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Abstract

Member State Support Programs (MSSPs) have assisted the IAEA Department of Safeguards by developing new safeguards technologies and techniques for the IAEA's use. This support enables the IAEA to keep pace with an expanding portfolio that includes an increased number and variety of facilities and quantity of nuclear materials under safeguards. The U.S. Support Program to IAEA Safeguards (USSP) has provided technical assistance to the IAEA Department of Safeguards since 1977. To meet the demands placed on the IAEA, the USSP directs its resources to the needs and challenges identified by the IAEA. For example, in the mid-1990s, the USSP assisted the IAEA with the exploration of new technical safeguards measures identified by the Secretariat in its Programme 93+2. The USSP focused on environmental sampling, remote monitoring, and open source information collection and analysis for safeguards applications and the enhancement of training for IAEA inspectors. As the IAEA's experience with these new safeguards measures matured and they were implemented for safeguards purposes, the USSP worked with the IAEA and other MSSPs to determine how the traditional and new measures could be appropriately combined to ensure that safeguards remain effective and efficient. More recently, USSP projects have focused on the development of safeguards instrumentation, the collection and analysis of various forms of open source information, and the improvement of infrastructure. This paper will summarize a variety of USSP activities in support of the Department of Safeguards over the last 20 years.

Introduction

The U.S. Support Program to IAEA Safeguards (USSP) was established in January 1977, and January 2013 marked its thirty-sixth anniversary. The program was established as a source of extrabudgetary funding to respond to identified, urgent needs of the IAEA Department of Safeguards more quickly than could be met through the IAEA's regular budget. Although it was originally intended as a short-term program, the USSP has continued due to its success in transferring technology to the IAEA and providing the IAEA with access to technical expertise from the U.S. national laboratories and commercial equipment suppliers. Since 1977, the USSP has contributed funding in excess of $300 million, has funded over 1,200 tasks, and has completed over 1,100 tasks. The tasks are generally categorized as nondestructive and destructive analysis (NDA and DA), procedures and training, system studies, information technology, containment and surveillance, and management support.

The interagency Subgroup on Safeguards Technical Support (SSTS) is responsible for the activities of the USSP. The SSTS includes members from the U.S. Department of State, the U.S. Department of Energy, the U.S. Nuclear Regulatory Commission, and the U.S. Department of Defense. The SSTS delegates the day-to-day technical and administrative management of the program to the International Safeguards Project Office (ISPO) at Brookhaven National Laboratory (BNL).

Traditional IAEA Safeguards involve the application of nuclear material accountancy, containment, and surveillance techniques to confirm the nondiversion of nuclear material. The USSP's support from 1977 to the early 1990s helped the IAEA obtain the necessary tools and strengthen its capabilities to perform these activities. In 1993, with the advent of the IAEA's Programme 93+2,[i,ii] the USSP's assistance to the IAEA changed somewhat to focus on specific IAEA programs and initiatives. This paper will address the highlights of support provided by the USSP between 1993 and 2013.

Programme 93+2 and Strengthened Safeguards – 1993 through 2000

As a result of the revelations of Iraq's clandestine nuclear program in 1991, the IAEA and its member states recognized the need for the IAEA to confirm the absence of undeclared activities and facilities in addition to carrying out traditional safeguards activities to confirm the nondiversion of declared nuclear material from declared facilities. Shortly thereafter, the IAEA embarked on Programme 93+2, which reviewed the IAEA's existing safeguards measures, identified new measures that could be used to strengthen safeguards and increase their efficiency, and planned for the implementation of the new measures that were deemed practicable. Programme 93+2 began in 1993 and concluded in about 1998 with the approval by the Board of Governors of the Additional Protocol. "Strengthened safeguards" was the term used for the combination of traditional safeguards measures with the new Programme 93+2 measures.

The USSP assisted the IAEA with the investigation and implementation of the new measures defined by Programme 93+2. In particular, the USSP assisted with remote monitoring, environmental sampling, open source information collection and analysis, and enhanced training.

Remote monitoring in support of safeguards implementation started within the IAEA in the late 1990s following a successful field trial that was conducted by a team of staff members from the Department of Safeguards with the assistance of Switzerland, which provided a reactor facility as a test-bed.[iii] Eventually, the IAEA investigated the use of telephone, Internet, frame relays, virtual private networks, and satellite for transmission of data. To assist the IAEA in its effort to identify the right combination of technologies, the USSP sponsored the Workshop on International Data Communications in October 1999.[iv] The USSP also assisted with three formal field trials of remote monitoring. The first, performed by Lockheed Martin Energy Systems, was intended to demonstrate the use of low-cost global satellite equipment to transmit data from the Y-12 Plant in Oak Ridge, Tennessee, USA, to IAEA Headquarters in Vienna, but this task was eventually accomplished through telephone transmission. From the field trial, the IAEA learned to simplify and adapt technologies for safeguards purposes. The second field trial was a similar exercise using telephone communication between the Republic of South Africa and IAEA Headquarters.[v] In 1997, the USSP sponsored a cost free expert (CFE) to assist the IAEA in establishing its program. Two more CFEs joined the IAEA's remote monitoring program in 2002. The USSP provided funding for the renovation of an area of the Vienna International Centre that was dedicated to equipment testing and was known for a time as the Remote Monitoring Test Facility.[vi] As a result of the efforts of the USSP, other MSSPs, and the IAEA's Remote Monitoring Team, the Department of Safeguards currently transmits 3.5 Gigabytes of data from 263 systems composed of 583 cameras and 150 electronic seals.[vii]

Similar assistance was provided to help the IAEA establish the open source collection and analysis program. During Programme 93+2, the USSP provided access to information analysis tools such as WATSON and PATHFINDER. WATSON was supported by Lawrence Livermore National Laboratory, and PATHFINDER was supported by Pacific Northwest and Los Alamos National Laboratories. In both cases, USSP contractors placed the software on Agency computers, customized the software as necessary, and evaluated the software based on the IAEA's needs. Although these tools were not adopted, the IAEA conducted field trials and learned about the technology. USSP consultant Carlton Thorne worked with experts from other member states to assist the IAEA with early analysis projects and with the adoption of information collection techniques. Following these efforts, the USSP and other member states provided open source experts who advised the IAEA on tools and techniques that could be adapted for the IAEA's program. Around 2000, the USSP began to work with the Monterey Institute for International Studies to provide interns for open source information collection. Interns have formed the foundation of the IAEA's open source information program by assisting with the collection of information. The USSP also helped the IAEA to evaluate the usefulness of numerous sources of open source information. The use of satellite imagery for safeguards purposes was also introduced during this period, and the USSP provided a CFE with expertise in satellite imagery analysis to help the IAEA develop its program.[viii]

The IAEA's investigation of environmental sampling began with a series of field trials conducted with the assistance of MSSPs in the early 1990s. The USSP's early contribution involved providing experts to participate in the field trials and providing training in the collection of environmental samples. The United States provided funding for the IAEA's Clean Laboratory at Seibersdorf, Austria, which was built between 1994 and 1997. Richard Perrin, a USSP CFE with expertise in analytical chemistry, served as the project manager for the clean laboratory construction. He oversaw the planning, design, and construction and advised the IAEA on necessary procedures and reference materials. USSP CFEs assisted the IAEA with the development of the Environmental Sample Database, which is used to store information regarding environmental samples, and with the early analysis of environmental samples. The USSP provided technical assistance on requirements for quality assurance for environmental sample handling, analysis, and archiving, and together with other MSSPs, support the IAEA in evaluating Wide Area Environmental Monitoring techniques and technology for broader IAEA applications. Since the mid-1990s, the USSP periodically provided references materials to the IAEA through the U.S. national laboratories.[ix]

Throughout its history, the USSP has provided support to the IAEA for the establishment of training programs and specific training for IAEA inspectors in subjects related to traditional safeguards activities such as nuclear material measurement, enrichment, and containment and surveillance. Because the focus on safeguards inspections would expand to include verifying the absence of undeclared activities as part of Programme 93+2, the IAEA reviewed its Safeguards Training Programme to ensure that it would meet the needs of the future. Recognizing that inspectors would have to be more observant of their surroundings, the IAEA and Pacific Northwest Laboratory developed a new course called Basic Visual Observational Skills Training.[x] This course introduced and helped inspectors to understand the change in their role brought about by Programme 93+2 and to develop some of the skills needed to be successful in the new safeguards regime. The USSP also helped the IAEA explore computer-based training (CBT) as a new delivery mechanism. In 1996,

Aquila Technologies completed a CBT course on operation and maintenance of the MIVS surveillance system.[xi,xii]

By contributing to the development of new capabilities in remote monitoring, open source information, environmental sampling, and training, the USSP helped the IAEA change from an inspection regime that was focused on accountancy to one where inspectors can be more inquisitive.

Integrated Safeguards – 2000 through 2008

The adoption of the Programme 93+2 measures was accompanied by member state concerns about associated increases to the IAEA's regular budget and the additional burdens the nonnuclear weapons states would assume due to additional activities conducted on their soil. Many member states called for a safeguards regime in which the conduct of safeguards was customized to the state, its nuclear activities, and its record of Nonproliferation Treaty compliance. "Integrated safeguards" refers to the combination of safeguards measures applied such that the burden to the member state is not increased as compared to what the state was subject to under traditional safeguards.

Since the USSP is a technically oriented program, and the decisions involved in determining the appropriate application of safeguards measures are in large part policy driven, the USSP's direct contributions to integrated safeguards were limited. However, the contributions of the USSP and other MSSPs positively impacted the effectiveness and efficiency of safeguards under integrated safeguards. For example, remote monitoring of surveillance, containment, and unattended radiation measurements enabled the Department of Safeguards to establish a virtual presence in some types of facilities and thereby reduce inspection frequency and make random interim inspections and short notice random inspections possible. Contributions to the development of open source collection and analysis, satellite imagery, and environmental sample analysis capabilities further enabled the IAEA to execute its new authority under additional protocols, such as complementary access.[xiii]

The USSP's support to the IAEA during this time is marked by innovative and complex programs. The USSP started its intern and Junior Professional Officer (JPO) programs, assisted the IAEA with the application of safeguards at the Chernobyl Nuclear Power Plant (ChNPP) and the Rokkasho Reprocessing Plant (RRP), and supported large, technical projects such as the Next Generation Surveillance System (NGSS) and the IAEA Safeguards Information System Re-engineering Project (IRP).

One of ISPO's long standing roles is recruiting U.S. citizens for regular and extrabudgetary staff positions in the IAEA Department of Safeguards. ISPO attends trade shows and career fairs and speaks to students at colleges and universities with nuclear engineering and related programs to promote the IAEA as an employer and career advancement opportunity. In the early 2000s, ISPO experienced difficulty in speaking to students about career opportunities at the IAEA because there were very few entry-level positions, as the most widely available positions required six to fifteen years' experience.[xiv] To address this gap, in 2002, the USSP funded six internship positions in the Division of Information Management. The interns were intended to work with and support regular staff members and perform basic, yet essential work, thereby freeing the more senior employees to perform more complex tasks. The internship program was successful, and in 2006, after the placement of 40 interns, the program was replaced by the U.S. JPO program, which gave the

recruits the status and benefits of IAEA staff members. Many of the interns and JPOs have been selected for regular staff positions and short term assignments at the IAEA. As shown in Figures 1 and 2, the internship and JPO programs were successful in training a new generation of safeguards professionals to become qualified for positions in the IAEA Department of Safeguards and elsewhere.[xv]

Figure 1: Post Internship Positions

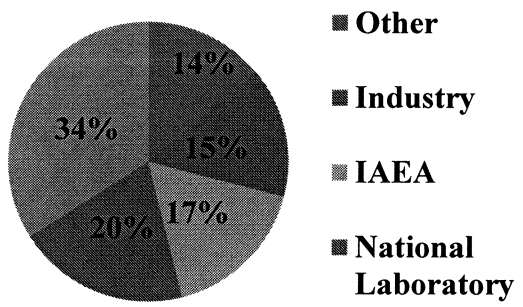
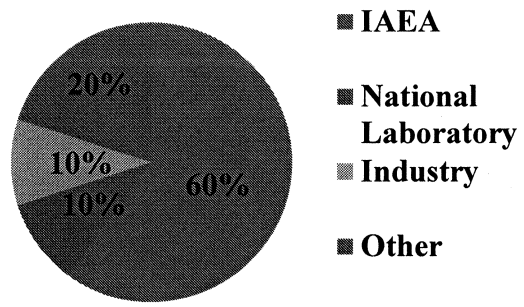


Figure 2: Post JPO Positions



In the early 2000s, the USSP undertook an ambitious project to develop monitoring systems for the ChNPP railcar transport system, conditioning plant, and dry storage facility. A system was developed and installed on the railcar to monitor the transport of spent fuel from wet storage to the conditioning facility. A system for the conditioning facility was developed and tested by the IAEA, but due to delays in the construction of the conditioning facility, the system was not implemented. Work on the dry storage monitoring system was postponed until the conditioning facility construction resumed.

The USSP has supported the IAEA's JNFL (Japan Nuclear Fuel Limited) Project for the implementation of safeguards at RRP since the 1990s, but support intensified in the late 1990s and early 2000s when the schedule for operation of RRP became definite. The USSP sponsored many tasks that contributed to the development of software and hardware systems for the facility. The USSP sponsored three CFEs, two interns, and one JPO that assisted the IAEA team assigned to the project.[xvi] The Japanese conducted active testing of the facility in 2006[xvii] and at that time, IAEA monitoring systems were in place.

The USSP assisted the IAEA in the development of the NGSS to replace the DCM-14-based family of surveillance and remote monitoring systems. The NGSS project began in 2003 with an international workshop in New York City where experts critically reviewed the IAEA's working paper that outlined the IAEA's requirements for the new system.[xviii] Following this workshop, the USSP teamed with the German Support Program to fund the work of Canberra and Dr. Neumann Consultants in the development of the NGSS. The NGSS was field tested by the IAEA and was approved for safeguards use on March 21, 2013. To date, the IAEA has installed 70 cameras and is deploying them at a rate of 15-20 per month.[xix]

The USSP's contribution to IRP began in 2003 when the project was discussed during a meeting at Brookhaven National Laboratory. The project's three phases are IRP Solution Design, IRP Foundation Projects, and IRP Implementation Projects. "Phases one and two include the design, installation, and configuration of the new IT infrastructure; and phase three focuses on the development of specific applications needed by the users in their various roles."[xx] The USSP's involvement in Phases I and II strictly involved cash donations. The USSP's assistance during Phase III is discussed in the following section.

Contemporary Safeguards – 2008 through present

In 1977, the Program of Technical Assistance to IAEA Safeguards (POTAS) was the sole vehicle for funding projects under the USSP. Presently, there are several funding mechanisms. In 2008, the Department of Energy's National Nuclear Security Administration established the Next Generation Safeguards Initiative (NGSI) to "develop the policies, concepts, technologies, expertise, and international safeguards infrastructure necessary to strengthen and sustain the international safeguards system as it evolves to meet these new challenges."[xxi] The program includes Human Capital Development, Policy Development and Outreach, Concepts and Approaches, Technology Development, and International Nuclear Safeguards Engagement subprograms.[xxii] NGSI complements the USSP by ensuring that there will be U.S. resources to support the IAEA in the future and to continue the development of concepts and equipment that have been a hallmark of the USSP over its history. Under the U.S. Voluntary Contribution, the U.S. Department of State provides funding for High Priority Safeguards and Other Programs (HPSOP), environmental sample analysis, and the procurement of commercially available safeguards equipment. Each of these programs is administered independently by the responsible agency, but the Subgroup on Safeguards Technical Support (SSTS), through its members, is aware of the programs and how they can be used to improve international safeguards.

The USSP activities since 2008 are characterized by additional high value, complex projects, and the return to more traditional support activities such as human resources, equipment development, training, and human resource support. One such example is the development of the Universal NDA Data Acquisition Platform (UNAP). The UNAP concept was developed to assist the IAEA in reducing the number of individual NDA systems and to replace systems that are no longer commercially available or supportable. The UNAP development team is composed of Canberra, Los Alamos National Laboratory, Pelowitz LLC, and Foiani LLC. UNAP is in the final stages of development; prototypes were delivered to the IAEA in spring 2013 for testing, and software development is scheduled to be complete in July 2013.

The USSP's support of the IRP continued during this period. Although the IRP project was originally envisioned to be a four-year program, issues related to financing, project management, and scope have extended the project. The IAEA successfully completed Phases I and II, but software development challenges in Phase III led the IAEA to terminate the development contracts. In 2011, the USSP offered information technology consultants to assist the IAEA in developing a plan for completing the project. To date, the USSP has contributed over $12 million to the IRP Project.

A major project sponsored by the USSP over the past five years is the Enhancing Capabilities of Safeguards Analytical Services Project (ECAS), which has involved the expansion of the IAEA's Clean Laboratory and the construction of the new Nuclear Materials Laboratory (NML) to provide a more functional, safe, and secure analytical infrastructure for the long term. The USSP provides the services of a senior project manager, a construction manager, and a fundraiser for this project. In addition to manpower, through HPSOP, the USSP has contributed €19.11 million of the total €80.82 million needed for the project.[xxiii] The Clean Laboratory expansion, completed on schedule and under budget in June 2011, accommodates the Large Geometry Secondary Ion Mass Spectrometer donated by Japan and now also houses a multi-collector, inductively-couples plasma mass spectrometer.[xxiv] The new NML is the replacement for the aging Safeguards Analytical Laboratory (SAL) and involves the planning, design, and construction of a new building on land provided by the government of Austria to the IAEA on the site of the Austrian Institute of Technology (AIT). The scope of the project also includes an update of the security operations for the entire Seibersdorf site, significant modifications to the site's infrastructure and services to include power, water and waste water, and radioactive material handling and storage. A new main entrance to the Agency's laboratories at Seibersdorf will be created, including a new main gate for site access and security including a redesigned traffic and parking plan. The construction of the NML was substantially completed on schedule and on budget, and transition began on June 12, 2013. All substantial work under the ECAS program is scheduled to be complete by December 2014, when all SAL operations will be occupying the NML.

During this period, ISPO and the SSTS emphasized human resources and training, as requested by the IAEA, as a means to improve IAEA Safeguards. From 2008 to present, 37 individual CFEs and 22 JPOs were funded. Because the United States is one of very few member states with the inclination and resources to fund CFEs, the SSTS considered it necessary to provide experts to assist with high priority projects for which the IAEA does not have the expertise or the financial resources. The SSTS considers JPO assignments to be excellent "investments" in that the assignments provide experience and training for individuals who will hopefully work in the international safeguards community for many years following their JPO assignments. As shown in Figure 2, this investment has been successful in terms of preparing well-qualified staff for regular staff or short-term assignments with the IAEA. As a result of this approach and increased costs for CFEs and JPOs, a significant portion of the USSP's resources, nearly 40 per cent, was directed to the support of CFEs and JPOs in recent years. In 2012, because of anticipated budgetary reductions, the SSTS made the difficult decision to begin reducing the number of CFEs and limiting the number of JPOs supported by the USSP.

The USSP and NGSI have teamed up to conduct two workshops aimed at improving the United States' recruitment of U.S. citizens for positions in the IAEA Department of Safeguards. In 2008, the Workshop on Enhanced Recruiting for International Safeguards was held at Brookhaven National Laboratory to discuss the obstacles to recruiting for IAEA positions and to establish a plan for addressing them.[xxv] In 2011, based on a recommendation from the 2008 workshop, BNL and Argonne National Laboratory collaborated to conduct the Workshop for Americans in International Organizations in Vienna (AIOV) to "improve dissemination of information to U.S. citizens preparing to arrive, live and work at [international organizations] in Vienna, as well as to U.S. citizens stationed there, with an emphasis on the IAEA Department of Safeguards." The workshop served as an opportunity for U.S. citizens to meet one another, share experiences, and provide

feedback to U.S. government stakeholders.[xxvi] As a result of this workshop the AIOV Club was established at the Vienna International Centre.

The USSP spends an estimated $2 million on safeguards training annually. Table 1 lists the training courses currently provided through the USSP to the IAEA Department of Safeguards. The USSP's training portfolio reflects traditional topics such as NDA for new inspectors and enrichment as well as new courses that were developed as a result of Programme 93+2 and expanded requirements of IAEA safeguards.

Conclusion

The contributions of the USSP have been critical for the IAEA to carry out successfully its safeguards mission and to aid in the evolution of that mission to ensure the effectiveness and efficiency of IAEA safeguards. In the last 20 years, the support provided by the USSP has been influenced by the changes to safeguards that were initiated through Programme 93+2. In addition, the USSP's work has been characterized by contributions to complex projects and innovation.

The United States will continue to work diligently to provide the IAEA with support in the field of international safeguards in order to satisfy the Agency's current and future needs.

Table 1: USSP Sponsored Training Courses[xxvii]

Course	**Delivered by**
Traditional Safeguards Topics	
Nondestructive Assay	Los Alamos National Laboratory
Advanced Plutonium Verification Techniques	Los Alamos National Laboratory
Enrichment	Oak Ridge National Laboratory
Observational Skills	Sonalysts with Human Performance Associates (HPA) until 2010; since 2011, BNL with Sonalysts and HPA[xxviii]
Strengthened and Integrated Safeguards Topics	
Pyroprocessing	Idaho National Laboratory
Complementary Access	Brookhaven National Laboratory
Communication Skills	Sonalysts with Human Performance Associates until 2010; since 2011, BNL with Sonalysts and HPA
Research Reactor Design Information Verification	BNL in collaboration with the Belgian Support Program
Export Controls	Argonne National Laboratory

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[iv] Woodhead, Avril, D., "Proceedings from the Workshop on International Data Communications," ISPO-423, January 18, 2000.

[v] "Digest of Completed Tasks," International Safeguards Project Office (ISPO).

[vi] S. Pepper, "U.S. Support Program Contributions to Remote Monitoring," poster presented at the 22nd ESARDA Annual Meeting and Seminar on "Strengthening Safeguards: Integrating the New and the Old," Dresden, Germany, BNL-67434, May 2000.

[vii] STR-371, "Development and Implementation Support for Nuclear Verification – 2012-2013," IAEA, 2012.

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[ix] Ibid.

[x] Toquam, J.L., F.A. Morris, J.R. Griggs, R. Badalamente, "Final Report: Basic Visual Observation Skills Training Course," PNL-SA-26411, UC-515, ISPO-378, June 1995

[xi] "Digest of Completed Tasks," ISPO.

[xii] MIVS refers to the Modular Integrated Video Surveillance system that was in use by the IAEA Department of Safeguards during the 1990s.

[xiii] Hoffheins, B., N. Miyaji, T. Asano, T. Nagatani, K. Ishiyama, T. Kimura, Y. Kodani, "the Impact of Advanced Technologies on the Efficiencies of Safeguards and Facility Operations," presented at the 52nd INMM Annual Meeting, Palm Desert, CA, July 2011.

[xiv] Up until the early 2000s, a P3 position required six years' experience, and P4 position required ten years experience and a P5 position required 15 years experience. The IAEA has since reduced the experience requirements to 5, 7, and 10 years respectively.

[xv] Pepper, SE, J. Cruz, J. Patterson, "Evaluation of the United States Support Program's Internship and Junior Professional Officer Programs," poster presented at the 2012 INMM Annual Meeting, July 2012, Orlando, FL.

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