Nuclear Non-Proliferation Activities in Hungary 1999-2009

Hungarian Atomic Energy Authority

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H-1036 Budapest, Hungary
Phone: +36-1-436-4800
Editor in Chief: József Rónaky, PhD, director general

Abstract

For Hungary, the year 2009 was an anniversary in the fight against the proliferation of nuclear weapons, because 10 years elapsed since the ratification of the Additional Protocol (AP) to the Comprehensive Safeguards Agreement between the International Atomic Energy Agency and Hungary, and the so-called Integrated Safeguards System of the International Atomic Energy Agency was implemented 5 years before.

Due to this anniversary this report gives an overview of the international safeguards system and practice and the pioneering work of Hungary in gaining experience in their state level implementation, focusing especially on the last ten years.

In addition to safeguards, other efforts contributing to the prevention of the proliferation of nuclear weapons are also introduced and evaluated via their relation to the international regimes. These include activities in nuclear export-import control, in relation to the Comprehensive Test Ban Treaty and as well as those aiming to prevent the illicit trafficking of nuclear materials.

Content

Introduction

The present report is the first of a planned series, which will periodically report on the activities taken in Hungary in relation to the international fight against the proliferation of nuclear weapons.

The year 2009 can be seen as an anniversary on this road, because until then 10 years elapsed since the ratification of the Additional Protocol (AP) belonging to the Comprehensive Safeguards Agreement between the International Atomic Energy Agency and Hungary and the so-called Integrated Safeguards System of the International Atomic Energy Agency was implemented 5 years before. In connection to this anniversary this report provides the overview of the period between 1999 and 2009.

The objectives of nuclear non-proliferation in general are to prevent, timely detect and respond to (1) the open and covert diversion of nuclear materials, (2) the covert operation of the facility or its technological processes and equipment and (3) the covert processes aiming at the production of nuclear materials, and the (4) non-licensed operation of equipment on the site of the facility, and during the application, storage and transport of nuclear materials.

Since timely detection and response are mostly covered by the international safeguards verification regimes (IAEA and EURATOM), the role of the individual states is especially important from the prevention point of view. In this effort the establishment and maintenance of a well functioning national SSAC is essential.

The overview of the international safeguards system and practice contributing to objectives described above and the pioneering work of Hungary in gaining experience in their state level implementation will be given below, focusing especially on the last ten years.

Additionally, the national efforts contributing to the prevention of the proliferation of nuclear weapons will be introduced and evaluated via their relation to the corresponding international regimes with the aim of providing a comprehensive overview of the international and national activities for not only the experts in the field, but also for all those interested.

1. International safeguards system

Article III (1) of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which was opened for signature in 1968, provides that each non-nuclear-weapon State Party to the NPT undertakes to place all of its nuclear facilities under safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency (hereinafter referred to as “IAEA”). The safeguards agreement covering all declared nuclear material in each nuclear facility in a State is of a comprehensive type, and it is very different from the item-specific safeguards agreements with States not party to the NPT. The latter ones do not cover all the nuclear activities in a State, but only the nuclear material, facilities, equipment and/or materials specified in the agreement. The disadvantage of such item-specific safeguards agreements is that the knowledge and materials gained in the facility under safeguards can theoretically be utilized in other nuclear activities not under international safeguards agreement.

Hungary, signing the NPT among the first States in 1969, signed a comprehensive Safeguards Agreement with the IAEA on the verification regime of the NPT obligations, which entered into force in 1972.

The international non-proliferation regime was greatly challenged in the 90’s from two aspects. On the one hand a State party to the NPT happened to have an undeclared nuclear facility or on the other hand had covert activity in a declared facility. These events forced major revision of the IAEA safeguards system with objectives to detect undeclared facilities and activities as well. The principal legal document of the strengthened safeguards system is the Additional Protocol (INFCIRC/540), which was signed by Hungary in 1998 and entered into force in April 2000, among the firsts. At that time, out of the States with considerable nuclear industry, only Japan, Australia and Canada had Additional Protocol in force. The initial Additional Protocol declaration of Hungary was sent to the IAEA in 2000.

The State-level integrated safeguards approach of the IAEA was introduced in Hungary in 2004 for which the IAEA must draw the conclusion that there is no indication of diversion of declared nuclear material from peaceful activities and no indication of undeclared nuclear material and activities for the State as a whole. For Hungary this broad conclusion was first published in the Safeguards Implementation Report of 2003.

In May 2004 Hungary became member of the European Union and according to the accession treaty, member of the European Atomic Energy Community (Euratom) as well. Since then the safeguards provisions set by the NPT for Hungary are fulfilled by multilateral safeguards agreement and additional protocol between the European Atomic Energy Community, the IAEA and the Member States. The multilateral system is needed, because due to the Euratom Treaty ratified in 1957, the European Commission has direct competence in every member state to fulfill obligations provided by international agreements signed against the proliferation of nuclear weapons within the limits of its power. For the control of the peaceful application of nuclear materials the Commission therefore has national authority competence, entitled to directly regulate the facilities, conduct in field inspections and impose sanctions. The multilateral agreement and protocol came into force in Hungary by the Act LXXXII of 2006.

2. Peaceful application of nuclear materials – nuclear fuel cycle

Definition of the nuclear fuel cycle in a broad sense includes all activities that are needed for the production, irradiation, interim storage, reprocessing and final disposal of nuclear fuel. The individual nuclear fuel cycles may be very different depending on the type of fuel applied, the type of reactors used for irradiation and whether the spent fuel is reprocessed or not. There are in principle two types of fuel cycles: open or closed. In the open cycle the fuel is used only once, while in the closed one the utilizable portion of the irradiated fuel is extracted and fed back into the nuclear fuel cycle again. The choice of a nuclear fuel cycle in a state is determined by political and economical considerations. Both the open and the closed fuel cycle can be found in the countries applying nuclear energy peacefully.

The nuclear fuel cycle in Hungary is open in both ends, since there is no production of nuclear fuel (all of them are being imported), and the spent fuel is not reprocessed but stored in an interim storage facility. There are four pressurized water reactors of VVER-213/440 type used for power production at Paks site currently.

The spent fuel of the power reactors are temporary (50 years) stored in the Interim Spent Fuel Storage Facility (ISFSF) at Paks, which is a modular vault dry storage with passive air cooling.

Besides, there is a tank type research reactor of 10 MWth power operated by the Hungarian Academy of Sciences KFKI Atomic Energy Research Institute (Budapest Research Reactor), and a 100 kWth powered pool type training reactor at the Institute of Nuclear Techniques of the Budapest University of Technology and Economics (Training reactor, BUTE).

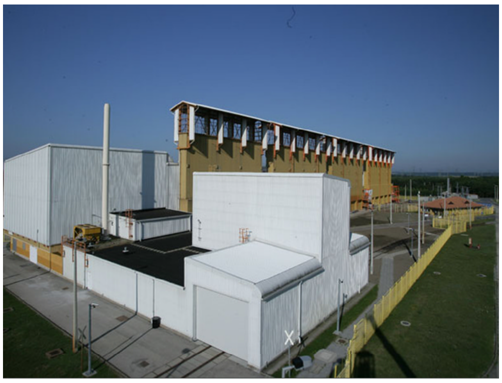
For economical reasons, after 40 years of production and export of 20 tones of uranium, the Hungarian uranium mine was closed in 1997. The facilities of the Hungarian nuclear fuel cycle are shown in figure 1.

Closed uranium mine, Mecsek

Paks Nuclear Power Plant

Budapest Research Reactor

Training reactor, BUTE



Interim Spent Fuel Storage Facility, Paks

Figure 1. Facilities of the Hungarian nuclear fuel cycle

3. National safeguards system

Section (1) a) of Article 68 of Act CXVI of 1996 on Atomic Energy gives authorization for the minister supervising the Hungarian Atomic Energy Authority (HAEA) to regulate in a decree the accountancy for and control of nuclear materials in accordance with the international agreements. The detailed rules of this regulatory task of the HAEA are provided in the Ministerial decree 7/2007. (III. 6.) IRM.

Fulfillment of obligations related to inspection of nuclear materials as undertaken in international agreements is ensured by keeping the nuclear materials under comprehensive control. The comprehensive control is implemented through application of an efficient safeguards system and continuous application of the whole system of regulatory control tools. For establishing and maintaining the effective national safeguards system for the control of nuclear materials and nuclear material related activities, the HAEA applies the following tools of the regulatory system:

- preliminary checks during safeguards licensing procedures (including on site inspection in advance) if the safeguards measures to be implemented by the organization possessing nuclear material are appropriate for complying with the requirements, for efficient implementation of control activity, and if they facilitate the meeting of site inspection objectives;

- ensures continuous supervision in relation to nuclear materials and equipment and to nuclear material and nuclear fuel cycle related activities and to corresponding production and R&D activities by prescribing information provision obligations, by processing the submitted reports and by evaluation of the activity of the licensee;

- verifies during site inspections the information obtained through information provision and inspects the equipment and operation of containment and surveillance system, and the real and efficient implementation of the prescribed safeguards measures.

3.1. Safeguards licensing procedures

According to the Ministerial decree 7/2007. (III. 6.) IRM, a first safeguards license issued by the HAEA is necessary to possess nuclear material and launch any activity related thereto.

A safeguards modification license is required to launch any important safeguards relevant modification.

For the transport of nuclear materials not requiring export-import license according to separate regulation to and from the territory of the Republic of Hungary (see also section 7.3) a safeguards transport license is necessary.

A safeguards termination license is issued for the termination of safeguards requirements subsequent to termination of nuclear activities.

Safeguards licensing procedures shall be initiated at the request of the licensee. After the evaluation and approving of the license application, the safeguards license is granted by the HAEA in form of an authority decision.

Since 2007 there have been 33 first safeguards licenses, 13 modification safeguards licenses and 2 safeguards transport licenses granted by the HAEA.

3.2. Nuclear material accountancy

Based on the information submitted to and verified by the HAEA, a central accountancy and data provision system is operated. The system contains all the information provided for the Euratom and the IAEA together with all the detailed data about the licensees and their inspections, contributing to the efficient operation of the system.

The central accountancy system of nuclear materials closely follows the requirements set forth by the IAEA. After Hungary's accession to the European Union, the accountancy system of the facilities has to be slightly modified, which was also manifested in the corresponding change in the central accountancy system.

The central accountancy system of nuclear materials is based on *material balance areas* determined for the following facilities and sites:

Budapest Research Reactor

The Hungarian built, Soviet designed 10 MWth reactor is in operation since 1959 in the capital. It is operated by the Hungarian Academy of Sciences KFKI Atomic Energy Research Institute (AEKI).

Training reactor, BUTE

The pool-type nuclear reactor is in operation since 1971 operating with a core built of EK-10 fuel assemblies with 10% enrichment. The maximum thermal power is 100 kW. The reactor located on the premises of the Budapest University of Technology and Economics (BUTE) is operated by the Institute of Nuclear Techniques for research and training purposes.

Central Isotope Storage of the AEKI

The storage is located on the site of the Budapest Research Reactor. The Central Isotope Storage is used for the temporary storage of disused radioactive sources (including nuclear materials) of all the research institutes on site (except that of HAS Institute of Isotopes).

Paks Nuclear Power Plant

The Paks Nuclear Power Plant contains 4 pressurized water reactors (PWR) of VVER-213/440 type, which were connected to the grid in 1982, 1984, 1986 and 1987, respectively. The original electric power of the units were 440 MW, a power uprate to 500 MW was later carried out with the gradual efficiency upgrade of the traditional energetic components. As a result, the Paks Nuclear Power Plant shared 43 % of the total domestic electric power production in 2009.

Interim Spent Fuel Storage Facility (ISFSF)

The ISFSF is a modular vault dry storage facility, which provides interim storage for the spent fuel assemblies of the Paks Nuclear Power Plant. The facility that is located just next to the site of the Paks Nuclear Power Plant is operated by the Public Limited Company for Radioactive Waste Management.

Minewater Treatment Plant of the Mecsek Öko Zrt.

While the Headquarters of the Mecsek Öko Zrt. is located in the city of Pécs, its Minewater Treatment Plant is operating in Kővágószőlős. In order to meet the authority requirements, the uranium content of the surface and subsurface water contaminated by the formal mining and milling activities is removed in the Minewater Treatment Plant to protect the two water reservoirs located in the area. During a continuous process uranium is concentrated in the form of uranium oxide ("yellow cake") that is exported.

The following material balance areas are defined in the central accountancy system of nuclear materials:

WHUA	Budapest Research Reactor, Budapest
WHUB	Training reactor of BUTE, Budapest
WHUC	Locations outside facilities with small amount of nuclear materials (LOFs)
WHUD	Central Isotope Storage of the AEKI, Budapest
WHUE	Paks Nuclear Power Plant Unit 1 and 2, Paks
WHUF	Paks Nuclear Power Plant Unit 3 and 4, Paks
WHUG	Interim Spent Fuel Storage Facility, Paks
WHUH	Minewater Treatment Plant of the Mecsek Öko Zrt., Kővágószőlős

The material balance areas are obliged to have local accountancy system and have to report to the Euratom accountancy system, which is described in detail in the COMMISSION REGULATION (Euratom) No 302/2005 of 8 February 2005 on the application of Euratom safeguards.

The individual material balance areas shall report changes in their nuclear material inventory monthly, and take physical inventory of nuclear materials annually. These material balance areas, except WHUC, send their report simultaneously to the central accountancy system as well. The WHUC contains locations outside facilities (LOFs) having small amount of nuclear material. The 36 licensees having small amount of nuclear material are also required to have local accountancy system and send their reports to the HAEA, who fulfills the international reporting obligations collectively for them.

The local accountancy systems of the facilities are based on computer databases. The European Commission provides the necessary computer programs for reporting the accountancy data of nuclear materials and declarations required by the additional protocol. In order to avoid unnecessary duplication of data provision to the central accountancy system, the HAEA accepts the format of the reports as required by the European Commission. The data reported by the LOFs is recorded into the Euratom reporting database by the HAEA.

3.3. Data provision and reporting system

For efficient operation of the national safeguards system, the entity possessing nuclear material shall provide the HAEA with preliminary data on the basic technical characteristics of its activity.

With the implementation of the Additional Protocol, Hungary agreed to the provision of more detailed and more comprehensive information about its nuclear facilities. The comprehensive data provision obligation includes all nuclear fuel cycle related activities (production, research and export-import). By ratifying the protocol Hungary accepted the new verification methods of the IAEA for the completeness and correctness of the declared information. Examples may include verification of existing site maps with satellite images, identification of new sites by GPS technology, environmental sampling and analyses, access right of the inspectors to any building on site and off site. In addition, access must be granted on short (2-24 h) notice for Additional Protocol inspections. In this way Hungary facilitates the IAEA in gaining a comprehensive picture about the state’s nuclear activities and in being able to find no indication of the diversion of declared nuclear material from peaceful nuclear activities and no indication of undeclared nuclear material or activities. Since October of 2000 Hungary has submitted 11 comprehensive declarations and 40 export reports for the international non-proliferation regime.

When the Additional Protocol came into force, Hungary was not a member of the European Union. When the Integrated Safeguards system was introduced in Hungary by the IAEA in November 2004, the 23 non-Weapon Member States of the European Union have just started the implementation of the Additional Protocol that came into force on the 30th of April in 2004. The multilateral safeguards agreement between the IAEA, the Euratom and the Member States came into force in Hungary on the 1st of July in 2007. Accordingly the State’s obligation to fulfill the Additional Protocol provisions fell into shared competence. This means that provision of information on activities involving nuclear materials falls into the competence of Euratom, while information on nuclear fuel cycle related activities not involving nuclear materials is provided to the IAEA directly by the HAEA (see figure 2). The share of tasks is also manifested in site declarations include buildings containing no nuclear materials.

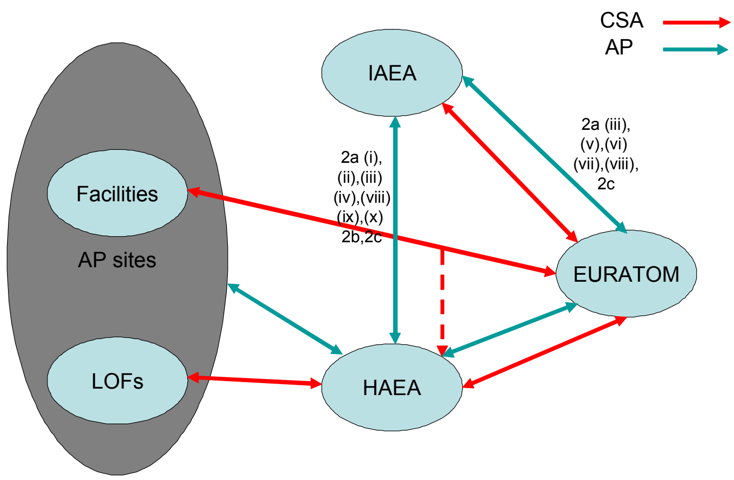


Figure 2. The flow of safeguards information. CSA – comprehensive safeguards agreement; AP – Additional Protocol; LOF – Location Outside Facility. The signs *2a (i), (ii), …, 2a(x), 2b, 2c* refer to the data provision requirements depicted in Article 2. a), b) and c) of the Additional Protocol, respectively

3.4. Challenges of international data provision

The implementation of the Additional Protocol brought up challenges in many areas.

3.4.1. Exempted materials

Before the signature of the Additional Protocol, in the period between 1972 and 1999, Hungary requested the IAEA for the exemption of small amount of nuclear materials from safeguards, the accountancy for which was only necessary to document that their total amount was below exemption level.

Even before the signature, Hungary started to prepare the declaration of the exempted materials according to the Additional Protocol. By the time of the deadline, the whereabouts of all the exempted materials could be traced and the relevant declaration submitted. After the accession to the Euratom, however, these materials had to de-exempted and included into the nuclear material accountancy system, since their amount regionally exceeded the limit specified in the safeguards agreement.

3.4.2. Information on activities prior to Safeguards Agreements of Hungary

During the inspections under the Additional Protocol, the IAEA made use of the environmental sampling possibility. Based on the analysis results of some of the environmental samples further clarification were required for nuclear activities conducted before 1972, i.e. prior to the ratification of the Safeguards Agreement between the IAEA and

Hungary. Although, there was no solid legal base of the IAEA to require information from this period, it was Hungary's vital interest to give reasonable explanation for the results.

3.4.3. Site declarations

Information provision under the Additional Protocol includes the general description of all the buildings of a declared site with map attachment. While the definition of the site boundary was fairly straightforward in the case of the Paks Nuclear Power Plant, it was more difficult in the case of sites used for research and development.

The most critical site definition was the campus of Central Research Institute for Physics (KFKI), which is still subject to consideration today. Several buildings of the site have evident relation to the application of nuclear materials and to the nuclear fuel cycle. Other buildings however are hired by companies for non nuclear activities. The annual variation in the list of renters makes the situation even more difficult.

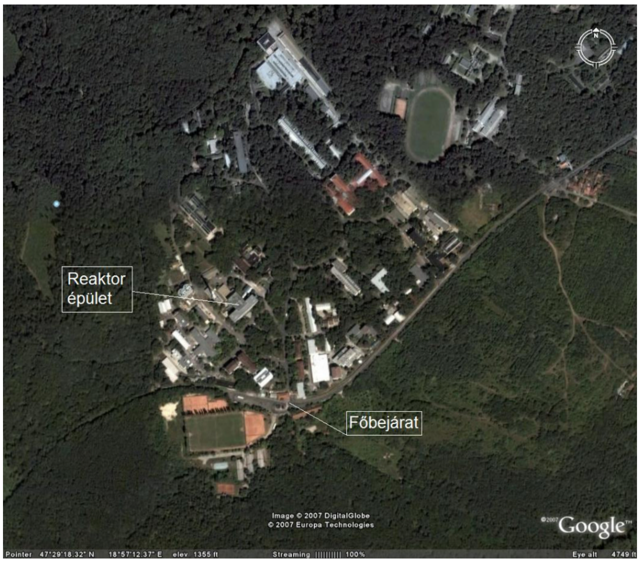


Figure 3. The KFKI campus

At the beginning Hungary provided information about all the buildings on the KFKI campus, separately listing those that are not related to the nuclear fuel cycle. By this declaration however, responsibility was taken to provide the IAEA inspectors with access to any buildings in 24 hours notice. Hungary was responsible to grant access also to any buildings in 2 hours notice in conjunction with traditional safeguards inspection carried out on the site.

After the accession of the European Union, following the best practice of other member states, the campus was declared as an "island site" and since 2009 the site declaration sent to the Euratom includes only those buildings that contain nuclear materials and/or activities related to the nuclear fuel cycle.

Similar difficulty arose in the site definition of universities having nuclear materials in separate buildings, which could however be solved much quicker.

3.4.4. Declaration of uranium mine, uranium milling facility and source materials

Based on the provisions of the Additional Provision, Hungary is obliged to provide information specifying the location, operational status, annual production capacity and actual production of uranium mines and concentration plants. Information must be provided also about source materials which have not reached the composition and purity suitable for fuel fabrication or for being isotopically enriched.

The uranium ore production was stopped in the uranium mine of the Mecsek in 1997, when the mine was closed. The produced ore and the ore concentrate were out of the scope of the traditional safeguards agreement between the IAEA and Hungary. Due to the ratification of the Additional Protocol, information had to be provided about the closed shafts and the ore concentrate produced during recultivation. This led to the interesting fact that data provision was not required for the operating mine, but it is required for the closed mine under the Additional Protocol.

4. The System of Safeguards Inspections

4.1. Inspections under the Additional Protocol

There have been 35 complementary access inspections performed in Hungary by the IAEA under the Additional Protocol since 2000, the annual distribution of which is shown in figure 4. Environmental samples were taken in 25 cases, the results of which were in agreement with the declared nuclear and nuclear fuel cycle related activities.

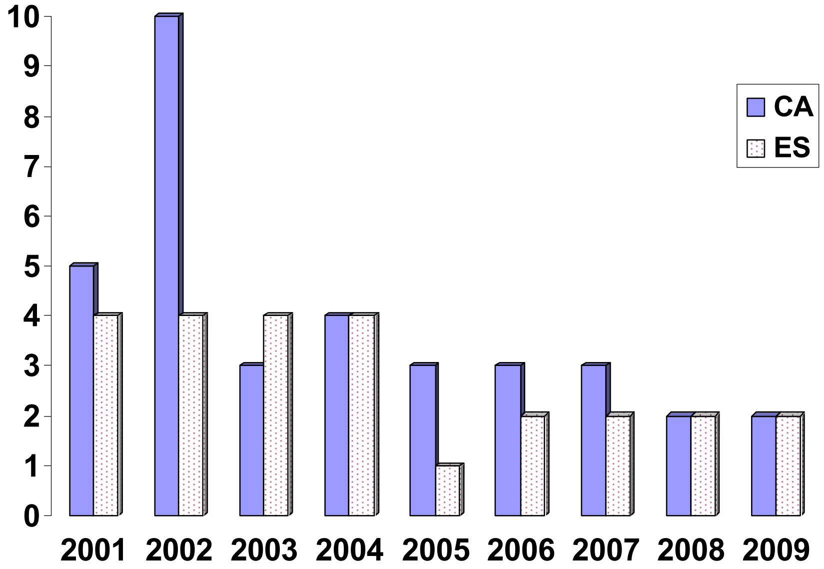


Figure 4. The annual number of complementary access inspections (CA) since 2000. (The number of environmental samples taken is also indicated (ES))

4.2. Traditional Safeguards Inspections

The trend of the annual IAEA inspections performed in accordance with the comprehensive safeguards agreements in Hungary are shown for the main material balance areas in figure 5.

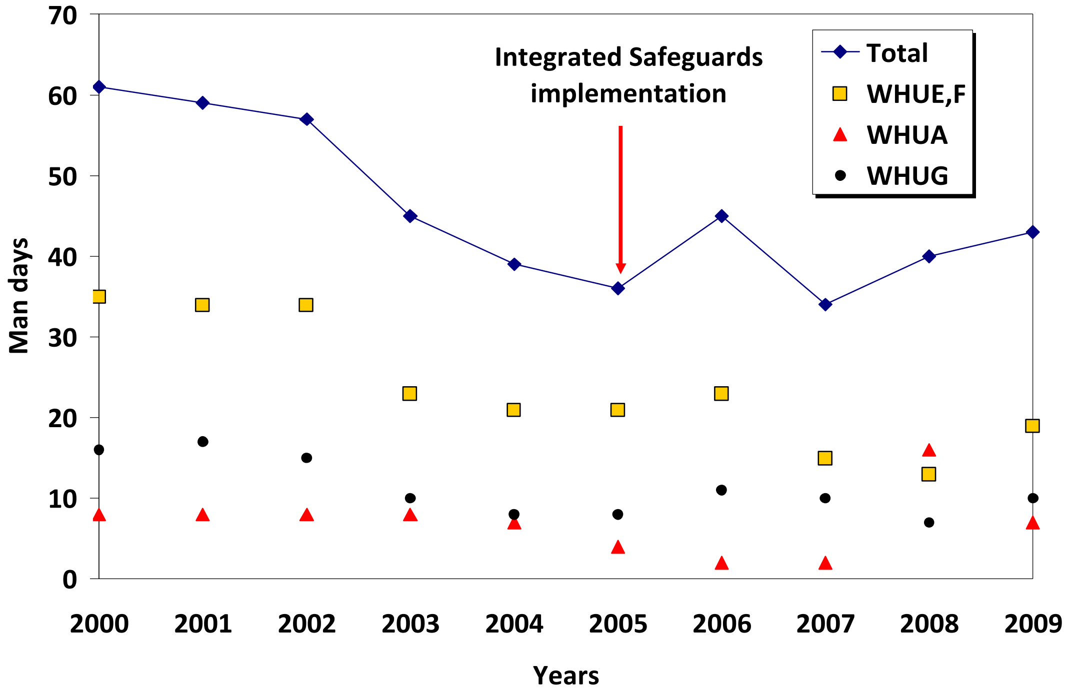


Figure 5. The annual amount of inspections under the comprehensive safeguards agreements in Hungary in the main material balance areas and in total

From the analysis of the trend of the annual inspections carried out at the Paks Nuclear Power Plant (WHUE, F), at the Budapest Research Reactor and in the Interim Spent Fuel Storage Facility, it can be seen that the man days of inspections has somewhat decreased since 2003 as compared to the level in 2000.

It can also be concluded from figure 5 that the introduction of the integrated safeguards system in Hungary did not result in the decreased amount of the international inspections. This is, however, not due to the inefficiency of the new system, but to the extra inspection activities required by the 2003 serious incident when fuel assemblies were damaged at the Paks Nuclear Power Plant, and by the repatriation of highly enriched fuel from the Budapest Research Reactor to Russia in 2008.

The relatively higher intensity of inspections in the WHUE, F and WHUG material balance areas for the 2000-2002 period is due to the increased cases of spent fuel shipments. Figure 6 clearly shows the correlation between the number of annually shipped assemblies and the inspection intensity for WHUG.

Figure 6. The annual number of international inspections and the number of fuel assemblies shipped into the WHUG

4.3. National Safeguards Inspections

The national safeguards inspections are based on containment, surveillance and monitoring measures that facilitate the international inspection system (IAEA/Euratom). The schedule of the national inspections of the HAEA is adjusted to the international inspections, part of them being performed simultaneously. In this way significant increase of the efforts of the operators can be avoided.

The national authority may trigger inspections independently of the international inspections. The aim of these inspections is to guarantee that the international obligations of Hungary under the international non-proliferation agreements, the Euratom Treaty and the related Euratom regulations are fulfilled anywhere on the site of the organizations possessing nuclear materials or subject to information provision requirements. During these activities the HAEA inspectors verify the information provided for meeting the requirements (validation).

Independent inspections are conducted by the HAEA during activities with non-proliferation relevance in which no international inspectors are involved. A typical example is the core verification after refueling of the units of Paks Nuclear Power Plant. The HAEA performed 15 national inspections in 2009, out of which 5 were at the Paks Nuclear Power Plant, 2 at the Budapest Research Reactor and 8 at licensees possessing small amount of nuclear materials (LOFs).

Independent national verifications of the information provided under the Additional Protocol are also carried out by the HAEA, especially of information falling exclusively into national competence (production, R&D, etc.) and in those areas that are covered by shared competence with the Euratom.

The HAEA has the authority to trigger on site inspection at any organization, if possessing materials or performing activities that are subject to information provision requirements are assumed. The sole aim of these inspections is the verification of the presence of those materials or activities. There has been no such verification yet, but such authorization had to be given by the HAEA to fulfill our Additional Protocol obligations.

5. Priority areas of international and national control of nuclear materials

Relying on the Hungarian technical support organizations, the HAEA actively initiates and coordinates the solution of safeguards problems. Therefore the HAEA is a member of the European Safeguards Research and Development Association (ESARDA) together with other European organizations from the field of nuclear safeguards.

The most challenging problems, different from routine inspection tasks of the HAEA during the last ten years are summarized below.

5.1. Safeguards aspects of the incident at Paks Nuclear Power Plant

On April 10, 2003, in the service shaft of Unit 2 at the Paks Nuclear Power Plant 30 fuel assemblies were damaged seriously during the ex-vessel chemical cleaning process due to cooling failure and they became untreatable with the conventional tools used in the plant. During the restoration phase of the incident (2006-2008), parts of the damaged fuel assemblies were encapsulated into new casks, which resulted in an inhomogeneous mixture of fuel material with different burn-up values.

The international and national regulations provide clear requirements for the accountancy for and control of nuclear materials that must be met by Paks Nuclear Power Plant as a nuclear facility. The most important one was the ability to account for the amount of nuclear materials with gram precision. For the determination of the nuclear material content of each cask, the development of an underwater NDA method was necessary. The technology was developed by the Institute of Isotopes of the Hungarian Academy of Sciences (IoI HAS) with close cooperation of the IAEA, the Euratom and the HAEA. Since no similar measurement case were known from the literature, the formulation of the principle of the method posed a significant task for both national and international experts.

The optimal solution was based on scanning the casks by gamma-spectrometry and neutron intensity measurement and the automatic evaluation of the great amount of data, for which a „FORK” type device was constructed (see figure 7.).

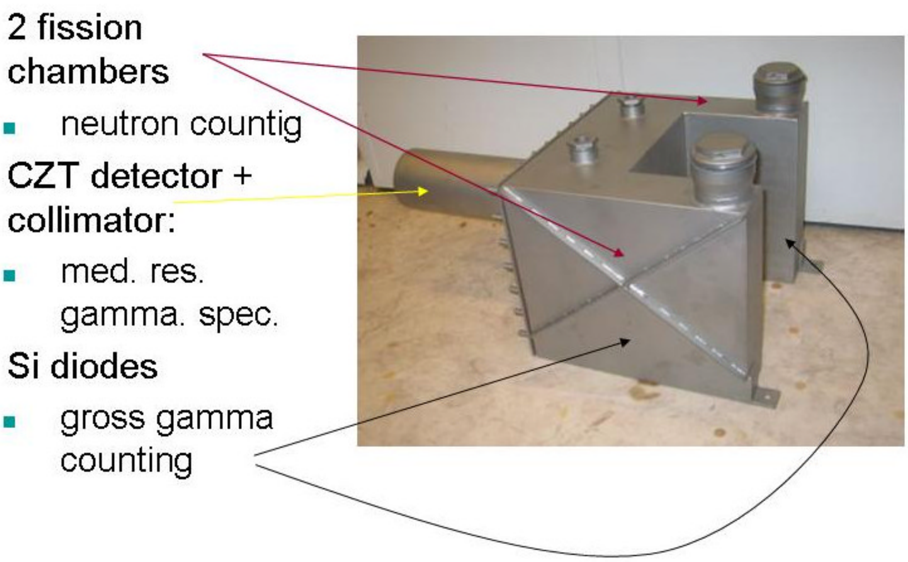


Figure 7. The FORK device

Each cask was measured in upward and downward scanning mode from three sides resulting in 47 data package for each face (neutron intensity, gamma-spectrum and gross-gamma intensity), which required the evaluation of 36 000 data packages in total. From the gamma-spectra the amount of fissile materials (^{235}U, total U and Pu) can be calculated. The amount of fuel material for a unit length of a cask could be determined from the neutron intensity and weight measurement data. Based on these results, the amount of nuclear material in each cask could be calculated with precision appropriate for the nuclear accountancy purposes.

The material balance refined with these measurements was produced for the Paks Nuclear Power Plant by the IoI HAS. The correctness of the nuclear accountancy reports of the casks was checked by the HAEA, and verified by the IAEA and the Euratom by NDA measurements of randomly selected casks.

5.2. Determination of the Pu content of Pu-Be neutron generators

The determination of the Pu content of Pu-Be neutron generators is of importance from points of view of the correct nuclear accountancy and from the nuclear forensic of this type of sealed sources. There were plenty of neutron sources of Russian origin in use in Hungary and their Pu content could only be calculated on the basis of the neutron-yield data provided by the supplier, which formed the base of their nuclear accountancy. The majority of these sources became disused and the measurements of their real Pu content were necessary before their shipment to a storage place.

To meet this request, the IoI Has, as the technical support organization of the HAEA, developed a measurement method. According to the method, the isotopic composition (atomic mass: 238, 239, 240, 241 and 242) is determined by high-resolution gamma-spectrometry (HRGS), the neutron yield is determined by gross- and neutron coincidence counting[1], which was later modified to use only neutron coincidence counting[2].

Applying this technique 76 disused, Pu-Be neutron generator kept in old container with expired license were measured. The measured sources were placed in new stainless steel containers designed and licensed for neutron sources (ISO 9001) with engraved identification number (see figure 8).


Figure 8. Containers of Pu-Be sources before (left) and after measurements (right)

Based on the results of the measurements, the original Pu content of 76 sources had to be significantly modified (from 2,050 g to 563 g). The method was offered for the IAEA under the Hungarian Safeguards Support Program and it is also applicable for nuclear forensic purposes.

5.3. Repatriation of highly enriched uranium fuel elements from the KFKI AEKI to the Russian Federation

The Budapest Research Reactor took part in the Global Threat Reduction Initiative (GTRI) Russian Research Reactor Fuel Return - RRRFR programme of the US Department of Energy, during which its highly enriched uranium spent fuel elements were repatriated in 2008, and the highly enriched uranium fresh fuel elements were transported back to Russia in 2009. The active involvement of Hungary in the programme facilitated the reduction of the risk of proliferation of nuclear weapons and contributed to the strengthening of the non-proliferation regime.

For some of the activities needed for the repatriation program the KFKI AEKI was required to hold a safeguards modification license granted by the HAEA. It was partly necessary because some of the fuel elements had to be removed from their original holder before putting them into the transport container, which resulted in the change of their identification.

[1] Laszlo Lakosi, Janos Bagi, Cong Tam Nguyen, Nuclear Instruments and Methods in Physics Research B 243 (2006) 385–391.

[2] Cong Tam Nguyen , Janos Bagi, Laszlo Lakosi, Nuclear Instruments and Methods in Physics Research B 262 (2007) 75–80.

The facility was to provide advance notification on the entire schedule of safeguards relevant activities connected to the repatriation project. Daily reports on the actual activities (mail-box approach) in course of the loading campaign were also requested by HAEA. The facility was also requested to assure free access of the HAEA inspectors to the site without advanced notification, during which the content of the daily reports and conditions of the international inspections could be verified. Compliance with information reported in advance (schedule of loading, change in activities) was sufficiently controlled by the HAEA on announced and unannounced basis to optimize its human resources.

During the repatriation, harmonization of the IAEA, the Euratom and the HAEA inspections was of primary goal in order not to disturb the work of the operators. For the optimization of the inspection effectiveness surveillance and containment safeguards measures were applied simultaneously. Each fuel element item was verified before loading to the shipping container by batch number and gamma-spectrometry. The measurement data were shared between the IAEA, the Euratom and the HAEA to make independent conclusions. For the surveillance of the loading hall, the IAEA installed a camera, shipping containers were sealed with IAEA/Euratom common seals (see figure 9.).

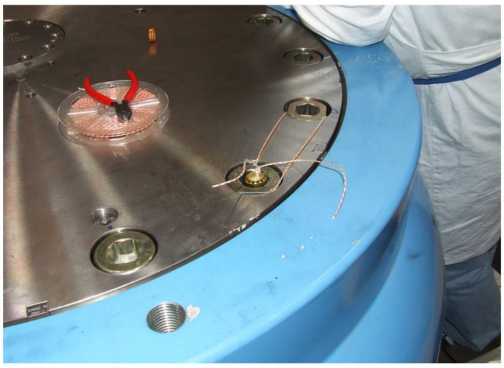



Figure 9. Surveillance of the loading hall with an IAEA camera and sealing of the containers with common seals

The Hungarian SSAC could not only satisfy its safeguards requirements as a signatory to the NPT, but could also act as a facilitator between the operators and the IAEA/Euratom inspectors creating optimal conditions for their verification activities. Satisfying safeguards requirements on three different levels could be performed with due attention to the operators' interests and to avoid duplication of efforts[3].

[3] E. Szöllösi, A. Vincze, K. Horváth: Safeguards Aspects of the Repatriation of HEU Spent Fuel from Hungary to the Russian Federation, 2009 ANS Annual Meeting

6. The Support Program to the International Atomic Energy Agency

For strengthening the safeguards system of the International Atomic Energy Agency, Hungary offers its support coordinated by the HAEA, since 1991.

Some of the tasks of the Hungarian Safeguards Support Program offered for the IAEA have a double goal. They contribute to the strengthening of the national safeguards system on one hand and support the IAEA in implementing its safeguards system on the other hand. Some of these tasks are financed by the HAEA from its budget dedicated for financing of the technical support activities (TSA). Other tasks are performed on in-kind bases by involving training sites and experts. There are numerous ongoing national R&D projects that may contribute to the safeguards implementation work of the IAEA and therefore could be offered in the support program later.

The first goal of the Hungarian support program is to contribute to the enhancement of the human resources of the IAEA. For this the HAEA with the active participation of the Hungarian facilities and experts helps to develop course materials, hosts and provides sites and gives lectures for training activities.

The training sites are provided by the KFKI Atomic Energy Research Institute and the Institute of Isotopes of the Hungarian Academy of Sciences, by the Institute of Isotopes Ltd., by the Paks Nuclear Power Plant, by the sites of the Public Limited Company for Radioactive Waste Management at Paks, Püspökszilágy and Bátaapáti, by the Institute of Nuclear Techniques of the Budapest University of Technology and Economics and by the MECSEK-ÖKO Ltd.

There were 12 trainings organized by the HAEA between 1999 and 2009. Among the typical trainings of the last years is a two-week course entitled “In-Field Training in the Framework of the Safeguards Traineeship Programme” (2000, 2002, 2004, 2006 and 2008) held for the nuclear experts from developing countries with the involvement of Hungarian experts. Due to the experience in the implementation of Additional Protocol and Integrated Safeguards of Hungary, one week courses has been organized for IAEA inspectors since 2005 for the practice of the complementary access inspections (“Additional Protocol Complementary Access Exercise”, 2005, 2006, 2007, 2008 and 2009). In addition, there were one week courses for the training of the comprehensive verification activities and integrated safeguards (“Comprehensive Inspection Exercise Training” in 1999 and „Integrated safeguards meeting in Hungary” in 2004, respectively)

The other goal of the support program is to provide facility environment for testing of newly developed or novel safeguards technologies and equipments. Under these tasks methods are developed to meet the needs of the Hungarian facilities and enhance the safeguards verification effectiveness of both the HAEA and the IAEA. In these tasks mainly the Institute of Isotopes of the Hungarian Academy of Sciences and the Institute of Nuclear Techniques of the Budapest University of Technology and Economics took part.

Several tasks were successfully finished, which were developed for the detection of the presence and the determination of the amount of nuclear materials. During the period in question the following major activities were carried out:

- Tomographic Method for Verification of Irradiated Fuel Assemblies (FIN, SWE, HUN) (1999-2003)
- Verification of WWER-440 Absorber Assemblies and Co-60 Source Holders at Paks NPP (1999)
- Verification method and equipment of Pu in Pu-Be Neutron sources by Neutron Assay (2004-2008)
- Software development for the prototype of the Tomographic Spent Fuel Detector System (2004-2009)
- Multiplicity Spectrometer Prototype to support neutron coincidence data analysis for safeguards (2007-2009)

Additionally, Hungary also offered experts to elaborate on the safeguards approaches for the final disposal of spent fuel assemblies (Joint Finnish-US-Hungarian task: „Evaluate NDA Techniques for Spent Fuel Verification and Radiation Monitoring in Open Repository and Conditioning Facility", and „Application of Safeguards to Geological Repositories" - ASTOR).

In connection with safeguards surveillance equipment and monitoring systems, test of prototypes of new equipment and of the data transmission in real facility environment were carried out in two cases. The subject of one of the tests was the digital image surveillance system („Field Test of a Digital Image Surveillance (DIS) System", 1997-1999), the other tests focused on satellite data transmission („Testing of Secure Satellite Communication for Remote Monitoring and Inspection Support", 2007-2009). For the trial tests the Paks Nuclear Power Plant and the Public Limited Company for Radioactive Waste Management provided the necessary environment.

One of the greatest events in the last two years was the official announcement in 2008 of the ICP-MS Laboratory of the Institute of Isotopes of the Hungarian Academy of Sciences of its aim to join the IAEA's Network of Analytical Laboratories. The laboratory has implemented the necessary Quality Management Requirements of the IAEA and passed the national accreditation as well. The experts of the IAEA have conducted a visit to check the available conditions of the laboratory. Presently the IAEA test samples are being processed in the laboratory and after having completed this task successfully, they will be eligible to analyze environmental samples taken by IAEA inspectors.

7. Nuclear export-import control

7.1. The Zangger-Committee

Article III, paragraph 2 of the Nuclear Non-Proliferation Treaty (hereinafter referred to as the NPT) declares the responsibilities undertaken by the parties to the NPT stating to deny export of nuclear materials and equipment into non-nuclear weapon States unless those materials and equipments are subject to the IAEA safeguards system. Parties to the NPT declare in the above mentioned article that they do not supply any source or special fissionable material, equipment or materials which has been especially designed or prepared for the processing, use or production of special fissionable material for peaceful purposes unless they are not subject to the safeguards required by this Article (IAEA safeguards).

Following the elaboration of the NPT, upon beginning of the negotiations on the Safeguard Agreements in connection to the Treaty several concrete concerns have been raised regarding the interpretation of the Article III, paragraph 2. Therefore, parties to the NPT decided to summon a meeting of professionals in Vienna in order to clarify the definitions of the Article's concepts. Parties to the NPT being potential nuclear suppliers have been invited to the meeting. Regular meetings following that of Vienna became to be known as the Zangger Committee (named by Claude Zangger, the Ambassador of Switzerland). The committee still holds its meetings redefining and modifying the definitions mentioned above according to the technical and technological development from time to time.

Hungary takes its part in the Committee's activities among the firsts from 1974. An annual report is provided for the members of the Committee on the supply of equipments and nuclear materials to the States not party to the NPT.

7.2. Nuclear Suppliers Group (NSG)

The NSG has been established in 1974 following the first nuclear explosion attempt by India, which highlighted the deficits of the current system of nuclear export control. The objective of the informal group is the development and update of Guidelines and control lists for the export of nuclear and nuclear dual use materials, products and technologies needed to the development of nuclear weapons.

Member states are bound to apply the Group's directives at every transport with peaceful purposes in order to prevent the transported product or technology to be used in a nuclear fuel cycle not under IAEA safeguards or for development of nuclear explosion devices. As a result of the discovery of Iraq's nuclear activity a significant demand arose at the beginnings of the 1990's for increasing the non-proliferation efforts and for the inclusion of the dual use products into the control list. (They are products applicable both in the nuclear and non-nuclear industry and their application can contribute to the development of nuclear weapons to a great extent). The available information is regularly analyzed by the Group while it also discusses concerns that have arisen. The 45 members are States parties to the NPT with developed nuclear industry. Hungary joined the Group in 1985. In all issues of the

NSG the annual Plenary has the highest managing and legislative power, whereas the Consultative Group operating as a workgroup submits proposals to the plenary session. Both the NSG Plenary and the NSG Consultative Group works on the basis of consensus. One of the participant countries is appointed on a rotation basis on the Plenary to hold the presidency of the following NSG Plenary. As the host, it is the president's task to organize the next session and also to chair on the Information Exchange Meetings during the Plenary. The meetings are important forums of NSG member states, where they have the opportunity to discuss issues of concern regarding the spread of nuclear weapons. Furthermore, the president represents the NSG at negotiations with third parties.

The NSG Guidelines are implemented by each Participating Government in accordance with its national laws and practices. Decisions on export applications are taken at the national level in accordance with national export licensing requirements.

The presidential tasks of NSG in the period 2009-2010 have been accomplished by Hungary. The NSG Plenary and the associated work group sessions took place in June 2009 in Budapest organized by the HAEA in co-operation with the Ministry of Foreign Affairs.

In times of increased interest towards nuclear energy, NSG is given more and more tasks and responsibility, which in turn attempts to respond to the more and more severe proliferation challenges by strengthening its rules and the renewal of its co-ordination work. The Hungarian presidency has played a significant role in this task.

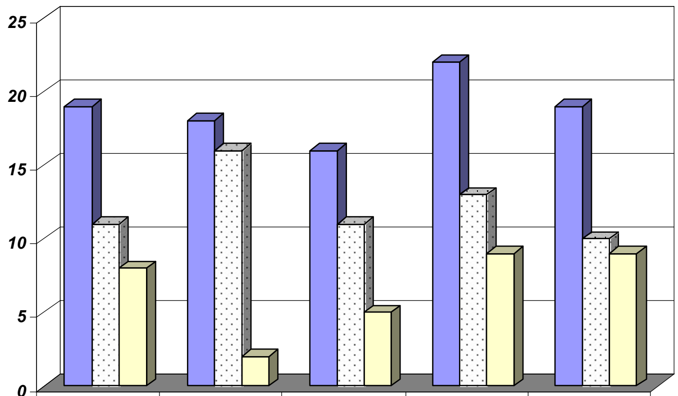
7.3. Regional/national export- import licensing

The regulation 1334/2000/EC of the Council of the European Union replaced by the council regulation 428/2009/EC (hereinafter referred to as Council Regulation) regulated the implementation of the community control system regarding the export of dual use products, their transfer, brokering service and transit. The efficient operation of the system is the precondition of the free flow of nuclear and nuclear dual use products within the Community at the same time.

The nuclear control list and the nuclear dual use control list are determined by the co-operating countries in the non-proliferation regimes. The Council Regulation includes the list of goods of all the non-proliferation regimes, which are actualized on the level of Council Regulation. Only the export of the nuclear and the nuclear dual use products is controlled by the Council Regulation, while their import regulation remains within the power of national authorities.

The Hungarian regulation is based on the Govt. decree 50/2004. (III. 23.) Korm. and the Govt. decree 263/2004. (IX. 23.) Korm. According to the above mentioned regulations, upon request of the Hungarian Trade Licensing Office within the frames of an authority procedure, the HAEA contributes to the export/import licensing by issuing authority consent in full accordance with the NSG directives.

The HAEA issues approx. 10 consents for import applications annually, involving first of all the import of fresh fuel assemblies for the nuclear power plant, smaller amount of other nuclear materials, measurement devices, equipment for the nuclear power plant and related technology, as well as intellectual products. The extent of the export applications is of similar magnitude, most of them having the subject of refueling machines for reactors, their components and related technology. The number of import/export licenses issued annually in last few years is shown in figure 10.



	2005	2006	2007	2008	2009
Total	19	18	16	22	19
Import	11	16	11	13	10
Export	8	2	5	9	9

Figure 10. Consented nuclear import/export licenses in the last 5 years

In line with the Additional Protocol, the IAEA is officially informed about the accomplishment of the exports based on the information on the date of export provided by the licensee. For nuclear products, whose import is subject to state assurance required by the supplying country, the necessary commitment will be issued by the HAEA and the imported products will also be physically controlled for their entire life cycle by the HAEA.

8. Activities related to the Comprehensive Nuclear Test Ban Treaty (CTBT)

It is within the HAEA's responsibility to be the national point of contact to the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). The Department of Nuclear and Radioactive Materials of the HAEA organizes and coordinates the participation of Hungarian institutions in the programs aimed to establish the operability of the verification regime of the CTBT provided by the Preparatory Commission. An important objective of the HAEA is to provide help for the Hungarian institutions in making use of the experience accumulated at the Preparatory Commission as effectively as possible.

The CTBT maintains a global verification regime made up by the International Monitoring System, IMS, the International Data Center, the Global Communication Infrastructure, GCI, Consultation and clarification, optional initiation and accomplishment of On-Site Inspection (OSI) and confidence-building measures.

Access to IMS data and IDC products is provided by way of secure user access for the National Data Center supervised by the HAEA. In addition to the HAEA being the primary user, other institutions such as the Eötvös Lorand Geophysical Institute of Hungary (ELGI), the NBC Information Center of the Hungarian Defense Forces and the Hungarian Meteorological Service were also given general access rights in 2008. These organizations provide technical support for the HAEA in the interpretation of the data if needed. Guidance on the operation of the National Data Centre and the interpretation of the data was developed by the HAEA in 2010, which can be downloaded from its web site.

The national organizations mentioned above support the work of the Preparatory Commission and the establishment of the On-Site Inspection of the verification regime. The NBC Information Center of the Hungarian Defense Forces and the ELGI provide professional lectures on the training courses organized by the Preparatory Commission and offer experts in reconnaissance and liquidation to be sent to potential future On-Sight Inspections in order to support the work of the Preparatory Commission.

The CTBTO can efficiently make use of the experiences of the experts of the ELGI in the establishment and development of the verification regime. In 2007 seismological devices were offered and ELGI also provided its devices and professionals for the preparation course and for the Integrated Field Exercise in Kazakhstan (IFE08) in 2008. The field exercise was organized in September 2008 in Semipalatinsk, on a former Soviet nuclear test area with the participation of three ELGI employees. The ELGI experts also took part in several additional methodological and on-site inspection trainings during 2009 and participated in scientific conference organized by the CTBTO.

There was an introductory course organized by the Preparatory Commission for the on-sight inspectors on 21 October 2007 in Szolnok-Táborfalva, in its successful preparation and conduction the HAEA and the Hungarian Defense Forces took a significant part. Due to this successful co-operation, the next training cycle for surrogate inspectors was held in Hungary again from 28 June to 9 July 2010, in the Bakony Combat Training Center, Várpalota.

Figure 11. Participants of the training 28 June - 9 July 2010 in Várpalota

9. Prevention of Illicit Trafficking

In the past fifteen years there has been an increased emphasis put by the international organizations on the prevention and detection of illegal trafficking of nuclear and other radioactive materials and the compliance of related regulations. It is the state's responsibility to prevent, detect and respond to any illegal activities in connection with nuclear and other radioactive materials. In Hungary the HAEA is responsible for the coordination and implementation of actions domestically in all cases related to the prevention of illicit trafficking of nuclear and other radioactive materials, and for keeping contact with international organizations.

In accordance with the recommendation of the IAEA (IAEA-TECDOC-1311, -1312, -1313) the domestic system is based on three pillars of prevention, detection and response.

9.1. Prevention

The elements of the prevention are: (i) establishment of proper legal environment, (ii) accountancy of nuclear and other radioactive materials, (iii) prevention of nuclear and other radioactive materials to go out of regulatory control. The most important prevention related national measures are the maintenance of the national registry of the nuclear and other radioactive materials, the export/import control, the regulation of transport and packaging, the regulation of physical protection as well as the licensing of activities in relation to nuclear and other radioactive materials (packaging, transport of nuclear and radioactive materials, possession of nuclear materials, safeguards licensing procedures, export/import control of nuclear and nuclear dual use goods).

9.2. Detection

Boarder control by using radiation detection devices is an efficient way to detect illegal transports, since this is the most liable place for orphan radiation sources and lost or intended to be smuggled sources to appear. Currently there are 26 radiation portal monitors positioned on the borderlines of the countries that have not joined the Schengen Agreement since 2008 (see figure 12.) The border controls ceased on the borders with Austria, Slovakia and Slovenia, whereas with Romania being an EU - member state there are currently simplified border formalities in force. On the Romania borderline there are 13 radiation portal monitors still deployed.

Figure 12. Location of the radiation portal monitors operated by the Hungarian Customs and Finance Guard in 2009

In addition to the border crossing points there are radiation gates installed at scrap metal dealers and processing companies as well as at foundries.

The temporal distribution of events detected in Hungary is shown in figure 13.

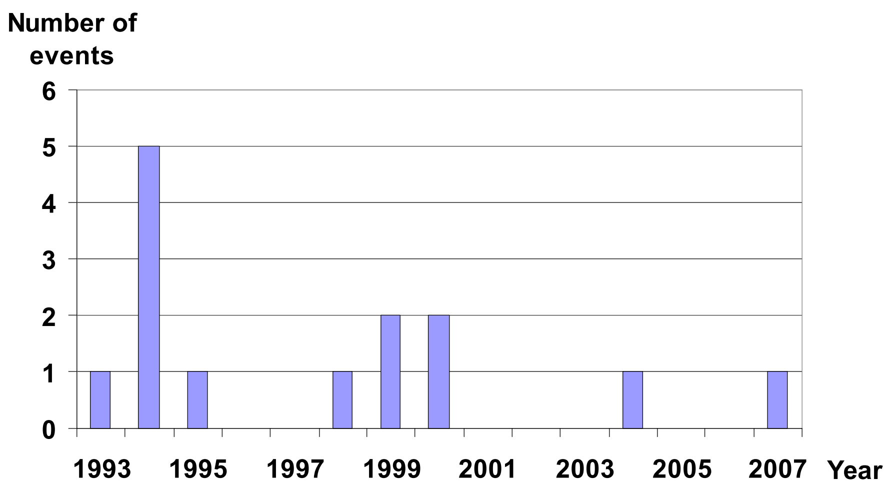


Figure 13. Number of illicit trafficking events detected in Hungary so far

9.3. Response

In Hungary a government decree (Govt. decree 17/1996. (I. 31.) Korm.) on measures related to found or seized radioactive or nuclear materials regulates transport, storage and handling of confiscated radioactive or nuclear materials as well as materials contaminated with them. The domestic tactical response plan takes into account the recommendations of the IAEA TECDOC-1313.

The Department of Nuclear and Radioactive Materials of the HAEA organized a comprehensive exercise in 2008 on the premises of the KFKI campus in Csillebérc, where confiscation of nuclear and radioactive materials was simulated. The objective of the exercise was to practice response measures in connection with found or seized nuclear or radioactive materials, the training of cooperation between the authorities and the organizations taking action following the detection of the smuggled nuclear material, furthermore, the control of the preparedness of the technical services[4].

Figure 14. The situation assessment phase of the comprehensive exercise in 2008

The press demonstration organized during the exercise allowed the representatives of the media to gain insight into the measures related to the detection or confiscation of potentially hazardous nuclear and radioactive materials and the hazard mitigation procedures. Following the exercise a summary report was compiled based on the evaluations of the participating organizations and the remarks of the international observers. On the basis of these the cooperation of the participants will further be improved regarding the measures following the detection of the smuggled nuclear material.

9.4. International Relations

Hungary has joined the „Illicit Trafficking Database" operated by the IAEA for the registration of events of illicit trafficking of nuclear and other radioactive materials. The Hungarian contact point of this information system is the HAEA.

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[4] Á. Vincze, G. Rácz and K. Horváth: „Detection and Response to Malicious Use of Nuclear and other Radioactive Materials: Illicit Trafficking Exercise in Hungary", NATO Advanced Research Workshop (ARW), "Threat Detection, Response and Consequence Management associated with Nuclear and Radiological Terrorism" November 17–20, 2008, Brussels

The international organization called International Technical Working Group for Combating Illicit Trafficking of Nuclear Material (ITWG) was established in 1996 with participating organizations with nuclear forensic analysis interests (e.g. laboratories and authorities). Among the objectives of the ITWG there is the development of recommendations regarding radioactive and inactive sample-taking and methods applicable in nuclear forensic analysis as well as the organization of intercomparison measurement exercises. Besides, one of its most valuable functions is the exchange of experiences among nuclear forensic laboratories. The ITWG Nuclear Forensics Laboratories (INFL) established within the framework of the ITWG is the international forum of laboratories operating in the field of nuclear forensic analysis. The aim of the INFL is the development of nuclear forensic analysis in order to be able to fulfill the demands of the relevant authorities. Employees of the HAEA and the IoI HAS take active part in the activities of both the ITWG and the INFL by regularly attending the meetings of both organizations while also being represented in their governing bodies.

10. Relevant regulations

- Act CXVI of 1996 on Atomic Energy
- Govt. decree 114/2003. (VII. 29.) Korm. on the scope of activities, authority and penalizing rights of the Hungarian Atomic Energy Authority, and on the activities of the Nuclear Energy Coordination Council
- Act LXXXII of 2006 on the ratification of the Agreement between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear weapons and Additional Protocol.
- Govt. decree 263/2004. (IX. 23.) Korm. on the international transport of nuclear and nuclear dual use goods.
- Council Regulation (EC) No 428/2009 of 5 May 2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items (Recast)
- Treaty establishing the European Atomic Energy Community (Euratom), done at Rome 25th day of March in the year 1957.
- COMMISSION REGULATION (Euratom) No 302/2005 of 8 February 2005 on the application of Euratom safeguards.
- Decree of the Minister of Justice and Law Enforcement 7/2007. (III. 6.) IRM on the rules of accountancy for and control of nuclear material.
- Act L of 1999 on the ratification and promulgation by the Republic of Hungary of the Comprehensive Nuclear Test-Ban Treaty adopted on 10 September, 1996 by the General Assembly of the United Nations.