that assurance and being able to maintain it in a state the IAEA can leave some traditional routine safeguards activities undone there.

At present, the nuclear fuel cycle in Finland under the national and international safeguards is very limited, the main objects under control being four light-water reactors with a once-through uranium-based fuel cycle. On the other hand, the national safeguards system is strong and competent. Therefore, Finland should be able to fulfill the provisions of the Additional Protocol fast and well. Also the state-level evaluation of Finland by the IAEA can be assumed to be quite straightforward. An IS system suitable to the Finnish conditions would put an end to the interim routine inspections and to the use of permanent camera surveillance. On the other hand, the IAEA could carry out one unannounced or short-notice inspection per year in Finland. The Agency would also get continuosly up-to-date information of all nuclear activities in the country. The Finnish SSAC is assumed to be maintained and further developed also in the future. The national safeguards inspections and measurements by Finnish Radiation and Nuclear Safety Authority (STUK) would be continued.

The implementation oft the provisions of the Additional Protocol and the application of the IS system in Finland requires good cooperation, mutual trust and division of work between four actors of the play: the operators of the nuclear facilities, STUK, Euratom and the IAEA. Each of them shall have the well-specified roles and functional responsibilities. The international safeguards agencies should utilize the national resources more effectively than before.

CONTENTS

ABSTRACT 3

1 INTRODUCTION 5

2 FINNISH NUCLEAR HISTORY 6
2.1 Beginning of the nuclear era 6
2.2 Experimental nuclear facilities 6
2.3 Uranium exploration 7
2.4 Construction of the nuclear power rectors 7
2.5 Nuclear industry in Finland 7
2.6 Back-end of the nuclear fuel cycle 7

3 NUCLEAR FUEL CYCLE UNDER SAFEGUARDS IN FINLAND 8
3.1 Nuclear power reactors 8
3.2 FiR 1 facility 8
3.3 Other owners of nuclear materials 9

4 PRESENT SAFEGUARDS SYSTEM IN FINLAND 10
4.1 Accounting measures 10
4.2 Safeguards inspections in Finland 10
4.2.1 Safeguards activities of STUK 10
4.2.2 International inspections by the IAEA and Euratom 11
4.3 Containment and surveillance measures 11

5 INTEGRATED SAFEGUARDS MODEL FOR FINLAND 12
5.1 Acquisition and maintenance of “Credible Assurance” 12
5.2 Qualitative factors in the state-level evaluations 12
5.3 Implementation of the Additional Protocol in Finland 13
5.4 Integrated Safeguards Proposal 13
5.5 Roles of national and international agencies in the application of the IS 14

6 SUMMARY 15

REFERENCES 17

APPENDIX 1 Nuclear materials in Finland 1998–1999 18
APPENDIX 2 Safeguards inspections in Finland 1991–1999 19

1 INTRODUCTION

The comprehensive safeguards system of the International Atomic Energy Agency (IAEA) has been one of the main tools in the fight against nuclear proliferation since the entry-into-force of the Nuclear Non-proliferation Treaty three decades ago. In the 1990s some of the inherent weaknesses of this so-called traditional safeguards system were revealed first in Iraq and then in North Korea. Therefore, the member states of the IAEA decided to give the Agency additional legal authority in order to make its control system more effective as well as more efficient than before. This was accomplished by the approval of the so-called Model Additional Protocol (INFCIRC/540) in 1997. Some member states have already ratified the Protocol and many others are expected to do so in the near future.

Straightforward implementation of new safeguards measures without careful review of the old procedures would only result in increased costs within the IAEA and in the member states. The old and new means available to the Agency shall be combined to form an optimised safeguards system, which is called “Integrated Safeguards (IS).” The measures allowed by the Additional Protocol, namely increased access to information and locations, as well as new improved technical means should eventually enable the Agency to decrease the amount of routine work in its safeguards activities.

The member states under the comprehensive safeguards differ from each other appreciably from the safeguards point of view. Therefore, each state should be evaluated separately and as a whole during the implementation of the Integrated Safeguards system. In this state-level evaluation the features of the nuclear fuel cycle are of the greatest importance, but many other factors, some of which are not quantifiable, should be taken into account. The assessment of a country's nuclear field should result in credible assurance of the absence of diversion of declared nuclear materials to prohibited purposes and of the absence of clandestine nuclear activities, facilities and materials. The state-level evaluation will take some time and positive results can be expected only, if the Agency and the actors in the state are working in close co-operation.

The IAEA has requested several member states to present their proposal of the application of the Integrated Safeguards system in their nuclear facilities. This report contains a draft IS model for Finland. From the safeguards point of view Finland has some interesting characteristics. There are only four nuclear power reactors, but the role of nuclear power in the production of electricity is quite large (about 30%). The nuclear fuel cycle of the Finnish reactors is a simple once-through cycle based on fresh uranium. In Finland there are no uranium (or thorium) mines, no fuel fabrication plants nor any other fuel cycle facilities such as enrichment and reprocessing plants. Finland has never established a large nuclear research centre and nuclear R&D work has always been quite limited. Finland has established and maintained an independent and competent national SSAC. Finally, since joining the EU in 1995 the Finnish nuclear fuel cycle has been also under the Euratom safeguards.

2 FINNISH NUCLEAR HISTORY

2.1 Beginning of the nuclear era

Interest in the commercial use of nuclear energy started to increase in Finland in the middle of the 1950s. One reason was the first UN Conference on the Peaceful Use of Nuclear Energy held in Geneva in 1955. Finland sent a delegation of five scientists to the meeting. Already in the spring 1955 the government of Finland had appointed a committee to study the potential role of nuclear power in Finland. This Energy Committee completed its report in the autumn 1956. The main conclusion of the report was quite cautious. Only in the end of the next decade there was seen to be a need for a nuclear reactor producing about 200 MW of electricity.

The Energy Committee recommended, however, that a research and development program should be started in order to educate a large enough cadre of nuclear experts for peaceful applications of nuclear energy. Atomic Energy Commission should be established for the co-ordination of the program. The main task of the Commission should be to follow the international development in the nuclear field. The government accepted the recommendations. Quite a large stipend system was started and it was continued successfully for one and half decade. At the outset, it was decided that no separate nuclear research centre would be established in Finland. The stipendiates of the Atomic Energy Commission worked in the Finnish universities and in the existing research institutes like the Technical Research Centre of Finland (VTT). Many of them participated in international research programs.

Finland joined the IAEA in 1958. In the same year, the Institute for Radiation Physics (later Radiation and Nuclear Safety Authority, STUK) was established. It had initially two main tasks: first, the institute controlled the use of x-ray devices and secondly, it studied the effects of radioactive fallout of atmospheric nuclear tests. The Institute for Radiation Safety set up a special department for nuclear safety in 1968.

2.2 Experimental nuclear facilities

Some twenty Finnish industrial companies established an association for advancing their knowledge of nuclear technology in the middle of 1950s. One of the first decisions of the new organisation was to donate a subcritical pile to the Helsinki University of Technology. The pile was designed and manufactured in Finland. The uranium fuel was acquired from the Soviet Union with the assistance of the IAEA. The subcritical pile was used for research and training up till the end of the 1970s. There were short-lived plans to convert the pile into a zero-power reactor, but these ideas were not realised. The facility has been dismantled.

Atomic Energy Commission of Finland decided in 1960 to buy a Triga Mark II research reactor with the thermal power of 100 kW from General Atomic, which delivered also the fuel elements. The IAEA was involved also in this purchase. The research reactor ("FiR 1") became a part of the Helsinki University of Technology. Its nominal power was upgraded to 250 kW after a few years of operation. The facility was used quite extensively for research and training during the first twenty years of operation. In the 1990s a Boron Neutron Capture Therapy unit was constructed in the connection of the reactor.

In the end of the 1960s some studies on the feasibility of a Material Testing Reactor in Finland were carried out. The main conclusion was that the use of available foreign testing facilities was a more reasonable option.

2.3 Uranium exploration

Uranium exploration was started with great enthusiasm in Finland in the middle of the 1950s. Many companies as well as private people participated in this uranium rush. However, only at two sites exploration activities resulted in uranium mining and milling. In both cases, uranium deposits were small and uranium content low. Therefore, the mines and the facilities producing uranium concentrate were closed in 1961. Both sites were environmentally restored in the 1980s and 1990s. Few companies continued small-scale efforts to find profitable uranium deposits in Finland. After the first oil crisis in the 1970s systematic uranium prospecting with public funding was started, but with no real success. After the middle of the 1980s systematic uranium exploration was stopped. The known uranium deposits in Finland are a few thousand tons, but no deposits are in the low-cost category.

The feasibility of domestic nuclear fuel fabrication was briefly studied in Finland in the 1960s, but with discouraging results.

2.4 Construction of the nuclear power rectors

The decision to order and construct the first nuclear power reactor in Finland was made only after a complicated process in the end of the 1960s. The then state-owned Imatran Voima Oy (now Fortum Heat and Power Oy) ordered a VVER-440 unit in 1969 and the second one in 1971. Both units were constructed near a small town Loviisa in the south coast of Finland The privately owned Teollisuuden Voima Oy ordered two BWRs from AB Asea Atom in 1973 and 1975. The reactors were built at the same site in Olkiluoto, in the western coast of Finland. These four units started their commercial operation in years 1977–1982.

2.5 Nuclear industry in Finland

The Finnish companies delivered many reactor internals and other components for the Loviisa and Olkiluoto reactors. Their aim was to establish a role on the then promising nuclear markets. A special company, Finnatom was also set up. However, it became clear very soon that the expectations would not be realised and the Finnish companies left the nuclear field.

2.6 Back-end of the nuclear fuel cycle

The Russian supplier of the Loviisa nuclear reactors and Imatran Voima Oy made a long-term fuel management contract, which included also the taking-back of the spent fuel assemblies to the Soviet Union. An amendment of the Finnish Nuclear Act accepted by the Parliament in 1994 forbade the export and import of nuclear waste. Accordingly, the last shipment of the spent fuel from the Loviisa power plant was carried out in 1996. The spent fuel assemblies are now stored in the interim storage facilities closely connected to the reactor building.

During the construction of the Olkiluoto nuclear power plant Teollisuuden Voima Oy negotiated with the European companies about a reprocessing agreement. However, the costs of the reprocessing option seemed to be very high. Teollisuuden Voima Oy decided to build an interim storage facility for the spent fuel at the plant site. The TVO-KPA store started its operation in 1987.

3 NUCLEAR FUEL CYCLE UNDER SAFEGUARDS IN FINLAND

3.1 Nuclear power reactors

In Finland there are in operation the following four nuclear reactors at two sites:

Unit	Type	Net capacity (MWe)	Start of commercial operation
Loviisa-1	VVER	488	1977
Olkiluoto-1	BWR	840	1979
Loviisa-2	VVER	488	1981
Olkiluoto-2	BWR	840	1982

The original power utilities own and operate the Finnish nuclear reactors. However, the large state-owned energy companies were recently fused together to form a new company called Fortum Group, the daughter company of which, Fortum Heat and Power Oy, owns now the Loviisa power plant. Fortum Group is planned to be privatised.

All Finnish nuclear reactors have gone through a modernisation project including a power upgrade in the end of the 1990s. The Loviisa reactors have now an operation licence up till 2007 and the Olkiluoto units up till 2018 (an interim safety review in 2008).

In Appendix 1 there are shown the numbers of the fresh and spent fuel bundles at the Finnish nuclear power plants (NPP) in the end of 1998. At present, all spent fuel bundles produced in Finland are stored at the plant sites, because an amendment of the Finnish Nuclear Energy Act forbade the return of the spent fuel assemblies of the Loviisa power plant to Russia. Up to 1996 altogether 2853 spent VVER-440 assemblies (totally 330 tU) were sent back to the Soviet Union/ the Russian Federation (to the Mayak reprocessing plant). No radioactive waste was returned to Finland.

The fuel bundles including uranium and its enrichment for the Loviisa reactors have been of Russian origin except five lead assemblies delivered by BNFL in 1998. Fortum Power and Heat has recently made a contract with BNFL about the delivery of several reload batches.

Already in the beginning of the 1980s the active cores of the Loviisa reactors were decreased by replacing 36 fuel assemblies with the steel elements of equal size in order to reduce the neutron fluence at the pressure vessel. These so-called dummy assemblies are stored together with the spent fuel assemblies.

The fuel management of the Olkiluoto NPP has been based on uranium acquired from several sources, mainly from Australia, Canada, Russia or China. The enrichment services have been bought from Russia or Urenco Ltd and the fuel bundles of the Olkiluoto units have been manufactured in Sweden, Germany or Spain.

According the present plans the spent fuel of the Finnish nuclear reactors will be disposed of deep in the Finnish bedrock at one site starting from 2020. If the operational lifetime of the units will be increased, the disposal project will be delayed accordingly. The fuel bundles with their flow channel will be placed as such in the disposal canisters.

3.2 FiR 1 facility

At the FiR 1 research reactor there are 127 fuel rods containing 27 kg of uranium (5.4 kg of U-235), which have been acquired many years ago. In the core there are 79 bundles, 22 bundles have been removed from the core and placed in the storage facilities in the reactor building and 26 fresh bundles are available for future operation.

The fuel pins of the decommissioned subcritical pile are also stored at the FiR 1 facility. There are 1196 fuel pins of natural uranium (mass of uranium 1 416 kg), 189 pins of enriched uranium (enrichment of 10%, mass of uranium 30 kg) and some pieces of metallic natural uranium (mass of uranium 93 kg).

3.3 Other owners of nuclear materials

Also a few other Finnish research institutions (presently at VTT, STUK, University of Helsinki, Geological Survey and OMG Kokkola) have small amounts of nuclear materials (see Appendix 1), mainly for experimental purposes, under safeguards.

4 PRESENT SAFEGUARDS SYSTEM IN FINLAND

4.1 Accounting measures

The Loviisa power plant is treated as a single Material Balance Area (WL0V), which contains two reactor cores with their fuel ponds, one storage facility for the fresh fuel assemblies and two storage facilities for the spent fuel assemblies (the “old” and “new” storage facility).

The Olkiluoto nuclear facilities are divided into three Material Balance Areas: two reactor units (two identical MBAs; W0L1 and W0L2) and the TVO-KPA-store for the spent fuel (W0LS).

The operators of the nuclear power plants as well as other owners of nuclear materials keep accounts of nuclear materials in their possession. They have to report the material inventories and the inventory changes to the international and national safeguards agencies according to the safeguards provisions of the international agencies and the regulatory guides issued by STUK (STUK 1996a, STUK 1999b).

4.2 Safeguards inspections in Finland

4.2.1 Safeguards activities of STUK

According to the Finnish Nuclear Energy Act the Ministry of Trade and Industry is the highest authority in the field of nuclear energy. Preparation of legislation, drafting and implementation of international agreements in Finland and co-ordination of Finland's participation in the activities of international organisations are a significant part the Ministry's duties on the field of nuclear energy.

The Radiation and Nuclear Safety Authority (STUK) working under the administrative control of the Ministry of Social Affairs and Health is the nuclear regulatory body in Finland. STUK controls the safety of the use of nuclear energy. From the safeguards point of view, the permanent presence of STUK inspectors at the Finnish nuclear power plant is important. STUK is also responsible of the radiation protection and nuclear emergency measures in Finland.

STUK is also responsible for safeguards activities in Finland including the maintenance of the comprehensive database of nuclear materials and activities. The Nuclear Materials office of the Nuclear Waste and Nuclear Materials Regulation department of STUK maintains and develops the SSAC in Finland. The office has presently (May 2000) a staff of six experts. These experts are responsible also of other tasks including the control of transport of radioactive materials, the prevention of illicit trafficking of radioactive materials in co-operation with customs officials and the Finnish support programs related to safeguards and safety of nuclear materials. It can be estimated that about three personyears are presently spent to safeguarding of nuclear materials. A small increase is probable due to the implementation of the Additional Protocol (Martikka & Hämäläinen, Eds., 2000).

During the last 20 years STUK has studied and developed routine and advanced verification methods for safeguards purposes, often in co-operation with Finnish research institutes, power utilities and international safeguards agencies. The Finnish support program to IAEA safeguards was started in 1988. STUK has acquired a capability to carry out independent safeguards inspections and measurements at the Finnish nuclear reactors (Tarvainen 1997, Rosenberg&Tarvainen 1998, Rosenberg, et al., 2000). Since the beginning of the 1990s STUK has used its expertise to help the Baltic States, Ukraine and the Russian Federation to create and improve their material accounting, protection and control systems (STUK 2000). STUK's experts have participated also in the work of the Iraqi Action Team of the IAEA.

4.2.2 International inspections by the IAEA and Euratom

Finland joined the European Communities in 1995. Since then the Finnish nuclear facilities have been under two international inspection systems; a global one by the IAEA and a regional one by Euratom. The Nuclear Energy Act requires that the representatives of STUK must be present in all international inspections.

The number of safeguards inspections in Finland by the IAEA and Euratom and the number of persondays devoted to them in 1991–1999 is shown in Appendix 2, where is also given the number of safeguards inspections and inspection persondays by STUK in 1997–1999. The IAEA and Euratom have agreed to apply the New Partnership Approach in the Olkiluoto nuclear power plant. However, the amount of international safeguards work has almost doubled in Finland after her EU membership, because the representatives of both the IAEA and Euratom participate still in almost every inspection.

The number of the separate inspection visits and the number of the working days spent on them may be the more relevant measures of the safeguards burden. In 1999 the IAEA, Euratom and STUK made eleven inspections visits to the Olkiluoto nuclear power plant and the TVO-KPA-store and 20 working days were used to carry them out. The corresponding numbers for the Loviisa nuclear power plant were nine visits and twelve days. STUK carried out independently three measurement and inspection campaigns in Olkiluoto and one in Loviisa in 1999. Euratom made two inspections in Olkiluoto (and the single inspection visit at the FiR 1 research reactor) without the presence of the IAEA inspectors.

The FiR 1 research reactor is inspected by the international agencies once a year and the locations outside facilities once in a few years.

The inspections in Finland are only a minor part, about a half percent of the safeguards activities of both the IAEA and Euratom (Gmelin 1999& IAEA Annual Report 1998).

4.3 Containment and surveillance measures

The very similar C/S principles and techniques are used in both Finnish nuclear power plants.

There is camera surveillance in each reactor hall and in the TVO-KPA-store. Each location is controlled by at least by two cameras, the central units of which are sealed by the Euratom seals.

The reactor lids are sealed with the joint Euratom/IAEA seals in Loviisa and with the cable wires and VACOSS seals in Olkiluoto. In the TVO-KPA-store the fully filled A-pond and the partly filled B-pond are sealed with a bar. In the old spent fuel facility in Loviisa STUK has verified and sealed the spent fuel assemblies.

5 INTEGRATED SAFEGUARDS MODEL FOR FINLAND

5.1 Acquisition and maintenance of “Credible Assurance”

The Integrated Safeguards system can be applied only in the states, which have in force both an INFCIRC/153 based safeguards agreement and the Additional Protocol. Besides this formal condition the states must pass a quite severe test before the implementation of the IS system. The IAEA must acquire “credible assurance” of the absence of diversion of nuclear materials from declared facilities and of the absence of clandestine nuclear materials and activities in a state. It is not yet thoroughly clear, what “credible assurance” will mean in the IS context, and how the IAEA can acquire and maintain that state of relations with a state.

The Additional Protocol will give the IAEA new measures to fulfil its safeguards obligations. Enhanced access to information and locations will help the Agency to acquire a more complete knowledge base of the nuclear situation in a state than before. Modern information analysis methods should enable the IAEA to combine and evaluate information delivered by a member state with that from open sources and third parties. New verification techniques (e.g. better measuring devices, wide-area environmental sampling, remote monitoring and satellite imagery methods) may eventually help the Agency to perform safeguards work including the state-level evaluations in a more effective and efficient way. However, information analysis methods as well new verification methods are still under development and their reliability and specially their cost-effectiveness are to be proved.

The IAEA will need a certain period of time (maybe from one to two years) to acquire an initial “Credible Assurance”, if the Agency and the state in question can co-operate in an efficient way. The maintenance of a credible enough assurance will be a continuous process, where the Agency must react immediately, if there seems to be inconsistencies and other alarming indications in the reports or activities of the state.

The transition period from the traditional safeguards to the Integrated Safeguards may be shortened if the state has prepared for and become acquainted with the new methods. In Finland, STUK with its R&D partners have been actively involved in projects related to development of new safeguards methods. Many subtasks of the Finnish Support Program have been aimed at solving problems and questions of the new safeguards system since the start-up of the “93+2” programme (Tarvainen 1997). However, already before the implementation of the IS system starts in Finland, more attention can still be paid to some practical questions. The completeness and correctness of information of nuclear activities in Finland must be checked, the definition of sites and locations has to be considered carefully and the potential objects of new safeguards measures must be informed thoroughly enough.

5.2 Qualitative factors in the state-level evaluations

The effectiveness and efficiency of the coming Integrated Safeguards system will depend to a great extent on co-operation between the IAEA and the member states. One important aspect in this regard will be “Nuclear Transparency” shown by the states, which in an ideal case should be more than only a formal, timely fulfilment of the conditions of the safeguards agreements.

Each country has her own nuclear and nuclear non-proliferation history and her own specific fuel cycle and infrastructure. These should be taken into account in the state-level evaluation by the

IAEA. An evaluation will always be based also on purely qualitative factors. There seems to be some disagreements, what kind of factors can be taken into account. However, it can be argued that also the past activities of a state regarding the use of nuclear energy and nuclear non-proliferation as well as her present political system should have reviewed in the evaluation of the Agency.

Finland has been a Non-Nuclear-Weapons State (NNWS) since 1947, when she ratified the Paris peace treaty. The Treaty forbade Finland to manufacture or acquire nuclear weapons. This fact has had an impact on Finland's whole nuclear history, especially on her non-proliferation policy. Finland has consistently supported global and other efforts to stem the proliferation of weapons of mass-destruction. Public funding has been used to develop verification methods for relevant global agreements (NPT, CWC, CTBT and BWC) and during the last ten years for helping the Baltic States and member states of the CIS (Partanen&Sarhimaa (compiled by) 1997).

The political system and culture of Finland is open and transparent. The role of the state has decreased in many aspects of economy including the energy sector especially during the last few years. The regulatory authorities are well protected against the outside and inside pressure. To start large-scale clandestine projects in Finland would be more than difficult.

5.3 Implementation of the Additional Protocol in Finland

IAEA, EURATOM and thirteen non-nuclear-weapon Member States of the European Union signed the Additional Protocol to their safeguards agreement (INFCIRC/193) in Vienna on September 22, 1998. National legislation is now being modified accordingly in each member state. In Finland the necessary legal acts are going through the parliamentary proceedings, which will be completed in spring 2000. However, the Additional Protocol will enter into force in all thirteen NNW EU states simultaneously. The original goal was that the national proceedings would be completed before May 2000. At present, some delay seems to be very probable.

One decision regarding the implementation of the Additional Protocol has already made in Finland, namely that Finland will not entrust to the Commission of the European Communities the implementation of any provisions of the Additional Protocol as specified in the so-called model side letter. This decision corresponds to Finland's policy to maintain a strong SSAC.

5.4 Integrated Safeguards Proposal

The nuclear fuel cycle under safeguards in Finland is simple and easy to control. Furthermore, there is no immediate need to change the present safeguards arrangements of the only research reactor and few locations outside facilities.

The nuclear fuel cycle in Finland relevant to the Integrated Safeguards system consists of four nuclear reactors at two sites using only uranium fuel in an annual reloading scheme. The spent fuel is stored in the facilities at the sites to wait for the disposal in the Finnish bedrock. Therefore, when the basic conditions for the implementation of the IS system will be fulfilled, some traditional safeguards activities can be left undone in Finland. At least, the four annual interim inspections for each MBA and the camera surveillance in the reactor halls between refuellings and in the TVO-KPA-store at the Olkiluoto site could be ended. The IAEA could compensate its reduced verification efforts by carrying out one annual unannounced or short-notice inspection at the Finnish nuclear sites. The safeguards inspections and measurements by STUK and the efforts to improve their effectiveness and techniques are assumed to continue as before.

A possible IS model for Finland could be as follows:

- One Physical Inventory Verification (PIV) annually for each MBA
- One (or none) unannounced or short-notice inspection in Finland annually
- Core sealing during operation
- Camera surveillance of the reactor halls during refuelling
- Containment with seals of the spent fuel storage facilities
- Material flows reported and confirmed (as before)

The Additional Protocol allows the IAEA, under some specified principles and conditions to carry out Complementary Accesses (CA) in order to verify declarations of a member state and to solve questions and inconsistencies found out by the Agency. Due to the small size and uncomplicated nature of the Finnish nuclear cycle, it is assumed that there will be only a limited need by the IAEA to carry out CAs in Finland.

The Agency could increase the deterrence value of the PIVs by introducing more accurate measurements methods, e.g. for the detection of both gross and partial defects of the spent fuel bundles. Advanced, reliable electronic seals would enhance the credibility of the IS model outlined above. Especially, there may be a need to develop more sophisticated systems for sealing the ponds in the interim spent fuel storage facilities in a way, which might decrease the amount of work related to their PIVs. However, the reliability of the new verification methods and instruments should be tested carefully. Otherwise, the cost-effectiveness of the new safeguards system would be endangered.

5.5 Roles of national and international agencies in the application of the IS

At present the representatives of three agencies (IAEA, Euratom and STUK) participate in almost all safeguards inspections of the Finnish nuclear facilities. It would be desirable that the enhanced co-operation between the IAEA and Euratom would some day result in a reduction of the international presence in their safeguards visits to Finland. Both agencies could also utilise more the expertise of the Finnish SSAC. The inspectors of STUK can perform all kind of safeguards inspections alone. A reasonable goal of all three agencies could be that STUK could carry out routine safeguards activities (PIVs, application of seals, etc.) under the control of the IAEA and/or Euratom. The reliable remote monitoring system could be developed to increase the credibility of the arrangement.

6 SUMMARY

Finland has been a non-nuclear-weapons state since signing the Paris Peace Treaty in 1947. After starting study and develop peaceful use of nuclear energy in the end of the 1950s her nuclear activities have been under the international control, first by the IAEA and since joining the European Union in 1995 also by Euratom. From the beginning Finland started to develop also a strong, competent and unified national control system for nuclear activities. Radiation and Nuclear Safety Authority (STUK) has developed a comprehensive expertise and knowledge base during its more than 40 years of operation.

Finland proceeded quite slowly and cautiously into the nuclear field, partly due to political and economic reasons. No large-scale centre was established for nuclear research and development. No effort was made to acquire expertise and technical capabilities covering the whole nuclear fuel cycle. The same cautiousness prevailed, when the decisions to build the first four nuclear power reactors at two sites were made in Finland in the end of the 1960s and at the beginning of the 1970s. Even if the Finnish companies manufactured components for all four reactors constructed in Finland, no lasting nuclear industry was established. A rather extensive uranium exploration by the state and private companies did result only in short-lived and small-scale uranium mining and milling at two sites, both of which were closed already in 1961 and are now environmentally restored.

The present nuclear fuel cycle in Finland under the national and international safeguards is very simple due to the specific features of her nuclear history. It consists basically of four nuclear reactors at two sites using only low-enriched uranium fuel in an annual reloading scheme. The spent fuel are stored in the facilities at the sites. In addition, there is a research reactor and a few other research institutes having only small amounts of nuclear materials.

Due to the limited scope of her past and present nuclear activities and a long experience of the international safeguards Finland should be able to fulfil the provisions of the Additional Protocol fast and well. It can be assumed that all will proceed in good co-operation between the IAEA, Euratom and the Finnish SSAC and that IAEA will acquire credible assurance of clandestine nuclear materials and activities in a state in Finland. It is also probable that the assurance of the absence of diversion of nuclear materials from declared facilities can be maintained. Then, the Agency will be in a position to proceed with an Integrated Safeguards system in Finland. Consequently, some safeguards activities can be left undone.

The IS model proposed in this report would put an end to four annual interim routine inspections per a Material Balance Area and to the use of camera surveillance between the refuellings. On the other hand, the IAEA could carry out one unannounced or short-notice inspection in Finland. The Agency would also get continuously up-to-date information of all nuclear activities in the country. The other IS safeguards measures in Finland would include one annual PIV per a MBA, camera surveillance of the reactor halls during the refuellings, sealing of the reactor cores between the refuellings and containment of the spent fuel storage facilities by seals. The system of nuclear material accounting records and reports would be as before. The Finnish SSAC is assumed to be maintained and further developed in the future. The national safeguards inspections and measurements by STUK would be continued and the findings as well as the results of measurements would be reported to the Agency for the use in connection of with analysis, evaluation and planning of its safeguards activities.

The implementation oft the provisions of the Additional Protocol and the introduction of the IS system in Finland requires good co-operation and division of work between four actors of the play: the operators of the nuclear facilities, STUK, Euratom and the IAEA. Each of them shall have the well-specified roles and functional responsibilities. Then, a strengthened as well as cost-effective safeguards system can be established. The most effective way to accelerate this adaptation process is to arrange field trials, where the actors can learn new procedures in practice.

The operators of the nuclear facilities must continue to maintain the nuclear material accounting system as required by the national and international safeguards agencies. Besides that they have to be prepared to answer in a timely manner to the questions of the safeguards agencies. They must also be able to arrange new kind of inspection visits, sometimes even within a short period of time.

The international safeguards agencies should utilise more the resources of the national safeguards authority, STUK, when applying the IS system in Finland. The new safeguards system will impose new responsibilities on STUK, which must first gather together and then regularly update large amount of information of nuclear activities in Finland, check its correctness and completeness and send the relevant information to the IAEA directly or via Euratom. However, STUK is well prepared for the increased responsibilities, because it already has comprehensive knowledge bases of all nuclear activities in Finland and in the neighbourhood. STUK will also maintain and upgrade its technical capability to carry out safeguards relevant examinations and measurements. A reasonable goal for enhanced co-operation could be that STUK would carry out routine safeguards activities under the control of the IAEA and Euratom.

The application of the Integrated Safeguards system should enable the IAEA to leave major part of routine safeguards measures to strong, competent national or regional agencies. It could then concentrate on optimising the system of safeguards measures and the utilisation of available resources. One of the main challenges is the effective evaluation of large amounts of diverse information coming from the declarations of the member states as well as from open sources and third parties in order to find out indicators and indications of clandestine activities in an early stage of affairs. Also the development of new facility-level and wide-area verification techniques may require more resources. Reliable remote monitoring and data transmission methods could improve the effectiveness of verification efforts. The inspectors of the Agency need more versatile training than earlier. As a whole, the Agency must be prepared to respond in a timely and effective way, when it finds something inconsistent or suspicious in the conduct of nuclear activities in a member state.

The role of Euratom should also be clarified before the introduction of the IS system in Finland. Euratom, partly alone and partly together with its member states, will have to send declarations to the IAEA according to the Additional Protocol. However, the main challenge will be that an enhanced co-operation between the various actors in the practical safeguards work in Finland could be defined and turned into an efficient practice. The adaptation of the Euratom safeguards practices to the coming IS system would be desirable.

The development of the Integrated Safeguards system should be a dynamic process. Most probably it will take several years, before a more or less final system will be in operation. Even if the same criteria for the efficiency and effectiveness of the system performance are applied for all member states, it is evident that the practical co-operation arrangements and implementation procedures will vary from a member state to another.

REFERENCES

Dassen, Lars van, Finland and Nuclear Non-Proliferation: The Evolution and Cultivation of a Norm. Swedish Nuclear Power Inspectorate, Report 98:15, March 1998.

International Atomic Energy Agency, The Annual report for 1998. IAEA:n web-sivut, http://www.iaea.org/worldatom/infosource/annual/anrep98/.

Gmelin, Wilhelm, Die Sicherheitsuberwachung von Euratom -Aufgaben and Aussichten. Atomwirtschaft, 44 Jg. (1999), Heft 4 - April, S. 237–239.

Martikka, Elina, Hämäläinen, Marko (Eds.), Control of Nuclear Materials 1998–1999, Radiation and Nuclear Safety Authority, report STUK-B-YTO 187, February 2000 (in Finnish).

Partanen, Jonna, Sarhimaa, Johanna (Compiled by) Finland and Verification of Disarmament Agreements. A Publication of the Ministry for Foreign Affairs of Finland, ISBN 951-274-100-3, 1997.

Radiation and Nuclear Safety Authority (STUK 1999a), The national system of accounting for and control of nuclear materials. Nuclear Regulatory Guide YVL 6.9 (September 23, 1999).

Radiation and Nuclear Safety Authority (STUK 1999b), Reports to be submitted on nuclear materials. Nuclear Regulatory Guide YVL 6.10 (September 23, 1999).

Radiation and Nuclear Safety Authority (STUK 2000a), Finnish Support Programme for Nuclear Safety. Progress Report, Annual Summary 1999. March 2000.

Rosenberg, Rolf J., Tarvainen, Matti, Preparing for routine analysis of environmental monitoring samples for safeguards and the CTBT. Proc. of the 39th INMM Annual Meeting, Naples, Florida, July 27–30, 1998 (on a cd-rom).

Rosenberg, Rolf, et al., Analytical Methods Used for Environmental Sampling in Finland. To be published in the Proc. of the ESARDA seminar on “Strengthening of Safeguards: Integrating the New and the Old”, the 22nd ESARDA Annual Meeting, Dresden, Germany, 8–12 May, 2000.

Tarvainen, Matti, New Verification Methods for Nuclear Material Safeguards. In Partanen, Jonna, Sarhimaa, Johanna (Compiled by) Finland and Verification of Disarmament Agreements, pp. 10–20.

APPENDIX 1

Nuclear materials in Finland 1998–1999 (Source: Radiation and Nuclear Safety Authority, STUK)

A) Transfer of fuel bundles to and in the Finnish nuclear power plants.

Place/Year		From	Assemblies	Enriched uranium (kg)	Plutonium (kg)
LO	1998	Russia	217	25 905	—
	1998	Great Britain	5	625	—
	1999	Russia	210	25 176	—
OL1	1998	Germany	146	25 349	—
	1999	Germany	130	22 610	—
OL2	1998	Spain	130	22 998	—
	1999	Spain	120	21 202	—
TVO-KPA	1998	OL1	246	40 738	370
	1998	OL2	328	57 070	474

B) Number of fuel bundles in the Finnish nuclear power plants.

Place/Year		Fuel assemblies/irradiated assemblies, amount *)	Enriched uranium (kg)	Plutonium (kg)
LO	1998	2 734/1 670	317 373	1 924
	1999	2 944/1 898	341 336	2 183
OL1	1998	1 112/486	189 066	720
	1999	1 242/626	210 550	929
OL2	1998	1 010/376	178 175	573
	1999	1 130/506	198 309	768
TVO-KPA	1998	3 608/3 608	616 462	4 931
	1999	3 608/3 608	616 462	4 931

*)Fuel assemblies in the reactor core are calculated as fresh (LO 313 and OL 500/reactor).

C) Nuclear materials in Finland.

Place/Year		Natural uranium (kg)	Enriched uranium (kg)	Depleted uranium(kg)	Plutonium (kg)	Thorium (kg)
LO	1998	—	317 373	—	1 924	—
	1999	—	341 336	—	2 183	—
OL1	1998	—	189 066	—	720	—
	1999	—	210 550	—	929	—
OL2	1998	—	178 175	—	573	—
	1999	—	198 309	—	768	—
TVO-KPA	1998	—	616 462	—	4 931	—
	1999	—	616 462	—	4 931	—
FiR-1	1998	1 510	60	— *)	—	—
	1999	1 510	60	— *)	—	—
Others	1998	24	2	35	— *)	1
	1999	24	2	35	— *)	1

*) below 1 kg

Safeguards inspections in Finland 1991–1999 (Source: Radiation and Nuclear Safety Authority, STUK)

APPENDIX 2

(Data of the inspections by STUK available only for the years 1997–1999)