Proceedings of the INMM & ESARDA Joint Virtual Annual Meeting
August 23-26 & August 30-September 1, 2021
Abstract #1617

THE AUSTRALIAN SAFEGUARDS SUPPORT PROGRAM FOR INTERNATIONAL ATOMIC ENERGY AGENCY SAFEGUARDS

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ABSTRACT

For over 40 years, the Australian Safeguards Support Program (ASSP) has assisted the IAEA in areas such as developing safeguards technology and approaches, delivering safeguards training, and providing safeguards technical services. Under the coordination of the Australian Safeguards and Non-Proliferation Office (ASNO), the ASSP aims to help the IAEA keep pace with evolving challenges in verification, as well as opportunities from emerging technologies and analytical techniques. The ASSP has helped develop new instruments for safeguards inspections (such as the Zebedee hand-held laser mapping device) and new safeguards approaches for facilities (such as centrifuge plants). Through the ASSP, the Australian Nuclear Science and Technology Organisation (ANSTO) and the University of Western Australia have also made long-standing contributions by analysing environmental samples from IAEA inspections as members of the Network of Analytical Laboratories. Today, the ASSP is one of 21 support programs established by member States and the European Commission. Currently, areas of focus for the ASSP include assisting the IAEA to update the Physical Model and related guidance for implementation of safeguards at the state-level, develop and deliver safeguards training (including online), refine open-source information collection and analysis techniques, and test potential robotic designs for inspections in nuclear facilities. This paper will outline Australia's contributions to the continuous improvement of the effectiveness and efficiency of IAEA safeguards through the ASSP. It will also discuss how ASNO has helped bring the IAEA together with Australian government agencies, research institutes and universities with specialised expertise, simultaneously benefiting IAEA safeguards and helping Australia cultivate a core of professionals with expertise in related fields.

INTRODUCTION

For over 40 years, the Australian Safeguards Support Program (ASSP) has made niche contributions to the IAEA's safeguards mission in areas such as developing safeguards technology and approaches, delivering safeguards training, and providing technical services. The ASSP forms an important part of Australia's contributions to international efforts to continuously strengthen the effectiveness and improve the efficiency of IAEA safeguards. This paper outlines the history and current directions of the ASSP. It provides examples of how a state regulatory authority can foster mutually beneficial partnerships between the IAEA and government agencies, research institutes and universities with specialised expertise.

The Australian Safeguards and Non-Proliferation Office (ASNO) is Australia's national authority for the implementation of IAEA safeguards, nuclear security, the Comprehensive Nuclear-Test-Ban Treaty and the Chemical Weapons Convention. ASNO is a small office of less than 20 staff but with significant experience. ASNO's IAEA Safeguards Section (three staff) is responsible for Australia's compliance with Australia's Comprehensive Safeguards Agreement and Additional Protocol and safeguards regulation of entities that hold nuclear material and associated items in Australia. The IAEA Safeguards Section also coordinates the

ASSP and Australia's support for regional safeguards outreach programs including the Asia-Pacific Safeguards Network.

STRUCTURE OF THE ASSP

Today, the ASSP is one of 21 programs established by IAEA member states and the European Commission to support the IAEA's safeguards development and implementation needs. Since the IAEA has limited capacity and facilities for research and development on new safeguards tools, provision of safeguards training, and analysis of samples collected during inspection, the Agency relies heavily on these Member State Support Programs (MSSPs).

The IAEA hosts biennial MSSP Coordinators' Meetings with representatives of the 21 programs (including representatives from ASNO) to discuss contributions to the Department of Safeguards' development and implementation support programs for nuclear verification [1, 2]. The IAEA and ASNO also hold an annual ASSP review meeting to discuss progress on individual support program tasks assigned to Australia.

The ASSP does not currently have a dedicated budget, instead relying on the dedication of Australian government agencies, ANSTO, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), other research institutes and universities with specialised expertise. ASNO has taken opportunities to promote the importance of IAEA safeguards among specialists in these organisations, and the organisations in turn have forged long-standing and mutually beneficial partnerships with the IAEA.

ASSP PROJECTS

The development and implementation of safeguards concepts and techniques has required different skills and support over time. The ASSP and other MSSPs have changed over time, both reflecting and driving the evolution of IAEA safeguards.

Historical activities

In 1980, Australia formally announced the establishment of the ASSP (referred to as the Bilateral Australian Assistance Program from 1980 to 1986[*]) to the IAEA Board of Governors. At the time, Australia contributed to the development of approaches to safeguards inspections for gaseous centrifuge enrichment plants through the Hexapartite Safeguards Project with the IAEA, Euratom and 5 other IAEA member states. During the early years of the Program, the Australian Atomic Energy Commission also provided advice to the IAEA on implementation of new technology to enhance efficiency, including the IAEA's Computerised Safeguards Information System and applications of remote surveillance equipment.

[*] The ASSP was also referred to as the "Australian Safeguards Assistance Program" from 1989 to 2000. It is also referred to as the "Australian Support Programme" and abbreviated "AUL SP" in various contexts. The early history of the ASSP is described in more detail in [3].

Throughout the 1980s, the ASSP peer reviewed papers on the development of criteria for attainment of IAEA inspection goals at nuclear facilities, which enabled the IAEA to plan inspections in a manner that ensures a high probability of detecting diversion of declared nuclear material even as the quantity of nuclear material and the number of nuclear facilities under IAEA safeguards increases.

Following the revelations regarding the nuclear programs of Iraq and the DPRK in the early 1990s, the IAEA began working with member states on strengthening safeguards, including development of capabilities to detect undeclared nuclear material and activities. The ASSP supported the strengthening of safeguards, particularly through Australia's hosting of trials of new safeguards techniques, such as environmental sampling, which remain in use by IAEA safeguards inspectors today.

As the first country where integrated safeguards was introduced, Australia also assisted the IAEA to develop generic guidance for the development of integrated safeguards approaches [3].

Guidance documents

As part of the ASSP, Australia has provided expert input to the drafting of the IAEA's Physical Model, a series of volumes first developed in the 1990s to describe the components of the nuclear fuel cycle. The Physical Model acts as a tool for identifying indicators of the existence or development of nuclear activities and for assessing the proliferation significance of questions or inconsistencies arising in safeguards implementation. Experts from ANSTO, ASNO, other Australian government agencies, and private companies contribute periodically as consultants to the development and review of the Physical Model, particularly Volume 1 on uranium mining/milling and Volume 3 on uranium enrichment.

The ASSP has also contributed to guidance for state systems of accounting for and control of nuclear material (SSACs) through the work of Australian safeguards practitioners on the Safeguards Implementation Practices (SIP) and Services Series guides.

In 2020, ASNO participated in the review of the IAEA's draft guidelines on implementation of safeguards for facilities and LOFs that are shutdown or under decommissioning. This proved beneficial for both ASNO and the IAEA, allowing ASNO to consider the types of reporting and inspections required at facilities and LOFs during future decommissioning activities that may take place in Australia.

Training and capacity building

Australian government agencies, including ASNO, work with the IAEA regularly on provision of safeguards training (both to the Agency and to other member states) and on development of safeguards concepts and guidance, particularly within the framework of state-level approaches to safeguards implementation. In the past, Australia has also hosted Regional Training Courses on SSACs as part of the ASSP, most recently a course on safeguards and security for states with small quantities protocols in 2016.

Since 2009, Australia has provided annual proliferation analysis training to IAEA safeguards staff to enhance their ability to apply structured analytical techniques to complex proliferation

issues. This training assists IAEA staff to analyse disparate sources of information, including state-declared and open-source information. The Office of National Intelligence (ONI) and the Australian Department of Defence planned to provide proliferation analysis workshops to the IAEA in 2020 and 2021 but the workshops have been postponed due to travel restrictions associated with the COVID-19 pandemic. The content of the workshop is regularly updated and participant feedback from workshops in recent years has confirmed that the training continues to meet the needs of the IAEA Department of Safeguards.

In 2021, ASNO is assisting the IAEA with development of online courses by peer reviewing the Agency's e-learning training modules on SSACs.

ASNO is also supporting the IAEA's Comprehensive Capacity Building Initiative for SSACs and RSAs (COMPASS), the IAEA's new initiative to provide tailored safeguards assistance to member states in areas such as training for the safeguards regulatory authority, outreach to nuclear operators, procurement of equipment and drafting of national regulations and reference guidelines/manuals.

Technology development

In recent years, the IAEA has also worked with member states to conduct broad searches of emerging technologies developed outside the traditional safeguards community that could be applied to safeguards. In 2013, ASNO invited the CSIRO to participate in the IAEA Workshop "Scanning the Horizon: Novel Techniques and Methods for Safeguards" in Vienna. During the workshop the IAEA was particularly interested in the CSIRO's recent invention of the Zebedee hand-held 3D laser mapping device. After a period of field testing, the IAEA began using the Zebedee in safeguards inspections in 2016 and it has proven useful for verifying the design of nuclear facilities and calculating volumes of large objects.

The CSIRO went on to host the IAEA's crowdsourcing Robotics Challenge in 2017, which saw robotics experts from around the world develop their own robotic systems to assist IAEA inspectors by automating lengthy or repetitive verification tasks, particularly in areas of nuclear facilities that may be difficult to access. Based on the outcomes of the challenge in 2017 and subsequent testing, the IAEA selected a design produced by Datastart Ltd of Hungary, which autonomously propels itself across the surface of a spent fuel pond while holding a device for measuring radiation glow patterns (known as Cherenkov glow). The robot has the potential to automate time-consuming inspection tasks required to verify nuclear material in spent fuel from power reactors.

The IAEA is continuing discussions with Member States, nuclear facility operators and Datastart Ltd to further refine and test the design to ensure it is compliant with all applicable requirements and regulations. The CSIRO is now working with the IAEA and Datastart Ltd on a new control module for the robot to upgrade the robot's autonomous features and user interface.

Separate from the Robotics Challenge, the CSIRO participated in the IAEA's Emerging Technologies Workshop in 2020, demonstrating the Organisation's own robotic system for inspecting drums of radioactive material in densely packed storage installations and presenting

on the potential applications of artificial intelligence to automatically analyse safeguards surveillance feeds.

Australia's universities also play an important role by conducting research on potential safeguards applications of new technologies developed outside of fields traditionally associated with safeguards, such as blockchain and machine learning. In 2018, a team of researchers at the Faculty of Engineering, University of New South Wales (UNSW) developed a blockchain (shared ledger) platform for recording nuclear material accounting data based on ASNO's existing centralised NUclear Material Balance and Tracking (NUMBAT) database. Their platform 'Shared-Ledger nUclear Material Balance and Tracking' (SLUMBAT) allowed testers to try out performing the roles of hypothetical nuclear operators, transporters and regulatory authorities and enter transactions involving hypothetical nuclear material into an encrypted blockchain. It demonstrated potential advantages of blockchain platforms in terms of data integrity, traceability and efficiency in tracking complex chains of transactions for data held among nuclear operators and regulators. Research on the potential applications of blockchain technology for nuclear safeguards information management, nuclear security and export controls is continuing as a partnership between the Finnish Radiation and Nuclear Safety Authority (STUK), the Stimson Center and UNSW.

Table 1. Active ASSP Tasks as of 30 June 2021

MSSP Task Proposal (SP-1) ID	Task ID for ASSP	Title
16/CCA-002	AUL C 2335	Technical Assistance on Methodology and Guidance for Implementation of Safeguards at the State-Level
17/CCA-001	AUL C 2298	Update of the Physical Model
18/CCA-003	JNT C 2523 AUL	Development of Safeguards Guidelines for Facilities under Decommissioning and Post-Accident Facilities
09/ICA-005	AUL B 1828	Proliferation Analysis Workshop
20/CTR-005	AUL B 2579	Online Course Development Consultation
11/ICA-004	AUL D 1915	Consultant - Assistance on Information Collection and Analysis
16/ISD-003	AUL D 2577	Creation of e-Learning Modules, Supporting Preparation of State Declared Information
94/SAL-004	AUL A 0859	Analytical Services for Environmental Sampling
06/TDO-007	AUL A 1856	Support for Instrumentation Technology Foresight (Novel Technologies)
18/TND-001	AUL A 2520	Field-Testing of an Unmanned Surface Vehicle (USV) and neXt generation Cerenkov Viewing Device (XCVD)
20/SPC-002	AUL X 2578	COMPASS: Comprehensive Capacity Building Initiative for SSACs and SRAs

Analytical services

ANSTO's Centre for Accelerator Science and University of Western Australia's Centre for Microscopy, Characterisation and Analysis have made long-standing contributions to IAEA safeguards by analysing environmental samples from inspections, as part of the Agency's Network of Analytical Laboratories [3]. ANSTO's Accelerator Mass Spectrometry (AMS) system provides bulk analysis, while UWA's large-geometry secondary ion mass spectrometer (LG-SIMS) provides particle analysis. Each centre has devoted a proportion of its resources to analysing environmental samples from IAEA safeguards inspections. The centres regularly participate in inter-laboratory comparison exercises with other NWAL members, helping to confirm the quality of analyses of environmental samples across the Network.

The ASSP also contributes to research and development on environmental sample analysis capabilities. In the mid-2000s, ANSTO's AMS helped develop the methodology for analysing sub-picogram quantities of plutonium in environmental samples. UWA is currently researching scanning electron microscopy (SEM) and time-of-flight secondary ion mass spectrometry (TOF-SIMS) for uranium particle characterisation, which may have safeguards applications.

Information collection and analysis

The Department of Government and International Relations at University of Sydney is providing an expert consultant to assist the IAEA Department of Safeguards' Division of Information Management with optimising the collection and analysis of open-source information for safeguards. The project involves applying network analysis software to map safeguards-relevant transfers and relationships within strategic trade networks for states in East and Southeast Asia using open-source trade statistics and transaction-level data. The goal is to strengthen the Agency's ability to identify trade flows of safeguards-relevant commodities.

CONCLUSIONS

The cooperation between the IAEA, the ASSP and other MSSPs continues to produce important technological and conceptual developments in safeguards, as well as ensuring ongoing, effective delivery of training and analytical services. These relationships have also helped Australia cultivate a core of professionals with expertise in safeguards, and in related fields such as nuclear forensics. The ASSP demonstrates that, even with very modest resourcing, a state can make enduring contributions to the work of the Department of Safeguards. Furthermore, the ASSP has provided a mechanism for Australia to help shape developments in safeguards, particularly where they may have a regulatory impact on Australian industries or research activities.

REFERENCES

[1] IAEA, Development and Implementation Support Programme for Nuclear Verification 2020–2021, STR-393 (January 2020) https://www.iaea.org/sites/default/files/20/01/d-and-s-programme-2020.pdf

[2] ASNO, Annual Report 2019–2020 (October 2020) https://www.dfat.gov.au/publications/international-relations/asno-annual-report-2019-20/report/index.html

[3] Ryan Hemsley, Craig Everton, Michael East and Robert Floyd, The Australian Safeguards Support Program, paper presented to the 54th Annual Meeting of the INMM, Palm Desert, July 2013.