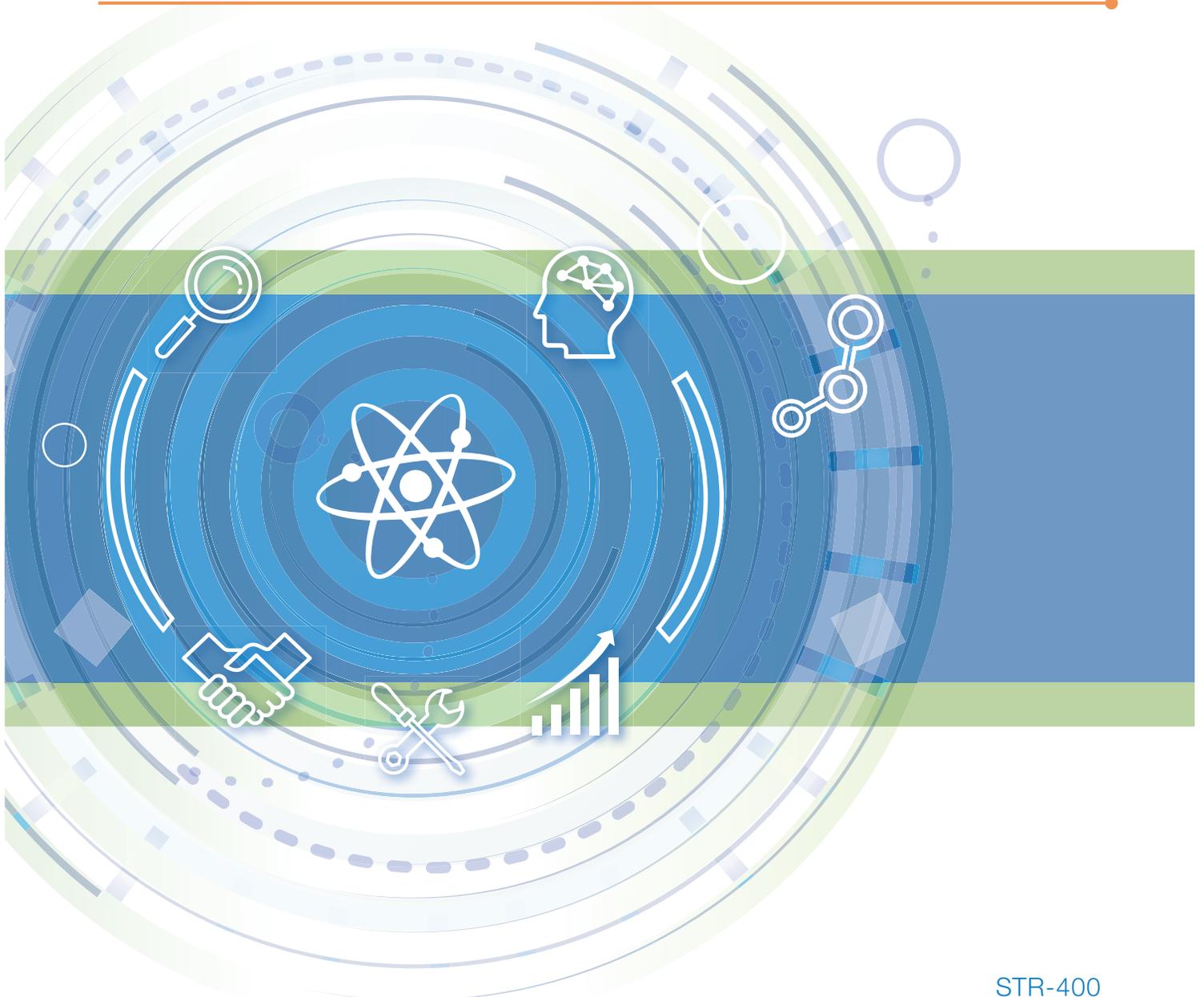




Safeguards

Development and Implementation Support Programme for Nuclear Verification 2022–2023



Foreword



This is a significant time to publish the next D&IS Programme: our last biennium’s worth of collaboration with our external partners—Member State Support Programmes (MSSPs) and non-traditional partners—corresponded with the timeline of the Covid-19 pandemic. But rather than see plans unravel, we witnessed an extraordinary collective effort amongst my colleagues and our external partners in delivering effective and efficient safeguards to the world, despite the challenges.

I am encouraged that you, our external partners, have been exceptionally responsive and collaborative during the pandemic, and we would not have accomplished all of the progress described in this document without you. Your support is crucial across a diverse range of technical plans, from implementing new, in-field verification systems, to enhancing our destructive analysis capabilities, to ensuring the confidentiality of information entrusted to the Department, and so much more.

To communicate our most urgent, short-term, extrabudgetary needs, the Department publishes this document, the Development and Implementation Support (D&IS) Programme for Nuclear Verification, every two years. We hope that you will use it to understand where we would like to go and how you can help us. We have designed the plans within specifically to inform your decision making about how best to allocate your valuable contributions to our important mission.

The work of the Department of Safeguards makes a vital contribution to international peace and security. To succeed, we will continue to rely on the invaluable expertise of Member States and on their assistance in keeping us abreast of the latest verification technologies and techniques. We are determined to vigorously pursue the plans we set forth in this document for 2022–2023 in order to deliver more efficient and effective safeguards. I call on all concerned to join us in our efforts and support this important objective.

A handwritten signature in black ink, reading "Massimo Aparo". The signature is written in a cursive, flowing style.

Massimo Aparo
Deputy Director General
Head of the Department

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Introduction

This document presents the Development and Implementation Support (D&IS) Programme for Nuclear Verification for the 2022–2023 Biennium (hereafter “the D&IS Programme”). The plans within are a part of the IAEA Department of Safeguards’ (the Department’s) strategic planning framework.

Audience

The main audience are the Department’s current and future traditional and non-traditional partners. This includes:

- Member State Support Programme (MSSP) Coordinators and Delegates
- R&D organizations
- State and regional safeguards authorities
- Permanent missions to the IAEA

Also, given the IAEA’s strengthened focus on non-traditional partnerships, the audience also includes:

- Academia
- Foundations
- Non-governmental organizations (NGOs)
- Private sector entities

All partners, existing and potential, are invited to collaborate with the Department.

Purpose

The purpose of this document is to communicate the Department’s 26 safeguards-relevant development and implementation plans that require extrabudgetary support to implement safeguards effectively, efficiently, and innovatively. This document also serves as the focus of discussions with external partners and inform their resource allocation decisions.

Scope

The D&IS Programme contains two types of activities:

- Development of new techniques and technologies.
- Deployment, maintenance, implementation, or improvement of existing capabilities.

The D&IS Programme endeavours to describe all development activities being undertaken within the Department regardless of the funding source. This is an important part of ensuring that external partners have a complete picture of relevant work towards a given objective. This, in turn, will help them understand where extrabudgetary support



Figure 1: Coordinators from the Member State Support Programmes and Safeguards staff meet at the 2020 MSSP Coordinators’ Meeting. The event informs MSSPs of Safeguards’ priorities and allows them to identify how extrabudgetary support may best serve IAEA Safeguards. This biennium’s MSSP Coordinators’ Meeting is scheduled for 2–4 March 2022.

can make the greatest impact: by complementing existing efforts and/or avoiding duplicative work.

The D&IS Programme's development activities aim at, inter alia:

- New capabilities identified through the Department's planning processes that address emerging and future needs.
- Continual improvement of the Department's processes, equipment/systems, tools, training, concepts and approaches, analysis services, information acquisition, analysis, and evaluation capabilities.
- Technology enhancement with efforts that focus on the Department's core capabilities and technologies, such as the development and customization of equipment.

In the area of safeguards implementation, the D&IS Programme covers MSSP-supported tasks that would otherwise remain unfunded. The Agency's Programme and Budget covers all other implementation-related work.

The D&IS Programme's implementation support activities aim primarily at:

- Sustainability efforts that focus on the Department's need to sustain core capabilities and technologies (for example, training IAEA Safeguards inspectors, refinement or replacement of equipment and systems).
- Increased capacity efforts needed due to an increased demand for verification activities or short-term projects (for example, laboratory analytical services, IT, and training).

Safeguards' Strategy Framework

Mission

To deter the proliferation of nuclear weapons.

Strategic Objectives

The Department of Safeguards' four over-arching strategic objectives are:

1. To detect early the misuse of nuclear material or technology;
2. To provide credible assurances that States are honouring their safeguards obligations;
3. To assist with other verification tasks;
4. To continually improve the Department's capabilities and performance.

(For exact wording of the first three strategic objectives, please see the Agency's Programme and Budget).

Planning Framework

The Department conducts strategic planning, which enhances its capability to face future challenges and benefit from opportunities. The strategic planning framework supports good management of resources through monitoring the operating environment and establishing prioritized objectives; it prevents duplicative work and promotes programmatic and organizational coherence. Another key element of the strategic planning framework is the development, maintenance, and enhancement of partnerships with respect to development and implementation support.

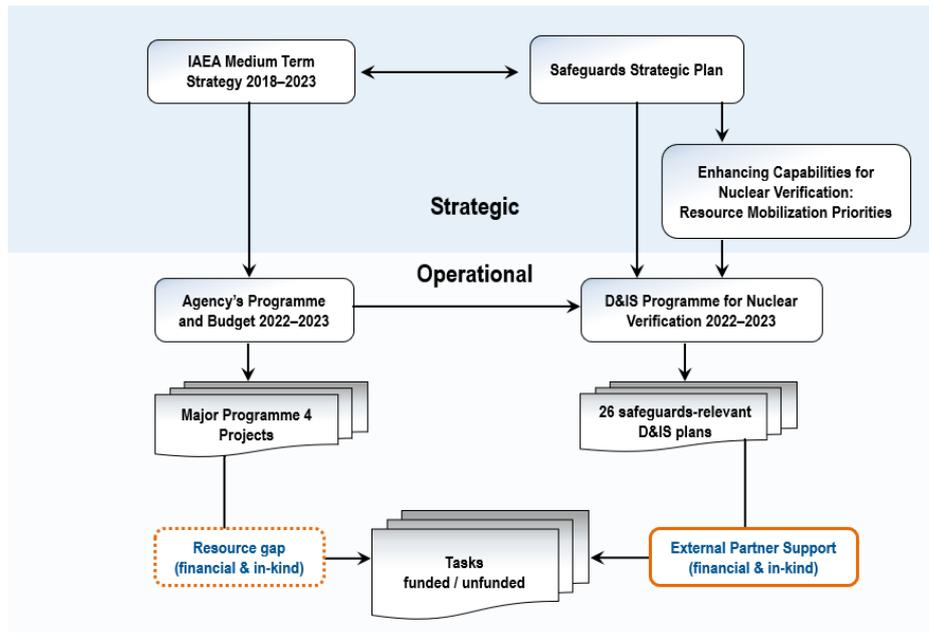


Figure 2: The Department uses these processes and documents to identify and address its resource needs.

The Department’s strategic planning framework is comprised of the:

- IAEA Medium Term Strategy
- Agency’s Programme and Budget
- Department’s Strategic Plan (described more below)
- Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (formerly known as the Safeguards Research and Development (R&D) Plan) (described more below)
- Development and Implementation Support (D&IS) Programme for Nuclear Verification (this document) (described more below and throughout)

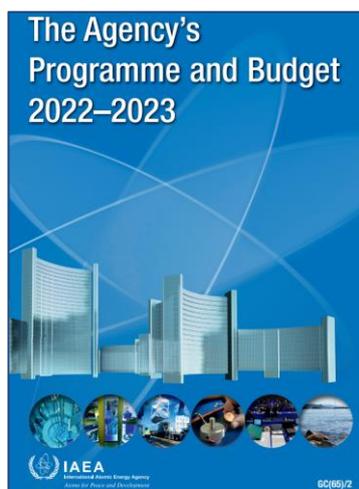
The strategic planning framework connects high-level strategic objectives, expected outcomes, and relevant resource mobilization priorities that require extrabudgetary support with implementation and development tasks. As a result, Department staff and external stakeholders can understand how even the most specialized tasks are connected to the bigger picture of strengthening safeguards capabilities.

Medium Term Strategy 2018–2023 (GOV/2016/57)



The *Medium Term Strategy 2018–2023* (GOV/2016/57) that was taken note of by the Board of Governors was developed by a working group of the Board of Governors with the assistance of the Secretariat. The *Medium Term Strategy* guides the development of the *Agency’s Programme and Budget* during the three biennia covered by it. It identifies priorities among and within its programmes for the achievement of the Agency’s statutory objectives in an evolving international environment. Find the *Medium Term Strategy 2018–2023* at <https://www.iaea.org/about/overview/medium-term-strategy>.

Agency's Programme and Budget 2022–2023 (GC(65)/2)



The *Agency's Programme and Budget 2022–2023 (GC(65)/2)* that was approved at the 2021 General Conference describes all approved activities that need to be carried out during the biennium. It also contains the approved budget that will be allocated to each of these activities. Find the *Agency's Programme and Budget 2022–2023 (GC(65)/2)* at <https://www.iaea.org/sites/default/files/gc/gc65-2.pdf>.

Several tasks of the Major Programme 4 (Nuclear Verification) remain unfunded. For the Department, this unfunded part amounts to €69.1 million over the 2022–2023 biennium, up from €65.6 million from the previous biennium.

Biennium	Unfunded
2022–2023	€69.1 million
2020–2021	€65.6 million
2018–2019	€45.7 million

In addition to these unfunded resources (human or material), there is a substantial amount of other resources that cannot be easily tallied but are still essential for effective implementation of the verification mandate. These resources are, for example, new equipment and software resulting from R&D activities performed in Member States, the availability of nuclear facilities for testing or training purposes, and the contributions of external experts.

Key Department Strategy Documents

Specific to the Department, its strategic planning framework consists of:

- The Department's Strategic Plan
- Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (formerly known as the Safeguards Research and Development (R&D) Plan)
- Development and Implementation Support (D&IS) Programme for Nuclear Verification (this document)

Together, these documents connect high-level strategy with required capabilities and associated support needs and implementation activities. They help ensure that the Department focuses its development efforts and resources where they are most needed, contributing to effective stewardship of limited resources and maximizing the impact of extrabudgetary support.

Strategic Plan



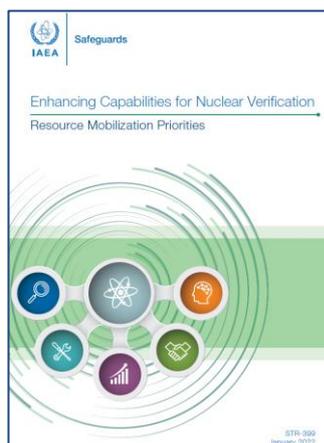
The Strategic Plan is a living, internal management and communication tool that describes departmental priorities across 5 focus areas:

- Core activities
- Technical capabilities
- Management
- Stakeholders and partnerships
- People and knowledge

Within each focus area, the Department has defined priority objectives. The Department implements its Strategic Plan through priority projects and actions.

Find the Department's Strategic Plan-on-a-Page on the next page.

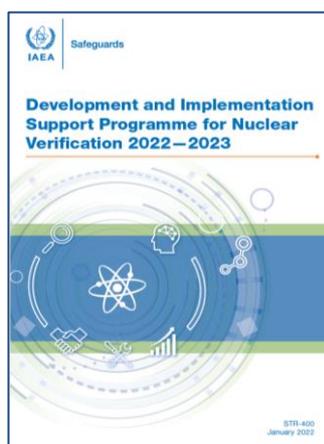
Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (RMP) (STR-399)



The Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (RMP) document communicates a prioritized set of needed capabilities for which the Department is seeking extrabudgetary support and describes the type of support needed. In so doing, it supports the Department in achieving its priority objectives.

Find the electronic version of the RMP document on SPRICS (https://sprics.iaea.org/api/SharePoint/DownloadDocument/Public%20Folder/General%20Files/Resources/Enhancing-Capabilities-for-Nuclear-Verification_Resource-Mobilization-Priorities_2022.pdf) (available only to SPRICS users at time of publication; please email SPCT@iaea.org for the public URL after February 2022).

Development and Implementation Support Programme for Nuclear Verification (D&IS Programme) (STR-400) (this document)



The Development and Implementation Support Programme for Nuclear Verification (D&IS Programme) 2022–2023 comprises of 26 nuclear verification-relevant plans that require extrabudgetary support. The D&IS Programme is updated every two years. Each plan links its outcomes to the Department's strategic planning framework.

Find [the electronic version of this D&IS Programme on SPRICS](#) (available only to SPRICS users at time of publication; please email SPCT@iaea.org for the public URL after February 2022).

Department's Strategic Plan-on-a-Page

MISSION

To deter the proliferation of nuclear weapons

STRATEGIC OBJECTIVES

- To detect early the misuse of nuclear material or technology*
- To provide credible assurances that States are honouring their safeguards obligations*
- To assist with other verification tasks*
- To continually improve the Department's capabilities and performance

VISION

IAEA nuclear verification contributes to a secure and peaceful world. The Agency's competence and independence enable it to operate with the trust and support of its Member States and the international community

VALUES

Integrity, professionalism and respect for diversity

Delivering on the Mission – Departmental Priority Objectives



- V.1** Strengthen information collection, integration and analysis
- V.2** Reinforce State evaluation and consistency in drawing SG conclusions
- V.3** Advance State-level safeguards
- V.4** Enhance SG effectiveness monitoring and evaluation
- V.6** Prepare for new types of facilities and activities



- T.1** Strengthen instrumentation capabilities for verification
- T.2** Enhance sensitivity, reliability and timeliness in sample analysis
- T.3** Ensure resilient, secure and up-to-date SG IT systems
- T.6** Enhance remote sensing, monitoring and verification capabilities



- M.1** Secure and optimally manage financial resources
- M.2** Manage SG assets strategically
- M.3** Mature process management and operational discipline
- M.4** Increase organizational resilience



- S.1** Communicate proactively and transparently
- S.2** Enhance States' safeguards capacity
- S.3** Promote safeguards-by-design
- S.4** Expand and leverage partnerships



- W.3** Build and retain organizational knowledge
- W.4** Advance workforce diversity, including gender parity

* For exact wording of the three strategic objectives, please see the Agency's Programme and Budget

Significant changes to the D&IS Programme for 2022–2023

For the 2022–2023 biennium, the Programme has 26 plans that meet current and emerging safeguards needs. The execution of the programme is performed through plans that are described in the main body of this document. For plans requiring extrabudgetary support, the work is performed through MSSP Tasks. Each task has an IAEA and MSSP representative assigned to oversee the work.

New Plans

ID	Title	Manager
SGTS-016	Occupational Health and Radiation Safety	Virginia KOUKOULIOU

Discontinued Plans

None.

Plan Title Changes

None.

Progress on 2020–2021 Plans

Find updates, progress, and statuses on the 2020–2021 expected outcomes and key outputs planned in the Section called Progress from 2020–2021 Outcomes and Outputs.

Member State Support Programme Administration

Collaboration between the Department and MSSPs is administered by the Department's Support Programme Coordination Team (SPCT) in the Section for Strategic Planning and External Coordination (CPC), Division of Concepts and Planning (SGCP) together with MSSP Coordinators. The appointed MSSP Coordinators are the IAEA's main points of contact (POCs) for each MSSP.

Task Lifecycle

See the Safeguards Member State Support Programme Task Life Cycle (figure 3 below) and corresponding phases and descriptions.

Initiation Phase	Departmental staff members write and approve task proposals. The SPCT transmits task proposals to MSSPs. When a MSSP accepts, the Department and the MSSP activate the new task and assign an IAEA Task Officer and a MSSP POC.
Active Task Phase / Reporting and Review	The Task Officer hosts a kick-off meeting and, in consultation with the MSSP POC, finalizes the task plan. Together, the IAEA and MSSP execute the task plan, write status reports, and meet at review meetings to discuss progress.
Completed Task Phase	When the IAEA and MSSP achieve the task objective, the Task Officer writes the task outcomes, how task outcomes were met, lessons learned, and how the Department is applying the task outcomes in a Completed Task Report, and all stakeholders agree to the completed status of the task.

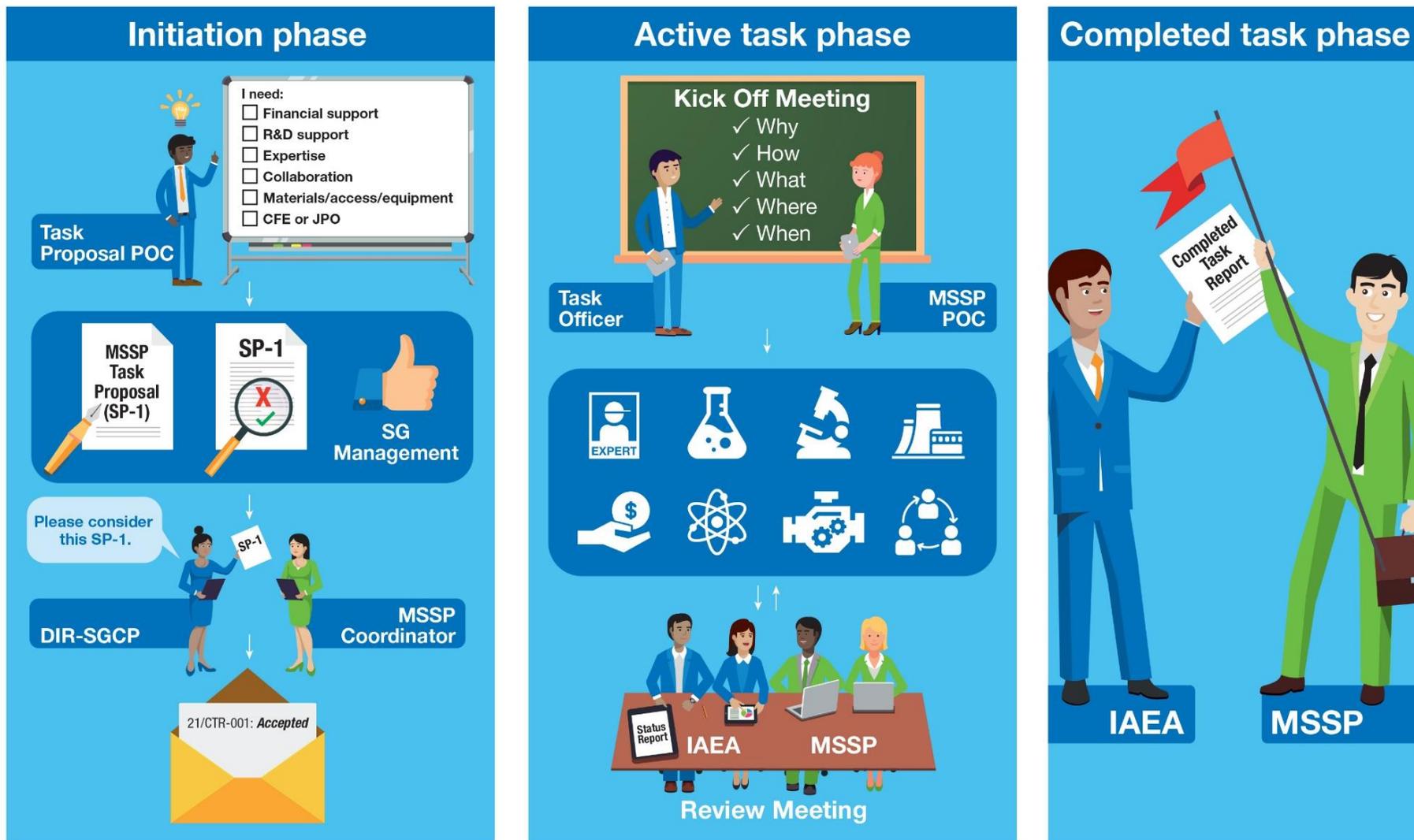


Figure 3: Safeguards Member State Support Programme Task Life Cycle

Administrative System



The Support Programme Information and Communication System (SPRICS) (sprics.iaea.org) is the administrative IT platform for the Department of Safeguards' MSSP. SPRICS stores task proposals, MSSPs decisions, and administrative details.

SPRICS is in IAEA's NUCLEUS Catalogue. To request access to SPRICS, please contact SPRICHelp@iaea.org.

IT Projects in the D&IS Programme

In years past, the largest portion of the departmental budget besides human resources went to procuring safeguards equipment. Today, though, it is IT. Many D&IS managers have IT in their plans. When IT is supported by MSSPs, D&IS managers will collaborate with SGIS-003: Safeguards Information Systems and System Usability to ensure compliance with the Office of Information and Communication Systems (SGIS) IT governance, standards, and best practices. The alignment of IT across the departmental facilitates the integration, integrity, security, and availability of safeguards data.

The Future

The Department will continue to rely on external partners to provide the necessary technology, expertise, and resources to meet its research, development, and implementation support needs. In recognizing the benefit in engaging non-traditional partners, the Department is also advancing its 'non-traditional partnership coordination programme' to mobilize and direct support from non-traditional partners to the Department.

Over the 2022–2023 biennium, the Department will continue to further align the planning and implementation process for D&IS activities with Departmental strategic planning and the RMP document. Efforts to maintain and extend existing partnerships and identify new ones will continue for the benefit of the Agency's successful implementation of its verification mandate.

Member State Support Programmes

As of January 2022, 22 MSSPs comprise the programme. MSSP(s) established within the last biennium appear in **bold**.

 Argentina	 Finland	 Russian Federation
 Australia	 France	 Spain
 Belgium	 Germany	 Sweden
 Brazil	 Hungary	 Switzerland
 Canada	 Japan	 United Kingdom
 China	 Netherlands	 United States of America
 Czech Republic	 Republic of South Africa	
 European Commission	 Republic of South Korea	

MSSP Observers

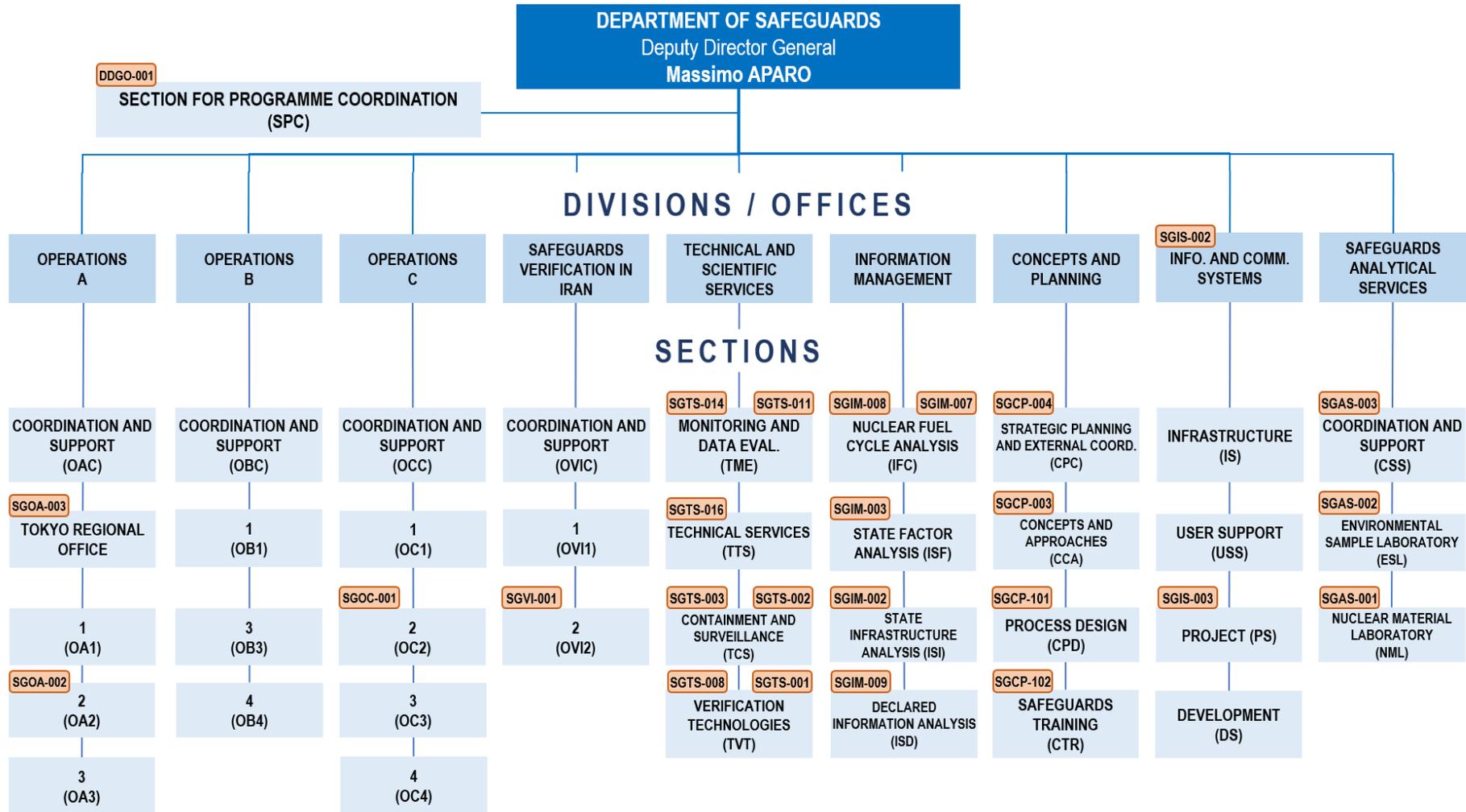
-  European Atomic Energy Community (EURATOM)
-  Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC)

D&IS Plans and Managers

As of January 2022, the programme contains the following 26 D&IS plans and managers. D&IS plans and managers newly appointed within the last biennium appear in **bold**.

Plan ID	Plan Title	Manager
DDGO-001	Overall Safeguards Management and Coordination	Malik DERROUGH
SGAS-001	Destructive Analysis of Nuclear Materials	Mika SUMI
SGAS-002	Environmental Sample Analysis Techniques	Matt KILBURN
SGAS-003	Analysis Support and NWAL Coordination	Veena TIKARE
SGCP-003	Safeguards Approaches	Jin Yong DOO
SGCP-004	Strategic Planning and Partnerships	Gary DYCK
SGCP-101	Quality Management	Roy FITZGERALD
SGCP-102	Training	Susan PICKETT
SGIM-002	Satellite Imagery Analysis	Marc LAFITTE
SGIM-003	Information Analysis	Woan Jin KIM
SGIM-007	Evaluation of Data from ES and Material Characterization	Mika NIKKINEN
SGIM-008	Statistical Analysis	Claude NORMAN
SGIM-009	State Declared Information Management	Snezana KONECNI
SGIS-002	Information Security and Infrastructure	Scott PARTEE
SGIS-003	Safeguards Information Systems and System Usability	Remzi KIRKGOEZE
SGOA-002	Safeguards System for JNFL MOX Fuel Fabrication Plant (J-MOX)	Christophe CREUSOT
SGOA-003	Fukushima Dai-ichi Safeguards	Glen HORTON
SGOC-001	Chornobyl	Faisal AJJEH
SGVI-001	JCPOA Verification	Andrew CATTON
SGTS-001	NDA Techniques	Mikhail MAYOROV
SGTS-002	Techniques and Instruments for Sealing and Containment Verification	Bernard WISHARD
SGTS-003	Surveillance Techniques	Melvin JOHN
SGTS-008	Instrumentation Technology Foresight	Dimitri FINKER
SGTS-011	Unattended Measurements Techniques	Not available
SGTS-014	Remote Data Transmission and Processing Systems	Angelo ALESSANDRELLO
SGTS-016	Occupational Health and Radiation Safety	Virginia KOUKOULIOU

Department Organigram with D&IS Plans Overlaid



2022–2023 Plan Details

2022–2023 Plan Outline

Each plan has the following sections:

Context Highlights

In previous publications of the D&IS Programme, managers were given specific topics to respond to. For this publication, managers chose the topics they most wanted to discuss in the context of their plans. For this reason, this section is not standard, and each plan will have different topics.

For example, in previous publications of this document, managers were asked to discuss their biggest challenges. While some managers still discussed their biggest challenges, most did not, and instead discussed a wide variety of topics: from the introduction of new projects, to timelines, and to Covid-19's impact on their D&IS plan.

The Department hopes the content in this section puts into context the conditions in which managers made their 2022–2023 plans.

Most Needed Extrabudgetary Support in 2022–2023

The table is a simplified summary of the types of extrabudgetary support requested in the 2022–2023 plans. Descriptions of each extrabudgetary support type are below:

Financial resources	Contribution through direct fund provision.
Expert meeting participation	Consultations and correspondence with experts through, for example, conferences, workshops, and trainings.
Consultants	Professionals under individual contracts (temporary staff assignments or consultancies) to work on short-term projects.
CFE	Cost-free expert; professional with specialized skills that are either not readily available among the IAEA's staff or cannot be financed under the Regular Budget of the IAEA, and are provided by donor States or institutions at no cost or partial cost to the IAEA to perform specific functions or tasks.
JPO	Junior professional officer; professional working as part of a team and under the guidance of a senior staff member in either a scientific, technical, or administrative field, and is provided by donor States or institutions at no cost or partial cost to the IAEA to perform specific functions or tasks.
Equipment	Equipment or other tangible assets essential for the IAEA's work on delivering on the safeguards mission.
Reference materials	A material or substance which is homogeneous and for which one or more values are well established.
R&D	Research and development activities of exploratory or developmental nature, including testing of ideas, methodologies, techniques, and tools and other innovations with potential for safeguards application.

Facility access	Ability to enter into nuclear facilities for testing and training purposes.
Training	Learning activities that are specifically designed to educate both Safeguards staff members and State system of accounting for and control of nuclear material (SSACs) in any and all aspects of safeguards implementation.
Studies	Research results and materials focused on a wide array of topics, from nuclear energy to safety and security, and from safeguards to nuclear technology and applications.

Development Plan for 2022–2023

This section is a description of the managers' visions (outcomes), the tangible things (outputs) they plan to produce to achieve that outcome, and their plans to realize those. The plans can include internal development activities supported with regular budget funds that will continue, but which would benefit from external contributions as well as extrabudgetary support they will need from external partners.

Agency Programme and Budget Linkages

The D&IS Plans are followed-up and/or coordinated by Agency staff and are aligned with the objectives of the Agency's Programme and Budget 2022–2023. Find each D&IS Plan and its linkage to the Agency's Programme and Budget in the table below.

D&IS Plan		Agency Project #	Agency Project Title
DDGO-001	Overall SG Management and Coordination	4.0.0.001	Overall management and coordination
		4.1.8.002	Integrated Life Cycle Management of Safeguards Assets (ILSA)
SGAS-001	Destructive Analysis of Nuclear Material	4.1.7.001	Analytical services and sample analysis
SGAS-002	Environmental Sample Analysis Techniques		
SGAS-003	Analysis Support and NWAL Coordination		
SGCP-003	Safeguards Approaches	4.1.1.002	Safeguards approaches and concepts
SGCP-004	Strategic Planning and Partnerships	4.1.1.001	Strategic planning and coordination
SGCP-101	Quality Management	4.1.1.003	Process design and quality management
SGCP-102	Training	4.1.1.004	Safeguards staff training and traineeship
		4.1.1.005	Training and assistance to SSACs
SGIM-002	Satellite Imagery Analysis	4.1.5.003	State infrastructure analysis
SGIM-003	Information Analysis	4.1.5.004	Information collection and analysis
SGIM-007	Evaluation of Data from Environmental Sampling and Material Characterization	4.1.5.002	Nuclear fuel cycle information analysis
SGIM-008	Statistical Analysis		
SGIM-009	State-Declared Information Management	4.1.5.001	Declared information analysis
SGIS-002	Information Security and Infrastructure	4.1.9.002	ICT infrastructure and support

SGIS-003	Safeguards Information Systems and System Usability	4.1.9.001	ICT Development
		4.1.9.002	ICT infrastructure and support
SGOA-002	Safeguards System for JNFL MOX Fuel Fabrication Plant (J-MOX)	4.1.8.001	Safeguards Implementation for States under the Responsibility of Division SGOA: Develop and implement a safeguards approach for J-MOX
SGOA-003	Fukushima Dai-ichi Safeguards	4.1.2.001	Safeguards Implementation for States under the Responsibility of Division SGOA: Verification for States with CSA and an AP in force
SGOC-001	Chornobyl	4.1.4.001	Safeguards Implementation for States under the Responsibility of Division SGOC: Verification for States with CSA and an AP in force
SGVI-001	JCPOA Verification	4.2.1.002	Verification monitoring of Iran's JCPOA nuclear related commitments
SGTS-001	NDA Techniques	4.1.6.001	Portable and resident non-destructive assay equipment
		4.1.6.005	Development of equipment components and stand-alone instruments
SGTS-002	Techniques and Instruments for Sealing and Containment Verification	4.1.6.004	Systems integration and coordination
		4.1.6.005	Development of equipment components and stand-alone instruments
SGTS-003	Surveillance Techniques	4.1.6.002	Unattended safeguards instrumentation
		4.1.6.005	Development of equipment components and stand-alone instruments
SGTS-008	Instrumentation Technology Foresight	4.1.6.006	Development of instrumentation systems and methodology
SGTS-011	Unattended Measurements Techniques	4.1.6.002	Unattended safeguards instrumentation
		4.1.6.006	Development of instrumentation systems and methodology
SGTS-014	Remote Data Transmission and Processing Systems	4.1.6.006	Development of instrumentation systems and methodology
SGTS-016	Occupational Health and Radiation Safety	4.1.6.003	Equipment logistics and storage

DDGO-001: Overall Safeguards Management and Coordination

Improving the lifecycle management and strategic recapitalization of critical safeguards assets and internal communications, and coordinating Departmental efforts to enhance assistance to States.

 Malik DERROUGH



Plan Acronyms

COMPASS	Comprehensive Capacity-Building Initiative for SSACs and SRAs
DDGO	Deputy Director General for Safeguards
ILSA	Integrated Lifecycle Management of Safeguards Assets
MCIP	Major Capital Investment Plan
NDA	non-destructive assay
SEQUOIA	Safeguard equipment asset management tool
SRA	States or Regional Authority
SSAC	State system of accounting for and control of nuclear material

Context Highlights

DDGO-001 Focus Areas

This D&IS plan intends to facilitate improvements to:

- The lifecycle management and strategic recapitalization of critical safeguards assets.
- Internal communications, through further implementation of the Internal Communications Strategy.
- IAEA assistance to States in the area of safeguards, through implementation of the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS).

Integrated Lifecycle Management of Safeguards Assets (ILSA)

By the end of 2020, the Department had over 58 000 active items deployed in over 60 States valued at over €238 million. The Department recognizes the importance of responsible and sustainable management of its assets and will further improve its asset management capabilities. Under the ILSA project, the Department created an asset management strategy to provide guidance and ensure consistency for managing the lifecycle of all departmental assets, including IT equipment, safeguards equipment supporting in-field activities, laboratory equipment, and software. Overall, this initiative enabled the Department to better foresee funding needs required to maintain, replace, and renew assets. Activities related to lifecycle asset management will be performed in close collaboration with all divisions and offices, primarily SGIS, SGTS, and SGAS.

Communications

As the Department continues to face important challenges, effective communication is essential. In order to facilitate valued, trusted, and efficient internal communication that enhances teamwork and performance, the Department developed an Internal Communications Strategy. It meets long-term communication goals, which considers inputs from departmental staff members and management surveys, focus groups, and interviews. The Strategy enhances benefits and mitigates risks from communication within the Department. It nurtures a culture of collaboration, teamwork, and information/knowledge sharing, as well as increases staff trust in leadership and colleagues. Work continues to fully implement the Strategy. Valuable contributions from the MSSPs continue to be important to this D&IS plan's ability to address the Department's communication goals.

New Initiative: COMPASS

Launched by the IAEA Director General in September 2020, COMPASS provides tailored safeguards assistance to States to help them strengthen and sustain the effectiveness of their State system of accounting for and control of nuclear material (SSAC) and their state or regional authorities (SRAs) responsible for safeguards implementation.

Building upon IAEA’s existing support to States, COMPASS offers targeted assistance to States to address their individual needs. By helping States carry out their safeguards obligations more effectively and efficiently, COMPASS contributes ultimately to the greater effectiveness and efficiency of IAEA verification work. Since the launch of the initiative with seven pilot States, the Department has received financial and in-kind contributions from Member States, including MSSPs. Their contributions are used to implement support activities in the pilot States, as well as to hire and retain staff who implement the initiative. While the pilot phase will end around the end of 2022, the Department will sustain its engagement and support to the pilot States beyond 2022, where needs continue. The Department will also review the initiative and lessons learned and determine next steps based on the experience gained during the pilot phase. Sustained support from external partners will, therefore, be critically important to continue the initiative, which relies mainly on extrabudgetary support.



Figure 1: As part of the Director General’s initiative for Capacity Building for SSACs and SRAs (COMPASS), the IAEA hosted an onsite National Training Course for Turkey in Vienna, Austria, on 15 November 2021.



Figure 2: IAEA’s COMPASS Team.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.1.C1** Ability to fully implement data-driven programmatic planning, monitoring and evaluation, to support managerial decision making
- M.2.C1** Ability to strategically plan, maintain and improve safeguards IT tools, information assets, and associated infrastructure
- M.3.C1** Ability to maintain an effective departmental communication framework and processes
- M.3.C2** Ability to enhance managerial decision-making processes, capabilities and competencies
- M.3.C4** Ability to deploy project management approaches to ensure effective execution of strategic priorities and projects
- S.1.C1** Ability to deploy data visualization and other methods and techniques to present safeguards findings and performance-related data in a clear and compelling manner
- S.2.C1** Ability to strengthen the capacity of SSACs/SRAs and monitor and measure progress
- T.3.C2** Ability to assist SRAs with the creation and submission of accountancy reports and additional protocol declarations with an IT tool
- V.4.C3** Ability to better measure and analyse safeguards performance (of the Department and the safeguards system more broadly) through use of analytical and IT tools, including data visualization
- W.4.C1** Ability to attract and retain a geographically diverse and gender-balanced workforce

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Enhanced foresight and decision support on funding needs and budgeting decisions for replacement of safeguards assets.

- Outputs**
1. Updated Asset Management Strategy and Plans.
 2. ISO 55000 Alignment Assessment.

Supporting Resource Mobilization Priorities

M.3.C4	M.3.C2	M.2.C1	M.1.C1
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Planned Activities

In 2020, the Department completed three topic-specific Asset Management Plans (Information Technology Assets; Laboratory Assets; and Inspection and Other Assets) and an overarching Asset Management Strategy. These documents describe the current state of the Department’s assets and forecast resource needs; they also highlight areas of the asset management system that need improvement. They are intended to be updated periodically. Topic-specific plans will be reviewed annually and the Strategy biennially.

The Department will revisit all three plans and the strategy in 2022. The review will focus on:

- Reviewing and updating of the asset data in the Safeguard Equipment Asset Management Tool (SEQUOIA), including condition, criticality, and forecasted replacement needs.
- Analysing progress made on the future improvements and development of new improvements.
- Adjusting the roles and responsibilities, as necessary.

Focusing on these aspects will be a key component of achieving the desired outcome.

The Asset Management Strategy and Plans were drafted with support from an outside consultant to help align with asset management best practices. In 2022–2023, the Department must assess actual performance against standards. The first step is a self-assessment using a methodology developed by the Institute for Asset Management. The next step will be to hire a consulting firm to perform an assessment. The results of these assessments will be used as input to the “Future Improvements” sections of the Asset Management Strategy and Plans.

The Department is supported by a CFE (USA X 2468: Safeguards Technical Specialist (Integrated Life Cycle Asset Management)) who leads the ILSA project. Further support to accomplish the tasks above could be requested in the form of:

- Consultants who can provide an ISO 55000 assessment or answer topic-specific asset management questions.
- Enhancements to IT tools to improve the integration of diverse data about our assets, in close collaboration with SGIS-003: Safeguards Information Systems and System Usability.
- Additional training to build expertise.

In addition, MSSPs may contribute directly to asset recapitalization either through direct contributions to individual projects or through the ILSA Major Capital Investment Plan (MCIP). ILSA MCIP funding will be used strategically with a long-term view on projects with a well-documented and reviewed whole lifecycle cost approach and a quantitative risk assessment. The decision to utilize ILSA MCIP funding resides with the DDG-SG.

Outcome #2: Increased capability for information sharing and greater collaboration.

Outputs	<ol style="list-style-type: none"> 1. Implementation of the Internal Communications Strategy to enhance senior leadership and departmental staff member communication capabilities. 2. Reviewed and updated use of the Safeguards Portal (intranet) and new or improved communication channels for feedback, sharing, and relationship building, in close collaboration with SGIS-003: Safeguards Information Systems and System Usability. 3. Coordinated development of published communication to ensure consistency of messages conveyed to departmental staff members and to Member States.
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Supporting Resource Mobilization Priorities

V.4.C3	M.3.C1	M.3.C2	S.1.C1
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Planned Activities

Communication in technical organizations require strong connections and coordination between systems, processes, and organizations, which requires ongoing learning, training, and mentoring to account for environmental shifts and new technologies.

The Internal Communications Strategy identifies three main pillars to the Department’s efforts to enhance internal communication:

- Use of internal communication tools, events, and channels.
- Facilitation of vertical and horizontal communication through meetings and reports.
- Establishment of feedback mechanisms.

Progress has been made on each pillar, but continued efforts are required to ensure the steady implementation of the Strategy. Communication tools such as video screens, newsletters, and graphic information sheets are more actively used in the Department.

Furthermore, a departmental communication working group convenes on a regular basis to promote further coordination and collaboration across divisions. Additional emphasis has also been placed on the frequency and prominence of meetings, including those at the level of the Deputy Directors General, Department, directors, divisions, and sections, through which to ensure effective information/knowledge sharing at appropriate levels.

Recently, a working group concluded that, while the internal SG Portal provides a useful platform for information sharing, a new solution is required, including planned governance to ensure the content is regularly updated and relevant. The SG-Communication team will work with SGIS to implement a solution for the Department, but external expertise and funding would be instrumental in ensuring optimal success in making the most of the Safeguards Portal (intranet).

In addition to these ongoing efforts, strategic tools and planning are still needed on risk mitigation and crisis communication, communication working group skills, mentoring, and improving accountability.

In-house expertise would support the implementation of these activities based on the Strategic Internal Communication Plan. However, further support will be welcome. Additional MSSP resources, including funding for consulting and design expertise would support the development of tools and materials as well as provide advisory support regarding other internal communication challenges.

Outcome #3: Increased departmental staff member engagement and satisfaction.

Outputs	<ol style="list-style-type: none"> 1. Results of spot/pulse surveys and communication surveys. 2. Facilitation of departmental staff member focus groups regarding communication.
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Supporting Resource Mobilization Priorities

M.3.C1

Planned Activities

Improved internal communication not only promotes appropriate information sharing and coordination beyond Divisions and Sections, but also supports increased engagement of departmental staff members in their respective work.

With wider opportunities for effective communication, departmental staff members can more readily share and collaboratively develop solutions in support of verification activities while also finding efficiencies and reducing duplication of work. Particular emphasis should be placed on internal and external reporting, as the continuous streamlining of reporting work will further enhance the quality and consistency of the Department’s information products. With an increased level of internal communication and coordination, departmental staff members will also more clearly understand departmental objectives, priorities, and resources available to support their work. Such information sharing will also remain compliant with departmental confidentiality procedures.

In addition to the ongoing implementation of the tasks identified above, DDGO-001: Overall Safeguards Management and Coordination has developed feedback and measurement strategies to assess the impact of communication initiatives. These include spot/pulse surveys, communication surveys, leadership interviews, departmental staff member focus groups, and skill-building follow-up. These surveys identify remaining challenges and to consider further steps to be taken to address them. Work will continue to implement the Strategic Internal Communication Strategy, while assessment of its impact will inform further implementation of the Plan with reprioritized tasks.

In-house expertise would support the implementation of these activities based on the Strategic Internal Communication Strategy. However, further support will be welcome. Additional MSSP resources, including funding for consulting expertise would support the development of feedback and information sharing mechanisms as well as provide advisory support regarding other internal communication challenges.

★ **Outcome #4: Enhanced performance of SSACs in recipient States.**

Outputs	<ol style="list-style-type: none"> 1. Full (100%) implementation of activities planned in the 2021–2022 COMPASS workplans defining a roadmap for improvement in respective SSACs. 2. Increased number of SRA/SSAC staff with a demonstrated increase in knowledge or skills for safeguards implementation. 3. Domestic processes and procedures developed for effective safeguards implementation. 4. Improved technical capability for domestic inspections, with the use of non-destructive assay (NDA) equipment.
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Supporting Resource Mobilization Priorities

S.2.C1

T.3.C2

W.4.C1

Planned Activities

In order to best direct IAEA assistance and maximize its impact on SSACs and SRAs, the Department has developed, in consultation with respective pilot States, workplans that define assistance packages, project timelines, and associated performance indicators to assess implementation progress. The workplans serve as roadmaps for SSAC/SRA improvement; assistance is designed to address individual States’ needs identified as a result of a joint SSAC/SRA needs assessment by the Department and a State, and is to be implemented in phases to support the gradual development of SSACs and SRAs.

Since project implementation started in the pilot States, COMPASS has made steady progress in accordance with the relevant workplans. Over the past year, a number of activities have been conducted, including outreach webinars, national trainings, legal and regulatory support, and transfer of IT hardware and safeguards equipment. Many more activities are planned to start during 2022, with increasing involvement of, and coordination with, supporting MSSPs. As of the end of 2021, 12 MSSPs have accepted the MSSP Task Proposal 20/SPC-002 (COMPASS: Comprehensive Capacity Building Initiative for SSACs and SRAs). In addition to financial support, MSSPs provide valuable in-kind support contributing directly to the implementation of COMPASS activities. Activities supported by MSSPs include procedure, manual, and guideline development for respective SSACs, workshops to share experiences and best practices in safeguards implementation, and technical visits to MSSP facilities and SRAs.

COMPASS implementation activities are monitored and assessed using performance indicators. Moreover, upon completion of the pilot phase, a joint assessment will be conducted with regard to the project’s impact upon the effectiveness of a relevant SSAC and SRA.

While sufficient support has been provided by Member States to implement the initiative in seven pilot States in 2021 and 2022, additional support is requested in order to continue providing targeted, high-quality assistance to States beyond 2022 in the forms of:

- Financial contributions to deliver assistance and hire and retain staff for the implementation of the initiative.
- Expert support advising participating SSACs on the development of SSAC processes, procedures, manuals, and guidelines.
- Support for training and workshops to build expertise and capacities within SSACs.
- CFEs/JPOs to support COMPASS implementation may be needed.

SGAS-001: Destructive Analysis of Nuclear Materials

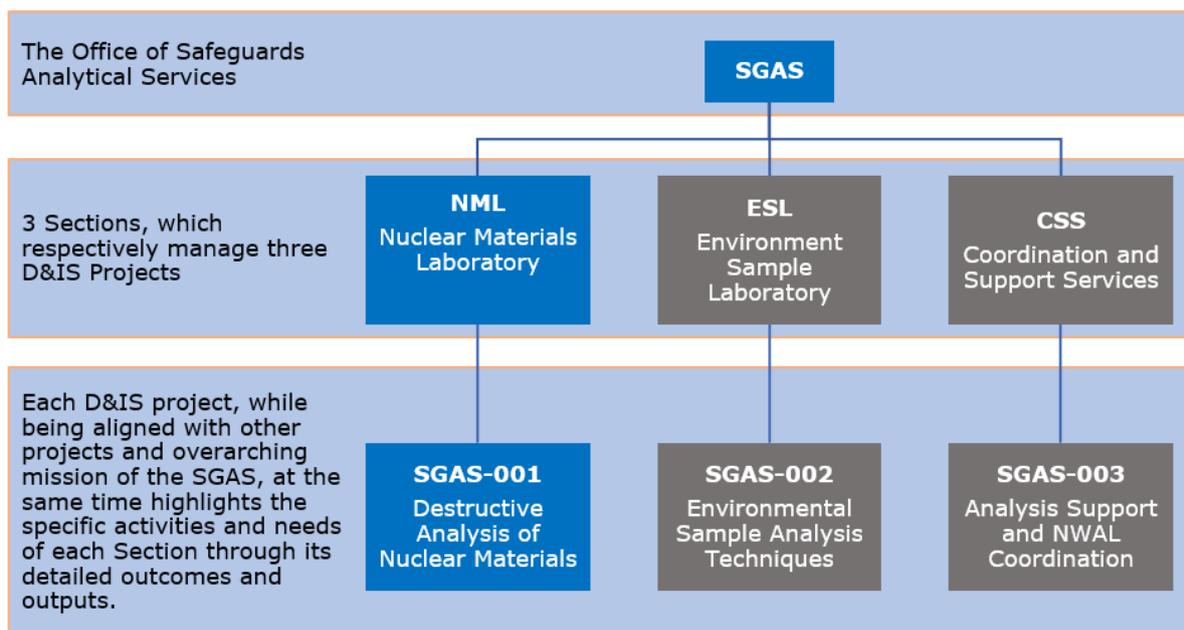
Improving destructive analysis (DA) capabilities and seeking new DA technologies in-house, with subject matter experts, and with MSSP support.

 Mika SUMI



Context for SGAS D&IS Plans

This text appears at the beginning of SGAS-001, SGAS-002, and SGAS-003 plans.



SGAS-001: Destructive Analysis of Nuclear Materials

Nuclear material sample analysis (also called destructive analysis, or “DA”) primarily supports the verification of accountancy and material balance evaluations. Provision of reference materials, development of new instrumentation and methods for analysis of ever-smaller samples, and the delivery of specialized analytical assistance highlight the support areas to the NML via the SGAS-001 plan.

Plan Acronyms

COMPUCEA	Combined Procedure for Uranium Concentration and Enrichment Assay
CPC	controlled potential coulometry
DA	destructive analysis
HKED	Hybrid K-Edge Densitometry
ILC	interlaboratory comparisons
NML	Nuclear Materials Laboratory
NWAL	Network of Analytical Laboratories
OSL	On-Site Laboratory
QC	Quality Control
Pu	Plutonium
TES	Transition Edge Sensor
U	Uranium

Context Highlights

How the Department Uses Nuclear Material Sample Analysis Techniques

Destructive analysis (DA) of inspection samples results are a direct source of independent, validated information that contributes to safeguards conclusions. The Department relies on the work of this D&IS plan to assure that its DA capabilities remain efficient, effective, and reliable.

The overall objective is to improve existing DA capabilities and seek new DA technologies through strengthened partnerships with subject matter experts and MSSP laboratories including the Network of Analytical Laboratories (NWAL) to support in-house activities. The Department continuously seeks ways to improve DA quality (sampling, timeliness of analysis, uncertainty quantification, and robustness) and efficiency (cost control and waste reduction) through advancements in hardware, software, and analytical procedures.

Lastly, certified reference materials are integral to SGAS's Quality Control (QC) programme and interlaboratory comparisons (ILCs). They are used to regularly calibrate instruments and processes and assess the accuracy of analysis.

Upcoming Challenges

The Rokkasho Reprocessing Plant in Japan is currently expected to become fully operational sometime in 2023 or 2024, which may require accelerated completion of current DA tasks during the 2022–2023 biennium. In addition, business continuity planning in the case of a shutdown of the On-Site Laboratory (OSL) in Japan (including analytical processes and authentication measures) is being planned with State authorities and the facility operator.

Requests for high-priority sample analysis and determination of new chemical and physical attributes of samples are increasing. Development and implementation of new sampling and analytical techniques which is optimized for analysis at safeguards analytical laboratories are therefore of much interest to improve timeliness in analysis and reporting.

Covid-19 and the Timeliness of Inspection Samples

Figures 1 and 2 show timeliness of inspection samples between sampling at facility, delivery, and analysis by SGAS and completion of the evaluation of analytical results by SGIM. Because of Covid-19, it took longer to import samples while time required for analysis at NML were slightly longer but almost equivalent to previous years. To maintain current timeliness with new chemical and physical attributes of samples, improvement of methods and instrumentation are necessary.

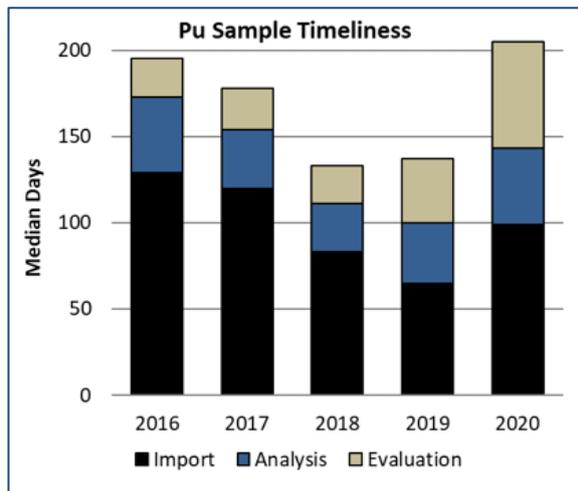


Figure 1: Pu timeliness plot for 2016–2020

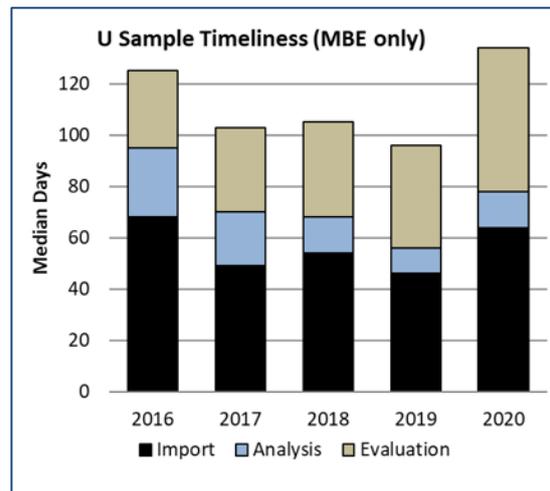


Figure 2: U timeliness plot for 2016–2020

Most Needed Extrabudgetary Support in 2022–2023

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|--|---|---|-----------------------------------|
| <input type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input checked="" type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.2.C1** Ability to reliably and quickly deliver sample analysis results for special and high priority demands
- T.2.C2** Ability to determine age of U and Pu in environmental samples through techniques and evaluation methods
- T.2.C4** Ability to perform mixed U-Pu particle analysis, including screening, isotopic and elemental composition analysis

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Improved analytical techniques, methods, and resources to ensure analytical capabilities at the On-Site Laboratory (OSL) in Japan.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> ★ Implementation of new evaluation software for Hybrid K-Edge Densitometry (HKED). Design new handling tools for glove box and hot cell operations. Evaluation of new instrumentation with regard to business continuity plan. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.2.C1

Planned Activities

Analytical capabilities at the On-Site Laboratory (OSL) in Japan are aided and improved with the support of multiple Member States. These capabilities must be fully operational before the Rokkasho Reprocessing Plant begins commercial operation, which is currently anticipated in 2023 or 2024.

HKED is the workhorse analytical technique used at the OSL for determining U and Pu concentrations. Newly-developed evaluation software must be tested and evaluated by analysing complex actinide mixtures and mixed U/Pu solutions. This evaluation will require support from various MSSPs with preparation of reference dissolver and product solutions. The third HKED workshop and ensuing HKED intercomparison exercise will be organized in Q1 or Q2 2022.

Sample handling tools for glove boxes and hot cells at the OSL are aging and must be replaced, possibly with newly-designed ones.

In addition, business continuity planning for the OSL is underway and includes a full backup of analytical procedures in case the OSL becomes unavailable for any period long enough to affect safeguard implementation.

The vulnerability for all addressed analytical activities in this D&IS plan shall also be assessed in the framework of the ongoing business continuity planning.

Outcome #2: Improved techniques and methods for independent verification of Pu amount in DA samples and reference materials.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none">1. A technical meeting for reference materials.2. Implementation and validation of a modernized software for controlled potential coulometry (CPC) system in the NML for Pu assay. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.2.C2

T.2.C4

Planned Activities

IAEA will organize a technical meeting focused on reference material needs for DA in the nuclear fuel cycle. IAEA seeks participants from MSSPs to review progress and discuss new needs since the 2014 Technical Meeting, "Reference Materials for Destructive Analysis in the Nuclear Fuel Cycle." The Technical Meeting may be combined with another technical meeting that focuses on the nuclear material round robin exercise, which is planned for the 2022–2023 biennium.

Controlled Potential Coulometry (CPC) is a primary analytical method for determining plutonium amount. It is used in NML for verification of the Pu amount in in-house reference materials prepared from certified reference materials. Implementation and validation of a modernized CPC software package at the NML will increase the reliability of reference material verification.

Outcome #3: Improved techniques, methods, and instrumentation to enhance the timely delivery of reliable analytical results.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none">1. ★ Development and deployment of a microcalorimetry system(s) at NML.2. ★ Implementation of the ABACC-Cristallini UF₆ sampling method for collecting safeguards samples from commercial uranium enrichment plants for analysis at NML.3. Support for reference materials and verification of in-house working standards used for the destructive analysis in NML. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.2.C1

Planned Activities

Microcalorimetry techniques provide high-quality results with a relatively simple sample preparation process and low uncertainties that are in the percent to sub-percent range. It can be applied for decay energy spectroscopy and high-resolution gamma spectroscopy measurements. Decay energy spectroscopy technique may be able to provide NML with an additional analytical method for high-precision laboratory analysis of plutonium samples obtained from nuclear fuel reprocessing facilities. It can also be potentially used for determining the presence of certain radionuclides in samples with very low concentration, such as high-active liquid waste samples. Implementation of this method at NML will reduce analysis time, increase throughput and timeliness, and reduce chemical separations and radioactive waste generation. Further validation of a microcalorimetry-based decay energy spectroscopy system performance and refinement of the sample preparation technique is needed before deployment at NML.

In addition, a microcalorimetry-based, high-resolution gamma-spectroscopy system will be validated for use with U and Pu samples. This recently developed system can be used for non-destructive isotopic composition measurements and has the potential to reach measurement accuracies between destructive and existing non-destructive analysis techniques. Microcalorimetry may therefore provide an alternative technique to time-consuming and complex destructive analysis for some sample types.

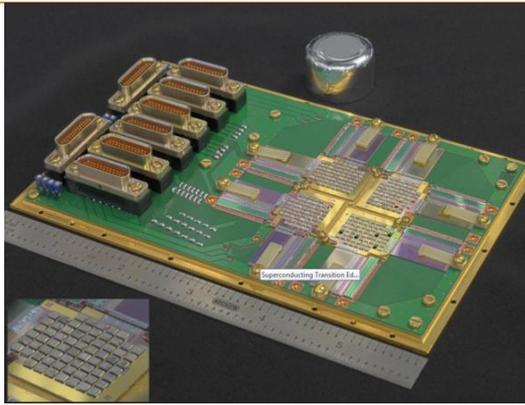


Figure 3: Transition Edge Sensor (TES) array for high-resolution gamma-spectroscopy applications.

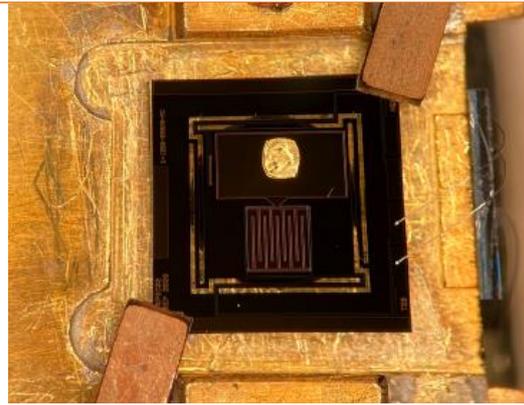


Figure 4: TES for decay energy spectroscopy applications.

The ABACC-Cristallini UF₆ sampling method was developed and extensively tested by the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC). The IAEA is currently validating the sampling technique at commercial uranium enrichment plants. Samples are delivered and analysed at NML to confirm the method performance. Practicalities of implementing this sampling method, such as conformance with facility safety procedures, working instructions, training, etc., are taking place at each facility so that the method can become a routine sampling method for UF₆.



Figure 5: ABACC Cristallini samples of UF₆.



Figure 6: Titrating samples in the U lab.

The NML continues to request reference materials from MSSPs for quality control and calibration of methods and instrument. This supports the precise and timely analysis of inspection samples. NML also continues to request verification of in-house produced working standards (spike solutions and large dried spikes) from MSSPs. Also, the IAEA seeks provision of highly-specialized certified or well-characterized reference materials from Member States to conduct a variety of ILC exercises and support internal quality control at the NML.

SGAS-002: Environmental Sample Analysis Techniques

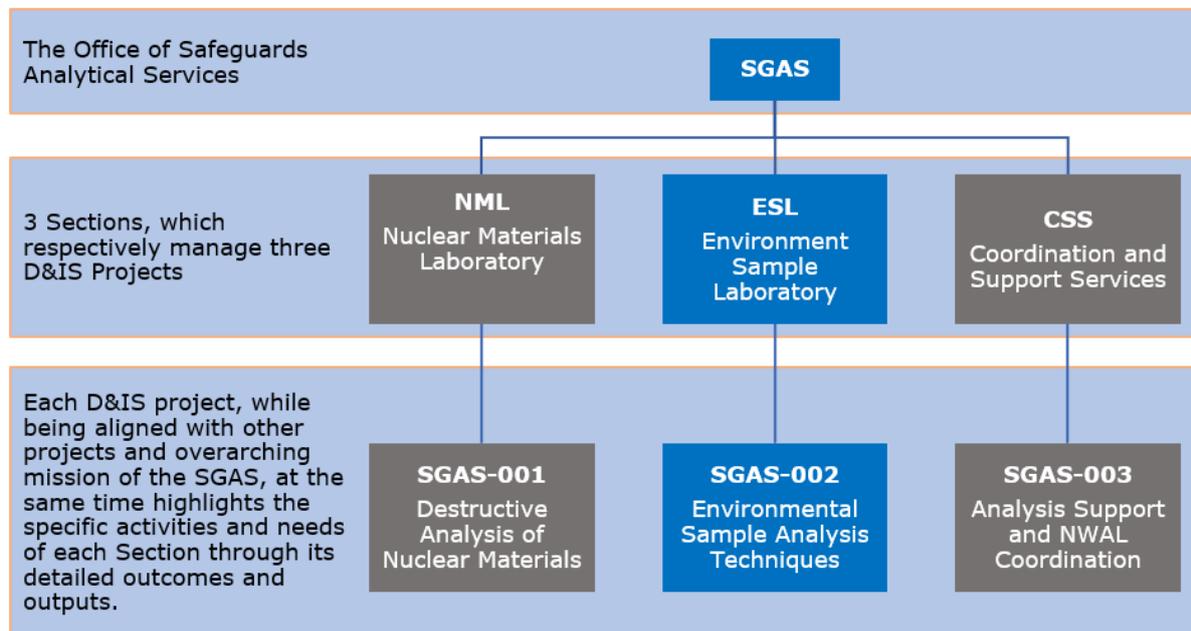
Providing timely, accurate, and precise analytical data from environmental samples collected by IAEA Safeguards inspectors.

 Matthew KILBURN



Context for all SGAS D&IS Plans

This text appears at the beginning of SGAS-001, SGAS-002, and SGAS-003 plans.



SGAS-002: Environmental Sample Analysis Techniques

Environmental sample analyses are used to indicate the presence or absence of undeclared nuclear materials and activities. SGAS-002 is the vehicle by which the Environmental Sample Laboratory (ESL) develops or acquires new reference materials, analytical methods, and instrumentation with enhanced sensitivity for U and Pu by bulk- and particle-based techniques.

Plan Acronyms

ES	Environmental Sampling
ESL	Environmental Sample Laboratory
FT-TIMS	Fission Track- Thermal ionization mass spectrometry
ICP-MS	Inductively-coupled-plasma mass spectrometry
LA-ICPMS	Laser-ablation inductively-coupled-plasma mass-spectrometry
LG-SIMS	Large-geometry secondary ion mass spectrometry
NFC	Nuclear Fuel Cycle
NWAL	Network of Analytical Laboratories
PIC	Pre-Inspection Check
QA	Quality Assurance
QC	Quality Control
SEM	Scanning electron microscopy
SIMS	Secondary ion mass spectrometry

Context Highlights

How the Department Uses Environmental Sample Analysis Techniques

Environmental sampling (ES) is a highly effective tool used by the Agency to detect the presence (or verify absence) of undeclared nuclear material and activities.

The detection and analysis of uranium (U) and plutonium (Pu) isotopes, either in the whole environmental sample (bulk analysis) or in individual micrometer-sized particles within the sample, requires state-of-the-art analytical instrumentation, highly-skilled staff, and a comprehensive quality management system.

To maintain the highest levels of sensitivity, accuracy, and precision, the Environmental Sample Laboratory (ESL) must stay aware of emerging technologies, facilitate development of new technologies and improvements to existing technologies, and continuously improve data quality through the implementation of a robust Quality Assurance/Quality Control (QA/QC) programme.

MSSPs continue to provide key support in the development of new technologies, methods, and materials to enhance sensitivity, reliability, and timeliness in sample analysis.

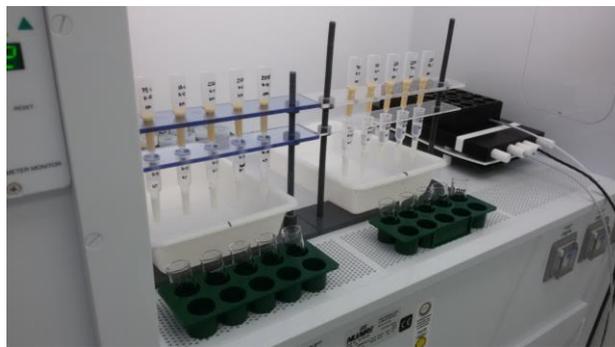


Figure 1: Analysis at the Environmental Sample Laboratory.

Challenges

The Department faces a number of challenges and opportunities going forward. Assuring the accuracy of data obtained through ES requires the implementation of robust quality control (QC) measures, both within the ESL and across the Network of Analytical Laboratories (NWAL). Reference materials and standards are used to calibrate instruments and provide traceability and to assess the reliability and performance of analytical laboratories. Although there has been much progress in the fabrication of new reference materials applicable to ES in the past few years, the limited availability continues to be a factor. Reference materials are essential for quality assurance and the quality control of analytical data. The production of QC material is both costly and time consuming due to the complexity of fabricating raw materials with a well-constrained and homogeneous composition. Preparing swipes from these materials that resemble inspection samples provides an additional challenge, requiring specialized production facilities and meticulous characterization.

A key objective of the Department is to develop and implement new and complementary techniques to enhance the detection of signatures of undeclared nuclear activities in environmental samples. As the sensitivity of analytical techniques continues to improve, samples may yield more information about the processes they have undergone, such as using isotopes to determine the age of a material or the presence of characteristic elements to indicate specific processes in the nuclear fuel cycle. As techniques evolve, novel QC materials are needed to calibrate instruments and check data accuracy, trueness, and precision.

A further challenge lies in maintaining the Agency's ability to provide analytical capabilities that meet the requirements of safeguards evaluators. Current ESL capabilities include the bulk analysis of environmental swipe samples by inductively-coupled-plasma mass spectrometry (ICP-MS) and the analysis of particles by large-geometry secondary ion mass spectrometry (LG-SIMS) and scanning electron microscopy (SEM). The regular replacement of ageing analytical equipment is key to independently verifying nuclear activities impartially and on time.



Figure 2: The regular replacement of ageing analytical equipment (like the ICP-MS on the left and the LG-SIMS on the right) is key to independently verifying nuclear activities impartially and on time.

Most Needed Extrabudgetary Support in 2022–2023

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|--|--|---|-----------------------------------|
| <input checked="" type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input checked="" type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.2.C1** Ability to reliably and quickly deliver sample analysis results for special and high priority demands
- T.2.C2** Ability to determine age of U and Pu in environmental samples through techniques and evaluation methods
- T.2.C3** Ability to detect NFC materials and determine nuclear activities based on elemental and morphological analysis of particles in environmental samples, with emphasis on the recognition of anthropogenic particles using scanning electron microscopy techniques
- T.2.C4** Ability to perform mixed U-Pu particle analysis, including screening, isotopic and elemental composition analysis
- T.2.C5** Ability to assure the quality of the NWAL, including SAL, in environmental sample analysis (specifically particle analysis) using fit-for-purpose quality control and quality assurance methods

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Improved reliability of analytical results through the provision of reference materials for internal and external QA/QC programmes.

Outputs

- ★ Additional new reference materials (one per year) to be made available for internal and external QA/QC programmes.

Supporting Resource Mobilization Priorities

T.2.C1

T.2.C5

Planned Activities

Working with MSSPs, the IAEA will make available additional reference materials to the laboratories performing ES analysis, for both internal and external QC purposes. An external Quality Control Programme for the Network of Analytical Laboratories (NWAL) has been developed by SGAS-003: Analysis Support and NWAL Coordination utilising materials provided by ESL and MSSPs. This D&IS plan currently has MSSP Tasks for QC particle production with the EC, FRA, GER, and USA, and bulk QC swipes are produced by both ESL and the United States Department of Energy. Member States are requested to ensure the availability of resources to sustain the ongoing production of valuable reference materials for ES analysis.

IAEA Technical Meetings and Working Group Meetings provide important forums for experts to review requirements, share expertise, and advise on technical aspects of QC material production. Through these forums the Agency will seek to remain aware of potential new sources of reference materials that might assist in delivery of its environmental sample analysis activities. Member States are encouraged to participate in such meetings.

Outcome #2: Improved techniques, methods, and equipment to detect signatures of undeclared nuclear activities in environmental samples.

Outputs

- ★ Implementation of a procedure for the age determination of particles using Large-geometry secondary ion mass spectrometry (LG-SIMS).
- Implementation of a procedure for the analysis of Pu and mixed U/Pu particles in environmental samples using laser-ablation inductively-coupled-plasma mass-spectrometry (LA-ICPMS).
- Development and implementation of a methodology to detect nuclear fuel cycle (NFC) materials and determine nuclear activities based on the elemental and morphological analysis of particles in environmental samples, in particular using scanning electron microscopy (SEM) techniques to determine anthropogenic origin of particles.
- ★ Development of a rapid particle screening method for Pre-Inspection Check (PIC) sample analysis.

Supporting Resource Mobilization Priorities

T.2.C2

T.2.C3

T.2.C4

Planned Activities

Determining the age of particles, or more specifically the time since last separation or irradiation, is key to understanding the timing of activities within a facility. The ESL will implement a methodology using LG-SIMS for particle age determination using the decay of ^{234}U - ^{230}Th . This key emerging technology needs to be assessed and validated before its use in drawing safeguards conclusions, and support in terms of technical assistance and reference materials would be highly beneficial.

The ESL is also developing a technique to measure isotopes in Pu and U/Pu mixed particles using laser-ablation ICP-MS to complement the Fission Track-Thermal ionization mass spectrometry

(FT-TIMS) analysis provided by the NWAL. The ESL is aware of a number of other Member State laboratories also developing a capability in this area and seeks technical cooperation.

An important requirement of safeguards evaluators is the ability to differentiate between natural mineral and man-made uranium particles using a combination of the physical, elemental, and isotopic properties in individual particles. The development of SEM and ancillary techniques to characterize different types of NFC materials and how they appear as particulate material in environmental samples is required.

Another top priority requirement is the ability to rapidly screen PIC samples for particles. A sensitive, high-throughput approach, such as secondary ion mass spectrometry (SIMS), would be required.

To achieve these outputs, the ESL would benefit from further development and collaboration with experts from Member States.

Outcome #3: Maintained ability to reliably perform analysis of nuclear material and environmental samples at SG Analytical Laboratories.

Outputs	1. Replace analytical and ancillary equipment in line with the Integrated Lifecycle Management of Safeguards Assets Project in DDGO-001: Overall Safeguards Management and Coordination.
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Supporting Resource Mobilization Priorities

T.2.C5

Planned Activities

The ability to maintain the capability and capacity of analytical services provided by the ESL is dependent upon the availability of staff resources and the timely replacement of ageing analytical equipment.

The ESL currently maintains highly sophisticated mass spectrometers, microscopes, and screening tools, along with ancillary equipment with a replacement value of approximately €10 million. In the 2022–2023 biennium, the ESL will replace its high-resolution inductively-coupled-plasma mass spectrometry (ICP-MS) (used for screening bulk environmental samples) with an anticipated cost of €500 000 and seek funding to replace the multi-collector ICP-MS (used for the bulk isotopic analysis of environmental samples) with an anticipated cost of €850 000.

SGAS-003: Analysis Support and NWAL Coordination

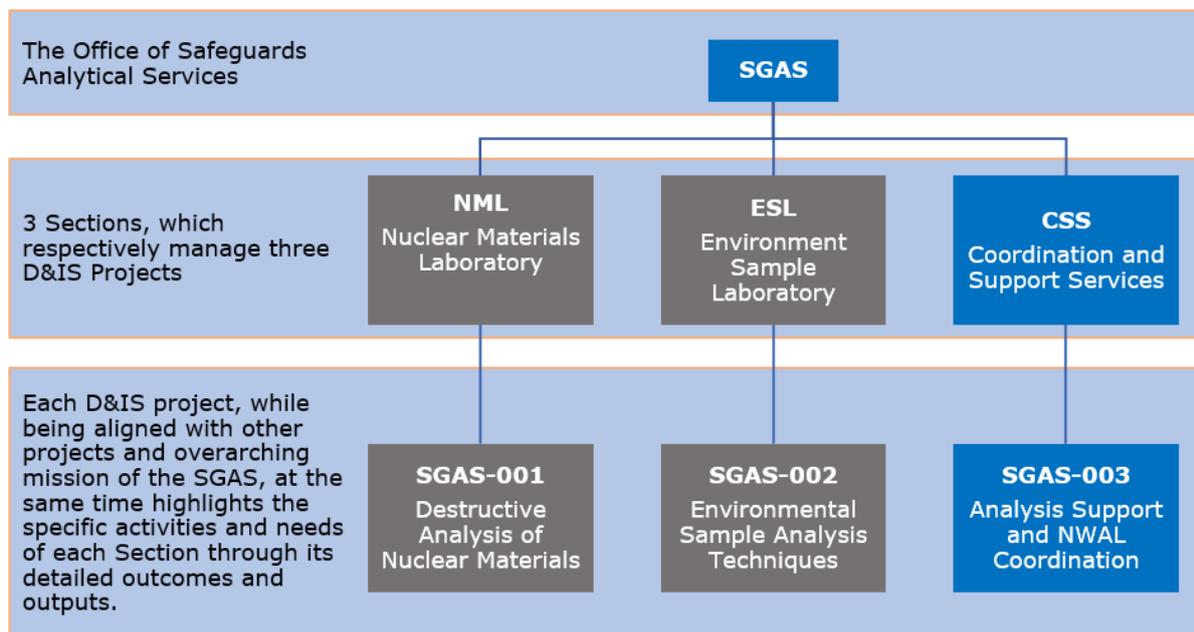
Enhancing the effectiveness and efficiency of the NWAL's sample analysis capabilities, capacity, quality and timeliness to support IAEA's verification mission.

 Veena TIKARE



Context for all SGAS D&IS Plans

This text appears at the beginning of SGAS-001, SGAS-002, and SGAS-003 plans.



SGAS-003: Analysis Support and NWAL Coordination

The Network of Analytical Laboratories (NWAL) provides extensive support to analysing environmental samples and furnishing quality control services for both nuclear material and environmental samples. Through SGAS-003, Coordination and Support Services (CSS) manages the capacity and scope of NWAL services to the Department. SGAS-003 also supports the development of custom, laboratory-specific software that is used to enhance the efficiency and reliability of operations.

Plan Acronyms

AFTAC	Air Force Technical Applications Centre
ANSTO	Australian Nuclear Science and Technology Organization
AWE	Atomic Weapons Establishment
CEA	Commissariat à l'Énergie Atomique et aux Énergies Alternatives
CETAMA	Commission d'Établissement des Méthodes d'Analyses
CIAE	China Institute of Atomic Energy
CSS	(SGAS) Coordination and Support Section
EC-JRC	European Commission Joint Research Centre
ES	Environmental Sampling
ESL	Environmental Sample Laboratory
FJZ	Forschungszentrum Jülich
FT-TIMS	fission-track detection + thermal ionization mass spectrometry
IDMS	isotope dilution mass spectrometry
ILC	Inter-Laboratory Comparison (Exercise)

IRD	Instituto de Radioproteção e Dosimetria
JAEA	Japan Atomic Energy Agency
KAERI	Korea Atomic Energy Research Institute
KRI	Khlopin Radium Institute
LANIE	CEA Laboratoire d'Analyses Nucléaires Isotopiques et Élémentaires
LANL	Los Alamos National Laboratory
LG-SIMS	large geometry secondary ion mass spectrometry
LIMS	Laboratory Information Management Systems
LLNL	Lawrence Livermore National Laboratory
LMA	Laboratory for Microparticle Analysis
NBL	New Brunswick Laboratory
NML	Nuclear Materials Laboratory
NWAL	Network of Analytical Laboratories
ORNL	Oak Ridge National Laboratory
PIC	pre-inspection check
PNNL	Pacific Northwest National Laboratory
QA	Quality Assurance
QC	Quality Control
SAL	Safeguards Analytical Laboratory
SALIMS	Safeguards Analytical Laboratory Information Management System
SEM	Scanning electron microscopy
SRNL	Savannah River National Laboratory
US DOE	United States Department of Energy
UWA	University of Western Australia

Context Highlights

Background Information

IAEA Safeguards inspectors collect nuclear material (NM) and environmental samples during field activities, and these are analysed at the Safeguards Analytical Laboratories in Seibersdorf, Austria and the broader Network of Analytical Laboratories (NWAL). NM sample analysis primarily supports the verification of material accountancy and material balance evaluations used to assess Member State declarations of NM holdings. Environmental sample analyses are used to detect undeclared nuclear materials and activities. Environmental samples are generally analysed by two methodologies: bulk and particle analysis. Bulk analysis determines the total amounts of uranium (U) and plutonium (Pu), together with their average isotopic compositions in the entire portions of samples collected by IAEA Safeguards inspectors. Particle analysis measures the U and Pu isotopic composition in individual particles extracted from samples, and when required, elemental composition and morphological attributes of nuclear and non-nuclear materials involved in nuclear activities.

The NWAL analyses NM and environmental samples and provides results to the safeguards data evaluators (see SGIM-007: Evaluation of Data from ES and Material Characterization). The data evaluators then draw conclusions about the correctness and completeness of the State declarations based on these analysis results and other relevant information. Thus, it is vitally important that the quality and impartiality of the field sample analysis results are of the highest standards.

How the Department Uses the Work of Analysis Support and NWAL Coordination

SGAS CSS administers and coordinates sample analysis by the NWAL, assures analysis impartiality, and administers a rigorous quality control (QC) programme. A major tenet of the NWAL QC programme includes regular Inter-Laboratory Comparison (ILC) exercises to confirm the quality of analytical results across the NWAL so that analysis results can be interpreted with appropriate confidence. SGAS CSS also ensures there is sufficient capacity within the NWAL for the established types of analyses. Lastly, certified reference materials are integral to SGAS's QC programme. They are used to regularly calibrate instruments and processes and assess the accuracy of analysis.

Priorities

To accomplish these, SGAS CSS relies on Member States to support these broadly categorized priorities:

1. Provide timely, accurate analysis of environmental and NM samples by the NWAL.

2. Expand the overall capacity of the NWAL for the analysis of environmental samples while maintaining high-quality analysis.
3. Support assessment of NWAL member capabilities by participating in ILC exercises organized by SGAS and others (for example, United States Department of Energy).
4. Produce a variety of highly specialized reference materials to support the NWAL QC programme and internal quality control at the laboratories.

The NWAL

SGAS CSS maintains a vigorous collaboration with the NWAL to communicate the unique analytic requirements of the Department, achieve an optimal balance between the Agency’s in-house laboratory capabilities and those of the external NWAL members, and foster a collegial working relationship between all NWAL members. SGAS CSS also distributes samples for analysis while ensuring sample anonymity and transport safety, and tracks their progress from collection to reporting of results.

Analysis of field samples (**priority #1**) is conducted by the NWAL, which consists of the Agency’s Safeguards Analytical Laboratory (SAL), which consists of the Environmental Sample Laboratory (ESL) and Nuclear Material Laboratory (NML) in Seibersdorf, Austria, plus 24 external laboratories from 11 Member States and the European Commission.

Environmental particle samples are analysed by these 10 qualified NWAL members:

- Safeguards Analytical Laboratory Environmental Sample Laboratory (SAL ESL) (IAEA)
- University of Western Australia (UWA), Australia
- China Institute of Atomic Energy (CIAE), China
- European Commission Joint Research Centre (EC-JRC) Karlsruhe, EC
- Commissariat à l’Energie Atomique et aux Energies Alternatives (CEA), France
- Japan Atomic Energy Agency (JAEA), Japan
- Korea Atomic Energy Research Institute (KAERI), Republic of Korea
- Laboratory for Microparticle Analysis (LMA), Russian Federation
- Atomic Weapons Establishment (AWE), UK
- Air Force Technical Applications Centre (AFTAC), USA

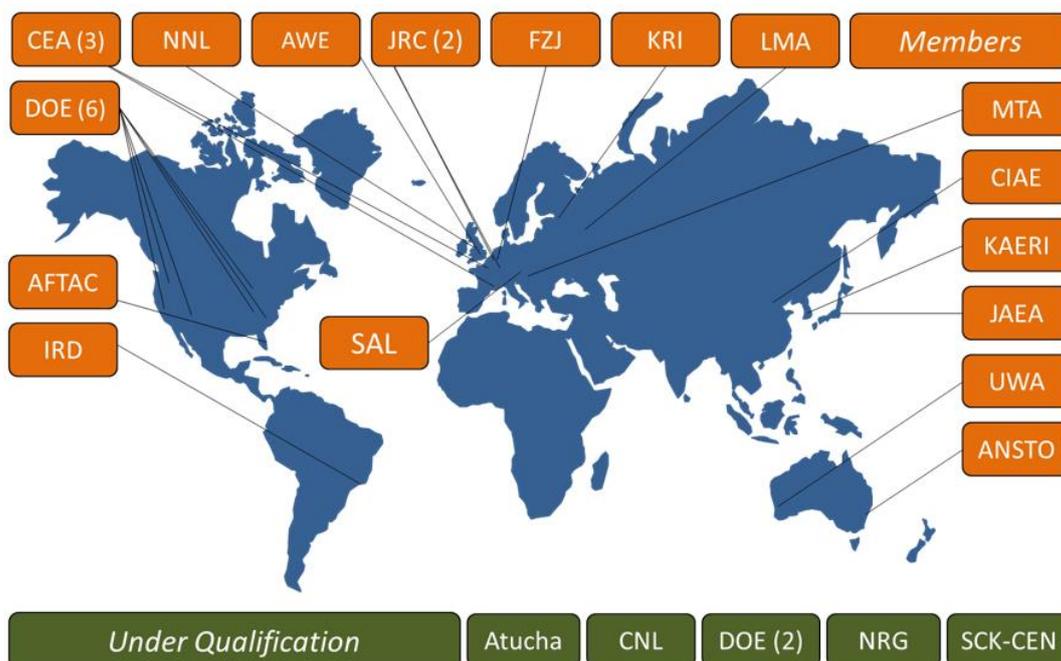


Figure 1: IAEA Network of Analytical Laboratories.

Bulk analysis of environmental samples is carried out by 11 qualified NWAL members:

- Safeguards Analytical Laboratory Environmental Sample Laboratory (SAL ESL) (IAEA)
- Australian Nuclear Science and Technology Organization (ANSTO), Australia
- Instituto de Radioproteção e Dosimetria (IRD), Brazil
- Commissariat à l’Energie Atomique et aux Energies Alternatives (CEA), France
- Japan Atomic Energy Agency (JAEA), Japan
- Korea Atomic Energy Research Institute (KAERI), Republic of Korea
- Khlopin Radium Institute (KRI), Russian Federation
- Four laboratories of the United States' Department of Energy (US DOE), USA:
 - Los Alamos National Laboratory (LANL)
 - Lawrence Livermore National Laboratory (LLNL)
 - Oak Ridge National Laboratory (ORNL)
 - Pacific Northwest National Laboratory (PNNL)

All NM sample analyses for material accountancy verification purposes are currently performed by the IAEA NML. However, support from the NWAL is required for quality assurance and as a backup in the event that the NML is temporarily unavailable. Four laboratories are qualified by the Agency to analyse NM safeguard samples:

- Safeguards Analytical Laboratory Nuclear Materials Laboratory (SAL NML) (IAEA)
- European Commission Joint Research Centre (EC-JRC), Karlsruhe, EC
- CEA Laboratoire d’Analyses Nucléaires Isotopiques et Élémentaires (LANIE), France
- US DOE Savannah River National Laboratory (SRNL), USA

In addition to accountancy analyses, other NM analyses, such as materials characterization, may be needed to determine the accuracy or completeness of Member State declarations. While the IAEA NML is equipped to perform many of these types of analyses, additional support is provided by several laboratories, including EC-JRC Karlsruhe, CEA in France, LANL, LLNL, ORNL, and PNNL of the US DOE, and the NNL Preston Laboratory in the United Kingdom.

Analysis of heavy water samples is performed by Centre for Energy Research (EK-CER), Hungary.

Finally, seven members of the NWAL provide reference materials and quality control services:

- Safeguards Analytical Laboratory Environmental Sample Laboratory (SAL ESL) and Nuclear Material Laboratory (NML) (IAEA)
- European Commission Joint Research Centre (EC-JRC) Geel, EC
- Commission d’Etablissement des Methodes d’Analyses (CETAMA), France
- Forschungszentrum Jülich (FJZ), Germany
- Khlopin Radium Institute (KRI), Russian Federation
- Two laboratories of the United States' Department of Energy (US DOE), USA:
 - Lawrence Livermore National Laboratory (LLNL)
 - New Brunswick Laboratory (NBL)

Expanding the NWAL

Over the past ten years there has been a nearly 50% increase in the number of environmental sample analyses. To address this steadily increasing number of environmental samples, and accompanying pre-inspection check (PIC) samples, the IAEA seeks to expand the current capacity of the NWAL (**priority #2**). In particular, the IAEA seeks greater capacity for the particle analysis of environmental samples—specifically from laboratories using large geometry secondary ion mass spectrometry (LG-SIMS) and fission-track detection + thermal ionization mass spectrometry (FT-TIMS)—either through increased support from existing NWAL members or from the addition of new laboratories to the network. Furthermore, the IAEA would welcome increased capacity from expert laboratories that perform elemental or morphological analysis of particles by scanning electron

microscopy (SEM), micro-Raman, and other similar techniques. Absent additional ES analysis capacity, the timeliness improvements witnessed in recent years will be in jeopardy.

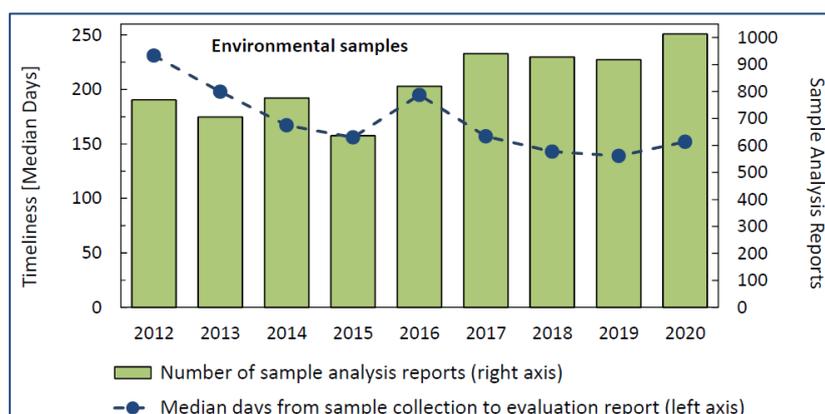


Figure 2: Environmental sample analyses is increasing.

Three laboratories in Belgium, Canada, and the Netherlands are currently under qualification for the analysis of NM samples for accountancy purposes, and the IAEA is currently not seeking extra capacity in this area. In addition, a laboratory in Argentina is under qualification for the analysis of heavy water samples.

The Quality Management Programme

SGAS CSS has established a comprehensive quality management programme, which includes regular ILC exercises covering the major safeguards analytical techniques to confirm the quality of analytical results across the NWAL and assess the quality of all supporting infrastructure such as IT tools used for tracking samples, collecting, and managing all associated data and metadata.

SGAS seeks support in maintaining high quality of analysis and interpretation of these analytic data from the NWAL (**priority #3**) by participating in SGAS’s ILC exercises, as well as in the external proficiency testing programmes conducted by JRC-Geel, CETAMA, and NBL. The IAEA seeks highly specialized certified or well-characterized reference materials (**priority #4**) from Member States to conduct a variety of ILC exercises and support internal quality control at NWAL laboratories.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|--|---|-----------------------------------|
| <input checked="" type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input checked="" type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.2.C1** Ability to reliably and quickly deliver sample analysis results for special and high priority demands
- T.2.C5** Ability to assure the quality of the NWAL, including SAL, in environmental sample analysis (specifically particle analysis) using fit-for-purpose quality control and quality assurance methods
- T.2.C7** Ability to reliably manage and deliver safeguards analytical results, for example, through SGAS laboratory information management system (LIMS)

Development Plan for 2022–2023

★ The plans below bear the same high priority.

Outcome #1: Modernized distribution of safeguards samples to the NWAL.

Outputs	1. Delivery of a re-engineered NWAL coordination application to track sample assignment, shipping, analysis, and reporting, and full integration of this application into the SGAS Laboratory Information Management Systems (LIMS) architecture.
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Supporting Resource Mobilization Priorities

T.2.C1	T.2.C5	T.2.C7
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Planned Activities

The IT tool to manage the distribution of samples to the NWAL was written by multiple developers using outdated software infrastructure and different operating system versions. While functional, it is increasingly challenging to maintain and difficult to improve.

Financial support is sought to cover the HR costs for an IT systems analyst who will re-engineer the NWAL Coordination Application into a modern, single, integrated IT tool with consistent coding practices for the entire management system.

The IT Systems Analyst would also assist in the testing, maintenance, and documentation of the enhanced NWAL Coordination Application and its proper integration into the SGAS LIMS architecture thus contributing to the Safeguards Analytical Laboratory Information Management System (SALIMS) upgrade project.

Outcome #2: Improved reliability of analytical results through the provision of reference materials for internal and external quality assurance/quality control (QA/QC) programmes.

Outputs	1. Qualification of one—possibly two—additional NWAL members for the provision of particle reference materials.
	2. Continued support from NWAL and other laboratories of high-quality reference materials.

Supporting Resource Mobilization Priorities

T.2.C1	T.2.C5
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Planned Activities

Reference materials are indispensable to the SGAS QC programme. They are used routinely to calibrate instruments, trace to ISO standards, and develop analytical methods. For external quality control purposes, they are used in ILC exercises. For this last purpose, SGAS is seeking the provision of well-characterized particle reference materials for ES particle analysis. SGAS CSS relies on SGAS-002: Environmental Sample Analysis Techniques to verify and, if needed, characterize reference particles, as fit for safeguarding purposes. High-quality particles with specified isotopic composition of U, mixed U-Th, Pu, and mixed U-Pu particles in micro- to milligram quantities are needed to assess the quality of environmental sample analyses. SGAS CSS is seeking qualification of laboratories with unique capabilities and/or particular expertise in the production and characterization and, if possible, certification of reference materials to develop highly-specialized materials for quality control of analytical performance in support of safeguards, for example, reference materials for trace element or minor isotope composition of uranium, for material age-dating techniques, and for SEM analyses.

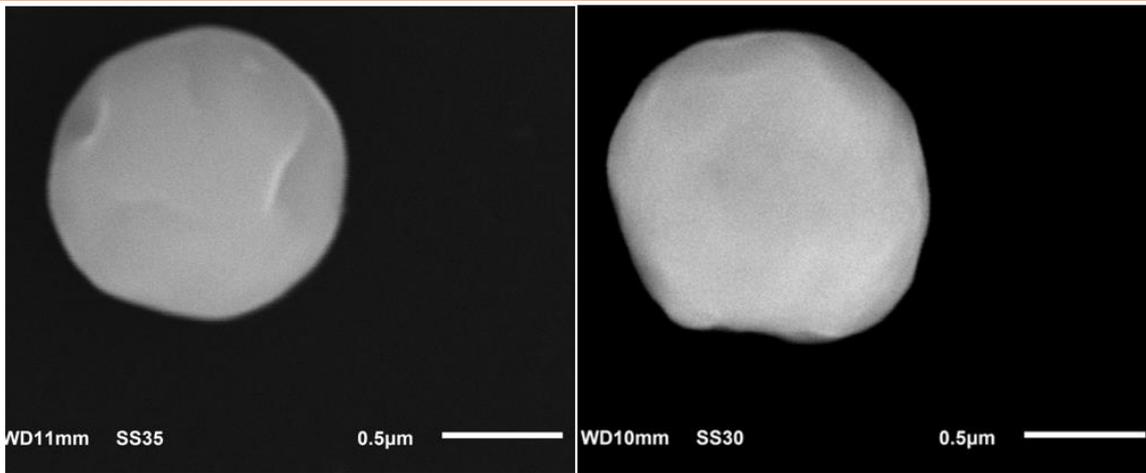


Figure 3: Scanning electron microscopy (SEM) images of produced U reference particles.

Outcome #3: Strengthened quality assurance of the NWAL analytical services.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. Conduct an ILC exercise on bulk analysis of environment samples in 2022. 2. Conduct an ILC exercise on particle analysis of environmental samples in 2023. 3. Conduct a NM analysis round-robin exercise during the 2022–2023 biennium. 4. Conduct an ILC exercise for controlled potential coulometry in 2023. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.2.C5

Planned Activities

ILC exercises provide safeguards evaluators with insight into the capabilities of NWAL members to detect elements and isotopes, their abundance, and their relative amounts.

SGAS CSS seeks to design, interpret, and provide feedback to the NWAL members on the detection and measurement of materials of interest through ILC exercises. It also seeks to provide safeguards evaluators the understanding they need to interpret the data collected from the analysis of field samples. For this purpose, SGAS CSS seeks the assistance of NWAL and MSSPs in participating in the IAEA ILC exercises and welcomes participation in the external proficiency testing programmes conducted by JRC-Geel, CETAMA, and NBL.

Outcome #4: Expanded NWAL capabilities and capacity to analyse field samples quickly and to high-quality standards.

Outputs 1. Qualify up to three new laboratories to join the NWAL for analysing environmental samples.

Supporting Resource Mobilization Priorities

T.2.C1

T.2.C5

Planned Activities

This outcome ensures that the NWAL has sufficient capacity and capability to complement the Agency's in-house resources for environmental sample analysis and to mitigate against temporary loss of analytical service from one or more active laboratories.

The Department is seeking expanded capacity and capabilities for environmental sample analysis, with special emphasis on the following:

- Bulk analysis by isotope dilution mass spectrometry (IDMS);
- Particle isotopic composition of U and Pu by FT-TIMS and LG-SIMS;
- Particle characterization by SEM, micro-Raman, and other similar techniques (in close collaboration with SGAS-002: Environmental Sample Analysis Techniques); and
- Particle screening techniques for PIC swipes (also in close cooperation with SGAS-002: Environmental Sample Analysis Techniques).

During NWAL Technical Meetings, a community of experts from the NWAL reviews analytical practices, shares information on method improvements, and revises technical objectives for performance monitoring.

SGCP-003: Safeguards Approaches

Developing, modelling, and demonstrating concepts and approaches to meet evolving safeguards challenges.

 Jay DOO



Plan Acronyms

AIP	Annual Implementation Plan
APA	Acquisition Path Analysis
CCA	Concepts and Approaches Section
DIQ	Design Information Questionnaire
DIV	Design Information Verification
HTR-PM	High Temperature Gas Cooled Reactor Pebble Modules
IMSR	Integral Molten Salt Reactor
KLT-40S	Russian Afrikanov OKBM transportable (floating) nuclear power plant model (type of SMR)
PM	Physical Model
SLA	State Level Approach
SMR	Small Modular Reactor
SSR-W300	Stable Salt Reactor - Wasteburner

Context Highlights

Mission

As long as an ingenuity for new types of nuclear facilities endures, SGCP-003: Safeguards Approaches will be developing new safeguards concepts and approaches to safeguard them.

Challenges

An increasing number of new types of facilities, facilities that require early adoption of safeguards by design, facilities that face decommissioning, and the non-stop emergence of new technologies require new safeguards concepts and approaches that can only be developed with augmented knowledge and expertise from MSSPs.

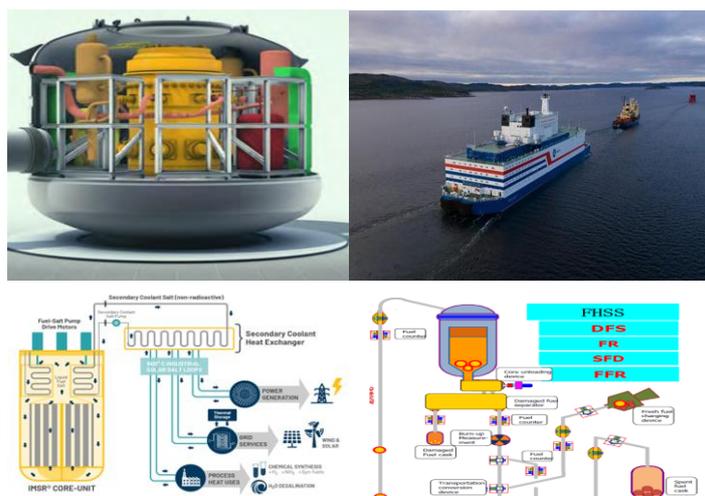


Figure 1: New types of Small Modular Reactors (SMRs).

With many new concepts and approaches coming online, the IAEA must carefully align its safeguards methodologies, procedures, and guidelines to further enhance the consistency of safeguards implementation at the State level.

State Level Approaches (SLAs)

Based on IAEA's experience and feedback from the IAEA safeguards departmental working group, detailed technical guidance reports will be continually prepared for developing and updating State Level Approaches (SLAs). Methodology and guidance for assessing acquisition path steps, including a State's technical capability to develop nuclear fuel cycle technologies and facilities as well as nuclear material diversion and facility misuse scenarios will be assessed.

Physical Model

The Physical Model will be continuously updated to ensure that the lists of signatures and indicators of nuclear fuel cycle activities are complete and that the weighing of the indicators is accurate with respect to evolutions in fuel cycle technology. The IAEA may contact MSSP experts during its internal consistency and coherency review for targeted support. A JPO has been requested to support the internal consistency and coherency review of each Physical Model volume.

New Facility Types Including Small Modular Reactors

Technical challenges for safeguards implementation involving new types of facilities including small modular reactors will be assessed to incorporate safeguards-by-design principles at an early stage of the design. The IAEA, with Member State authority and facility designers/operators, will identify and evaluate details of the facility design that could affect safeguards, investigate strategies for implementing safeguards, and identify ways to incorporate safeguards by design principles. For each type of facility or small modular reactor, at least two meetings per year will be held between the Member State authority/designers and the IAEA.

Facilities Under Decommissioning, Facilities to be Decommissioned, and Post-Accident Facilities

For *International Safeguards Guidelines for the Post-Operational Phases of Nuclear Facilities and Locations Outside Facilities (STR-396)*, the IAEA will host workshops with Member States who have facilities under decommissioning or to be decommissioned. To develop *Safeguards guidelines for post-accident facilities*, the IAEA will host two or three consultancy meetings. The Japan Support Programme will support a CFE to develop safeguards guidelines for post-accident facilities and to assist workshops for facilities under decommissioning or to be decommissioned.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|--|--|---|
| <input type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.4.C3** Ability to maintain awareness of changes in the nuclear landscape and associated impact on safeguards implementation, including the impact of emerging technologies and non-State actors
- S.3.C1** Ability to identify and address the needs of designers and operators of modified or new facilities in the early preparation for efficient implementation of safeguards
- T.1.C3** Ability to more effectively and efficiently verify spent fuel from on-load reactors
- V.3.C1** Ability to derive verification intensities and frequencies from performance targets and to determine detection probabilities
- V.3.C2** Ability for safeguards information systems to assist analysts in identifying significant changes in a State's nuclear fuel cycle, which may trigger a need to update the APA, SLA, and AIP
- V.4.C2** Ability to comprehensively evaluate, record, and document safeguards effectiveness at the State level
- V.6.C1** Ability to implement effective and efficient safeguards for geological repositories
- V.6.C2** Ability to implement effective and efficient safeguards for SMRs and microreactors
- V.6.C4** Ability to perform process monitoring and associated data analysis for safeguarding facilities, particularly advanced reactors with liquid or pebble fuel

Development Plan for 2022–2023

Outcome #1: Improved ability to fully implement the State Level Concept through the development of internal guidance documents and additional tools for the development of State Level Approaches.

Outputs 1. Acquisition path analysis reports on nuclear fuel cycle technologies.

Supporting Resource Mobilization Priorities

V.3.C1

V.3.C2

V.4.C2

Planned Activities

For developing and updating SLAs, methodology, and guidance for assessing acquisition path steps, including a State's technical capability to develop nuclear fuel cycle technologies and facilities as well as nuclear material diversion and facility misuse scenarios will be assessed on the basis of IAEA's experience and feedback from the IAEA safeguards departmental working group. Based on experience and feedback from the departmental working group, detailed technical guidance reports will be prepared for developing and updating State Level Approaches (SLAs).

The IAEA will organize consultancy meetings at IAEA HQs for assessing the remaining nuclear fuel cycle technologies (sub-tasks) in 2022–2023, and the 16 MSSPs who have the active MSSP Task called Umbrella Task -Technical Assistance on Methodology and Guidance for Implementation of Safeguards at the State-level will be asked for support (AUL C 2335; BEL C 2277; BRZ C 2311; CAN C 2238; CZ C 2224; EC C 2305; FIN C 2399; FRA C 2261; GER C 2245; HUN C 2236; JPN C 2230; NET C 2454; RUS C 2516; SWE C 2218; UK C 2268; and USA C 2241).

Outcome #2: Increased ability to detect undeclared nuclear material and activities through an updated and improved of the *Physical Model*.

Outputs 1. A completed version of the Physical Model, which would contain Volumes 1–3 and 5–11.

Supporting Resource Mobilization Priorities

V.3.C2

V.6.C1

M.4.C3

T.1.C3

Planned Activities

1. Volume 1 (Mining and ore processing)
2. Volume 2 (Conversion)
3. Volume 3 (Uranium enrichment)
4. Volume 5 (Fuel fabrication)
5. Volume 6 (Reactor and neutron sources)
6. Volume 7 (Heavy water)
7. Volume 8 (Reprocessing and recycling of spent fuel)
8. Volume 9 (Spent fuel management)
9. Volume 10 (Radioactive waste)
10. Volume 11 (Hot cells)

The Physical Model serves as a technical resource for departmental staff members involved in safeguards activities such as State evaluation, acquisition path analysis, and State Level Approach development and training. The PM needs to be continuously updated to ensure that the lists of signatures and indicators of nuclear fuel cycle activities are complete and that the weighing of the indicators is accurate with respect to any evolution in fuel cycle technology.

The PM should be organized and accessible in such a way that it facilitates analysis by State Evaluation Groups. During the internal review of the volumes to improve consistency and coherence of all the volumes, MSSP experts may be contacted for targeted support.

The Department has requested a JPO to technically edit and digitize the PM. A coherent, consistent, and digital version on the right platform will allow departmental staff members to access the content easily from anywhere and allow CCA to update it much more easily. The conversion to a digital version will reduce the amount of time, money, and paper utilized in hard copy document management. So far, no MSSPs have accepted MSSP Task Proposal 20/CCA-002 (Junior Professional Officer - Editing of the updated Physical Model).

Outcome #3: Enhanced ability to safeguard new types of facilities through development of safeguards concepts and approaches for pyroprocessing plants and small modular and/or Gen IV reactors.

Outputs	<ol style="list-style-type: none"> 1. Model SG approach for a pyroprocessing plant proposed by the ROK SP. 2. Model SG approach for a transportable (floating) nuclear power plant (KLT-40S) proposed by RUS SP. 3. Model SG approach for a pebble-bed modular reactor (HTR-PM) proposed by the CPR SP. 4. Model SG approach for a passive small modular pressurized light water reactor (SMART: System-integrated modular advanced reactor) proposed by the ROK SP. 5. Model SG approaches for NUWARD proposed by FRESPAS. 6. Model SG approaches for Moltex Stable Salt Reactor Wasteburner 300 (SSR-W300 of Moltex) proposed by the CAN SP. 7. Model safeguards approaches for Integral Molten Salt Reactor (IMSR of TEI) proposed by the CAN SP. 8. Model safeguards approaches for two micro modular reactors for district heating proposed by the FIN SP. 9. Model safeguards approaches for SMRs (types to be decided) to be proposed by the USSP. 10. Model safeguards approaches for emerging nuclear fuel cycle technologies and SMRs that are proposed by other Member States.
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Supporting Resource Mobilization Priorities

V.6.C2	V.6.C4	S.3.C1
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Planned Activities

All outputs for this expected outcome are carried over from the previous biennium, as work was delayed but is still in progress.

Technical challenges for safeguards implementation involving new types of facilities including small modular reactors will be assessed to incorporate safeguards by design principles at an early stage of the design. The IAEA, with Member State authority and facility designers/operators, will identify and evaluate details of the facility design that could affect safeguards, investigate strategies for implementing safeguards, and identify ways to incorporate safeguards by design principles.

The IAEA will work with the State authority and facility designers/operators to identify and evaluate details of the facility design that could affect safeguards, investigate strategies for implementing safeguards at that facility, and identify ways to incorporate safeguards by design principles into the facility design. Once the facility model is proposed by the State, the State with the IAEA will:

- Develop a model design information questionnaire (DIQ) response.
- Develop nuclear material accountancy and control strategies.
- Evaluate and test (if applicable) the technical feasibility of safeguards measures such as design information verification (DIV), application of containment and surveillance (C/S),

nuclear material verification methods, unattended monitoring, and nuclear material flow verification systems.

For this 2022–2023 biennium, the IAEA will schedule at least two meetings per year with State authority/designers for each type of facility or small modular reactor.

Outcome #4: Improved ability to verify facilities under the decommissioning phase through the development of safeguards implementation guidelines and concepts.

Outputs	<ol style="list-style-type: none">1. Workshops on safeguards implementation at facilities under decommissioning.2. Finalized safeguards guidelines for post-accident facilities.
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Supporting Resource Mobilization Priorities

S.3.C1

Planned Activities

In October 2021, the IAEA shared *STR-396 (International Safeguards Guidelines for the Post-Operational Phases of Nuclear Facilities and Locations Outside Facilities)* with Member States. The IAEA will host a few decommissioning workshops in 2022–2023 at IAEA headquarters and Member States holding facilities under decommissioning or to be decommissioned.

To draft safeguards guidelines for post-accident facilities to be decommissioned, the IAEA will host two or three consultancy meetings at IAEA headquarters and Member States with experts from MSSPs. The Japan Support Programme will support a CFE to develop safeguards guidelines for post-accident facilities and assist with the organization of workshops for facilities under decommissioning or to be decommissioned.

SGCP-004: Strategic Planning and Partnerships

Strategic foresight, planning and execution; coordination of MSSPs and other partnerships; organization of stakeholder events.

 Gary DYCK



Plan Acronyms

ESARDA	European Safeguards Research and Development Association
ETW	Emerging Technologies Workshop
INMM	Institute of Nuclear Materials Management
MSSP	Member State Support Programme
NGO	non-governmental organization
SPCT	Support Programme Coordination Team

Context Highlights

Growing Importance of Strategic Planning and Partnerships

With an ever-complex operating environment, increasing safeguards workload and worsening budget constraints expected in years to come, the Department seeks to further strengthen strategic foresight and planning and expand and better leverage partnerships to meet emerging challenges and seize opportunities in support of its nuclear verification mission. Through this development and implementation support plan, the Department is strengthening both traditional and non-traditional partnerships to complement other efforts to meet its R&D and other support needs.

The Department's strategic planning framework supports preparedness and good management of resources through continuous monitoring of the operating environment and establishing objectives that are prioritized to focus resources on top priorities. A key element supporting strategy execution is the establishment of new and enhancement of existing partnerships with respect to development and implementation support.

Leveraging Partnerships

Maintaining active engagement with our external partners means the Department is always learning, improving, and building support. Learning from external partners at the Emerging Technologies Workshops and Symposia on International Safeguards help the Department mitigate risks and make sound decisions. The information from external partners also helps the Department capitalize on opportunities that emerging technologies and other changes in the safeguards environment may present. Therefore, further cultivating external partnerships is increasingly important for the successful implementation of the Agency's nuclear verification programme for the 2022–2023 biennium and beyond.

Non-Traditional Partnerships

In line with the Agency's overall approach and one of the 'ideas for action' from the 2018 Safeguards Symposium, the Department is expanding partnerships with non-traditional entities (for example professional associations, foundations, non-governmental organizations, and corporations), to further expand its support base and complement the support provided by Member State Support Programmes (MSSPs). In delivering SGCP-004: Strategic Planning and Partnerships' outputs, the Department will be looking for collaboration with existing non-traditional partners to develop needed capabilities and support implementation, as well as to establish new partnerships based on need.

Traditional Partnerships

With respect to its traditional partnerships, the Department seeks to expand and diversify its MSSPs. Prior to the establishment of the Swiss Support Programme in November 2021, it had been almost 14 years since a new MSSP was established. Initial discussions have been held with representatives from multiple Member States, and the Department is pursuing targeted outreach to continue these conversations.

Evolving Support Needs

For decades, the Department's requests for 'in-kind' contributions (chiefly of expertise, equipment, or technology transfer) far surpassed requests for direct financial contributions.

This now is changing. While operational activities, such as in-field verification work and IAEA Safeguards inspector salaries, are covered exclusively through the Department's regular budget, other activities that directly or indirectly support safeguards implementation, such as equipment procurement, IT tools, subscriptions to safeguards-relevant information sources, and development of improved techniques, can be supported through extrabudgetary support in cash or 'in-kind'.

By necessity, such activities are increasingly being relegated to "unfunded activities" in the Agency's Programme and Budget, meaning that in order to follow through on its plans, the Department must mobilize resources to meet these needs.

In recent years, the Department has significantly increased both the number and magnitude of specific appeals for direct financial contributions. This has particularly been the case when it comes to the Department's IT needs, which are consistently a top priority for resource mobilization.

In the previous biennium the Department successfully developed the strategic management processes and tools to help predict, manage, communicate, prioritize, and align resources to execute the Department's priorities. The Department will continue to utilize and mature these processes through experience and lessons learned, while shifting the development focus in 2022–2023 on improving the strategic project management capabilities specifically for the implementation of departmental priority projects and actions.



Figure 1: On 19 November 2021, the Swiss Support Programme was established through the virtual signing of Practical Arrangements between the Department and the Swiss Federal Office of Energy in Bern.



Figure 2: IAEA Director General Rafael Mariano Grossi (left) looks on as Massimo Aparo, Deputy Director General and Head of the IAEA Department, signs the Practical Arrangements between the IAEA and both the Institute of Nuclear Materials Management (INMM) and the European Safeguards Research and Development Association (ESARDA), the first non-traditional partnerships to be formalize by the Department. (Photo: D. Calma / IAEA)

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|--|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.1.C1** Ability to fully implement data-driven programmatic planning, monitoring and evaluation, to support managerial decision making
- M.3.C3** Ability to assess and improve the implementation efficiency of the Department's system of processes, procedures and supporting tools
- M.3.C4** Ability to deploy project management approaches to ensure effective execution of strategic priorities and projects
- M.4.C3** Ability to maintain awareness of changes in the nuclear landscape and associated impact on safeguards implementation, including the impact of emerging technologies and non-State actors
- S.1.C2** Ability to more clearly and effectively communicate the value and importance of IAEA safeguards, and to reach a broader audience

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Enhanced dialogue among global safeguards stakeholders with increased understanding of common challenges and opportunities and ideas for solutions.

Outputs 1. ★ The 2022 Safeguards Symposium.

Supporting Resource Mobilization Priorities

M.4.C3

S.1.C2

Planned Activities and Support Needed

The 2022 Safeguard Symposium, with a theme of *Reflecting on the Past and Anticipating the Future*, will bring global stakeholders together to celebrate important anniversaries, including 60 years of IAEA inspections, 50 years of comprehensive safeguards agreements, and 25 years of additional protocols—reflecting on lessons learned and advancements made thus far, and anticipating and preparing for the changing landscape in the coming decades. It is an opportunity for States, researchers, industry and civil society to identify challenges and opportunities, showcase research, share ideas, and build partnerships in support of IAEA safeguards.

There are no regular budget funds allocated to the Symposium. The Department is seeking extrabudgetary support in the form of general funding for its organization; support for temporary assistance, including by a JPO and consultants; sponsorship of participants from developing countries; sponsorship of participation of speakers, experts, facilitators; and development of communication products. In-kind assistance is also requested to support event design, abstract reviews, programme development, and promotion of the event.

Outcome #2: Improved organizational ability to monitor, identify, and adjust to changes in the operating environment in a timely manner.

- Outputs**
1. ★ The 2023 Emerging Technologies Workshop.
 2. External operating environment analyses.

Supporting Resource Mobilization Priorities

M.4.C3

Planned Activities and Support Needed

The Department's strategic foresight activities supports the Department programmatic strategic planning activities by scanning the external environment for key developments of consequence to the safeguards mission, and identifying associated challenges and opportunities for Safeguards. This informs the development of strategy. The Emerging Technologies Workshops contributes to fulfilling the Departments obligation for taking "full account of technological developments in the field of safeguards" under safeguards agreements, by identifying scientific and technological developments with potential for safeguards application.

Partner support is requested for provision of external expertise (experts, consultants, JPOs); facilitation and other expert assistance in conducting workshops; advancement and sharing of knowledge (for example studies, research); and sponsorship of external training or other development curricula for IAEA staff in the field of strategic foresight and planning.

Outcome #3: More efficient coordination and more effective resource mobilization support to the needs of the Department.

- Outputs**
1. Implementation of improvements to MSSP Annual Review meetings based on surveys and focus groups with internal and external participants.
 2. Organization of biennial MSSP Coordinators' meeting in 2022.
 3. Implementation and refinement of weekly tracking on CFE and JPO recruitment activities for relevant SG divisions and MSSPs.

Supporting Resource Mobilization Priorities

M.3.C3

S.1.C2

Planned Activities and Support Needed

Efficient coordination and effective resource mobilization support ensures the Department can make the most of MSSP contributions. The Support Programme Coordination Team (SPCT) and MSSP Coordinators are both keenly interested in swift, transparent transfer of financial and in-kind contributions while respecting all the applicable rules and regulations, so that both sides can expend minimal effort on administration and maximize the programmatic impact of contributions.

One way that the efficiency of coordination is improved is through the biennial MSSP Coordinators' Meeting. There, MSSPs learn how extrabudgetary support can contribute to the Department's development and implementation plans and network among other MSSPs and IAEA staff members. In the past, the SPCT has taken advantage of MSSPs' time and attention at this meeting to learn how administrative support can be simplified or improved. At this 2022 meeting, the SPCT plans to actively engage with MSSPs again and would greatly benefit from MSSP participation.

Annual and semi-annual review meetings also help coordination efficiency. The Department hosted nearly all of the last biennium's MSSP review meetings remotely, and while WebEx meetings are not the same as in-person meetings, the Department has found it to work well under the current circumstances. The Department now plans to provide a remote participation option alongside an in-person option for every meeting if both sides agree. The Department is interested in learning MSSPs' ideas for better meeting facilitation. To improve the meeting experience the Department would greatly benefit from MSSPs' participation in surveys and focus groups, which are planned in 2022.

The significant time and resources required for CFE and JPO onboarding is a challenge for both IAEA hiring managers and MSSP stakeholders. The Department will use MSSP support, namely

through JPN F 2511 (Expert - Support Programme Administrator), to increase the speed and transparency of CFE/JPO onboarding process.

The Department uses internal resources to help advise and guide D&IS managers on the implementation of their plans that utilize MSSP resources. A staff member is dedicated to helping task proposal POCs, task officers, and D&IS managers; this staff member will also conduct proactive check-ins with D&IS managers periodically. These check-ins and associated troubleshooting can often lead to more streamlined engagement with MSSPs. While no MSSP support is needed in this area, the Department also welcomes suggestions from MSSPs on how to best meet and exceed expectations for good stewardship of provided support and resources.

★ Outcome #4: Enhanced strategic project management capabilities to manage the Department’s priority projects and actions.

Outputs 1. Enhanced strategic project management processes and competencies for Departmental priority projects and actions.

Supporting Resource Mobilization Priorities

M.1.C1	M.3.C4
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Planned Activities and Support Needed

Through strategic planning, the Department’s management, with support from SGCP, identifies priority projects and actions that are required to develop its needed capabilities and to achieve its priority objectives. Departmental priority projects and actions are high-priority projects that are endorsed or initiated by the DDG-SG, and implemented with the support of the whole Department. A significant number of these rely on extrabudgetary support. The Department aims to ensure such support and resources are well managed and utilized. Enhanced strategic project management capabilities, across the Department, are required to ensure the best use of resources, that changes are managed well, and that the intended results are achieved.

To further develop the strategic project management capabilities, partner support is requested for external expertise (for example, CFE and/or consultants); facilitation and other expert assistance with conducting trainings and workshops; and sponsorship of external training or other development curricula for IAEA staff. Financial support to develop new or maintain existing IT systems would be coordinated with SGIS.

SGCP-101: Quality Management

Implementing and enhancing processes and management tools supporting the Department's Quality Management System (QMS).

 Roy FITZGERALD



Plan Acronyms

BPMN Business Process Mapping Notation
QMS Quality Management System

Context Highlights

Implementation of the Quality Management System (QMS) and the underlying process framework is essential for providing assurances that international standards enable consistency in the performance of safeguards activities and to ensure the Department draws soundly-based, impartial, and non-discriminatory safeguards conclusions.

The Department's process framework is an important element of the QMS and has been in place for over 10 years. The Department has undertaken significant efforts to implement and improve the functionality of the QMS and process framework and has completed self-assessments of both the QMS and the process framework for the purpose of identifying and implementing targeted improvements.

Over the course of the last several years, the Department has benefitted from an internal network of quality managers along with Member State Support for JPOs, CFEs, and financial assistance. Ongoing support for continued improvements in process management, process governance, and process performance monitoring are key to the success of this plan in 2022–2023.

Most Needed Extrabudgetary Support in 2022–2023

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|---|---|--|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.1.C1** Ability to fully implement data-driven programmatic planning, monitoring and evaluation, to support managerial decision making
- M.3.C2** Ability to enhance managerial decision-making processes, capabilities and competencies
- M.3.C3** Ability to assess and improve the implementation efficiency of the Department's system of processes, procedures and supporting tools

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Improved process management and an enhanced process framework to support consistent implementation of departmental processes.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> ★ Standards and templates for business process mapping. Standards and guidelines for managing shared processes. Options for improving process management and governance through updated processes and procedures. |
|----------------|---|

Supporting Resource Mobilization Priorities

M.1.C1

M.3.C3

Planned Activities

Effective process management and governance are an integral component of the Department's QMS and help ensure that safeguards activities are efficient, effective, and consistent. SGCP-101: Quality Management continues to assess and identify opportunities for further improvement in the deployment, governance, measurement, and monitoring of processes.

Following a recent assessment on the maturity of the Department's process framework, activities have been identified to ensure:

- Process documentation is updated, valid, and available.
- Process ownership is defined.
- Roles, responsibilities, accountabilities, and authorities of process owners are consistently applied.
- Process compliance is standardized, defined, and fully documented.
- Process design activities are developed and documented uniformly and consistently.
- Processes are reviewed and analysed for improvement opportunities.
- Process governance is strengthened.

Support for these activities has been supported under MSSP Task USA F 2355 (Junior Professional Officer - Associate Process Design Officer) and in close collaboration with SGIS-003: Safeguards Information Systems and System Usability. Additional support may be requested for supporting business process governance including process mapping tools, standards, and applications.

Outcome #2: An enhanced web-based domain for processes and process applications linking associated documentation and relevant IT applications.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> ★ Business case and proposal(s) for process mapping software and application. |
|----------------|---|

Supporting Resource Mobilization Priorities

M.1.C1

M.3.C3

Planned Activities

Following the introduction of Business Process Mapping Notation (BPMN) standards, the Department aims to further improve access and use of processes and process maps. Initial efforts undertaken involve the creation and publication of web-based process maps using Microsoft Visio. Opportunities exist to create a more comprehensive domain with improved capabilities for mapping processes consistently, improving the user interface to these processes, and capturing and using information to monitor and improve process performance.

The following activities will further facilitate maturity of the Department’s process framework:

- Capturing and documenting user requirements and expectations.
- Documenting gap analyses between current state and user requirements.
- Developing use cases for improved process mapping.
- ★ Identifying and researching commercial off-the-shelf (COTS) tools and applications.

Activities will be conducted in close collaboration with SGIS-003: Safeguards Information Systems and System Usability.

Outcome #3: Improved process performance monitoring enabling more efficient operations and improved process management.

Outputs	<ol style="list-style-type: none"> 1. Identification of process outputs and products. 2. ★ Identification of specific performance attributes for process outputs and products.
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Supporting Resource Mobilization Priorities

M.1.C1	M.3.C2	M.3.C3
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Planned Activities

To support ongoing efforts to improve efficiencies and ensure an appropriate balance between resources and workloads, efforts and actions have been identified to improve the performance and effectiveness of processes. Some of the benefits of this activity include:

- Improving the efficiency in the performance of work.
- Providing greater visibility and transparency into departmental process health.
- Standardizing work practices further as needed and necessary.
- Identifying further opportunities for improvement.

SGCP-102: Training

Providing effective training and learning opportunities to ensure that target audiences can perform their tasks and implement IAEA safeguards.

 Susan PICKETT



Plan Acronyms

COMPASS	Comprehensive Capacity-Building Initiative for SSACs and SRAs
CTR	Section for Safeguards Training
ISSAS	IAEA SSAC Advisory Service
KM	Knowledge management
LMS	Learning Management System
SRA	State or regional authority
SSAC	State Systems of Accounting for and Control of Nuclear Material

Context Highlights

The Training Situation 2 Years Later

While this D&IS plan's mandate has not changed, the delivery methods have. The Covid-19 pandemic and lockdowns forced the Department to train differently. In some ways, the Department delivered the training more effectively, and many of the outcomes and outputs from the 2020–2021 plan benefitted from the unprecedented constraints because it forced new approaches and innovation. Additionally, under the new IAEA 2022–2023 Programme and Budget, the task of knowledge management was transferred to this plan. More details are below.

COMPASS Initiative

In addition, the Section for Safeguards Training has taken a major role in supporting and leading the COMPASS¹ initiative, which has also fuelled innovation in State Systems of Accounting for and Control of Nuclear Material (SSACs) capacity building.

For 2022, the Section for Safeguards Training (CTR) will devote approximately a third of its resources on the COMPASS initiative and also increase its focus on national training and support to Member States not in the COMPASS pilot programme.



Figure 1: Trainees from the Jordan SRA, EMRC, participate in the SSAC training event under the COMPASS Initiative in November 2021. Here, a trainer is demonstrating non-destructive assay techniques used to verify nuclear material.

New Initiative: Safeguards Mid-Career Leadership Programme

The Department will launch a pilot Safeguards Mid-Career Leadership Programme in 2022 in order to develop the leadership and safeguards knowledge of mid-career professionals from Members States with limited or no nuclear fuel cycle-related activities, in order to strengthen the human capacity within State authorities responsible for safeguards or other organizations that are a part of

¹ COMPASS stands for Comprehensive Capacity-Building Initiative for SSACs and State or regional authorities (SRAs). The COMPASS initiative provides tailored safeguards assistance to States to help them strengthen and sustain the effectiveness of their SSAC and SRA responsible for safeguards implementation.

State systems of accounting for and control of nuclear material. This programme is developed in direct response to the Director's General support for the Safeguards Traineeship Programme and call for additional engagement opportunities. The Department will host the 3-month programme in 2022, and it will be open to representatives from the seven COMPASS pilot states. Continuation of the programme would be based on subsequent support and funding available, and it would be open to more Member States.



Figure 2: Rafael Mariano Grossi, IAEA Director General met with Safeguards Trainees at the IAEA headquarters in Vienna, Austria on 12 November 2021.

New Function: Knowledge Management

The Department transferred Knowledge Management (KM) functions to CTR. KM is the process of identifying, capturing, evaluating, retrieving, and sharing the Department's information assets to improve its efficiency and effectiveness. The Department plans to integrate KM into its training and learning activities to disseminate the knowledge and preserve institutional memory. Despite limited human resources devoted to implement KM activities, this plan includes modest first steps in Outcome #4. If MSSPs can assist the Department in this regard, then more robust KM activities could be implemented.

Additional Member State Training Resources

In addition to targeting national training and support, CTR conducts International and Regional Training courses, coordinates IAEA SSAC Advisory Service (ISSAS) missions, reviews and supports States embarking on new nuclear power programmes in close collaboration with the Department of Nuclear Energy, and develops an e-learning library for all Member States. CTR also coordinates on training and consultation within SGCP as well as with the Department of Nuclear Safety and Security and others, as requested.

Foreseen Challenges

Looking ahead, the main challenges centre around having the necessary financial, human, and technical resources to meet the training needs of Member States and the Department. The main challenges are:

1. Severe limits to facility access due to Covid-19. The Department needs to ensure facility access to implement high-priority training for departmental staff members, in particular IAEA Safeguards inspectors.
2. Unfit systems and possible gaps in training records due to a lack of human resources who would ensure the learning management system meets departmental needs. The Department must integrate a functional learning management system for staff training and development, which is under development by Oracle for the Agency.
3. Possible lack of financial, human, and technical resources to ensure the resources are available to provide learning and support resources to States to establish and strengthen their SSACs. With greater Agency focus on capacity building, it is critical that the Department has the resources to assist **all** States requiring support to establish and maintain their SSACs, including reliable accounting for and control of nuclear material, together with the needed administrative, legislative, and regulatory systems. This is fundamental to enable States to fulfil their nuclear non-proliferation obligations.
4. Possible lack of human and other resources to address the incoming function of knowledge management.
5. While CTR continues to train staff in organizations and authorities in Member States, changes or staff rotation as well as other outside factors pose a challenge to ensuring progress in the performance of the respective SSAC.

The Essentiality of MSSP Support to Training

Member States and MSSPs provide the necessary resources for CTR to operate. For over 25 courses, facility access is required and are provided by Member States and MSSPs. This also includes significant in-kind resources to support course development. MSSPs also provide human resources for Staff Training, including provision of a JPO and a CFE. Furthermore, our SSAC training and assistance relies almost 100% on the support of Member States and MSSPs to implement training, fund, travel, and implement. Our two regular budget P-staff positions are complemented by MSSP funding of three full time positions (two CFEs and one MS extrabudgetary funded P3) and two consultants. Without this support, CTR would not be able to address the training needs of staff required to carry out the mission of the Department nor be able to address the continued demand and need for support and capacity building of SSACs such that States themselves have the knowledge and skills to implement safeguards and fulfil their obligation to the international community.



Figure 3: New IAEA Safeguards inspectors participate in the Comprehensive Inspection Exercise at Dukovany Nuclear Power Plant provided by the Czech Republic Support Programme where they are learning about verification of fresh fuel.



Figure 4: New IAEA Safeguards inspectors participate in the Comprehensive Inspection Exercise at Dukovany Nuclear Power Plant provided by the Czech Republic Support Programme where they are discussing next steps with the State authority.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- S.2.C1** Ability to strengthen the capacity of SSACs/SRAs and monitor and measure progress
- W.3.C1** Ability to train inspectors on spent fuel measurement techniques inside facilities
- W.3.C2** Ability to further develop the expertise of the Safeguards Department's workforce and train the next generation of safeguards experts
- W.3.C4** Ability to effectively utilize knowledge and expertise already existing with the Department
- W.3.C5** Ability to preserve and disseminate critical organizational knowledge to overcome staff turn-over and other associated challenges
- W.4.C1** Ability to attract and retain a geographically diverse and gender-balanced workforce

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Competent and confident SSAC staff members with the knowledge and skills to effectively implement safeguards and fulfil safeguards obligations.

Outputs	<ol style="list-style-type: none"> 1. SSAC Support: Virtual national engagements and webinars for 60 states as identified by Operations Divisions. 2. COMPASS: Implemented workplans for the seven COMPASS pilot states that have a balance of virtual and in-person training, fellowships, and other engagements. 3. IAEA SSAC Advisory Service (ISSAS): ISSAS Missions in response to Member States' requests. 4. E-learning: More e-learning and online course offerings and a structured package on the Open Learning Management System (CLP4NET) (elearning.iaea.org).
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Supporting Resource Mobilization Priorities

S.2.C1

W.3.C2

W.4.C1

Planned Activities

SSAC Support: When an Operations Division identifies a State in need of SSAC support, the Department will combine one-on-one virtual engagements, virtual regional engagements, and webinars in order to build competent and confident SSAC staff members.

In Q3 2022, the Department plans to re-start in-person events in high-priority regions and the annual training events with Japan and ROK. In response to the Deputy Director's General for Safeguards initiative to target more Member States to build capacity, the Department will invite non-successful applicants from the Safeguards Traineeship Programme to virtual or in-person workshops in order to build interest in Safeguards and to help strengthen the SSAC material.

COMPASS: As the entity mainly responsible for implementing COMPASS, CTR has dedicated staff to ensure that training and support to the seven COMPASS pilot states can be implemented in accordance with the workplans and those plans be evaluated. The Department has developed specific learning sites for each state that contain material for training, references, and e-learning opportunities.

ISSAS: CTR published the updated ISSAS guidelines for Member States that provide extensive detail on the assessment so that they and the Department can best prepare for and implement the missions. CTR is working with the Deputy Director General for Safeguards to promote ISSAS missions to give more opportunities for States to seek assistance in the development of its SSAC. MSSPs have provided extrabudgetary support to facilitate ISSAS missions—enabling two to be undertaken in 2019—and their success will continue to rely upon extrabudgetary support.

E-learning: CTR has developed a remote learning strategy with short-, medium-, and long-term steps in order to provide access to online learning opportunities including a diverse range of offerings to address needs of Member States and universities. This includes standalone e-learning on appropriate topics and an increased set of learning materials and tools that provide online references and learning opportunities during the current travel restrictions, which can later be leveraged as prerequisites for classroom training.

Support Required

- Continued support of CFEs (currently from the USA and Japan) and financial contributions. IAEA may request one additional JPO or CFE.
- Financial contributions for travel and equipment will be required to deliver the scheduled courses. This is commonly provided by three or four Member States.
- Additional financial contributions for an extrabudgetary post is requested to be able to hire a video technician for an initial period of two years.

Outcome #2: Knowledgeable and skilled departmental staff members who can plan, conduct, and evaluate safeguards implementation issues.

Outputs	<ol style="list-style-type: none"> 1. Secured access to a facility(ies) for 10 high-priority training courses per year for the next 5 years. 2. A comprehensive Safeguards Training Programme for Staff. 3. A comprehensive State evaluation curriculum that clearly defines and maps state evaluation processes and guides. 4. An industrial safety curriculum.
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Supporting Resource Mobilization Priorities

W.3.C1	W.3.C2	W.3.C4	W.3.C5
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Planned Activities

1. **Facility Access:** In-person training at nuclear facilities remains an essential tool to ensure the Department integrates the knowledge, skills, and abilities to fulfil the verification mission. While prioritisation and assessment of risks to hosts and participants have now become part of the planning and decision-making process, facility access remains an absolutely indispensable, essential need.
2. **A Comprehensive Safeguards Training Programme:** An expert in instructional design (extrabudgetary or CFE) is needed to consistently apply the Systematic Approach to Training. The expert would support the analysis of training needs, design or re-design the training (depending on in-person or virtual), and evaluate the effectiveness of training. Additionally, punctual support is required to support the development of e-learning content to improve access to basic induction materials for staff training. Finally, continued support for MSSP Tasks USA B 2436 (Junior Professional Officer - Associate Training Officer) is needed to support the evaluation of training effectiveness and USA B 2559 (Expert - Nuclear Instrumentation Training Expert).
3. **Industrial Health and Safety:** Until now, the Department has relied on MSSPs to provide issue-specific courses, for example, MSSP Task CAN B 2495 (Fall Arrest Training Course). In order to respond to multiple field hazards and the varied operating conditions, the Department is now revisiting the overall industrial safety training approach with the intent of developing an effective, practical, and comprehensive industrial safety induction training. The first step is to analyse the training needs, then design a comprehensive industrial safety induction (possibly from existing commercial training).
4. **State Evaluation Curriculum:** The quality of State evaluation depends on departmental processes as well as the systematic use of structured analytical techniques. The United States of America, United Kingdom, and Australian Support Programmes contribute to training on analytical skills in support of State Evaluation. The Department, in defining the State evaluation process, requires training for managers and State Evaluation Groups (SEGs) on the integration of critical thinking and structure analysis into the process. CTR is coordinating with the process owner and the Department to define such a curriculum. The review and alignment of the aforementioned tasks with this curriculum is a crucial step. The Section for Safeguards Training is proposing a 1-year development reassignment to assist with this task. Additional support from MSSPs may be requested based on the outcome of the current State Evaluation mapping, assessment, and coordination effort.

In order to attain the outputs and achieve the outcome, the Agency needs continued MSSP support for the 95 active tasks. This includes current CFEs and JPOs.

Support Required

- Continued support for in-field activity courses (facility access).
- Specific expertise in instructional design (analysis of training needs, design or redesign of training and evaluation of the effectiveness of training), and punctual support for the development of e-learning materials in the form of a P3 CFE or extrabudgetary temporary assignment contract.
- Support for the needs analysis and the development of training in the specific area of industrial safety.

- In the form of a consultant or financial contribution to pay for a consultant who can develop blended learning components or webinars (for example, remote webinars to introduce the topics that do not require an annual, full-scope training).

Outcome #3: Increased accessibility of training and learning.

- | | |
|----------------|--|
| Outputs | 1. Tailoring of the new IAEA Learning Management System (LMS) to the Department. |
|----------------|--|

Supporting Resource Mobilization Priorities

W.3.C2	W.3.C4	W.3.C5
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Planned Activities

With the availability of an IAEA-wide LMS system, the Department is revising and adjusting the current training processes to integrate them in the LMS system. This requires migration of existing training data, development of specific workflows for selection of course participants, testing of functionalities, and development of training and documentation not provided by the supplier.

Support Required

Funding for or provision of a consultant to coordinate testing of the new LMS and develop a manual for departmental use.

Outcome #4: Improved knowledge sharing management and communication culture.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. ★ 100% managerial participation at a 1-day knowledge management (KM) workshop (there will be several opportunities throughout the biennium). 2. For every section in the Department, a 1-page document that declares its key KM activities. |
|----------------|---|

Supporting Resource Mobilization Priorities

W.3.C4	W.3.C5
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Planned Activities

This outcome is now the responsibility of CTR as specified in the 2022–2023 Programme and Budget.

In close collaboration with the Department of Nuclear Energy, CTR will hold 1-day workshops to make managers aware of KM and how it relates to their work. Specifically, the workshop will have three main objectives:

- Identify the movement of knowledge through an organization and how it impacts performance.
- Review three main knowledge loss risk issues that may impact their section or team, including what is critical knowledge and explicit versus tacit knowledge.
 - Identify three steps to address this risk and the resources needed.
- Identify three business benefits of an effective knowledge sharing culture.

Support Required

Funding/support for 1 full time employee (extrabudgetary post or CFE) or funding for the workshops.

Outcome #5: Increased knowledge of safeguards and aspects of the nuclear fuel cycle in Member States with limited or no nuclear fuel cycle technologies.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none">1. Yearly implementation of the Safeguards Traineeship Programme.2. Launch of the IAEA Safeguards Mid-Career Leadership Programme. |
|----------------|---|

Supporting Resource Mobilization Priorities

S.2.C1

Planned Activities

Through the Safeguards Traineeship Programme for Young Graduates and Junior Professionals, the Department enhances the technical skills and competence of the trainees relative to the implementation of safeguards and to broaden their knowledge of the peaceful applications of nuclear techniques and the implementation thereof in their respective States.

Running for almost 40 years, this programme is now offered annually. Nine participants in the 2021 programme are from Saudi Arabia, Jordan, United Arab Emirates, Angola, Indonesia, Malaysia, Senegal, Sri Lanka, and Tunisia. The application process secured gender parity.

As a result of the Director's General request to expand the programme, the Department is launching the IAEA Safeguards Mid-Career Leadership Programme. It offers mid-career professionals from Member States for a three-month engagement, both in-person and online. The programme is offered to staff nominated by Member States who work in nuclear-related regulatory bodies and have duties and responsibilities which involve the implementation of or management of safeguards issues.

Support Required

- **Financial contributions:** The total costs are approximately €550 000, of which €350 000 is requested from Member States. The financial contributions will support travel and sustenance of the trainees, the 6-week nuclear fuel cycle-related training, and the 4-week nuclear physics and nuclear fuel cycle curriculum at the Atominstutut in Vienna, as well as the support for the Traineeship Coordinator who is hired on a yearly basis to coordinate the programme.
- **In-kind support:** Access to facilities and state experience and training is essential to the programme and is currently provided by the EC, Hungarian, Czech Republic, and Finnish Support Programmes. More facilities would be a welcome form of support.

The IAEA will offer the pilot Mid-Career Leadership Programme to professionals from the 7 COMPASS pilot States in 2022. For subsequent programmes, approximately €100 000 would be required depending on the final programme design.

SGIM-002: Satellite Imagery Analysis

Acquiring, processing, analysing, and exploiting satellite imagery and geospatial information to support nuclear verification activities.

 Marc LAFITTE



Plan Acronyms

AI	Artificial Intelligence
AP	Additional Protocol (declarations)
API	Application Programming Interface
CSI	Commercial Satellite Imagery
DL	deep learning
GDI	Geo-Based Data Integration
GIS	Geographic Information System
GPU	Graphics processing unit
GSD	ground sample distance
HSI	Hyperspectral imaging
HR	High-Resolution
LR	Low-Resolution
ML	machine learning
MR	Medium-Resolution
MS	Multi spectral
SAR	satellite imagery analysis
SOM	structured observation management
SSD	solid-state drive
SWIR	Short-Wave Infrared
TIR	Thermal Infrared imagery
UHR	Ultra-High Resolution
VHR	Very-High Resolution

Context Highlights

Importance of Satellite Imagery Analysis to the Department

2022 marks the 20th anniversary of when the Satellite Imagery Analysis Unit commenced operations in the Department. Over the past two decades, Satellite Imagery Analysis has increased the effectiveness and efficiency of safeguards implementation and confidence in safeguards conclusions. The experience gained from the analysis of remote sensing data and moreover new capabilities and associated technologies have opened up new perspectives for the information analysis component of the strengthened safeguards system. Space-borne remote sensing data has become an essential enabler of "other relevant information," contributing to IAEA's ability to increase the effectiveness and efficiency of safeguards implementation, increase confidence in safeguards conclusions, and lead to even better decision making while assessing the correctness and completeness of a State's declaration.

The Department routinely purchases Commercial Satellite Imagery (CSI) from selected suppliers through contract purchase agreements, which legally frame the access to commercial imagery providers. By nature, most of the satellites collect imagery on-demand (tasking).

A Growing Demand

The demand for satellite imagery analysis continues to evolve and grow. The use of geospatial information has become one of the most effective means of engaging in collaborative analysis and incorporating safeguards-relevant information. Satellite imagery analysts have made increasingly direct and important contributions to safeguards verification activities as members of State Evaluation Groups for States with complex nuclear fuel cycles.

Emerging Abilities

At the same time, space-based earth observation is undergoing a revolution with an unprecedented fleet of sensors recently placed into orbit, or that are ready to be launched. These sensors will cover even more of the electro-magnetic spectrum.

Satellite imagery analysis efforts focus on the spatial resolution, or detail, of the imagery. The advent of optical imagery led to a key ground sample distance (GSD) of 30 cm and enhanced analysis capabilities. Experts in the field of satellite imagery continue to develop unique capabilities as needs shift toward greater spectral and temporal resolution.

Resolution definitions:

UHR	Ultra-High Resolution	<0.3m
VHR	Very-High Resolution	0.3–1m
HR	High-Resolution	1–5m
MR	Medium-Resolution	5–10m
LR	Low-Resolution	>10m

The integration of Synthetic Aperture Radar (SAR) analysis into analytical products has significantly enhanced safeguards capabilities and these efforts need to be continued.

Spectral analysis is a promising source of information. New constellations of satellites include broader capabilities to acquire mid- to high-resolution Short-Wave Infrared (SWIR) or mid-resolution hyperspectral (HSI) imagery (data cubes). Industrial processes are mainly characterized by heat release. Currently, commercially-available Thermal Infrared imagery (TIR) provides very limited ground sample distance (GSD). New high-resolution sensors, planned to be launched before 2023, will provide the Department with unprecedented abilities to detect, measure, and assess heat release, which will significantly enhance IAEA's capabilities.

Challenges and Opportunities

This sensor revolution opens up new perspectives to enhance Safeguards implementation and reveals new challenges. The very large volume of satellite imagery available, the significant growth of satellite imagery analysis requests, and the more complex nature of the requests necessitates the development of artificial intelligence (AI), machine learning (ML), and deep learning (DL) techniques to support satellite imagery collection, processing, analysis, and dissemination to benefit analytical assessments and enhance multimodal data discovery.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input checked="" type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.6.C3** Ability to leverage new types of space-borne sensor data from open sources, including the processing of synthetic aperture radar data, analysis of multi/hyperspectral data, and thermal imagery
- V.1.C2** Ability to process and integrate the variety and volume of safeguards-relevant information in a timely, user-friendly and cost-effective manner
- V.1.C4** Ability to apply machine learning for automatic selection or change detection in open source text and other media, commercial satellite imagery and cloud data streams, including a library of training data
- V.1.C5** Ability to enhance the sharing, aggregation, visualization and analysis of geo-based information (for example, verification data, satellite imagery)
- W.3.C2** Ability to further develop the expertise of the Safeguards Department's workforce and train the next generation of safeguards experts

W.3.C4 Ability to effectively utilize knowledge and expertise already existing with the Department

W.3.C5 Ability to preserve and disseminate critical organizational knowledge to overcome staff turn-over and other associated challenges

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Enhanced satellite imagery analytical capabilities (sensors, data services, software tools, analytical/processing techniques, technologies, methodologies, etc).

Outputs

1. Broaden, diversify, and ease access to relevant commercial satellite imagery (spatial, spectral and temporal) and ensure the integrity and authenticity of satellite imagery as an independent source of information for the Agency.
2. ★ Enable effective spectral analysis by incorporating more in-depth spectral analytics derived from SWIR, TIR, SAR, multi spectral (MS), and HSI satellite imagery analysis products.
3. Sustain/perpetuate the ability to process all types of satellite imagery and enhance accuracy and pixel consistency of large datasets for better and additional applications.
4. ★ Optimize the selection of the most relevant imagery by using new technologies.
5. Enhance satellite imagery analysis skills, geospatial analysis skills, and data science capabilities that are required to conduct effective and in-depth analysis of nuclear-related infrastructure.

Supporting Resource Mobilization Priorities

V.1.C4

T.6.C3

Planned Activities

In order to strengthen the access to available and relevant imagery, and to ensure the integrity and authenticity of satellite imagery as an independent source of information, it is necessary to:

- Monitor upcoming satellite launches of imaging sensors, broaden IAEA’s portfolio of satellite imagery types, and increase the number of subscriptions to online streaming services.
- Enhance the use of Application Programming Interfaces (APIs) in order to aggregate the discovery of a broad range of supplier’s archive catalogues.
- Leverage new constellations of satellites in order to more effectively plan imagery collection (active tasking) and more efficiently anticipate and fulfil safeguards needs and expectations.
- Enable access to historical archives of satellite imagery acquired by decommissioned satellites prior to 2000.

Therefore, the Department would request the following:

- Financial Support: Anticipated to support the cost of new subscription services.
- Consultants: Expertise on the use and integration of APIs to the enterprise system.
- Reference Materials: Any access to satellite imagery or subscription services.

In order to enhance analytical capabilities, it is necessary for the Department to:

- Enhance and sustain (perpetuate) existing in-house processing capabilities (processing chain and technical skills) for all types of satellite imagery.
- Pursue the effort(s) to incorporate analytics derived from spectral imagery in order to deliver more comprehensive satellite imagery analysis products.
- Pursue effort(s) to develop tools, algorithms, technical and analytical skills, and knowledge. Also incorporate advanced analytical capabilities focused on the assessment of nuclear-related industrial facilities or processes, using SWIR, hyperspectral, SAR, and TIR imagery.

- Acquire and/or develop spectral signature libraries of materials/compounds that are associated with the nuclear fuel cycle and are compatible with the current and future hyperspectral/multispectral satellite sensor capabilities.

Therefore, the Department would request the following:

- Financial Support: To pay for new software or algorithms and consultants.
- Training: Satellite Imagery Processing; SAR Processing; TIR Processing; use of HSI for small target analysis, use of HSI for geology and mining.
- Reference Materials: Spectral signature libraries of materials/compounds associated with the nuclear fuel cycle that are compatible with current and future hyperspectral/multispectral satellite sensors capabilities.
- Consultants: Satellite imagery processing, use of HSI for geology and mining, use of TIR imagery to assess industrial infrastructures.
- CFE/JPO: Provision of personnel with strong technical backgrounds and experience in processing all types of satellite imagery with the primary emphasis on advanced processing of HSI and SAR data in order to maintain state-of-the-art analytical capabilities of multispectral, SWIR, and SAR data.

To cope with the very large volume of satellite imagery available and to enable the use of new technologies, the plan will focus on:

- Enabling prioritized, consistent (pixel consistency/in-depth registration), and more intelligent processing of very large volumes of data by applying AI, investigating cloud computing and machine learning platforms, and enhancing computer power (in other words, graphics processing unit (GPU)).
- Investigating artificial intelligence (ML and DL) for change detection and pixel classification for industrial facilities and processes, but also to assist and optimize the selection of the most relevant imagery available.
- Gaining expertise and training in deep learning tools for the development of training sets for satellite imagery analysis, particularly for non-technical end-users with subject matter expertise as well as in modern algorithms and tools for image segmentation in satellite imagery for the purposes of landcover classification at industrial facilities.
- Identifying user-in-the-loop machine learning tools to assist end users to improve, understand, and trust the trained models.

Therefore, the Department would request the following:

- Financial Support: To attend training and workshops and cover consultancy costs.
- Training:
 - Training in deep learning tools to develop training sets for satellite imagery analysis, particularly for non-technical end-users with subject matter expertise;
 - Training in modern algorithms and tools for image segmentation in satellite imagery for the purposes of landcover classification at industrial facilities; and
 - Attendance at ad-hoc workshops.
- Reference Materials: Any dataset for machine learning. Any tool, algorithm, or software for co-registration/pixel consistency of large satellite imagery datasets.
- Consultants: User-in-the-loop machine learning tools to assist end users to improve, understand, and trust the trained models.
- CFE/JPO:
 - Expert in data science (satellite imagery), artificial intelligence, computer vision to sustain current capabilities.
 - An additional JPO to develop methodologies and deployment of algorithms.

Outcome #2: Maintain and enhance staff skills in processing and analysing satellite imagery and geospatial data.

Outputs

1. Ensure awareness of satellite imagery and geospatial analysis capabilities (users), new techniques and applications (analysts).
2. ★ Ensure the understanding and more effective use of geospatial analysis capabilities and associated techniques, and incorporate new technologies in analytical products.
3. ★ Investigate and use artificial intelligence technology to:
 - Sustain the exploitation and analysis of very large volumes of data and optimize the prioritization of the workload (tasking) and image queue.
 - Support and ease satellite imagery analysis processes with new technologies (automatic detection of specific features, detection of anomalies, etc).
4. Enhance (and automate) the verification (compliance/discrepancies) of Additional Protocol (AP) declarations versus Imagery or Foundation Data.
5. Sustain and enhance the understanding of nuclear fuel cycle imagery signatures (all types of satellite imagery).

Supporting Resource Mobilization Priorities

W.3.C2

W.3.C4

W.3.C5

Planned Activities

To ensure state-of-the-art Satellite Imagery and Geospatial Analysis capabilities, the Department must:

- Attend specific training courses, workshops, seminars, and onsite familiarization visits to nuclear fuel cycle sites.
- Investigate AI (in particular ML and DL) and computer vision to enhance building extraction, feature detection, automatic change detection, coherent change detection or anomaly detection, analytical capabilities and planning/prioritization of tasking.
- Develop machine learning, deep learning, and computer vision-associated technologies to detect AP declaration discrepancies and improve verification processes (site plans).
- Gain knowledge through exchanges with international subject matter experts (remote sensing techniques, use of IA using satellite imagery, geospatial analysis, etc.).

Therefore, the Department requests support in this area through:

- Financial Support: To attend priority events including GEOINT Symposium, DGI, UK Engage, and Esri User Conference/Developers Organization of ad-hoc meetings with international experts (and to cover registration fees, travel expenses, accommodation to international conferences).
- Training:
 - Onsite familiarization visits to nuclear fuel cycle sites (mines, conversion, enrichment, reactors (different types), heavy water production plants, spent fuel, waste storage, phosphate processing plants, etc).
 - Training on satellite imagery and geospatial analysis techniques.
 - Any training material associated with the analysis of nuclear fuel cycle-related facilities using satellite imagery, and in particular hyperspectral/multispectral satellite sensors.
- Equipment: Any tool, algorithm or dataset to enable automatic change detection or anomaly detection, feature extraction.
- Consultants:
 - Contribute to the evaluation or integration of new software.
 - Support the delivery of training (for example, the Satellite Awareness Course).
 - Gain in-depth knowledge on ad-hoc topics (geo-projection, geology, etc.).
- CFE/JPO: Professionals with strong technical backgrounds and experience in satellite imagery analysis of nuclear infrastructures and geospatial analysis.

Outcome #3: Enhanced collaborative analysis and synergy of safeguards-relevant information.

Outputs

1. Enhance the capture of safeguard-relevant geospatial information.
2. ★ Enhance Imagery Analysis knowledge management.
3. ★ Boost the synergy and dissemination of geospatial data, including satellite imagery and geospatial analysis.
4. Enforce the data quality (data accuracy and reliability) and improve procedures for data capture and quality control processes.
5. Enhance IT infrastructure to cope with the growing volume of data.
6. Strengthen international geospatial network cooperation or partnerships regarding methodologies, techniques, or R&D.

Supporting Resource Mobilization Priorities

V.1.C2

V.1.C5

Planned Activities

In order to enhance collaborative analysis and synergy of data, the Department must:

- Implement a system for structured observation management (SOM).
- Improve the current foundational data schema, enhance and optimize workflows, and develop ad-hoc tools for data quality performance.
- Onboard web-based geospatial application developers with knowledge of Elastic and Esri server technologies.
- Improve existing geospatial integrated in-house system(s) to enable more effective and efficient integration, discovery, and collaborative analysis of all types of geospatial and safeguards-relevant information.
- Continuous improvement of:
 - IAs with products such as Additional Protocol Verification and capitalization tools.
 - Management with various analytical and decision-making tools based on geospatial data and products.
- Improve delivery of imagery-derived data and products using geospatial technology.
- Enhanced cooperation with other Sections in terms of data exchange and provision of Geographic Information System (GIS) support.

Therefore, the Department requests:

- Training:
 - Esri User Conference: 3 or 4 persons. It could be remote or in person.
 - ElasticSearch: 3 or 4 persons. It could be remote or in person.
 - Analytical tools PowerBI/Tableau. It could be remote or in person.
- Reference Materials:
 - Any training material associated with the analysis of nuclear fuel cycle-related facilities using satellite imagery, in particular hyperspectral/multispectral satellite sensors.
 - Any tool, algorithm, or dataset to enable automatic change or anomaly detection, feature extraction.
- Consultants: Web-based geospatial application developers with knowledge of Elastic and Esri server technologies.
- CFE/JPO: With backgrounds in geospatial data, analysis, and automation tools development.

To enhance data storage, access, display and sharing, the Department requests:

- Financial Support:
 - Azure credits to process imagery in the Azure Cloud.
 - Azure credits to perform Machine Learning in the Azure Cloud.

- ArcGIS Online credits to support use of available GIS Web Services.
- Equipment:
 - Solid-state drive (SSD) storage rack dedicated to the Department imagery needs: $\geq 300\text{TB}$.
 - 3-node production servers for Elasticsearch.
- Consultants: with software development capabilities around GIS, Satellite Imagery, and Machine Learning.
- CFE/JPO: To manage Jira.

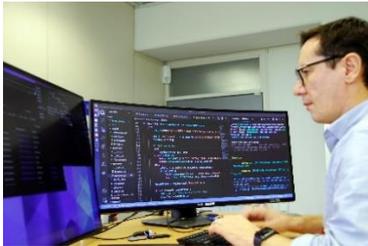


Figure 1: A Department staff member developing a proof of concept.



Figure 2: Department staff members work in the machine learning laboratory.

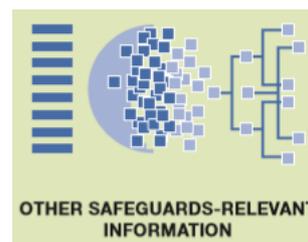


Figure 3: Departmental staff members at an on-site training visit.

SGIM-003: Information Analysis

Collecting, analysing, and integrating information disparate sources detect possible inconsistencies in States' declarations.

 Woan Jin KIM



Plan Acronyms

APA	Acquisition Path Analysis
COTS	commercial off-the-shelf
ISE	Integrated Safeguards Environment
ISF	State Factor Analysis Section
JRC	Joint Research Centre (European Commission)
NFC	Nuclear Fuel Cycle
OSIS	Open Source Information System
SLA	State Level Approach
TBT	The Big Table

Context Highlights

Importance of Information Analysis to Safeguards

The State Factor Analysis Section (ISF) is responsible for the Department-wide collection, evaluation, and dissemination of open source information. This happens daily as an essential component of performing continuous State Evaluation through the updating of State Files and the Open Source Library with information assessed to be Safeguards-relevant. It also includes the production of Open Source Highlights newsletters.

These processes maintain ongoing awareness of safeguards and non-proliferation developments and timely identification of issues across the Department and within State Evaluation Groups, with particular focus on the assessment of the completeness of State Declarations. It is increasingly vital that the information is collected, maintained, and utilized consistently. It is also critical that the risk to proliferation coming from the accelerated dissemination of knowledge and technologies through globalization in the 21st century be addressed effectively.

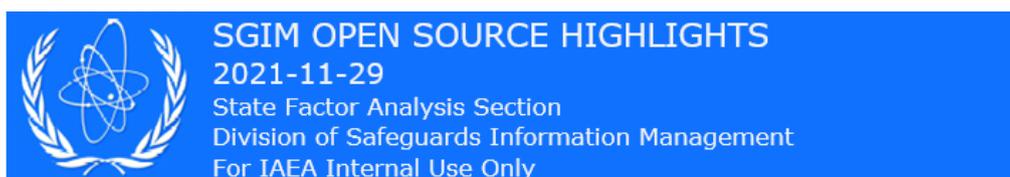


Figure 1: The SGIM Open Source Highlights is delivered to departmental staff members' inboxes each working day.

Prioritizing New Platforms

With the volume and variety of available safeguards-relevant information continuing to increase, the strategy for SGIM-ISF is focused around the definition, implementation, and use of the most updated data collection, information management, and data analytics platforms. The development and introduction of new platforms is a priority area.

Continuing Development of the State Level Approach and Acquisition Path Analysis

The continuing development of the State Level Approach and Acquisition Path Analysis within the Department brings an increased focus on the contribution of IAEA Headquarters-based activities in contributing towards the achievement of safeguards objectives. In particular, there is an urgent need to improve the consistency of the assessment of the States' infrastructure and technical capability to support the ongoing operations a nuclear fuel cycle and its future development. Drawing Safeguards conclusions at the State level through the analysis of all safeguards-relevant information requires constant improvement to the associated processes and supporting competences and tools.

Importance of Extrabudgetary Support to Information Analysis

SGIM-ISF has benefitted extensively from the support of MSSPs in the past, and the need for continued extrabudgetary support is more important than ever. Support continues to be required in a variety of areas, including access to new streams of safeguards-relevant information, improved methodologies for information collection and analysis, including validation, data analytics, focused technical consultancies, and the development and maintenance of knowledge and expertise.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- S.1.C1** Ability to deploy data visualization and other methods and techniques to present safeguards findings and performance-related data in a clear and compelling manner
- V.1.C2** Ability to process and integrate the variety and volume of safeguards-relevant information in a timely, user-friendly and cost-effective manner
- V.1.C3** Ability to efficiently process and interpret multi-lingual safeguards-relevant information, including within the Agency's secure air-gapped network
- V.1.C4** Ability to apply machine learning for automatic selection or change detection in open source text and other media, commercial satellite imagery and cloud data streams, including a library of training data
- V.1.C7** Ability to effectively maintain situational awareness of safeguards-relevant nuclear trade activities and developments
- V.4.C3** Ability to better measure and analyse safeguards performance (of the Department and the safeguards system more broadly) through use of analytical and IT tools, including data visualization
- W.3.C2** Ability to further develop the expertise of the Safeguards Department's workforce and train the next generation of safeguards experts
- W.3.C4** Ability to effectively utilize knowledge and expertise already existing with the Department

Development Plan for 2022–2023

★ The six areas listed below bear the same high priority as the strengthening of the effectiveness and improvement of the efficiency in information analysis will only happen if they all progress in parallel.

Outcome #1: Enhanced identification and collection of open source information through the development of optimized tools and methods.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> 1. Improved capability to provide an increasingly automated identification and collection of safeguards-relevant information from internet-based sources. 2. Enhancement to the processing and management of safeguards-relevant open source information, including mechanisms for adding structure to unstructured data. 3. Structured data library for the storage of historic safeguards-relevant information and for the recording of newly-collected information. |
|----------------|--|

Supporting Resource Mobilization Priorities

V.1.C2

V.1.C3

V.1.C4

Planned Activities

SGIM-ISF utilises its own automatic open source collection system (OSIS) to provide continuous monitoring of news and other open source information streams. OSIS automates a number of the information monitoring, collection, and pre-analytic supporting tasks for open source analysis in support of State Evaluation.

In the 2022–2023 biennium, SGIM-ISF will seek to implement enhancements to tools and methods for collecting, processing, and managing text-based safeguards-relevant semi-structured and unstructured open source information. This would include enhanced automatic collection of information from identified sources and mechanisms for adding structure to unstructured data.

SGIM-ISF will identify and consolidate its historical datasets. A structured data library will be implemented to receive both historical data and fresh information as it is identified and collected. Support is potentially foreseen with the recovery of data from obsolete computer systems and in the identification of a suitable data management architecture.

Support in this area could be formulated primarily with financial contribution, which would allow the exploration of internally-developed solutions or consultants and experts providing guidance from lessons learnt from supporting communities.

Outcome #2: Improved integration of all “other safeguards-relevant information.”

Outputs	<ol style="list-style-type: none">1. Implemented strategy for the selection and implementation of a data analytics platform for the assemblage, integration, and analysis of information from multiple data sources.2. Increased and consistent integration of collected open source information with State Files and other applications in the Integrated Safeguards Environment (ISE).3. Use of a commercial reference manager software to facilitate the efficient capture and structuring of science and technology publications.
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Supporting Resource Mobilization Priorities

V.1.C2	V.1.C3	V.4.C3
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Planned Activities

It is increasingly necessary to optimize the integration of open source information into tools and methods for ‘all source analysis’ in order to detect possible signatures of undeclared activity and to improve analysis of States’ nuclear fuel cycles.

SGIM-ISF will seek to explore the potential for the exploitation of open source software to assist in the design and implementation a multi-function, all-source data analytics platform. The plan includes continuing to work closely with the European Commission Joint Research Centre (JRC) at Ispra under MSSP Task EC D 1880 (Collection, Analysis and Dissemination of Open Sources), which assesses an open source data analytics platform from KNIME. The Department would greatly benefit from other MSSPs that assess or apply data analytics or reference management software platforms.

SGIM-ISF will continue to collaborate closely with SGIS to further structure and integrate open source information into other departmental systems, including (but not limited to) State Files and other applications on ISE. New methodologies that assist the analysis of large, disparate datasets through link analysis and data visualization will be developed for safeguards, spanning the entire range of analytical activities including information collection, assessment, classification, analysis, and reporting.

The use of commercial reference management software packages (including the currently deployed CITAVI platform) will be further investigated, with the aim of allowing the import structured science and technology articles into commercial link analysis and other appropriate software packages.

Support in this area could be formulated primarily with financial contributions, which would pay for integrating commercial off-the-shelf (COTS) and developing IT solutions or in-kind contributions of tools that have been elsewhere developed.

Outcome #3: Extending the collection of available safeguards-relevant, open source information.

Outputs	<ol style="list-style-type: none"> 1. Identification and acquisition of new streams of safeguards-relevant information. 2. Increased ability to collect safeguards-relevant data from sources not published in English.
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Supporting Resource Mobilization Priorities

V.1.C2	V.1.C3
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Planned Activities

The IAEA seeks to ensure the broadest possible set of safeguards-relevant information to support the State Evaluation Process. Therefore, the Department requests support in this area through access to paid subscription databases. Such support will be essential during 2022–2023.

The increased access to regional, scientific, and technical information brings the challenge of identifying and translating safeguards-relevant information that is not published in English. The Department greatly benefits from support to this activity, namely under MSSP Tasks:

- UK D 1728 (Regional Information Collection Centre-East Asia)
- UK D 1730 (Regional Information Collection Centre-Middle East)
- ROK D 1213 (Provision of Open Source Information)

Support for the retrieval of information from new media is provided under:

- RSA D 1489 (Open Source Information Collection)

A number of other sources for trade and procurement data have been identified and evaluated for departmental use. Support is needed to continue this process through MSSP Tasks:

- EC D 1662 (Improving Analysis of Covert Nuclear Trade)
- UK D 1916 (Improving the Analysis of Trade Data for Safeguards-relevant Proliferation Activities)
- HUN D 1919 (Collection and Analysis of Nuclear Trade Related Information to Strengthen Safeguards)

In addition to a continuation of current support, assistance from external partners will be sought to expand the number of sources of both non-English language information and trade and procurement data. The provision of CFEs and JPOs proficient in open source, NFC-related science and technology, or trade with multiple languages capabilities will be sought.

Outcome #4: Improved collection and analysis of large volumes of science and technology and nuclear trade data.

Outputs	<ol style="list-style-type: none"> 1. Implementation of a workplan to develop and implement the use of Natural Language Processing techniques to optimise the use of automated textual searches and the classification of science and technology-related open source information. 2. Better utilisation of advanced analytical techniques and data visualization tools for disparate sources of open source information, including global trade data and science and technology publications. 3. Successful deployment of The Big Table (TBT) software tool developed in conjunction with JRC, Ispra on the IAEA Safeguards network.
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Supporting Resource Mobilization Priorities

V.1.C2

V.1.C7

V.4.C3

S.1.C1

Planned Activities

New methods are required to support the development of APAs and SLAs as part of the State Evaluation Process, in particular in relation to the assessment of nuclear fuel cycle technical capability and infrastructure and industrial capability.

SGIM-ISF plans to investigate and analyse the use of Natural Language Processing techniques to optimise the use of textual searches and the classification of open source information. This will allow for the optimal identification of science and technology publications for evaluation by safeguards analysts and/or subject matter experts. The focus is on increasing the signal to noise ratio for safeguards-relevant information in computer-collected data.

The implementation of tools already developed in collaboration with the JRC through MSSP Task EC D 1662 (Improving Analysis of Nuclear Trade-Related Information), such as TBT, a software tool designed to support nuclear trade analysis for IAEA safeguards, and Maps of States' nuclear-related industrial capabilities, will be continued.

Additional support will be sought from JRC to assist in the development of a system for the monitoring in the global of trade of phosphate minerals and their derivatives.

Outcome #5: Enhanced analysis of open source information, science and technology publications, and nuclear trade data.

Outputs

1. Identification and implementation of technical consultancies to support identified analytical needs.
2. Evaluation of nuclear fuel cycle modelling software for use in the State evaluation process.
3. Attendance at technical conferences and trade fairs and technical visits to safeguards-relevant industrial and manufacturing locations.

Supporting Resource Mobilization Priorities

V.1.C2

V.1.C7

Planned Activities

Inputs from specialist technical consultants play a significant role in enhancing the Department's ability to carry out information and data analysis and to support the evaluation of specific nuclear fuel cycle technology areas.

It is intended that future support will continue to be requested from MSSPs, for example through the following MSSP Tasks:

- USA D 1126 (Consultant - Assistance on Information Collection and Information Systems)
- UK D 1819 (Nuclear Fuel Cycle Specialist Assistance)
- AUL D 1915 (Consultant - Assistance on Information Collection and Analysis)
- EC D 1880 (Collection, Analysis and Dissemination of Open Sources)

There is interest in securing a trial license for the use of nuclear fuel cycle modelling software that could prove a useful tool for providing input to the State evaluation process. Initial discussions carried out under MSSP Task UK D 1329 (Support for SGIM Analysis) for the use of ORION, a systems dynamics fuel cycle code developed and maintained by the National Nuclear Laboratory in the United Kingdom, will be continued.

The Department will assess which technical conferences and trade fairs will be carried and then transmit MSSP Task Proposals or letter requests. Similarly, assessments will be made of the benefit of requesting visits/access to identified nuclear fuel cycle, industrial, and manufacturing facilities.

Outcome #6: Structured training and development plans to support staff in the collection, analysis, and reporting of open source information and nuclear trade data.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. Development of “learning paths” for SGIM-ISF staff. 2. Portfolio of training resources to support open source, technical, and trade analysis. 3. New training products developed to specifically support open source, technical, and trade analysis. |
|----------------|---|

Supporting Resource Mobilization Priorities

V.1.C2	W.3.C2	W.3.C4
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Planned Activities

Work will be carried in conjunction with SGCP-CTR to develop “learning paths” for staff in SGIM-ISF. A portfolio of training resources to support open source, technical, and trade analysis will be developed.

Existing training products will be identified and improved and where necessary new bespoke training products will be developed.

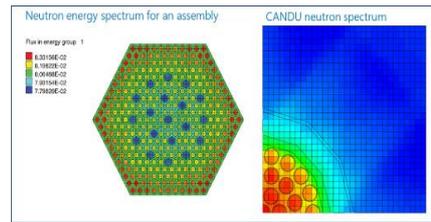
Increased technical training and familiarisation for SGIM-ISF staff in specific areas of the nuclear fuel cycle through organized technical visits and the use of bespoke technical seminars.

Training through MSSP Task GER B 1560 (Nuclear Trade Analysis Related Support and Training for Trade and Technology Analysis Unit) has proven effective in raising the competence levels of trade analysts and will be continued in future years.

SGIM-007: Evaluation of Data from Environmental Sampling and Material Characterization

Evaluating environmental sampling (ES) and material characterization data to detect undeclared nuclear material and activities.

 Mika NIKKINEN



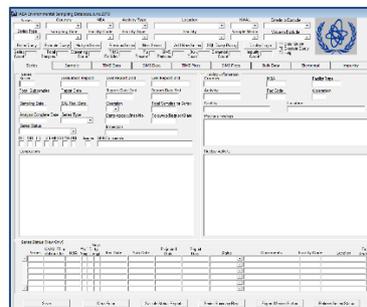
Plan Acronyms

ES	environmental sampling
ESDB	Environmental Sampling Database
ESEE	Environmental Sampling Environment Enhancement
LA-ICPMS	Laser Ablation Inductively Coupled Plasma Mass Spectrometry
MOX	mixed oxide
NFC	nuclear fuel cycle
NWAL	Network of Analytical Laboratories
UOCs	uranium ore concentrates

Context Highlights

Background Information

Environmental sampling has been a core part of safeguards verification for nearly 30 years. The IAEA has amassed a huge knowledge base for evaluation purposes that is used daily for contributing to safeguards conclusions. A central part of the knowledge base is the Environmental Sampling Database (ESDB), which hosts most of the data collected over the years of environmental sampling (ES) implementation in a structured and easily accessible manner.



Introducing the Environmental Sampling Environment Enhancement (ESEE) Project

As the tools for manipulating and managing ESDB data are at the end of the product lifecycle and to streamline the ES evaluation processes, the IAEA has initiated the ESEE Project in order to:

- Re-engineer the core part of the data repository.
- Add report generation workflows.
- Enable future enhancements.

The IAEA selected MS SQL server and .NET framework for this project, which will ensure the continuity of ES business for decades to come. While the software will be developed by an external contractor and in close collaboration with SGIS-003: Safeguards Information Systems and System Usability, a JPO or CFE would be valuable to test and enhance the new platform.

In addition to data management, the IAEA needs to maintain its tools for modelling nuclear fuel cycle (NFC) processes. This is vital for managing the increasing number of environmental samples and making the evaluation process as efficient as possible. To do this, extrabudgetary support would be valuable to support IT development and provide additional human resources for developing and testing the new system.

Enhancing Nuclear Process Modelling Tools

The work of SGIM-007: Evaluation of Data from ES and Material Characterization also aims to further enhance NFC modelling tools. Approaches that improve and facilitate decision making and compare recent findings with such models, as well as with historical results, are needed. The IAEA must maintain an updated data processing system with potential new data forms and inform external partners more on these kinds of needs so that they can provide support for the development of analytical methods and efficient ways of data reporting as necessary.

New Method Development

The IAEA would also benefit from new method development that the Network of Analytical Laboratories (NWAL) provides (for example refined age determination of uranium particles, simultaneous U/Pu mass ratio determination in particles, interpretation of particle elemental data and morphological characteristics, and improvements in detection capabilities in general). In this respect, increased communication between the NWAL and IAEA ES evaluators, including the opportunity for evaluators to visit the NWAL, would promote a common understanding of the needs of the evaluators and the capabilities of the laboratories.

Most Needed Extrabudgetary Support in 2022–2023

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| <input type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.2.C6** Ability to maintain and further enhance the environmental sampling database and the process models, databases, and tools that support trace elements analysis (material characterization)
- V.1.C1** Ability to synthesize and evaluate disparate sets of verification data from the field through data analysis methods and tools
- W.3.C4** Ability to effectively utilize knowledge and expertise already existing with the Department
- W.3.C5** Ability to preserve and disseminate critical organizational knowledge to overcome staff turn-over and other associated challenges

Development Plan for 2022–2023

★ Indicates top priority

★ **Outcome #1:** Enhanced environmental sampling evaluation environment.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> ★ Transition of the current environmental sampling database (ESDB) to Environmental Sampling Environment Enhancement (ESEE), the new technical environment. An enhanced ES evaluation process to provide more efficient workflow and faster turnaround of evaluations. Easier management of the interaction between modelling tools and the ESDB. |
|----------------|---|

Supporting Resource Mobilization Priorities

V.1.C1

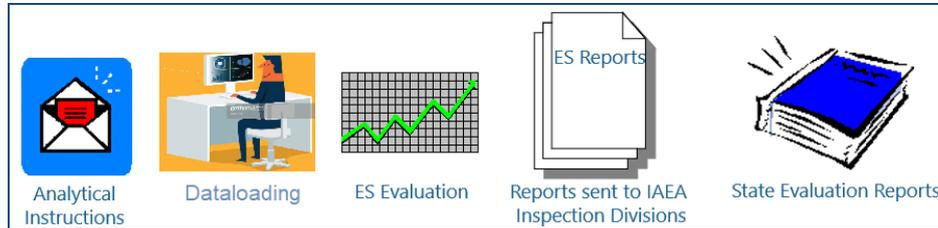
T.2.C6

Planned Activities

SGIM launched the ESEE Project to enhance and re-engineer the ESDB and integrate all evaluation tools to provide a streamlined evaluation platform that will serve the IAEA for decades to come. The first stage of the evaluation platform is expected to be deployed in 2023 with further

enhancements planned for 2024. R&D, testing, and possible development support from external partners would be valuable.

Core functions such as data loading, drafting/formatting reports, and report management must be semi-automated to reduce evaluator workload. Automatic matching of current ES results with historical information will allow IAEA evaluators to contend with the ever-growing amount of data in the ESDB and devote energy to other tasks.



ES tools that provide, for example, reactor burn-up calculations and uranium enrichment modelling, need to interface with the new ES evaluation platform to support evaluations. The IAEA plans to incorporate two-way data transfer between these tools and the ESDB.

Outcome #2: Improved nuclear fuel cycle (NFC) modelling tools and pre-calculated models.

- Outputs**
1. Functional and maintained tools for uranium enrichment modelling and reactor burn-up calculations.
 2. New, calculated reactor models, with one being a comprehensive mixed oxide (MOX) scenario.
 3. An enhanced impurity library with new samples collected from additional uranium processing locations.
 4. Improved automatic analysis, analytics, and evaluation methodology.

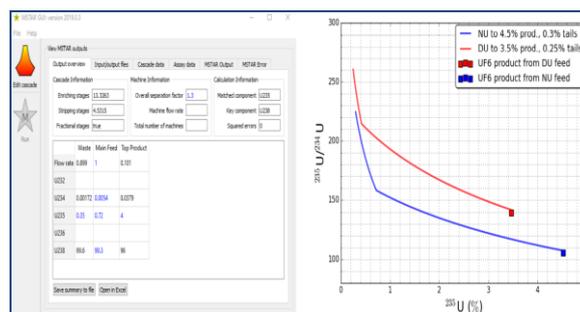
Supporting Resource Mobilization Priorities

V.1.C1

T.2.C6

Planned Activities

Evaluation of ES and material characterization data relies on updated uranium enrichment modelling and software utilities, reactor burn-up calculations, and other NFC modelling tools. Extrabudgetary support to maintain these tools would be highly appreciated.



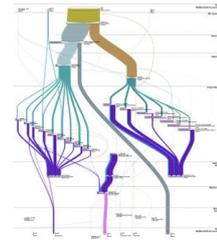
In addition to ensuring the availability of the reactor modelling tools, the IAEA would benefit from pre-calculated nuclear fuel burn-up models and reactor modelling software training. While there are many pre-calculated models currently available to IAEA ES evaluators, the IAEA lacks such pre-calculated models for certain scenarios and would benefit from, for example, pre-calculated MOX models for various reactor and fuel types. Furthermore, training in the SCALE modelling package would enhance the IAEA's understanding of the prepared reactor burn-up calculations and provide IAEA evaluators with the necessary knowledge to build ad-hoc models not within the scope of MSSP Tasks.

Expansion of the IAEA uranium ore concentrates (UOCs) library, further enhancements to tools for determining the most likely origin of a UOC material (for example, DAVE software), and

SGIM-008: Statistical Analysis

Developing statistical and probabilistic methodologies to design and evaluate safeguards approaches and inspection activities and optimize resources.

 Claude NORMAN



Plan Acronyms

ABC	approximate Bayesian computation
ADP	achieved detection probabilities
APA	acquisition path analysis
DA	destructive analysis
ESARDA	European Safeguards Research and Development Association
GUM	Guide to the Expression of Uncertainty in Measurement
IMUF	Inspector's material unaccounted for
INMM	Institute of Nuclear Materials Management
ITV	International Target Value
J-MOX	JNFL MOX Fuel Fabrication Plant
MBA	material balance area
MBE	material balance evaluation
MOSAIC	Modernization of Safeguards Information technology
MUF	material unaccounted for
NRTA	Near Real Time Accountancy
RSD	relative standard deviation
SEG	State Evaluation Group
SLA	State-level approaches
SLAIP	State-Level Approach Improvement project
SRD	Shipper-Receiver Difference
STEPS	Statistical Evaluation Platform for Safeguards
TRIPS	Tool for Random Inspection Planning for Safeguards
UQ	Uncertainty Quantification

Context Highlights

Statistical Methodology Scope Expansion

Statistical methodologies for safeguards were developed at an early stage in safeguards' history and are rooted in a criteria-driven, facility-based approach which has long underpinned IAEA's conclusions.

While statistical methodological principles and approaches remain generally valid in the framework of a State-level evaluation, their scope—previously restricted to material balance areas (MBA) within facilities—needs to be expanded.

The expansion includes the analysis of nuclear material flows, inventories, and balances for a whole State and considers the increasing use of random inspection schemes in State-level approaches (SLAs) and the implications for the statistical analysis of data collected according to these patterns.

In addition to this undertaking, which poses a number of methodological challenges, new approaches are needed to:

- Address increasingly large and diversified data flows.
- Optimize the distribution of limited statistical analysis and verification resources.
- Align them with the State-level technical objectives (TOs) identified through the acquisition path analysis (APA) performed by the State Evaluation Groups (SEGs).
- Develop probabilistic methods for the quantification of their targeted and achieved attainment.

In addition, statistical evaluation results of State-declared and verification data need to be consolidated and compared to information from other sources.

IT and Statistical Methodologies

Considerable progress was made in the field of information technology (IT) and statistical methodologies since they were first applied to safeguards several decades ago. The migration of the IAEA safeguards IT platform under the Modernization of Safeguards Information technology (MOSAIC) project provided a unique opportunity to adapt and evolve methodologies and to integrate them into new software tools, including data visualization tools.

Uncertainty Quantification (UQ) Method Upgrade

With this goal in mind, the IAEA initiated a biennial International Technical Meeting on Statistical Methodologies for Safeguards in 2013 to gather worldwide expertise in addressing current gaps and questions, draft recommendations, and build a network of specialists to remedy the lack of internal resources, which are almost entirely consumed by “core production activities,” like providing reports and supporting Operations Divisions. The work was organized along a high-level structure (see Figure 1) resting on the review and upgrade of UQ methods as a first fundamental step because knowledge of uncertainties determines the level of verification efforts as well as the confidence associated with verification data and the related conclusions. MSSPs who accept MSSP Task Proposal 21/IFC-002 (Statistical Methodology Development) will greatly assist in the development and refinement of IAEA's statistical methodologies for UQ, random verification schemes (sampling plans, random inspections), and data evaluation.

Tool for Random Inspection Planning for Safeguards (TRIPS)

Extensive progress was made in the UQ and Random Verification Scheme areas thanks to MSSP support in the form of CFEs and JPOs who substantially contributed to theoretical developments as well as to the software prototyping.

Rather than being negatively impacted by the Covid-19 lockdown period, some development benefited from the associated re-planning of the Statistical Analysis team's work, as the downtime in other areas was reallocated to harmonizing UQ processes in the context of the 2020 International Target Values revision (ITV-2020 Project).

However, the initial workplan had to be altered to support the requirements associated to the State-Level Approach Improvement project (SLAIP) initiated in September 2019, which led to the development of a prototype of the Tool for Random Inspection Planning for Safeguards (commonly called TRIPS) to support random inspections for the detection of nuclear fuel cycle facility misuse.

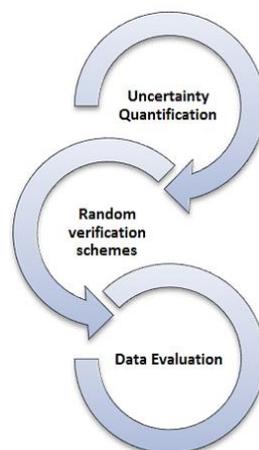


Figure 1: Three high-level interconnected methodological development areas as identified during the first technical meeting on Statistical Methodologies for Safeguards (Vienna, October 2013).

Most Needed Extrabudgetary Support in 2022–2023

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|--|---|--|---|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- V.1.C1** Ability to synthesize and evaluate disparate sets of verification data from the field through data analysis methods and tools
- V.1.C2** Ability to process and integrate the variety and volume of safeguards-relevant information in a timely, user-friendly and cost-effective manner
- V.3.C1** Ability to derive verification intensities and frequencies from performance targets and to determine detection probabilities
- V.4.C1** Ability to leverage statistical methodologies to evaluate verification data, to assess verification performance (detection probability, timeliness and deterrence) and the associated level of confidence, at the facility and State levels
- V.6.C3** Ability to implement effective and efficient safeguards at J-MOX

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Standardized methodologies in support of State Level Approaches for calculating detection probabilities achieved through verification activities at facility and State levels.

Outputs	<ol style="list-style-type: none"> 1. Development of simulation-based methodologies to estimate achieved detection probabilities against all diversion scenarios. 2. Development of optimized sampling plans achieving a maximum detection probability using the same inspection effort. 3. Integration of non-Gaussian Uncertainty Models and mixed random/systematic models.
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Supporting Resource Mobilization Priorities

V.3.C1	V.4.C1
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Planned Activities

Under MSSP Task Proposal 21/IFC-002 (Statistical Methodology Development), the IAEA plans to develop Monte Carlo simulation methods to determine achieved detection probabilities (ADP) from verification measurements at stratum level against all diversion scenarios, in other words, beyond the assumption of equal diversion from all items. These simulations will be further extended to determine ADP at material balance area (MBA), facility, site, sector, and State level. They should integrate the use of non-Gaussian measurement error distributions for one or more measurement methods as well as the possibility of using mixed random/systematic uncertainty models.

Based on the above simulation results, the IAEA will calculate sample sizes to achieve specified detection probabilities with or without constraints on sample sizes (for example, maximum number of destructive analysis (DA) samples across MBA, maximum number of samples per one or more strata), and determine the optimal distribution of conventionally calculated sample sizes to maximize ADP using the same inspection effort.

The simulation input data include stratum inventories and inventory changes, sample sizes, random, and systematic uncertainty (relative standard deviations (RSD)) values and distributions as well as uncertainties of the RSD estimates. A fictitious State with realistic nuclear fuel cycle data is being internally developed to support the simulation work, which will be carried out under MSSP Task USA F 2600 (Statistical Methodology Development).

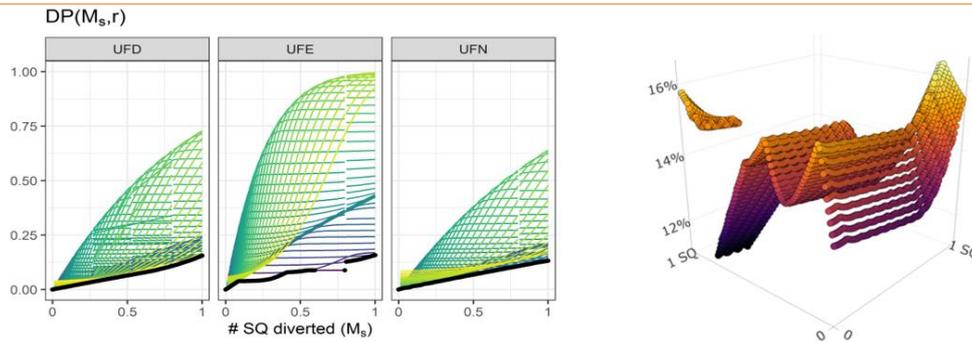


Figure 2: Detection probability is calculated for individual strata within a facility (left) and aggregated into an overall achieved detection probability (right).

★ **Outcome #2:** Improved and harmonized random verification schemes, including sampling plans and random inspection schemes, and methodologies to evaluate their effectiveness.

Outputs	<ol style="list-style-type: none"> 1. A peer-reviewed, revised version of Statistical Methods for Verification Sampling Plans (STR-381). 2. Prototype software implementing sampling plan procedures described in STR-381 and documentation of practical sampling plan implementation procedures for inclusion in the Inspector Handbook. 3. Development and documentation of a set of standard random inspection schemes (including standard evaluation methodologies and tools) as a basis for a more harmonized approach to implementing and evaluating such schemes in State-level approaches (SLA).
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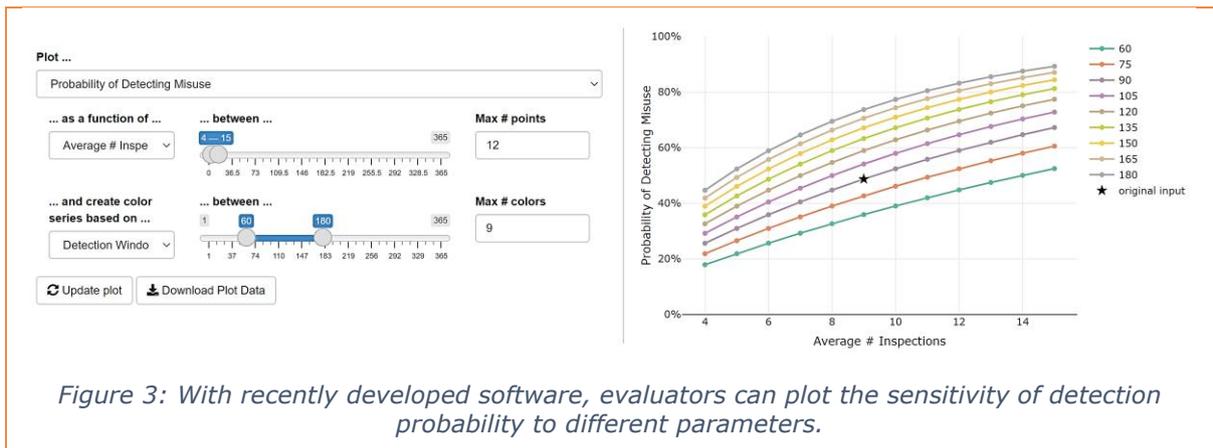
Supporting Resource Mobilization Priorities

V.3.C1	V.4.C1
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Planned Activities

For the peer-reviewed, revised version of Statistical Methods for Verification Sampling Plans and Prototype software (Outputs #1 and #2), sampling plan methodologies are being further enhanced under MSSP Tasks GER D 1925 (Optimization Approaches to Inspection/Verification Design) and USA F 2600 (Statistical Methodology Development) where of Statistical Methods for Verification Sampling Plans (STR-381) will be revised and peer-reviewed by experts. In parallel, these methodologies are being translated into user-friendly procedures and software to be used during in-field verification activities. This will be achieved through MSSP Tasks GER D 1925 (Optimization Approaches to Inspection/Verification Design), USA D 2526 (Junior Professional Officer - Associate Data Evaluation Officer), and in-house development work in close collaboration between SGIM, Operations Divisions, and SGIS-003: Safeguards Information Systems and System Usability.

For the development and documentation of a set of standard random inspection schemes (output #3), the expected outcome will be achieved through MSSP Task GER D 1925 (Optimization Approaches to Inspection/Verification Design) and in-house development work in close collaboration with SGCP, in continuation of the development work carried out in support of the State-level approach improvement project (SLAIP).



Outcome #3: Improved ability to determine measurement uncertainties from operator-inspector paired-data, 3-laboratory data, and calibration data.

- Outputs**
1. Peer-reviewed STR on the uncertainty quantification (UQ) methodologies used as a basis for UQ methods applied to safeguards verifications.
 2. Technical guidance document based on the continuation of the methodological work begun on approximate Bayesian computation (ABC) for UQ.
 3. Publication of the paper *Statistical model-based and GUM-based analysis of measurement uncertainties in nuclear safeguards – a reconciliation*.

Supporting Resource Mobilization Priorities

V.1.C1

V.4.C1

Planned Activities

A Safeguards Technical Report (STR) on UQ was drafted through MSSP Task USA A 1989 (Expert - Statistical and Probabilistic Methodologies for Inspection Approaches and Verification Result Analysis). Peer review of the document was delayed by the Covid-19 pandemic and will now be carried out by experts under MSSP Task USA F 2600 (Statistical Methodology Development).

Several papers on ABC were published describing its application to various measurement systems. Work will continue through in-house development to include these methodologies in the systems used by the IAEA to apply them to paired-data, 3-laboratory data, and calibration data.

The paper was finalised and submitted to the *Metrologia* journal. Unfortunately, the journal's editorial board did not accept to publish it. It will now be submitted to the ESARDA and INMM journals.

Outcome #4: Reviewed, updated, and consolidated methodologies, including Bayesian methodologies, applied to the evaluation of material unaccounted for (MUF), D Statistic (D), Inspector's MUF (IMUF), and Shipper-Receiver Difference (SRD) in the context of material balance evaluation (MBE).

- Outputs**
1. A technical document, most likely an STR, on MBE methodologies and their implementation in relevant analytical software.
 2. ★ Comprehensive Near Real Time Accountancy (NRTA) methodology documentation in the form of an STR and requirements documentation for a harmonized NRTA software system for use as a standardized platform for NRTA evaluation systems at the Rokkasho Reprocessing Plant and at the JMOX plant.
 3. Documented concepts, methodologies, and processes supporting MBE at the State level including prototype deliverables.

- Implementation of methodologies supporting the tracking of UF₆ cylinders in support of MBE, for example, SRD evaluation at enrichment and conversion facilities (related to SGIM-009: State Declared Information Management's Outcome # 7).

Supporting Resource Mobilization Priorities

V.1.C1

V.1.C2

V.4.C1

V.6.C3

Planned Activities

Enhanced methodologies for evaluating MBE statistics were developed and are being implemented in the MBE module of the Statistical Evaluation Platform for Safeguards (STEPS). Methodologies will be comprehensively documented in an STR as part of the STEPS development after deployment and comprehensive testing.

MSSP Tasks FRA D 2288, JPN D 2351, ROK D 2443, UK D 2308, and USA D 2462 (NRTA System Documentation and Requirements Gathering) are ongoing for NRTA system documentation and requirements gathering. The publication of NRTA methodology documentation is planned for early 2022 and requirements specifications for a harmonized NRTA software is foreseen to be completed by end 2022.

Starting from the analysis of nuclear material flows, inventories, and balances against a State's nuclear fuel cycle visualized on SNAKEY diagrams (see figure 4 below), the State-level MBE approach will consist of developing successive overlays leading to a map-type representation of detection effectiveness versus performance targets, in terms of detection probability for the TOs related to nuclear material diversion along the State's APA, making it possible to review the priority of MBE activities and/or to flag the need to intensify the focus on other TOs along the same path. This development will initially be carried out using in-house resources. Potential extrabudgetary support will be identified as work progresses

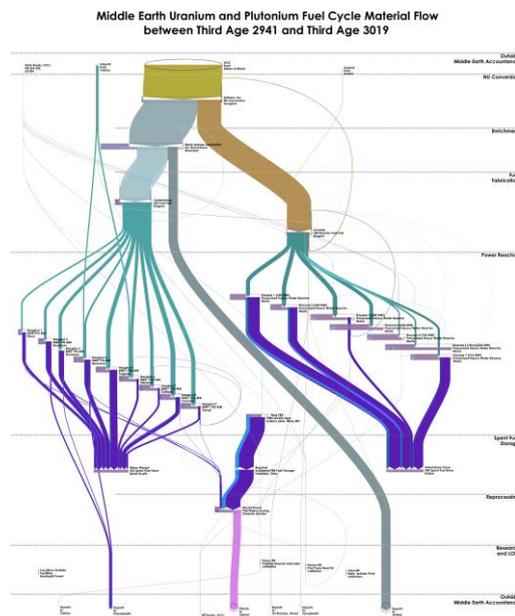
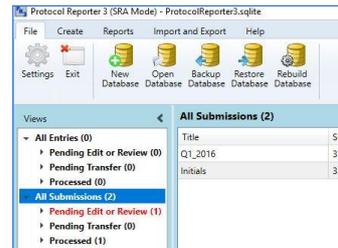


Figure 4: A SNAKEY State nuclear material flow diagram, which is a versatile and interactive visualization of nuclear material flows, inventories, and material balance results.

SGIM-009: State Declared Information Management

Collecting, managing, analysing, and utilizing State-declared information.

 Zana KONECNI



Plan Acronyms

ACMS	Agency Correspondence Management System
AIP	Annual Implementation Plan
AP	Additional Protocol
APA	Acquisition Path Analysis
APS	Additional Protocol System
COTS	Commercial Off the Shelf
CRM	Customer Resource Management
ERMS	Electronic Records Management System
GUI	graphic user interface
ICR	Inventory Change Report
ISD	Declared Information Analysis Section
ISE	Integrated Safeguards Environment
MBA	material balance areas
MBE	material balance evaluation
MBR	Material Balance Report
NMA	Nuclear Material Accountancy
NMAP	Material Accountancy Analysis Platform
OCR	Optical Character Recognition
ORNL	Oak Ridge National Laboratory
PIL	Physical Inventory Listing
PR3	Protocol Reporter 3
QC	quality control
SDP	State Declarations Portal
SER	State Evaluation Report
SGMD	Safeguards Master Data
SLA	State Level Agreement
SRA	State or Regional Authorities
SSDH	State Supplied Data Handling
SSDH-C	State Supplied Data Handling Core (system)
TM	Transit Matching
UF₆ID	UF ₆ cylinder unique identifier

Context Highlights

Plan Objective

The overall objective of this D&IS Plan is to enhance the IAEA's ability to collect, manage, analyse, and utilise State-declared information in support of the IAEA's verification mission, in particular with respect to the State evaluation process and support of in-field verification activities.

Priorities

1. Update and deploy tools and methodologies for Member States to collect, store, and submit State-declared information.
2. Enhance a Nuclear Material Accountancy Analysis Platform (NMAP) to integrate information from various sources that automatically generates relevant data outputs in multiple formats for routine and ad-hoc analytical work.

3. Enhance the State Declarations Portal (SDP) as the primary tool for information exchange between States and the IAEA, including the deployment of automated Nuclear Material Accountancy (NMA) quality checks against historical data via the State Supplied Data Handling Core (SSDH-C) System Quality Control (QC) engine.
4. Enhance SSDH-C to include the ability to track requests for exemption of nuclear material.
5. Develop training material and remote delivery methods to support the training of States or Regional Authorities (SRA) with reduced costs and increased accessibility.

Foreseen Challenges

The greatest challenge facing this D&IS plan is ensuring a sustainable level of IT resources to maintain and enhance the tools required to process and analyse State declarations.

SGIM has identified many opportunities to enhance the existing suite of IAEA software tools for the processing of State declarations. An enhanced analysis platform/environment is needed to integrate information from various sources. Improvements to the internal Safeguards Master Data (SGMD) and State Supplied Data Handling (SSDH) systems, as well as to the externally-facing SDP, are needed to increase Departmental effectiveness and efficiency. Sufficient developer resources are needed to realize the benefits of such enhancements.

Critical Projects

- Optical Character Recognition (OCR) with verification
- Extended SDP Functionality
- Nuclear Material Accountancy Analysis Platform (NMAP)
- Creation of E-learning Modules

Important Projects

- NMA training environment & dataset
- UF₆ Cylinder Tracking
- Import Communication Consultancy Meeting
- Further Development of Protocol Reporter 3 (PR3)
- Updates to Safeguards Master Data (SGMD)

Optional Projects

- Integration of Geospatial Information

Most Needed Extrabudgetary Support in 2022–2023

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| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input type="checkbox"/> Training |
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| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- S.2.C1** Ability to strengthen the capacity of SSACs/SRAs and monitor and measure progress
- T.3.C2** Ability to assist SRAs with the creation and submission of accountancy reports and additional protocol declarations with an IT tool
- V.1.C2** Ability to process and integrate the variety and volume of safeguards-relevant information in a timely, user-friendly and cost-effective manner
- V.1.C6** Ability to apply optical character recognition/text extraction as a robust service to enable information integration into digital systems
- V.1.C7** Ability to effectively maintain situational awareness of safeguards-relevant nuclear trade activities and developments

V.3.C2 Ability for safeguards information systems to assist analysts in identifying significant changes in a State's nuclear fuel cycle, which may trigger a need to update the APA, SLA, and AIP

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: More effective and efficient State Declarations Handling System with improved workflows.

Outputs	<ol style="list-style-type: none"> 1. Implement full workflow (including QC checks) for Exemption, Termination, and Re-application requests of nuclear material to be integrated with the nuclear material accounting system to allow for matching State NMA reports to requests for exemptions and terminations of nuclear material. 2. Apply optical character recognition (OCR)/text extraction as a robust service to reduce manual input of declarations received as hard copies while still allowing for robust verification procedures to eliminate data entry errors in the NMA database.
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Supporting Resource Mobilization Priorities

V.1.C2

V.1.C6

T.3.C2

Planned Activities

Implement updates to SSDH-C so it can accommodate and provide the above outputs.

Support would be most appreciated in the form of one additional developer for SSDH and direct funding to purchase and test scan/OCR/text extraction software.

Outcome #2: Improved effectiveness and efficiency of analysis of all State Declared Information (NMA, Additional Protocol (AP), SGMD, etc.).

Outputs	<ol style="list-style-type: none"> 1. ★ Development of a new analysis platform/environment (software tool) to integrate information from various sources. 2. ★ Ability to automatically generate relevant data outputs in multiple formats (flat tables, graphical, etc.) for routine NMA work, for example, State Evaluation Report (SER) contributions. 3. ★ Development of a new graphic user interface (GUI) that allows IAEA analysts to work with NMA data intuitively. 4. Easier comparison of SG-relevant data and State declarations and consistency analysis. 5. Ability to tag all locations declared in NMA and AP declarations with geospatial data.
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Supporting Resource Mobilization Priorities

V.3.C2

V.1.C2

T.3.C2

Planned Activities

In close collaboration with SGIS-003: Safeguards Information Systems and System Usability:

- Integrate databases and analytical tools on one platform/environment to enhance the efficiency of analysis by reducing manual calculation steps and manipulation of the data, for example, in MS Excel.
- Assess and implement prototype analytical GUI and data outputs, followed by an evaluation and test of this common database and analytical platform (both by IAEA analysts and IT specialists).

- An ability for IAEA analysts to add simple, structured comments, save the analysis in the common space that can be found, read, and shared in the future.
- Meetings with Member States who have recently developed their own modern NMA platforms to discuss best practices and lessons learned, for example, from the UK, Australia, and Japan (in progress).
- Develop the ability to tag all locations declared in NMA and AP declarations with geospatial data.
- Introduce geospatial data into the NMA database.
- Integrate this data with the information in SGMD.

NMA data is “structured” data, and it contains location information in the form of the facility code and material balance areas (MBAs) associated with the reports. Each report provides information for one MBA. Facility and MBA locations are stored in SGMD. AP declarations under article 2.a.(iii) also contain addresses and/or other geospatial information. These information sources should be combined and standardized in departmental internal databases (SSDH-C, APS, and SGMD) to allow for more streamlined integration with the Department’s geospatial tools.

Article 2.a.(iii)

“..... shall provide the Agency with a declaration containing:

(iii) A general description of each building on each *site*, including its use and, if not apparent from that description, its contents. The description shall include a map of the *site*.”

Figure 1: Excerpt from Guidelines and Format for Preparation and Submission of Declarations Pursuant to Articles 2 and 3 of the Model Additional Protocol to Safeguards Agreements, page 23.

The most needed support to achieve this outcome would be support of funding for staff to define the appropriate schema for the geospatial data, combine the data from the various sources, and implement the integration with the Department’s geospatial tools.

Resources required may include some/all of:

- Direct funding to purchase commercial off-the-shelf (COTS) tools.
- One or more CFEs (Cognitive Analysts) to assess tools.
- Developers to integrate tools with existing systems.
- Direct funding to cover travel expenses for meetings with Member States.

Outcome #3: Improved NMA testing & training capabilities.

- Outputs**
1. Creation of an NMA training and testing environment.
 2. Creation of a comprehensive set of simulated NMA training data.

Supporting Resource Mobilization Priorities

T.3.C2

S.2.C1

Planned Activities

Create an isolated database (platform) with representative NMA information for testing and training purposes.

Create a working environment of the NMA systems for testing and demonstration, including a test country mock-up.

Create an NMA dataset for training purposes to include complete NMA data: Physical Inventory Listing (PIL), Inventory Change Report (ICR), Material Balance Report (MBR), and Concise Notes. The data must be coherent, but at least one subset should have intentional discrepancies/internal inconsistencies to allow for training/identification of complex NMA issues. The dataset should be complex enough to include movements of material across State borders to allow for training in

Transit Matching (TM) procedures. The volume of the NMA data must allow for stratification, sample size, and MBE to be performed.

The most needed support to achieve this outcome would be:

- Software development resources to update internal systems to create a testing/training environment.
- Staff with an NMA background to prepare coherent (but scrambled) data and ensure that the NMA and some Material Balance Evaluation (MBE) tools can work with the data.

Outcome #4: More efficient information exchange by optimizing SDP processes.

Outputs	<ol style="list-style-type: none"> 1. Ability for Member States to validate NMA Reports so that corrective action can be taken. Validation would include QC checks against historical data. Validation results would be returned to the Member States as reports with easily-to-interpret QC error messages. 2. Ability to give near-real-time NMA feedback to Member States with on-demand requests for current NMA Book balances. An automated, on-demand service interface integrated with the SDP state-specific portal as "Self Service." 3. An implemented Customer Resource Management (CRM) system. 4. Integration with the new IAEA record-keeping system, the Agency Correspondence Management System (ACMS).
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Supporting Resource Mobilization Priorities

T.3.C2

Planned Activities

Activities to be performed in close collaboration with SGIS-003: Safeguards Information Systems and System Usability:

- Finalize implementation of the QC error checking.
- Develop additional links between SDP and internal systems to allow for Member States to query their own data.
- Acquire and implement a CRM. A CRM would provide a stronger and efficient working relationship between the Department and Member States as communication channels are clearly identified, tracked, and stored in a centralized location, as detailed below:
 - Establish a centralized place for Member States' contact information.
 - Create an easier management of communication and information workflows.
 - Create a historical record of communication and workflows.
 - Create the ability to track communication and report metrics on communication.
 - Establish efficient communication and eliminate communication duplication during the onboarding-to-SDP process.
 - Create an improved knowledge management resource.

The new ARMS records management system—called the Agency Correspondence Management System (ACMS)—serves the entire records management needs of the IAEA except the Department of Safeguards. The Department is still using the old Electronic Records Management System (ERMS) application, which is due to decommission by end of 2022 as it is no longer maintainable. The integration of safeguards-related activities of ARMS into SDP should address this gap.

The most needed extrabudgetary support to achieve this outcome would be:

- Direct funding for a developer to be shared between SSDH-C and SDP-related programming tasks.
- Direct funding to purchase a CRM.

- One JPO to replace the current JPOs (MSSP Tasks GER D 2444 and USA D 2476 (Junior Professional Officer - Associate State Declarations Portal Officer) to onboard new Member States and do outreach activities.
- One CFE to implement the CRM and do outreach and training for Member States.

Outcome #5: Enable creation, validation, and submission of declarations and other State-declared information for SRAs.

Outputs	<ol style="list-style-type: none"> 1. An established single client platform/application. 2. ★ An established open-source repository for application code and documentation. 3. ★ Defined governance for collaboration. 4. ★ Integration with the SDP for the transmission of files and messages. 5. ★ Capability to encrypt and digitally sign all files destined for the IAEA. 6. ★ Capability to decrypt and verify digital signatures of files received from the IAEA. 7. Feature to conduct real-time QC verification of Code 10 files in fixed, labelled, and xml formats. 8. Feature to conduct real-time QC verification of AP declarations. 9. Capability to allow the management of NMA data sufficient to allow creation of Code 10 reports.
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Supporting Resource Mobilization Priorities

T.3.C2

Planned Activities

Create a single client platform, to be used by SRAs, that allows for the creation, validation, and submission of declarations and other State-declared information. The platform is to be modular and open-source to allow collaboration with Member States.

1. Design the architecture of platform.
2. Draft governance for collaboration on the open-source project.
3. Set up and configure the project repository.
4. Develop the Application Programming Interfaces (APIs) required in SDP.
5. Develop an encryption module, including management of encryption keys.
6. Develop the QC module for Code 10.
7. Collect and draft requirements for NMA data management module. This module could be used to interface with already-existing Member State NMA systems, or with a future NMA Reporting Tool offered by the IAEA to assist Member States in preparing NMA reports.
8. Offer an offline option for the SRA to communicate with facility operators.

The IAEA seeks direct funding to fund some/all affiliates.

Outcome #6: Competent and confident State Authorities who have the knowledge and skills to effectively submit declarations to the IAEA.

Outputs	<ol style="list-style-type: none"> 1. An interactive e-learning portal to demonstrate the optimal method for States to submit declarations to the IAEA. 2. Translation of the e-learning modules into Arabic, French, Spanish, Chinese, and Russian.
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	<ol style="list-style-type: none"> 3. A nuclear material accounting e-learning portal that will provide support for in-person courses and a self-paced e-learning portal for State declarations, small quantities protocol, AP, and corrections to declarations. 4. 10 more NMA and AP e-learning modules.
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Supporting Resource Mobilization Priorities

T.3.C2

S.2.C1

Planned Activities

In order to provide informative and accurate e-learning modules, the IAEA plans to work with Subject Matter Experts (SMEs) to create e-learning content. The IAEA would ask experts and non-experts to review the modules to ensure effective presentation of the material.

Some e-learning modules require extrabudgetary support from programmers to create the interactivity that is desired. SMEs from the IAEA will narrate screencasts of the interactive activities.

External partners could assist with translating e-learning modules and screencasts, performing a gap analysis of the e-learning resources in the Safeguards and Verification Moodl (Nucleus), and also assist in identifying requirements for future development of e-learning modules.

Outcome #7: Enhanced UF₆ cylinder tracking via unique identifier.

Outputs	<ol style="list-style-type: none"> 1. Ability to track individual UF₆ cylinder unique identifier (UF₆ID) (ID to be voluntarily provided by Member States). 2. Increased value for Environmental Sampling reports from plants using UF₆ cylinders. 3. Increased ability to analyse Operators' measurement systems and data.
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Supporting Resource Mobilization Priorities

V.1.C2

Planned Activities

1. Develop a schema to report UF₆IDs, which can be voluntarily provided by Member States.
2. Prepare the SSDH-C database to load the UF₆ID.
3. Develop additional functionality to track UF₆ cylinders in the NMA database based on UF₆ID.
4. Prepare test data and/or solicit a collection of real UF₆ cylinder data from a Member State for testing.
5. Test cylinder tracking functionality.

UF₆ cylinders currently have up to seven tags, which complicates verification efforts, Environmental Sampling analysis, and Material Balance Evaluation (MBE) (tracking of tare weights, measurement systems, etc.). (See Outcome #4 of SGIM-008: Statistical Analysis.) A new tracking system and methodology are needed to support the MBE and shipping receiving difference evaluation at enrichment and conversion facilities.

The most needed support to achieve this outcome would be:

- A 6-month consultancy with an expert from Oak Ridge National Laboratory to determine the appropriate schema and tracking functionality.
- One CFE with experience in facilities that handle UF₆ cylinders to ensure the Operator's perspective is considered.
- A consultancy meeting with representatives from multiple Member States with facilities that handle UF₆ cylinders would also be beneficial to collate working knowledge.

Outcome #8: Further improvement of the Additional Protocol System (APS) and Protocol Reporter 3 (PR3).

Outputs	<ol style="list-style-type: none">1. Renewed translation tool in order to improve the quality of translations.2. Introduction of dashboards with different views.3. Redeployment of the latest PR3 version to EURATOM States.4. Ability for the Declared Information Analysis Section (ISD) to correct declarations in the PR3 format.
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Supporting Resource Mobilization Priorities

T.3.C2

Planned Activities

1. Integrate a statistical analyses tool.
2. Make Due Dates Report sortable/filterable.
3. Improve automated translation and request a translation tool and regular updates with extrabudgetary financial contributions.
4. Implement a dashboard for displaying status, issues, and combinations of information of different countries in different views.
5. To make corrections to loaded declarations easier and more efficient for the Department.

An updated version of PR3 needs to be deployed to EURATOM States. The IAEA would benefit greatly from external partner support by way of:

1. Willing EURATOM State users to perform user tests of PR3.
2. Willing non-EURATOM States users to perform user tests of PR3.
3. Development of new training material and a user manual for the new version.
4. Update of software help text.
5. Implementing the new print-outs depicting the higher granularity of the data structure on submission, declaration, and entry level in PR3.
6. Translating the user manual and software help text into UN languages.

Outcome #9: Improved functionality in and maintenance of the Safeguards Master Data (SGMD) application.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none">1. A centralized location for SRA addresses for easier maintenance and access for other Integrated Safeguards Environment (ISE) applications.2. Conversion of SGMD into a web-based application.3. Enhanced interface.4. Improved reports in line with internal guidelines. |
|----------------|--|

Supporting Resource Mobilization Priorities

V.1.C2

Planned Activities

SGMD stores Member States' SRAs contact and other relevant information, and the Department uses those addresses for official communication (for example, NMA, Transit Matching (TM), AP, 90 a/b, and 10 a/b). The Department needs to upgrade SGMD reporting capabilities, centralize all relevant SG information, and enhance the user interface. The Department would greatly benefit from financial contributions to hire one full time equivalent IT professional.

Outcome #10: Improved import communications with Member States.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none">1. Organization of an import communications consultancy meeting.2. Set of new import communications recommendations.3. Instructions and information regarding proper import tracking practices to send to Member States. |
|----------------|--|

Supporting Resource Mobilization Priorities

V.1.C7

T.3.C2

Planned Activities

A group of consultants met and issued a set of recommendations in 1984 on import communications. Based on those recommendations, the IAEA has sent quarterly import communication statements to Member States in order to make them aware of which nuclear material transfers have not been reported.

Transit matching has improved in the past ~40 years, but gaps still exist, particularly for source material transfers. Therefore, the IAEA would like to organize another import communications consultancy meeting to analyse the 1984 recommendations and provide a new set of recommendations in order to:

- Assist in achieving a 100% confirmation rate for international transfers of nuclear material—now with a greater focus on source material.
- Accomplish this on a timely basis within the reporting/information provisions of INFCIRC/66, 153 and 207.
- The IAEA would benefit greatly from import experts to participate in the consultancy meeting.

SGIS-002: Information Security and Infrastructure

Ensuring the confidentiality, integrity, and availability of the information entrusted to the Department.

 Scott PARTEE



Plan Acronyms

BC/DR	Business Continuity/Disaster Recovery
DR	Disaster Recovery
ISE	Integrated Safeguards Environment
PKI	Public Key Infrastructure
SG & NSNS ISMS	Safeguards and Nuclear Security Information Security Management System
SG IT DR	Safeguards Information Technology Disaster Recovery
SOPs	Standard Operating Procedures
SSDL	secure software development lifecycle

Context Highlights

In 2022–2023, this D&IS Plan intends to focus on delivering strategic security needs to the Department as well as to glean value from the Department’s investments in security-related systems, tools, infrastructure, processes, and people.

The most critical need for extrabudgetary support is to deliver the disaster recovery (DR) capabilities that the Department’s business continuity (BC) plans require. While the Department’s BC capabilities were able to meet the challenges of the pandemic, and the IAEA did not stop for a single minute, the risk imposed by threat scenarios—such as the total loss of the availability of the Vienna International Centre headquarters and other key facilities—remain inadequately remediated. Without support, the Department cannot meet the strategic and high-priority DR needs.

Other major investments in security, such as the physical security system at the Vienna International Centre headquarters, require attention and investment. Efforts have been underway to determine the technical feasibility of various options for enhancing or replacing the system that protects Safeguards areas (and Division of Nuclear Security) as well as data processing facilities and other sensitive areas of the Vienna International Centre. Based on the support of those efforts, future work will focus on ensuring an effective and resource-efficient system for the years to come, and this work will require extrabudgetary support.

Finally, the Department has robust information security processes, systems, tools, and staff in place to protect the Department’s information. The investment in information security has provided a solid foundation, but the ever-evolving threat landscape, the demands and challenges of meeting “all sources analysis” while providing the secure capabilities to work with data in the field, and the Department’s legal obligations require that continued investment in tools, process improvement, skills, capabilities, and people are central to the Department’s ability to fulfil its mission.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.2.C1** Ability to strategically plan, maintain and improve safeguards IT tools, information assets, and associated infrastructure
- M.4.C1** Ability to enhance working practices, leveraging Covid-19 lessons learned (for example, information architecture, secure cloud services, secure virtual meeting environment)
- M.4.C2** Ability to carry out mission-critical functions – needed for continued delivery of safeguards conclusions – in case of disasters (for example disruptive, massive cyber attack or physical loss of critical infrastructure)
- T.3.C1** Ability to secure information and quickly detect and respond to security events that arise within the Department’s information systems

Development Plan for 2022–2023

★ The 2022–2023 outcomes and outputs below bear the same high priority.

Outcome #1: Information security risk mitigation through an effective information security management system and security operations.

Outputs	<ol style="list-style-type: none"> 1. A measured and coordinated information security management and operations programme that is focused on the Department’s most critical information security risks. 2. Effective security operations, systems access management, training, and security control implementations that are tuned to the Department’s threats and enable the Department’s business processes, measured with appropriate maturity models. 3. A programme of risk, threat, and technical security controls assessment that includes at least three targeted or comprehensive security assessments per year. 4. A continuous social engineering awareness training and testing programme with both general and targeted campaigns for email phishing and other social engineering attacks.
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Supporting Resource Mobilization Priorities

T.3.C1	M.2.C1
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Planned Activities

The Safeguards and Nuclear Security Information Security Management System (SG & NSNS ISMS) is a structured framework that details how information security risk is managed for the Department and the Division of Nuclear Security. It must be continuously assessed, improved, and tuned in order to be effective against the constantly changing threat landscape. The ISMS defines roles, responsibilities, security processes (such as incident management, vulnerability management), and also includes baselines and standards to ensure that the Department’s systems and the processes they support are managed securely.

It is important that the ISMS processes, procedures, standards, and guidelines are updated to reflect the actual risks of the Department. Improvements to security operations—such as incident detection, threat analysis, and incident response include near-term objectives of:

- Establishing more standard operating procedures (SOPs).
- Defining and engineering prioritized event collection and detection based on threat intelligence.
- Developing analytical products surrounding the tools and techniques.
- Establishing procedures of the Department’s likely attackers.

To this end, the Department requests support for the ISMS and resultant security operations in several areas, including:

- Human resources to assist with risk assessments, threat assessments, threat intelligence analysis, incident detection, attack tactic, technique and procedure analytics, and other areas which identify, quantify, and manage the actual risks, vulnerabilities, and threats.
- Expertise in the form of mutual aid, consultancies, and CFEs in areas of security management (operations, incident response, threat detection, vulnerability management) to support and conduct assessments related to this outcome.

The Department’s readiness to address threats (both current and evolving), detect security events, and respond to security incidents is also critically-supported through MSSPs. Part of achieving the objectives is to focus on the essential strategies to mitigate targeted cyber intrusion. These strategies focus on the most effective controls as well as the most realistic and likely threat actors and scenarios for the information systems:

- Training for roles with information security responsibilities. Such roles are present throughout the Department, with many engineering and IT operational staff possessing significant information security responsibilities.
- Research and development into novel and innovative methods to detect various forms of attack and misuse in the Department’s information systems.
- Human resources, tools, and consultancies to assess the maturity level of the controls and baselines, plan remediations, and engineer solutions to automate the measurement and management of security baselines and control levels.

Finally, one of the most crucial elements of the Department’s information security programme is awareness training and testing. Social engineering threats are omnipresent in the Department’s systems, and the security personnel in the Department have reported an increased sophistication and capability to target the Department among the threat actors. The Department maintains an email phishing awareness training and testing tool and would like to expand this capability to cover more attack methods and more targeted audiences. Therefore, the Department requests support in this area through:

- Assessment of the in-place security awareness strategies and research into additional training and testing solutions.
- Financial support to maintain, operate, and improve such tools.

Outcome #2: Increased trust in the Department’s information and systems through improved security engineering and enhanced solutions for secure communications, data protection mechanisms, and data exchange.

Outputs	<ol style="list-style-type: none"> 1. Improvements to the Department’s secure software development lifecycle, including the cryptographic validation of all departmental software products. 2. Expanded and improved cryptographic support for additional and enhanced capabilities, including an assessment of the Agency-standard data protection mechanism for potential use in the Department to protect information outside of the secure Integrated Safeguards Environment (ISE) and bringing more resilience and uses to the Agency’s Public Key Infrastructure (PKI). 3. Provide staff in the field and the Department’s regional offices with communications solutions that meet the Department’s security requirements.
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Supporting Resource Mobilization Priorities

T.3.C1	M.2.C1	M.4.C1
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Planned Activities

The Department relies on a secure software development process and security tools to ensure that software products do not introduce critical security vulnerabilities into its information systems. Any vulnerabilities detected in software are managed, but introducing fewer vulnerabilities initially improves overall efficiency and reduces risk. This requires additional processes and tools in the software development process, often referred to as a secure software

development lifecycle (SSDL). At present, the Department’s SSDL comprises of a baseline security architecture and baseline security standards.

Support is requested to enhance the existing SSDL. This would include software security assessments, expertise, and resources that define and implement new tools and procedures and guidance through contact with other groups working on similar initiatives.

With a travelling staff and a workforce that spans the globe, the Department needs efficient and easy-to-use communication solutions. However, as the organization entrusted with the safeguards data of our Member States, such solutions must meet the Department’s stringent security requirements. Without such solutions in place, staff cannot collaborate or coordinate activities surrounding some of the most foundational and sensitive work that the Department undertakes, thereby negatively impacting the effectiveness and efficiency of the analysis, collection, and verification business activities.

External partners are requested to support the Department in achieving Outcome #2 by:

- Providing additional assessments of processes, procedures, tools, and solutions both in-place and under development by the Department.
- Contributing financially to the procurement of tools and expertise.
- Facilitating engagement between external experts and Department experts and supporting the development of staff knowledge and capabilities in the areas of security engineering, mobile technologies, and secure communications engineering.
- Continuing to support and expand the availability of CFEs and JPOs to build or enhance the mobile and site-to-site communications solution.

Outcome #3: Increased trust in the Department through enhanced physical security and environmental security solutions.

Outputs	<ol style="list-style-type: none"> 1. A feasibility study based on a technical proof of concept that will serve as the foundation for deciding the future of the Department’s physical security management system. 2. Depending on the outcome of the technical proof of concept, a project to either improve the existing system or migrate to a new system.
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Supporting Resource Mobilization Priorities

T.3.C1	M.2.C1
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Planned Activities

The Department’s physical security system has been in place for over 15 years and, while well-functioning, requires continuous maintenance and enhancements. The system is proprietary, and service contract options are limited. Therefore, in order to ensure optimized resource utilization, the Department is conducting a technical pilot project which will discover opportunities to utilize more open and standard components while preserving as much investment as possible.

The outcome of the technical pilot may lead to a project which will design and implement a system that meets or exceeds all capabilities currently in place, but would be more cost efficient in terms of service contracts, replacement components, and future expansion. The decision to develop a new system, enhance the existing one, or some hybrid of the two will be based on a financial analysis of the costs for migrating versus the projected cost savings that would be resultant from these planned activities.

The Department seeks support in the form of:

- Consultancies or expert engagements to determine optimal possible solutions through a pilot project and assessment, assist with the analysis of potential solutions, and to assess designs and plans for future systems.
- Financial contributions.

Outcome #4: Securely enabling the Business Continuity of the Department through the provision of reliable, resilient, and highly available IT infrastructure even during a disruptive event.

Outputs	<ol style="list-style-type: none"> 1. Enhanced IT DR capabilities for the information technology systems that enable the critical Safeguards business processes. 2. Identification and capability to utilize alternative facilities for DR scenarios. 3. Well-maintained and demonstrably executable BC and DR programme for the Department.
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Supporting Resource Mobilization Priorities

T.3.C1	M.4.C1	M.4.C2
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Planned Activities

The Department has established BC plans and defined overall requirements to ensure the continuity of core business capabilities for numerous threat scenarios. The fact that the Department’s work did not stop during the pandemic is evidence of the ability of the Department to overcome challenging situations. However, one threat scenario for BC that remains to be developed and implemented is the continuity of critical business processes even if the primary headquarter locations becomes unavailable for use. Such continuity requires a Disaster Recovery (DR) Plan and the necessary facilities, information, and IT systems required for nonstop operation.

The Department must identify alternate facilities for the relocation of departmental staff members from Seibersdorf, Tokyo, and Toronto; develop configurations of space at each of the alternate facilities; establish lists of vendors; and develop scopes of contracts for essential on-call services at each of the alternate facilities.

The Department has identified potential technologies and solutions for DR capabilities and facilities that meet the objectives for various recovery time and provide data protection that meet both the Department’s requirements and are feasible.

As part of DR, the Department must integrate existing IT resumption Standard Operating Procedures (SOPs) in the DR plan, add any missing documentation, identify function-critical departmental staff members to carry out the plan and assign primary, and alternate positions on the Safeguards Information Technology Disaster Recovery (SG IT DR) team. The SG IT DR team must develop a specific IT DR testing and maintenance plan focused on increased capabilities and complexities of scenarios.

The plan is to develop and implement a training and awareness programme. Training materials and other forms of communication (posters, website banners, etc.), as well as briefings for external stakeholders (other Vienna Based Organizations, other IAEA departments) on the SG Business Continuity/Disaster Recovery (BC/DR) programme, will be prepared.

Finally, the plan must include the creation and implementation of an exercise programme, aimed at BC/DR teams (primary and alternates) and other departmental staff members, including a series of exercises involving different scenarios with increasing complexity.

External partners are requested to assist this task by:

- Seeking opportunities to consult and engage the Department on arrangements for alternate sites and equipment.
- Validating plans and arrangements as well.
- Providing financial support for equipment and technologies to enable the plan.
- Supporting travel and training for departmental staff members involved in the implementation of the plan.

External partners are also requested to provide expertise in terms of consultants or CFEs to develop and implement the DR plan.

SGIS-003: Safeguards Information Systems and System Usability

Securely enabling the operation of the Department through the provision of IT applications that are maintained, enhanced and/or newly developed.

 Remzi KIRKGOEZE



Plan Acronyms

APA	Acquisition Path Analysis
CASCADE	Centralized Automated System for Correlated Analysis and Data Evaluation
CIOSP	Common Inspection On-site Software Package
GL	General Ledger
IRAP	Inspector Review and Analysis Platform
LIIs	List of Inventory Items
NDA	non-destructive assay
NGSR	Next Generation Surveillance Review
NRTS	Near Real Time System
RAD Review	Radiation Review/RAD Review
ROOGLE	An application to view the status of remotely connected systems
SAFIRE	Safeguards Inspection Reporting and Evaluation
SEQUOIA	Safeguard equipment asset management tool
UMS	Unattended Monitoring Systems
VIFM	VXI Integrated Fuel Monitor

Context Highlights

The Importance of IT in the Department

The Department is equipped with over 20 new and refurbished applications. These applications have increased consistency of data across IT applications, delivered higher quality outputs, and allowed more productive use of staff time. The Office of the Information Systems (SGIS) aligns core departmental processes with the management of the IT applications by domain processes:

State-Cooperation	Verification	Analysis	Services
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In 2022–2023, SGIS must continue to develop new applications to support all departmental processes as well as maintain and improve existing applications to further increase the efficiency and effectiveness of Safeguards. The domain processes outlined in the 2020–2021 Keeping Safeguards IT Updated implementation plan allows SGIS to be agile in meeting the evolving needs of departmental staff members.

Collaboration Between SGIS-003: Safeguards Information Systems and System Usability and the Other 25 D&IS Plans

All departmental projects with IT-related tasks will collaborate with SGIS-003: Safeguards Information Systems and System Usability to ensure compliance with IT standards and best practices. The compliance across the Department ensures the integration, security, and availability of data.

SGIS has enhanced its IT governance (see IT Governance figure 1 below) to ensure the plans align with departmental strategic priorities and business needs. Defined roles include:

- **Product Owners for IT applications:** They help SGIS elicit and define requirements and ensure that IT development occurs in line with operational needs.

- **Product Teams² and Product Owners:** They prepare roadmaps for IT applications undergoing active development. The roadmaps, which outline the milestones with main activities and planned benefits for each application, are updated and reviewed quarterly.
- **The Safeguards IT Programme Board:** It assesses IT needs in relation to the Department’s programmatic strategic priorities. It is chaired by the Deputy Director General for Safeguards.
- **The Safeguards IT Sub-Committee:** It is composed of representatives from across the Department, and it reviews and prioritizes proposed work on existing and new applications and reviews quarterly IT product roadmaps for their alignment with business strategy and user needs.

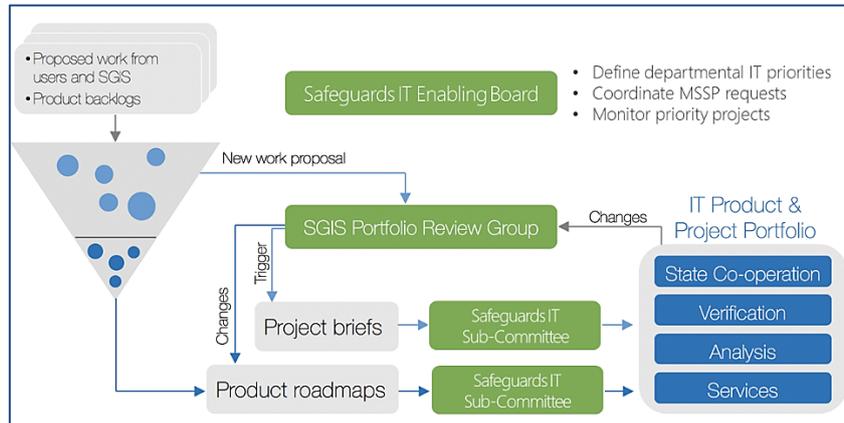


Figure 1: Safeguards IT Governance is the channel for departmental staff members to propose new ideas.

In 2020–2021, MSSPs provided vital resources under MSSP Tasks UK D 2465 and USA D 2419 (Keeping Safeguards IT Updated) and USA D 2460 (Updating Software to Support Safeguards Review of IAEA Technical Assistance). Enhancing and keeping updated the existing IT capabilities is essential for performing verification and reporting activities on time, effectively, and efficiently. Not having reliable Safeguards information and communication technology would result in:

- Significant delays in responding to user incidents and in adapting software to business changes.
- At-risk security of Safeguards-confidential information, for example, vulnerability to cyber-attacks due to delays in upgrades.
- Decreased ability to stay current with emerging technologies, which would in turn increase maintenance costs long-term.

In 2022–2023, MSSPs who accept MSSP Task Proposal 18/GIS-002 (Keeping Safeguards IT Updated) would provide much needed resources for developing Safeguards IT capabilities. Two CFEs are available in the 2022–2023 biennium who will help this plan to achieve its expected outcomes:

- USA A 2336 (Expert - User Experience Developer)
- USA D 2448 (Expert - Information Architect)

An increasing workload increases the Department’s IT support across business processes. Given a limited regular budget, continued extrabudgetary support is essential for maintaining and improving the current high-quality standards of IT applications. MSSP Task Proposal 18/GIS-002 (Keeping Safeguards IT Updated) asks for help in securely enabling the operation of the Department through the provision of IT applications that are maintained, enhanced, and/or newly developed.

² A Product Team, responsible for implementing roadmaps, includes product owners, subject matter experts, product managers, business analysts, quality engineers, and developers from SGIS.

Three additional CFE posts are envisioned:

- **Developer/Systems Analyst** to design, develop, and maintain IT solutions.
- **Data Architect** to manage the data architecture and its policies to enforce data standards for the storage and integration of data across all information systems.
- **Test Data Specialist** to develop, manage, and ensure test data is available and fit for the data masking, data subsets, and data generation capabilities needed to ensure the quality of data for pre-production testing processes.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|--|---|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.1.C1** Ability to fully implement data-driven programmatic planning, monitoring and evaluation, to support managerial decision making
- M.2.C1** Ability to strategically plan, maintain and improve safeguards IT tools, information assets, and associated infrastructure
- M.2.C2** Ability to enhance equipment reliability through improvements to the Safeguards Equipment Management System and monitoring of equipment performance
- M.3.C3** Ability to assess and improve the implementation efficiency of the Department's system of processes, procedures and supporting tools
- M.4.C1** Ability to enhance working practices, leveraging Covid-19 lessons learned (for example, information architecture, secure cloud services, secure virtual meeting environment)

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Increased efficiency of Safeguards processes through consolidation and integration of current IT systems.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. ★ Improved integration of IT systems that close gaps in the IT support of SG processes saving departmental staff member time to enter or re-enter data. 2. Increased performance of existing systems across all environments saving departmental staff member time. 3. ★ Reduced time for users to learn and use IT systems through a uniform user experience across all systems. 4. Full availability of all IT systems during business hours at IAEA headquarters and regional offices. |
|----------------|---|

Supporting Resource Mobilization Priorities

M.2.C1

M.2.C2

Planned Activities

- Support processing and input of electronic or hardcopy information in various formats received by IAEA Safeguards inspectors from the facility operators.
 - Integrate CASCADE (IRAP, NGS, NRTS) and UMS review software (such as VIFM, RAD Review, etc.) to populate Verification of Inventory and Physical Measurements.
 - Upgrade CIOSP so that IAEA Safeguards inspectors can process Operator GL and LIIs in various file formats and import the processed data into verification reports.

- Integrate results from remote monitoring/surveillance review results into the verification reporting software.
 - Integrate SEQUOIA to populate the list of equipment at a facility in NDA Equipment Used (M1.3) and Surveillance Equipment Activities (M10.1). ROOGLE users to be able to populate surveillance activities related to remotely-monitored systems.
 - Integrate with CASCADE (NGSR) to populate the surveillance review activities.
- Extend the electronic exchange of information with Member States via the State Declarations Portal (SPD) with additional submission types and workflows integrating the down-stream IT systems to allow fast processing and validation of the submitted information or request.
 - Develop a version to be used for training and demonstration purposes.
 - Offer the SDP interface in the 5 other official UN languages (Arabic, Chinese, French, Russian, and Spanish).
 - Support more Submission Types by adding explicit types and "Mailbox" declarations.
 - Allow multiple file uploads from the 'create submission' page and display more information on communications from SG "Recipient" list.
 - Integrate with other departmental applications (for example, SAFIRE).
 - Enhance the notification system.
- Implement a uniform user experience across all software products to make the software solution easy to use and faster to learn for users.
 - Finalize and baseline "look and feel" guidelines.
 - Strategize how to improve user experience for existing software products.

Support Needed

These activities have been supported under MSSP Tasks UK D 2465, USA D 2419 (Keeping Safeguards IT Updated), USA D 2460 (Updating software to support Safeguards review of IAEA Technical Assistance), and USA A 2336 (Expert - User Experience Developer). This plan is seeking extrabudgetary support in terms of CFEs, JPOs, and financial support for consolidating and integrating IT systems.

Outcome #2: Extended support of Safeguards processes through new IT capabilities.

Outputs	<ol style="list-style-type: none"> 1. Consistent implementation of the State Level Concept across Member States. 2. ★ Increased efficiency of verification activities through the integration of data received via remote monitoring and surveillance into the verification activity reporting. 3. More secure solutions replacing outdated IT technologies for environmental sampling. 4. Integrated work planning and reporting for equipment-related activities in the field.
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Supporting Resource Mobilization Priorities

M.1.C1	M.2.C1	M.3.C3
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Planned Activities

- Implement additional software capabilities around the support for the consistent application of the Acquisition Path Analysis (APA) and deriving the State Level Approach.
- Implement software to receive, process, and analyse data from remote monitoring/surveillance sources as well as from facility operators and integrate it into verification activity reporting.

(continued on next page)

- Replace the outdated technology for managing and analysing environmental samples.
 - Develop a solution architecture that is compatible with the SG IT standards and guidelines.
 - Create requirement specifications for the new system, which will include re-engineering of the present system.
 - Implement a solution that adheres to the SG IT standards and guidelines.
- Implement a solution to support the integrated work of planning and reporting inspection support-related activities performed by SGTS.
 - Re-design and extend the existing IT capability to include workplans used by SGTS.
 - Define reporting needs and implement an IT solution that provides reporting capabilities for all inspection technical supported-related activities.

Support Needed

Support for these activities has been supported under MSSP Task UK D 2465 and USA D 2419 (Keeping Safeguards IT Updated). This D&IS plan is seeking extrabudgetary support in terms of CFEs, JPOs, and financial support for consolidating and integrating IT systems.

Outcome #3: Enabled digital transformation.

Outputs	<ol style="list-style-type: none"> 1. A SG Enterprise Architecture that includes governance processes. 2. A future-proof software platform for all new, custom-built Safeguards applications. 3. ★ Harmonized IT environment with lower maintenance costs. 4. Lower software development costs through enforcing standards and fostering reuse of software services and platforms. 5. Improved integration and interoperability of IT solutions.
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Supporting Resource Mobilization Priorities

M.1.C1	M.2.C1	M.3.C3	M.4.C1
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Planned Activities

- Establish an Architecture repository to document standards, reference solutions, and the architecture landscape in the form of a business, data application, and technology architecture in the Department.
- Define roles and responsibilities in the Enterprise Architecture Governance process.
- Identify possible opportunities and solutions contributing to the harmonization of the IT environment and reducing complexity.
- Identify the target architecture and plan migration.
- Create reference implementation and proofs-of-concept.

Support Needed

Given the complexity and the importance of this outcome, the IAEA seeks extrabudgetary support in terms of CFEs, JPOs, and financial support.

SGOA-002: Safeguards System for JNFL MOX Fuel Fabrication Plant

Developing and implementing joint-use equipment, data collection systems, and evaluation software for the Japan Nuclear Fuel Ltd. (JNFL) mixed oxide (MOX) Fuel Fabrication Plant (J-MOX).

 Christophe CREUSOT



Plan Acronyms

AMGB	Advanced Material Accountancy Glove Box
C/S	containment and surveillance
CZT	Cadmium zinc telluride
DA	destructive analysis
DIE	Design Information Examination
DIV	Design Information Verification
EMC-HPGe	electromechanically cooled germanium radiation detector
JADE	Data Collection and Evaluation System (at the JNFL MOX Fuel Fabrication Plant)
J-MOX	JNFL MOX Fuel Fabrication Plant
JNFL	Japan Nuclear Fuel Ltd
JRC	Joint Research Centre
JTC	Joint Technical Committee
LaBr	lanthanum bromide
MCSR	Multiplicity Counter Shift Register
MELOX	a manufacturer of MOX fuel assemblies in France
MOX	Mixed Oxide (plutonium/uranium nuclear fuel)
NDA	non-destructive assay
NRTA	Near Real Time Accountancy
RRP	Rokkasho reprocessing plant
SLA	State Level Approach

Context Highlights

J-MOX at the Japan Nuclear Fuel Ltd. (JNFL) 1 Site

The Japan Nuclear Fuel Ltd. (JNFL) 1 site, located in north Japan, currently includes the large-scale Rokkasho Reprocessing Plant (RRP). In the future, the site will incorporate additional facilities including a mixed oxide (MOX) fuel fabrication plant (J-MOX), additional uranium trioxide (UO₃) storage, and various low-level-waste treatment and storage facilities.

JNFL Timeline

June 2005	The preliminary design information for J-MOX was submitted.
October 2010	Plant construction commenced.
March 2011	Plant construction was suspended following the major earthquake and tsunami that struck Japan.
April 2012	Construction restarted mainly on the foundations of the main process building and the completion of the utilities building.
Currently	Construction awaits further authorization by the safety authorities. The safety reviews are being performed based upon updated safety regulations introduced following the accident at Fukushima Dai-ichi.



Figure 1: Construction of MOX fuel plant at Japan Nuclear Fuel Ltd. 1 site taken December 2020. Credit Japan Nuclear Fuel Limited.

Resource Forecast

Because of the construction delays, limited efforts were devoted to J-MOX development and implementation activities in the previous biennium(s). The plan for 2022–2023 will therefore remain largely unchanged from the previous biennial plan, as construction has not yet restarted as of the end of 2021. The uncertain future of the plant provides a major challenge to planning resources for this plan.

It is expected that most of the funding for development and implementation of the safeguards verification systems for J-MOX will come from the Department's regular budget, but extrabudgetary support might also be needed in the future, should the construction restart in the near future. In addition, activities will be requested to focus on specific areas, including support to develop and test equipment and software dedicated to the J-MOX facility.

Plan Objective

The overall objective of this D&IS plan is to develop and implement J-MOX safeguards systems, which includes the development of joint-use equipment and data collection systems and evaluation software. The J-MOX Joint Technical Committee (JTC) (which includes Japanese State Authorities and the facility operator) monitor the development of the equipment, systems, and software. The development has been predominantly on hold since 2013 as a result of construction postponements. The latest information published by the facility operator indicates that the facility is scheduled to commence operation in 2024 at the earliest. However, construction can restart only after comprehensive safety reviews, which are ongoing and may delay the commencement of operation.

Most Needed Extrabudgetary Support in 2022–2023

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|---|--|---|---|
| <input checked="" type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

V.6.C3 Ability to implement effective and efficient safeguards at J-MOX

Development Plan for 2022–2023

★ If/when construction resumes in the 2022–2023 biennium, then all outcomes and outputs below will bear equally the same high priority.

Outcome #1: Effective and efficient safeguards approaches and procedures for J-MOX.

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|----------------|--|
| Outputs | <ol style="list-style-type: none">1. Safeguards approach for J-MOX based on the basic elements agreed with Japan.2. Design Information Examination (DIE)/Design Information Verification (DIV) procedures that assure that the facility is constructed and will operate as declared, while ensuring that the safeguards approach remains adequate and robust. |
|----------------|--|

Supporting Resource Mobilization Priorities

V.6.C3

Planned Activities

The Department needs a J-MOX safeguards approach based upon the agreed-upon elements with Japan and in line with the Japan State Level Approach (SLA). Then the Department can prepare implementation procedures tailored for J-MOX and negotiate them with the State Authorities and the facility operator.

As soon as the construction of the plant restarts, DIE/DIV procedures can be established and implemented in order to provide assurance that the facility is constructed and will operate as declared and to ensure that the safeguards approach remains adequate and robust. The DIE/DIV activities will be conducted from construction to MOX commissioning phases.

MSSP Task UK D 1878 (Development of a Software Tool to Simulate the Nuclear Material Accountancy System for MOX Facilities) (completed in 2017) provided a software tool that simulates the nuclear material accountancy system of a typical MOX plant. This will facilitate the IAEA's review of the J-MOX facility operator's accountancy system design, which helps in the design phase to evaluate the effectiveness of the IAEA's verification system and Near Real Time Accountancy (NRTA) tools.

Additional extrabudgetary support may be requested for further development of NRTA simulation tools, as well as for the development of destructive analysis (DA) sample treatment, analysis, and transportation procedures.

Outcome #2: Ability to meet safeguards requirements with high-quality, independent, and reliable results from safeguards equipment.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none">1. Designed, tested, and installed safeguards equipment (non-destructive assay (NDA) and containment and surveillance (C/S)).2. Designed, tested, and implemented integrated data collection and evaluation software for J-MOX using synergies with the RRP Information System. |
|----------------|--|

Supporting Resource Mobilization Priorities

V.6.C3

Planned Activities

Under this plan, several MSSPs have contributed to the design and testing of safeguards verification systems for JNFL J-MOX through a range of tasks. These tasks are intended to provide support that includes:

- Expert review of hardware and software designs.
- Assistance with developing and testing new systems (non-destructive assay, containment and surveillance (C/S) components, and identification readers).
- Assistance with configuring an integrated data acquisition and evaluation system.
- Assistance with developing, testing, and configuring evaluation software modules.

The potential for further activity under the various tasks of this plan, some of which are currently active whilst others are on standby pending progress on J-MOX construction, is as follows:

- **Prototype Testing:** Tests with a number of equipment items (electromechanically cooled germanium radiation detector (EMC-HPGe), a lanthanum bromide (LaBr) detector, liquid scintillator neutron detectors and magnetometers) were performed in March 2012 under MSSP Task FRA A 1944 (Support for the Safeguards Systems at the JNFL MOX Fuel Fabrication Plant) to validate the conceptual design for the J-MOX fuel rod verification system. Additional tests are foreseen at MELOX (a manufacturer of MOX fuel assemblies in France) in 2022, in particular to test the prototype fuel rod verification system with actual MOX rods at an operational facility.

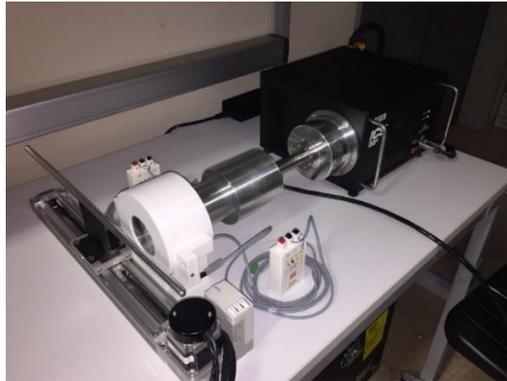


Figure 2: Testing of the fuel rod scanning system prototype.

- **Testing new generation detectors:** Under MSSP Task JPN A 1721 (Support for Development of J-MOX SG Systems), initial tests were conducted in 2013 to evaluate the potential use at J-MOX of new generation detectors (in other words, EMC-HPGe, Cadmium zinc telluride (CZT) and liquid scintillator neutron detectors) as well as the long-term testing of the EMC-HPGe. Tests of a new Multi-Channel Multiplicity Counter Shift Register (MCSR) and a second type of EMC-HPGe were carried out in an existing J-MOX facility in 2018–2019.
- **Refining and integrating the Advanced Material Accountancy Glove Box (AMGB) system:** The AMGB is one of the key NDA systems developed by the IAEA for J-MOX. Following a peer-review of its conceptual design under MSSP Task USA A 1801 (Support for the Safeguards Systems at the JNFL MOX Fuel Fabrication Plant), a prototype of the AMGB system was produced in 2010 under the contract with the MAGB supplier (BOT Engineering) and was tested at the Joint Research Centre (JRC)-Ispra from 2011–2013 under MSSP Task EC A 1778 (Support for the Safeguards Systems at the JNFL MOX Fuel Fabrication Plant). A peer review of a conceptual design for a fuel rods verification system was carried out in 2015 and 2018 under the same two tasks. Refinement and integration of the system continues in preparation for the MELOX tests.
- **Cost Free Expert:** The hiring of a CFE (MSSP Task Proposal 20/TSI-008: Expert - Senior Project Engineer (J-MOX)) is ongoing.

Further extrabudgetary support may be requested in the future including CFE assistance to coordinate the equipment and software development and to peer-review systems and prototype testing. For example, MSSP Tasks USA D 1802 and EC D 1779 (Support for the Data Collection and Evaluation System (JADE) at the JNFL MOX Fuel Fabrication Plant) were accepted at the end of 2008 to help with the design, development, procurement, testing, and installation of the J-MOX data collection and evaluation system.

The development and implementation of this integrated system is currently on hold. High-level user requirements were gathered in 2010–2011, but subsequent steps will depend upon an updated J-MOX schedule. The IAEA will re-activate work and/or define sub-tasks as needs arise in close collaboration with SGIS-003: Safeguards Information Systems and System Usability.

SGOA-003: Fukushima Dai-ichi Safeguards

Maintaining safeguards on nuclear material and facilities at the Fukushima Dai-ichi site.

 Glen HORTON



Plan Acronyms

NDA	non-destructive assay
OASM	Open Air Spent Fuel Monitor
TEPCO	Tokyo Electric Power Company Holdings, Incorporated
TSF	Temporary Storage Facility

Context Highlights

Background Information

At the time of the earthquake and tsunami that struck Japan in March 2011, there were six large nuclear power reactors on the Fukushima Dai-ichi site and two spent fuel storage facilities: one pool-type and one dry-cask-type. All of the facilities were under IAEA safeguards and in full compliance with all relevant Safeguards requirements.

The tsunami caused considerable damage to facilities and safeguards equipment. IAEA Safeguards inspectors were first able to enter the damaged site seven months later, in October 2011, to re-establish safeguards to the extent possible. Safeguards surveillance was re-established in accessible locations, and nuclear material was re-verified, in stages, as infrastructure was restored and as nuclear material was gradually removed from high-radiation areas.

By April 2021, the nuclear material inventories of Reactor Units 4, 5, and 6, as well as the inventories of both spent fuel storage facilities, and the inventory of spent fuel from the pond of Reactor 3 had been fully re-verified. The inventories of Reactor Units 1, 2, and the remainder at Reactor 3 remained inaccessible.



Figure 1: Tokyo Electric Power Company Holdings, Incorporated (TEPCO) recovery of Spent Fuel from Unit 3 (Image Credit TEPCO)

Foreseen Challenges

Currently, the Department faces two main challenges, which inform this plan's desired 2022–2023 outcomes and outputs.

Challenge 1: Ongoing challenge of providing assurances that there has been no unreported removal of nuclear material as the conditions on the site evolve.

The IAEA monitors the site with site-wide monitoring equipment. A second-generation surveillance tool will be installed in 2022. The IAEA would benefit from improved monitoring review software and would welcome support in scanning for novel technologies to enhance the IAEA's ability to perform site-wide monitoring.

Challenge 2: Development of safeguards approaches for newly-constructed facilities which will handle recovered core debris material.

There remains extremely limited access to the damaged cores and little knowledge, if any, of the precise location and form of nuclear material within them. This makes it difficult to begin the design of safeguards equipment in the near future.

In addition, remediation progress is slow. With small-scale sampling and retrieval of debris from one of the damage cores commencing in 2021, a new OASM (TSF) will be constructed onsite to receive the first retrievals, likely in 2025. Large scale retrieval operations will not begin for some years. For the interim period, measures are required to enable monitoring of any removal of nuclear material from a changing and challenging environment and the verification of material transferred to the TSF.

The IAEA would benefit greatly from new non-destructive assay techniques for heterogeneous, uncharacterized core debris material.

Top Plan Priorities

- Maintain a reliable safeguards system at the Fukushima Dai-ichi site that is capable of providing credible assurance that nuclear material cannot be removed from the damaged facilities without the IAEA's knowledge.
- Make improvements and adjustments to the monitoring system to accommodate changes in the remediation status of the damaged facilities onsite.
- Develop measures to re-verify the inaccessible nuclear material as soon as material is made available for verification.

Tentative Support

The Department has only needed in-house technology and expertise thus far for this plan. The Department may request support in developing techniques to verify the debris.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|---|--------------------------------------|---|-----------------------------------|
| <input type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- S.3.C1** Ability to identify and address the needs of designers and operators of modified or new facilities in the early preparation for efficient implementation of safeguards
- T.1.C5** Ability to develop, deploy and maintain new sealing system technologies with improved security and efficiency
- T.1.C11** Ability to rapidly detect, characterize and address breaches to unattended systems, and evaluate their vulnerabilities more broadly, particularly from threats arising from technology advancements (for example conduit integrity verification)

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Maintain ability to provide credible and reliable assurances that nuclear material is not being removed without the Agency’s knowledge as the site evolves. Seek new efficiencies, enhanced reliability for installed systems, and adopt novel technologies that offer advances.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> 1. Install upgraded site monitoring equipment. 2. Update configuration as new removal routes are opened up. 3. Enable OASM NDA review through use of IRAP. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.1.C5	T.1.C11	S.3.C1
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Planned Activities

That IAEA continuously monitors changes at the site and assesses new removal routes. Monitoring equipment upgrades would improve reliability and efficiency, and software updates would increase efficiency in reviewing monitoring data. Identification of new technologies for site-wide monitoring could further enhance capabilities at the site, and the IAEA would be interested in learning more from external partners.

★ **Outcome #2:** Implementation of effective and efficient safeguards approaches for the Fukushima Dai-ichi site that include measures applicable to removed fuel-containing debris.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. An approved Safeguards Approach with specific procedures applicable to the new facilities and activities related to the recovery of core debris. 2. A survey of new technologies for possible NDA verification of fuel-containing debris materials. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.1.C11	S.3.C1
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Planned Activities

The IAEA plans to develop a new safeguards approach in light of the design of new facilities, such as the TSF. As more is learned about the nature of the core debris material, surveys of novel technologies that may support NDA verification on a small scale and which may be applicable for future, larger scale retrieval activities may help the IAEA prepare for future challenges.

SGOC-001: Chornobyl

Developing and implementing effective and efficient safeguards systems at ISF-2 and the New Safe Confinement (NSC) placed over the existing Shelter that covers the Chornobyl Nuclear Power Plant (ChNPP) Unit 4.

 Faisal AJJEH



Plan Acronyms

ChNPP	Chornobyl Nuclear Power Plant
CSFSF	Central Spent Fuel Storage Facility
ISF-2	Chornobyl site at the Interim (dry) Spent Fuel Storage Facility 2 and the associated Conditioning Facility
NDA	non-destructive assay
NSC	New Safe Confinement
SLA	State Level Approach
TRC	Technical Review Committee

Context Highlights

Plan Objective

The main objective of this D&IS plan is to conduct efficient and effective regular safeguards inspections at different facilities at the Chornobyl Nuclear Power Plant (ChNPP), specifically at the:

- Interim (dry) Spent Fuel Storage Facility 2,
- Associated Conditioning Facility (collectively with the Interim Spent Fuel Storage Facility 2 is referred to as 'ISF-2'), and
- New Safe Confinement (NSC) placed over the existing Shelter that covers the ChNPP Unit 4.

IAEA's obligation is to ensure that safeguards are applied in accordance with the terms of the safeguards agreement (INFCIRC/550) on all nuclear material at these facilities while avoiding undue interference in the facilities operations.

Recent Timeline

August 2015	The principles of the safeguards approach to be applied during spent fuel transfers to the ISF-2 is approved.
1 May 2017	The updated State Level Approach (SLA) for Ukraine, which included the approved principles, enters into force.
End of 2020	All required safeguards equipment is installed and tested during a hot test.
August 2021	A safeguards approach for the spent fuel transfer, processing, and storage is developed and reviewed by the IAEA Technical Review Committee (TRC) and submitted to the Deputy Director General for Safeguards for approval.
December 2021	Detailed verification procedure for ISF-2 is approved by the DDG.

Most Needed Extrabudgetary Support in 2022–2023

<input checked="" type="checkbox"/> Financial Support	<input type="checkbox"/> Consultants	<input checked="" type="checkbox"/> Equipment	<input type="checkbox"/> Training
<input type="checkbox"/> Financial Support for IT	<input type="checkbox"/> CFEs	<input type="checkbox"/> Reference Materials	<input type="checkbox"/> Studies
<input checked="" type="checkbox"/> Financial Support for Travel	<input type="checkbox"/> JPOs	<input type="checkbox"/> R&D	
<input type="checkbox"/> Expert meeting participation		<input type="checkbox"/> Facility Access	

Plan Resource Mobilization Priority Linkages

- T.1.C5** Ability to develop, deploy and maintain new sealing system technologies with improved security and efficiency
- T.1.C10** Ability to rely upon an integrated system of instrumentation data (for example spectra) processing and review, with high level of automation and with unified user interface

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Safeguards are applied efficiently and effectively through finalized procedures for safeguards implementation at facilities.

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|----------------|--|
| Outputs | <ol style="list-style-type: none"> 1. ★ Carry out regular safeguards inspections at the Central Spent Fuel Storage Facility (CSFSF) and ISF-2 after approval of the safeguards approaches and procedures. 2. ★ Approval of safeguards approach for NSC. 3. Approval of verification procedures for NSC. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.1.C5

T.1.C10

Planned Activities

The NSC facility operator finished a one-year pilot operation without moving any objects from Unit 4 of the ChNPP, and the facility operator does not plan to remove nuclear material in the near future.

The IAEA has drafted a safeguards approach for the NSC, however, due to the delay of safeguards equipment installation, it has not yet been approved. Once the equipment is installed and its operability confirmed, the IAEA will modify the safeguards approach to reflect the current situation, review it through the TRC, and get approval from the Deputy Director General for Safeguards approval, all of which is expected by August 2022. A detailed verification procedure approval process would then begin.

Extrabudgetary support is requested to finance travel of IAEA staff to Chernobyl for the NSC project to meet with the facility operator and the equipment installation contractor; coordinate equipment installation, adjustment and testing; prepare the safeguards approach; verify the testing procedure; and adjust the equipment and procedures accordingly. Approximately 20 person days are foreseen in 2022 for NSC.

Outcome #2: Enhanced ability to carry out verification activities using equipment that is installed, adjusted, and approved for verification use.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none">1. Making a contract for the equipment installation at NSC.2. Installation of equipment at NSC is complete.3. Equipment at NSC is tested, adjusted, and approved. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.1.C5

T.1.C10

Planned Activities

The safeguards measures applied at ISF-2 utilize an integrated monitoring system consisting of surveillance and neutron and gamma radiation detectors, which is operated in unattended mode with remote data transmission. Installation, testing, and adjustment of the equipment have been completed and is currently in operation. The tasks were coordinated with SGTS-014: Remote Monitoring and Data Processing Systems, we will continue to collaborate closely with SGTS-014.

Delays exist for installing safeguards equipment at NSC and signing a contract for the infrastructure installation work. The installation and testing of safeguards equipment will be carried out later in 2022. It is planned that the final test, adjustment, and authorization of usage will be completed by the end of 2022.

In 2006, Safeguards equipment was installed at the Unit 4 Shelter at the main access points of the existing shelter for the detection of movements of nuclear material out of the area. The equipment, comprising surveillance and non-destructive assay (NDA) devices, was upgraded in 2013. Part of this equipment will continue to be used, together with new monitoring equipment that will to be installed on the main access points of the NSC.

MSSP support is requested to finance travel to Chornobyl to meet with the facility operator and the equipment installation contractor; install, adjust, and test equipment; and fine tune the equipment during the pilot operation. Approximately 80 person days are foreseen in 2022. In addition, the IAEA would also need financial support to procure the equipment, which would consist of portal monitors and surveillance for the NSC.

SGVI-001: JCPOA Verification

Verifying and monitoring the Joint Comprehensive Plan of Action (JCPOA).

 Andrew CATTON



Plan Acronyms

AP	Additional Protocol
CSA	Comprehensive Safeguards Agreement
JCPOA	Joint Comprehensive Plan of Action
SGVI	Office for Verification in Iran

Context Highlights

Background Information

As part of the transparency measures under the verifying and monitoring the Joint Comprehensive Plan of Action (JCPOA), IAEA Safeguards inspectors have enhanced access to uranium mines and mills and continuous surveillance of centrifuge manufacturing and storage locations. These measures go beyond the scope of Iran's Comprehensive Safeguards Agreement (CSA) and Additional Protocol (AP) and require IAEA Safeguards inspectors and analysts to be specially equipped and trained.

JCPOA Update

However, on 29 January 2021, Iran informed the Agency that, according to a new law passed by Iran's Parliament, Iran would take certain measures related to the JCPOA, including stopping Agency inspections beyond the Safeguards Agreement. On 15 February 2021, Iran informed the Agency that Iran "will stop the implementation of voluntary transparency measures as envisaged in the JCPOA, as of 23 February 2021." In recent months, there have been continued negotiations amongst the parties to the JCPOA. The IAEA stands ready to implement any resulting agreement, as appropriate.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|---|--------------------------------------|--|--|
| <input type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- V.1.C1** Ability to synthesize and evaluate disparate sets of verification data from the field through data analysis methods and tools
- V.1.C2** Ability to process and integrate the variety and volume of safeguards-relevant information in a timely, user-friendly and cost-effective manner
- V.1.C3** Ability to efficiently process and interpret multi-lingual safeguards-relevant information, including within the Agency's secure air-gapped network
- W.3.C2** Ability to further develop the expertise of the Safeguards Department's workforce and train the next generation of safeguards experts

Development Plan for 2022–2023

Outcome #1: SGVI inspectors and analysts who continue to have the knowledge and skills to conduct safeguards verification activities in Iran.

Outputs	<ol style="list-style-type: none"> 1. An implemented Carbon Fibre Mechanical Testing training for SGVI inspectors. 2. Identified need for any new, emerging, and/or unexpected training.
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Supporting Resource Mobilization Priorities

V.1.C1	V.1.C2	V.1.C3	W.3.C2
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Planned Activities

Annex I, section I, paragraph 54 of the JCPOA states that the Agency is required to verify certain aspects relating to the definitions agreed on implementation day. To do this, specialized training is required and supplied through MSSP Task FRA B 2405 (Carbon Fibre Mechanical Testing Training Course for Inspectors).

The technical content of the training, required to fulfil the needs of the IAEA Safeguards inspectors and technical experts involved in verification activities of the JCPOA in Iran, was discussed between SGVI and the French Support Programme in 2018. The training was assessed as fully consistent with the technical needs of the participants. SGVI had two Carbon Fibre Mechanical Testing Training Courses in 2018–2019, and a third in 2021. Further training may be requested to accommodate developing needs, depending on JCPOA developments.

SGTS-001: Non-Destructive Assay (NDA) Techniques

Pursuing development of non-destructive assay (NDA) systems and techniques to improve verification capabilities, reduce deficiencies and vulnerability of current systems and techniques, and address new safeguards needs.

 Mikhail MAYOROV

Plan Acronyms

API	Application Programming Interface
CTGS	Compact Tomographic Gamma Scanner
CZT	Cadmium Zinc Telluride (detectors)
DD	Deuterium-Deuterium (neutron generator)
DLL	dynamically linked library
ECGS	Electrically Cooled Germanium System
FFA	fresh fuel assemblies
FNCL	Fast Neutron Coincidence Collar
HM-5	Name of a Spectrometric Gamma Hand-Held Monitor and its related software
HM-6	The name of a new Spectrometric Gamma Hand-Held Monitor
IMCA	Inspector Multichannel Analyser 2000
IMCC	IMCA with CdZnTe
IMCL	IMCA with LaBr detector
MCAT	MCA Touch (software) that supports NDA measurements
MGA/MGAU	Multi-Group Analysis / Multi-Group Analysis code for Uranium
MTR	Material Test Reactor
NDA	non-destructive assay
PNNL	Pacific Northwest National Laboratory
UNCL	Uranium Neutron Coincidence Collar

Context Highlights

Introduction

In 2022–2023, SGTS-001: NDA Techniques intends to focus on fewer targets, but get them as far as it is feasible with the available resources. The high-priority objectives would be to complete the last biennium tasks (Compact Tomographic Gamma Scanner (CTGS), NDA methodologies for verification of uranium at bulk facilities) and accomplish the new outcomes listed below.

In-House Development Tasks

There are two activities that could possibly benefit from external contributions:

(1) Feasibility Study of Nuclear Material Assessment with In-Field Alpha Spectrometry

Expected by the end of 2023, and with the goal of having a field-deployable alpha-spectrometer, the IAEA will perform feasibility studies and a pilot deployment of in-field alpha spectrometers for nuclear material identification and isotopic composition analysis. The IAEA also plans to establish the necessary procedures for application of the methodology within the Department.

(2) Introduction of Calorimetric Assay in the Set of NDA Methods Available for SG Verification

Expected by the end of 2023, and with the goal of having an in-house capability to perform plutonium assay with calorimetry systems, the IAEA aims to introduce calorimetric assay as an NDA technique. It would be available to support verification activities for the quantitative assay of nuclear material. The target accuracy shall be, at a minimum, equivalent to the accuracy provided by other NDA methods (for example, neutron multiplicity counting).

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|---|--|---|---|
| <input type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input checked="" type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

In particular, the Department will seek the expertise required to integrate the neutron generator with the Fast Neutron Coincidence Collar (FNCL), which is not available at the IAEA.

Plan Resource Mobilization Priority Linkages

- T.1.C1** Ability to more efficiently verify and maintain knowledge of spent fuel in shielding/storage/transport containers at all points in their life cycle, including through remote means
- T.1.C2** Ability to verify nuclear material in closed containers in spent fuel ponds during short notice or unannounced inspections
- T.1.C6** Ability to verify nuclear material in containers with heterogenous matrices
- T.1.C9** Ability to detect and quantify contamination in equipment returned from the field with heterogenous matrices and shapes
- W.3.C1** Ability to train inspectors on spent fuel measurement techniques inside facilities

Development Plan for 2022–2023

★ Indicates top priority

★ **Outcome #1:** Faster verification of fresh fuel assemblies using NDA systems.

Outputs	1. A Deuterium-Deuterium (DD) neutron generator with the Fast Neutron Coincidence Collar (FNCL) that shortens fresh fuel assembly verification time from minutes to seconds.
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Planned Activities

The IAEA developed and authorized the FNCL as a technical solution to the limitations of the conventional Uranium Neutron Coincidence Collar (UNCL) to independently verify fresh fuel assemblies (FFA) containing burnable poisons. FNCL supports partial defect tests with an active neutron coincidence counting technique without a-priori information about the burnable poison content.

The main features of the FNCL are:

- Interrogation of FFAs with epithermal neutrons from a moderated Americium-lithium (Am(Li)) neutron source.
- Detection of fast neutrons ($E_n > 0.5$ MeV) from induced fission predominantly from U-235.
- Negligible intensity of accidentals enabled by a very short coincidence gate (120 ns).

The first and second features significantly reduce the influence of burnable poison content in the material being verified; the third feature increases the interrogation source emission rate (and hence, linearly reduces the verification time) by at least two orders of magnitude with no impact to the precision since the contribution of the accidentals remain negligibly small.

Am(Li) sources, emitting the desired neutron flux (around 1 million neutron/s), are not available and no new Am(Li) sources are manufactured. Isotopic sources of that strength already in existence would also be very difficult to transport internationally. Hence, an alternative solution was identified with integration of a DD neutron generator within the FNCL system. The neutron generator nGen-350 from Starfire Industries was procured in 2019 by the IAEA and delivered in Q2 2021 (Figure 1).



Figure 1: nGen-350 D-D neutron generator for use as a neutron interrogation source with FNCL.

The project goal is to improve the efficiency of FFA verifications by FNCL with no reduction of its effectiveness by using a DD neutron generator for interrogation of fissile material as an alternative to the conventional Am(Li) isotopic neutron source. In the longer term, use of solid-state neutron detectors in conjunction with FNCL and the neutron generator will be considered.

IAEA has limited knowledge and experience in applying neutron generators for NDA. Cooperation with external partners where similar work has been already done would be vital.

Outcome #2: Improved instruments and techniques to address verification of waste and scrap nuclear material with impure composition or heterogeneous isotopic composition.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. A new data processing algorithm. 2. Performance evaluation and authorization of the Compact Tomographic Gamma Scanner (CTGS). |
|----------------|---|

Supporting Resource Mobilization Priorities

T.1.C6

T.1.C9

Planned Activities

The IAEA will continue to promote activities associated with the evaluation and authorization of the CTGS for assessment of nuclear waste. The instrument was manufactured and delivered to the IAEA in 2016–2017 to address a particular verification challenge: the quantitative verification of heterogeneous waste and scrap containing nuclear material.

Neutron measurements may not be accurate enough to meet the specification for partial defect tests since the matrix of the material (particularly with regard to hydrogen and neutron-absorbing compounds) is unknown and difficult to assay. An alternative solution is transmission-emission high-resolution gamma spectrometry performed at the level of individual voxels in the inspected object.

Under MSSP Task USA A 2369 (Implementation Support of Compact Tomographic Gamma Scanner for Verification of Containers), the IAEA shipped the CTGS to the Pacific Northwest National Laboratory (PNNL), and PNNL experts will make the necessary improvements. Once the CTGS is ready, PNNL will ship it back to the IAEA for testing and authorization.

★ **Outcome #3:** An improved fresh nuclear material verification method with consolidated gamma-spectrometric techniques.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. Development of the successor to HM-5, a Hand-Held Monitor Version 6 (Spectrometric Gamma Hand-Held Monitors), with a new hardware platform and software environment. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.1.C6

Planned Activities

Currently, there is a number of gamma-spectrometric instruments in the NDA pool that are used for verification of un-irradiated nuclear material:

- Electrically Cooled Germanium System (ECGS), which is an electrically cooled portable high-resolution gamma spectrometer.
- IMCL, which is a portable gamma-spectrometry system based on InSpector-2000 Multichannel Analyser (IMCA) and a Lanthanum Bromide detector (LABR).
- IMCC, which is a portable gamma-spectrometry system based on IMCA and a CdZnTe (CDZT) detector.
- HM-5, which is a hand-held, low-resolution, user friendly, adjustment-free, light-weight, and ruggedized sodium iodide (NaI) gamma-ray field spectrometer.
- And others.

Performance of new ultra-large volume Cadmium Zinc Telluride (CZT) modules is sufficient to cover functionality of the above listed instruments. However, the IAEA needs to develop the hardware platform (power, user interface, etc.) and the software environment (a user shell and safeguards-specific applications). IAEA intends to develop a next generation of the Hand-Held Monitor Version 6 (a successor of the HM-5) and use it as a hardware platform and software environment for a "consolidated" system.

The HM-6 default module is an advanced gamma spectrometry probe based on large high-performance cadmium-zinc-telluride crystals (Figure 2).

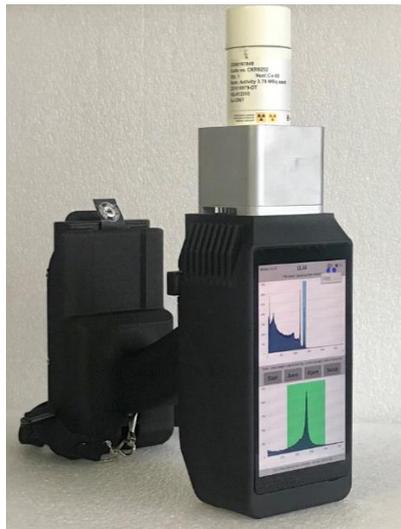


Figure 2: A functional HM-6 hardware platform, integrated with the H3D's smart CDZT module M400.

H3D, Inc. manufactures the gamma spectrometry module. The module is composed of 4 CDZT crystals of 2x2x1 cm each for a total detection volume of 16 cm³. The HM-6 will operate in attended mode and is a standalone handheld instrument capable of operating for a full work day without recharge.

Supported applications will include:

- Isotope identification (method H).
- Verification of the isotopic composition of Pu.
- Quantitative assay of uranium enrichment under infinite thickness conditions and partial defect measurements on pellets, rod, Material Test Reactor (MTR) plates, or other samples.

The same gamma spectrometry module is used in conjunction with the MCA Touch Version software using currently-available data evaluation tools.

In the future, advanced data evaluation tools (for example, relying on machine learning techniques) will be considered to take advantage of the pixelized nature of the CZT detectors. The HM-6 platform would be a complementary option for the MCA Touch (MCAT) platform integrated with the H3D CZT module.

The IAEA needs extrabudgetary support to evaluate the technical and functional performance of the HM-6.

★ Outcome #4: Enhanced performance and better usability of high- and medium-resolution gamma spectrometry for nuclear material verification.

Outputs	<ol style="list-style-type: none"> 1. Amendment of the MCAT software to include Multi-Group Analysis/Multi-Group Analysis code for Uranium (MGA/MGAU) modules. 2. Amendment of the MCAT software to include criticality check, reactivity determination, and neutron pulse train analysis modules (GER A 2278). 3. Integration of MCAT with H3D CDZT modules M400 via an established Application Programming Interface (API).
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Supporting Resource Mobilization Priorities

T.1.C1	T.1.C2	T.1.C6	W.3.C1
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Planned Activities

The IAEA intends to continue work under MSSP Task USA A 931 (NDA Implementation Support - Instruments and Techniques) and GER A 2278 (Upgrading of the MCA-Touch Software) to amend the MCAT software to include MGA/MGAU, criticality check, reactivity determination, and neutron pulse train analysis modules.

In order to consolidate nearly all gamma-spectrometric applications for fresh fuel verification under the umbrella of MCAT, the IAEA intends to implement a number of changes/upgrades in version 2.1. These will include small fixes in the user interface, the reporting abilities, and an update to IAEA’s dynamically linked libraries (DLLs) and generic setup files.

The IAEA is considering adding neutron-based NDA methods, such as criticality checks, reactivity determination (rod-drop and Feynman-Y) and neutron coincidence, and multiplicity analysis to the MCAT tool box functionality.

SGTS-002: Techniques and Instruments for Sealing and Containment Verification

Improving containment verification systems, identifying vulnerabilities in safeguards equipment, and increasing the data security of all safeguards equipment.

 Bernard WISHARD



Plan Acronyms

BNL	Brookhaven National Laboratory
LANL	Los Alamos National Laboratory
LCCT	Laser Curtain for Containment
LIDAR	Light Detection and Ranging
mmW	millimetre Wave
SMFOC	single-mode fibre-optic cables

Context Highlights

The Importance of Techniques and Instruments for Sealing and Containment Verification

IAEA Safeguards inspectors expend significant effort applying and verifying seals in relatively dangerous environments; such as at elevated heights at the top of casks or in high-radiation areas. To make inspections safer, the work of this D&IS plan decreases sealing efforts, removes the need to access dangerous locations, and/or minimizes radiation doses.

There are a number of active technologies emerging on the commercial market that would alleviate the need for attaching individual seals. These include millimeter Wave (mmW), advanced fibre-optics, and laser systems.

Vision

Containment is a key area where IAEA Safeguards inspector effort could be drastically reduced. Therefore, an assessment of emerging commercial technologies should be performed with the objective of the rapid development to a conclusive fully authorized safeguards system that drastically decreases IAEA Safeguards inspector effort and potentially decreasing their exposure to radiation.

Planned Activities:

- Coordinate with technology experts.
- Arrange for tests at technology centres.
- Construct a mock-up system for the conceptual testing in nuclear facilities such as spent fuel storages.

Most Needed Extrabudgetary Support in 2022–2023

<input type="checkbox"/> Financial Support	<input type="checkbox"/> Consultants	<input checked="" type="checkbox"/> Equipment	<input type="checkbox"/> Training
<input type="checkbox"/> Financial Support for IT	<input type="checkbox"/> CFEs	<input type="checkbox"/> Reference Materials	<input type="checkbox"/> Studies
<input checked="" type="checkbox"/> Financial Support for Travel	<input type="checkbox"/> JPOs	<input type="checkbox"/> R&D	
<input checked="" type="checkbox"/> Expert meeting participation		<input checked="" type="checkbox"/> Facility Access	

Plan Resource Mobilization Priority Linkages

- M.4.C2** Ability to carry out mission-critical functions – needed for continued delivery of safeguards conclusions – in case of disasters (for example disruptive, massive cyber attack or physical loss of critical infrastructure)
- T.1.C1** Ability to more efficiently verify and maintain knowledge of spent fuel in shielding/storage/transport containers at all points in their life cycle, including through remote means
- T.1.C5** Ability to develop, deploy and maintain new sealing system technologies with improved security and efficiency

Development Plan for 2022–2023

★ Indicates top priority

★ **Outcome #1:** Proven or disproven efficacy of millimetre Wave (mmW) technology for applicability in relatively confined location such as small rooms or inside cabinets.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. A constructed mock-up system of mmW. 2. Assessment report of mmW. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.1.C5

Planned Activities

IAEA's goal is to compare mmW to the authorized Laser Curtain for Containment (LCCT) system to determine its strengths and weaknesses.

Recent developments in mmW technology have resulted in a number of systems on the commercial market. The application of mmWave sensors for safeguards use would be to detect intrusion into closed areas similar to the LCCT but as a radar device. mmW technology can:

- Penetrate materials such as plastics, drywall, and clothing.
- Form beams of 1° angular accuracy (highly-directional).
- Focus and steer using standard optical techniques.
- Distinguish between two nearby objects (be of large absolute bandwidths).

mmW technology appears to be a more economical alternative to the LCCT in room-sized areas. The IAEA seeks to evaluate a mock-up so that it can test the efficacy of mmW in small confined locations such as small rooms or inside cabinets. A system that can detect intrusion into cabinets would greatly benefit the tamper indication and physical protection of secure components in those cabinets of which there are hundreds.

The USSP has offered and the IAEA has accepted participating in joint experiments at the Brookhaven National Laboratory (BNL). BNL and IAEA experts will jointly compare the IAEA's LCCT against the mmW in a number of closed environments. As the mmW is a board-based device, the final packaging of the mmW for safeguards-use will be an important requirement. Should mmW technology prove to be effective and a vulnerability review indicate acceptability for Safeguards use, then BNL will construct the mmW test system, and the Department will construct the Department version.

Member States are requested to support the Department by conducting joint tests, currently planned with BNL, along with travel for 1–2 departmental staff members for a 5-day trip to BNL.

If mmW is accepted, then internal development will continue.

Outcome #2: Ability to confidently maintain continuity of knowledge under critical emergence conditions at relatively low costs.

Outputs	<ol style="list-style-type: none"> 1. An assessment of advance fibre-optic techniques/the fibre-optical system based on interferometry proposed by Los Alamos National Laboratory. 2. A methodology that defines the active and passive seal perimeters of spent fuel cask boundaries.
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Supporting Resource Mobilization Priorities

T.1.C1	T.1.C5	M.4.C2
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Planned Activities

The Department’s goal is to demonstrate the efficacy of the Los Alamos National Laboratory’s (LANL) system by joint tests. Using commercial components, an inexpensive technique to uniquely detect tampering of single-mode fibre-optic cables (SMFOC) has been developed by LANL. Such a technique would be valuable for the construction of a passive/active seal which uses SMFCO. Such a seal might provide unique capabilities to indicate tampering of large arrays of spent fuel casks.

Member States are requested to support the Department by:

- **Expertise:** Expertise in sealing scenarios for testing in 2022, currently be to provided by LANL, upon transmittal of a letter request.
- **Financial Support:** Travel to LANL to perform the tests for 2 departmental staff members.

Should the system perform well, then internal development would continue.

Outcome #3: Ability to confirm the movements of casks in multiple planes without the need of surveillance images and with improved security.

Outputs	1. Assessment of new Light Detection and Ranging (LIDAR) technologies that could improve the security and capabilities of the LCCT.
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Supporting Resource Mobilization Priorities

T.1.C1	T.1.C5
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Planned Activities

The Department’s goal is to assess the efficacy of new 2D laser techniques for applicability in containment.

New, more economical LIDAR heads with advanced capabilities are arriving on the commercial market. Recently, a multi-line variant that has the ability to record in intrusions in 2.5 dimensions offers the IAEA possibilities for detecting spent casks movements.

The new systems could give the IAEA the possibility of extending the application of LIDAR systems to confirm the movement of items such as casks in multiple planes without the need of surveillance images. Testing will be required and significant modifications would have to be made to review software should these new LIDAR heads be implemented.

The Department would request the continuation of active MSSP Task ARG A 2318 (2D Laser Sealing System Test at RAD1) to assess the efficacy of new 2D laser techniques for applicable in containment. The IAEA envisions one test in 2022 and one test in 2023. Each test would last 5 working days.

Any further development will be performed by the IAEA internally.

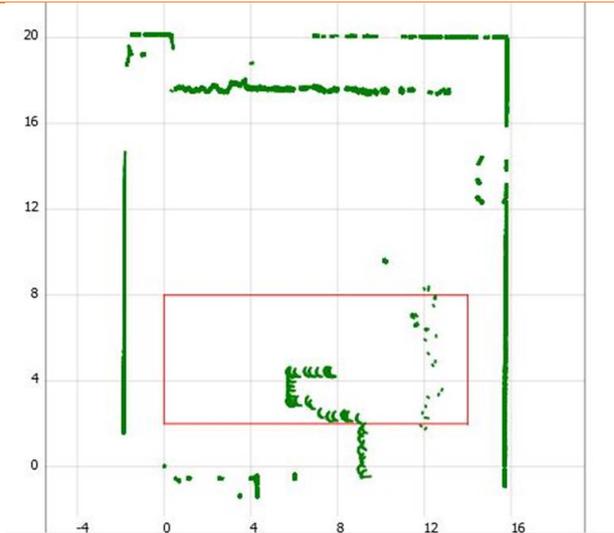


Figure 1: 2D Laser Curtail jointly developed with the JRC, Ispra; LCCT records events alleviating long reviews and is remotely capable & joint-use friendly. It is provisionally authorized and installed at Atucha-1 and currently under test in Belgium and Germany.



Figure 2: LCCT Sensor.

SGTS-003: Surveillance Techniques

Developing and implementing comprehensive surveillance equipment and replacing legacy surveillance equipment and instruments used for routine safeguards inspection activities.

 Melvin JOHN



Plan Acronyms

AI	Artificial Intelligence
DCM-A1	next generation analogue camera recording module
HEU	Highly Enriched Uranium
JRC	Joint Research Centre
LCCT	Laser Curtain for Containment
LED	light emitting diode
LEU	low enriched uranium
LIDAR	Light Detection and Ranging
MEMS	Microelectromechanical Systems
NGSR	Next Generation Surveillance Review
NGSS	Next Generation Surveillance System
PKI	Public Key Infrastructure
SD	Secure Digital (cards)
SSTDR	spread-spectrum time domain reflectometry
UHF	ultra-high frequency
VR	Vulnerability Review
XCAM	new generation surveillance camera

Context Highlights

Plan Objective

This D&IS plan's overall objective is to develop, implement, and maintain comprehensive surveillance solutions and replace legacy surveillance equipment and instruments used for routine safeguards inspection activities. Important parts of any surveillance solution are sustainable and secure software tools that enable IAEA Safeguards inspectors to review surveillance data efficiently.

Foreseen Challenges

The primary anticipated challenges that this plan could face in the near future include:

- Increasing volume of surveillance data that require advanced data review and analysis capabilities to facilitate a comprehensive and efficient review process.
- Hazardous radiation effects on surveillance equipment.
- Infrastructure problems experienced in remote or off-the-grid implementations, which could be mitigated with alternative surveillance power and data transmission capabilities.
- Scarce availability of highly-reliable batteries that perform in extreme environments for extended periods of time between maintenance windows.
- Mitigating the supply chain impacts caused by the Covid-19 pandemic as detailed thereunder.

Preview of the Top Priorities in the 2022–2023 Plan

- Complete the development and authorization of the Next Generation Surveillance Review (NGSR) software for deployment on (portable) computers used by IAEA Safeguards inspectors in the field.
- Continue with the development of advanced surveillance data analysis algorithms, using machine learning and deep learning techniques where appropriate, to provide rapid video review capabilities for large datasets.

- Identify and evaluate safeguards-relevant applications of new and/or emerging technologies to broaden the capabilities of surveillance by incorporating alternate technologies (for example radar, ultrasonic, acoustics, sonar, and hyperspectral imaging).
- Continue with the development of user requirements for the follow-on surveillance technology intended to replace the Next Generation Surveillance System (NGSS) in the future (beyond 2028).

Covid-19 Pandemic Impact to Surveillance Techniques

- Limited access to resources at IAEA headquarters (for example, access to laboratories) particularly during lockdown periods delayed progress.
- Backlog of maintenance for non-critical equipment will put a strain on available staff resources throughout 2022.
- Multi-week quarantine requirements in many countries reduced the availability and productivity of travelling staff.
- Delays in work performed by MSSP counterparts were experienced in some cases.
- Highly dynamic supply chain impacts are being observed as a consequence of the pandemic. Surveillance supplies, like rechargeable Li-Ion batteries and solid-state media, are inter alia affected. Mitigation in the form of an increased stock position for these items is being sought.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|--|---|---|
| <input checked="" type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input checked="" type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.1.C1** Ability to more efficiently verify and maintain knowledge of spent fuel in shielding/storage/transport containers at all points in their life cycle, including through remote means
- T.1.C7** Ability to unintrusively monitor the flow rate of UF₆ in cascades and at conversion plants
- T.1.C8** Ability to detect Highly Enriched Uranium (HEU) production in real time at declared low enriched uranium (LEU) enrichment facilities
- T.1.C11** Ability to rapidly detect, characterize and address breaches to unattended systems, and evaluate their vulnerabilities more broadly, particularly from threats arising from technology advancements (for example conduit integrity verification)
- T.6.C2** Ability to deploy next generation capabilities to the cameras used in future surveillance systems (for example non-optical surveillance, climate insensitivity)

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Enhanced ability to deploy equipment at facilities to meet safeguards requirements through development of highly effective and cost-efficient optical surveillance measures with improved security features.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> 1. ★ Authorize the Next Generation Surveillance Review (NGSR) software for application by IAEA Safeguards inspectors in the field. 2. ★ Integrate Artificial Intelligence (AI) image processing into NGSR and release for testing (see conditions and details below). |
|----------------|--|

3. ★ Conduct a workshop with stakeholders to refine user requirements and assess available technologies for an NGSS successor.

Supporting Resource Mobilization Priorities

T.6.C2

Planned Activities

The IAEA completed the core development of the NGSr software tool in May 2021, and NGSr was authorized for all SG surveillance data reviews performed at IAEA headquarters.

Due to the peculiarities associated with surveillance data reviews performed in the field when used on portable computers, the IAEA is performing additional testing and adding features to NGSr to facilitate in-field reviews securely. The IAEA will seek authorization of NGSr for surveillance data review in the field and on portable computing devices after the field tests, expected Q3 2022.

With the support of MSSP Tasks USA E 2486 and EC E 2521 (Advanced Signal Processing Algorithms for Video Analysis), the IAEA is developing learning-based algorithms to identify and track objects of Safeguards significance in video surveillance. This requires manual classification of a large amount of previously-recorded safeguards imagery, a task which requires execution at IAEA headquarters because of the confidentiality of the underlying data. In order to accelerate this task, the IAEA has requested a Junior Professional Officer - Associate Surveillance Systems Engineer under MSSP Task Proposal 20/TUS-002. If the IAEA onboards the JPO, then the IAEA expects to integrate AI image processing into NGSr and release for testing by the end of 2022.

MSSP collaboration will be essential when performing a detailed assessment of advanced surveillance data analysis algorithms using relevant, representative datasets to determine performance, efficiency, and effectiveness.

MSSP Task EC E 1992 (Research, Development, and Evaluation of a Surveillance Review Software Based on Automatic Image Summaries (VideoZoom)) provides access to another innovative surveillance review method based on 'Automatic Image Summaries,' which was developed by the Joint Research Centre (JRC) Ispra. The IAEA provided a draft of the final assessment report to JRC (EC) in April 2021 for comment. Technical discussions between the IAEA, Euratom, and JRC on how to integrate VideoZoom into NGSr continue. If VideoZoom functionality is a realistic solution, then the IAEA will integrate it into NGSr by the end of 2023.

The Department started developing the surveillance system concepts and related requirements to be considered for the successor to NGSS. The concept will leverage NGSS lessons learned and surveillance-relevant emerging technologies in collaboration with MSSPs and SGIS-003: Safeguards Information Systems and System Usability. The IAEA will propose and lead a multi-MSSP Task to fully engage stakeholders in the development of user requirements for the follow-on surveillance technologies that will supersede NGSS. A workshop with stakeholders to refine user requirements and assess available technologies for an NGSS successor is planned for Q4 2022. MSSPs support for conducting the workshop is being sought.

Research on and evaluations of emerging 3D camera technologies are carried out under MSSP Task EC E 1636 (Engineering Support for 3D Camera Development). Recent developments in 3D cameras for autonomous car navigation are making the technology within IAEA's reach of potential implementation into Safeguards equipment. Currently, evaluated technologies include Velodyne sensors and Microelectromechanical Systems (MEMS) Light Detection and Ranging (LIDAR) devices. Benchmark performance reports about the technologies are being produced at each deployment opportunity. When compared to the currently-used, two-dimensional (2D) optical surveillance, active 3D cameras strengthen the surveillance data authenticity and eliminate the need for ambient lighting. The work accomplished under this task provides essential input for the user requirements of safeguards surveillance equipment beyond the NGSS. This task also received valuable input from SGTS-002: Techniques and Instruments for Sealing and Containment Verification and SGTS-008: Instrumentation Technology Foresight.

MSSP Task GER E 1982 (NGSS Product Lifecycle Support) provides lifecycle support for NGSS to ensure sustainability of relevant technology. Activities performed under this task include changes and updates to address new needs from IAEA Safeguards inspectors; enhancements to support changes in the IAEA's data security environment Public Key Infrastructure (PKI), and firmware updates to address issues identified during acceptance testing and field implementation.

Under MSSP Task GER E 2609 (Junior Professional Officer - Associate Surveillance Systems Engineer), the JPO will support NGSS implementation, test, and analyse the radiation effects on solid state storage media (for example, Secure Digital (SD) flash cards).

MSSP Task USA E 2485 (Radiation Effects and Mitigation Techniques) provides valuable research on characterizing system-level radiation effects on NGSS instrumentation. Activities included modelling and analysis of radiation effects on NGSS system components; testing of relevant components in representative radiation environments and assisting in the development of mitigating actions to address any identified vulnerabilities. A tangible outcome of this research was inter alia the design of a neutron shield to enhance the radiation robustness of SD flash cards used in NGSS cameras. MSSPs will manufacture and provide approximately 250 neutron shields in early 2022, and the IAEA will implement and install them in cameras.



Figure 1: New IAEA Safeguards inspectors are being trained to install and adjust XCAMs, the new generation surveillance cameras at the Dukovany Nuclear Power Station (Czech Republic).

Outcome #2: Improved ability to detect undeclared activities at nuclear facilities with tools and techniques.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> 1. Surveys and assessments of emerging 3D camera and laser (LIDAR) technologies to provide lifecycle support to existing systems (3DLR) to provide valuable input for the eventual NGSS technology replacement. 2. ★ Test results from the upgraded LIDAR-based Laser Curtain for Containment (LCCT) system that was installed for field testing. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.1.C8	T.6.C2
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Planned Activities

The IAEA very much appreciates MSSPs’ continued support in surveying and assessing emerging 3D camera and laser (LIDAR) technologies to provide lifecycle support to existing systems (for example, 3DLR) that will provide valuable input for the eventual NGSS technology replacement.

In close collaboration with SGTS-002: Techniques and Instruments for Sealing and Containment Verification and SGTS-003: Surveillance Techniques, the IAEA installed an upgraded LIDAR-based LCCT system for field testing in 2021. This plan will now consider the test results.



Figure 2: LIDAR-based Laser Curtain for Containment (LCCT) System installed at a safeguarded facility.

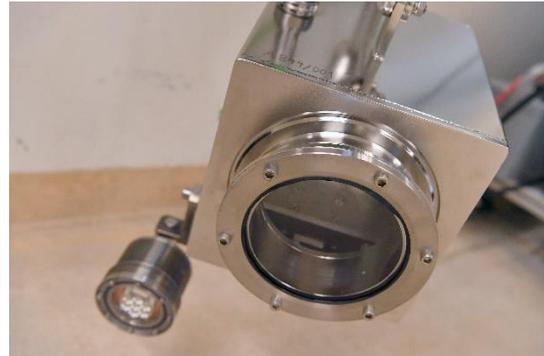


Figure 3: Next Generation Surveillance System (NGSS) underwater camera with high reliability light emitting diode (LED) light used in Spent Nuclear Fuel ponds.

Outcome #3: Improved response to new threats resulting from technology advancements, through advanced intrusiveness and vulnerability analysis on current and future use of unattended systems.

Outputs 1. ★ Evaluation and integration of data review capabilities in NGS as reported in the vulnerability assessment.

Supporting Resource Mobilization Priorities

T.1.C11

Planned Activities

The IAEA originally implemented an innovative method to monitor connection cables to analogue surveillance cameras in the NGSS camera core module. This method, based on spread-spectrum time domain reflectometry (SSTDR), augmented and enhanced the data security when using analogue cameras. Under MSSP Task USA E 2354 (Vulnerability Assessment of the DCM-A1 SSTDR Diagnostics Feature (LiveWire)) (DCM-A1 being a next generation analogue camera recording module), a vulnerability assessment of this particular implementation of SSTDR was performed and completed in 2020.

When the IAEA receives and evaluates the vulnerability assessment, the IAEA will develop and integrate data analysis features allowing the routine review of such SSTDR data into NGS. This is expected mid-2023.

Within the scope of this task, the IAEA does not plan to request any additional work.

Outcome #4: Improved real-time monitoring and flow measurement capabilities of nuclear material at nuclear facilities (for example, UF₆ cylinders and spent fuel casks) by developing tools and techniques.

Outputs 1. A developed ultra-high frequency (UHF) Passive Tag monitoring and tracking system with advanced capabilities for persistent, real-time, non-optical surveillance of items of interest.

Supporting Resource Mobilization Priorities

T.1.C1

T.1.C7

Planned Activities

Technology development work continues under MSSP Tasks USA E 2483 and FIN E 2528 (Passive Tag Technology), which potentially provides resources for technology field testing. The task is continuing with the identification of a suitable Safeguards facility for testing and a preliminary Vulnerability Review (VR) of the proposed technology conducted by departmental experts.

SGTS-008: Instrumentation Technology Foresight

Achieving effective and efficient safeguards verifications through the use of radical technology innovations.

 Dimitri FINKER



Plan Acronyms

CASCADE	Centralized Automated System for Correlated Analysis and Data Evaluation
CVD	Cerenkov Viewing Device
DCVD	Digital Cerenkov Viewing Device
ICVD	Improved Cerenkov Viewing Device
IRIS	Instrument Record Integrator for Safeguards
ISE	Integrated Safeguards Environment
LIBS	Laser Induced Breakdown Spectroscopy
MMXRF	micro-focusing X-ray fluorescent spectroscopy
RCVD	Robotized Cerenkov Viewing Device
XCVD	Next Generation Cerenkov Viewing Device
XRF	X-ray fluorescence spectroscopy

Context Highlights

Overall Objectives

The overall objectives of this D&IS plan are to identify, evaluate, test, develop, authorize, and deploy emerging technical advances from other scientific fields and optimize them for use in safeguards. The IAEA has recognized and articulated the need to take full advantage of relevant technical advances made outside the safeguards community to strengthen IAEA verification activities in a manner that is less costly, less 'custom' wherever possible, and more sustainable. For this reason, the IAEA placed renewed emphasis on developing a robust in-house technology foresight capability. As a result, major technological breakthroughs could be achieved by partnering with non-traditional technological stakeholders not previously engaged in developments for nuclear safeguards in fields as diverse as astronomy, robotics, or optical design.

The Technology Foresight Pipeline

The Technology Foresight pipeline underlying the innovation cycle consists of the following stages:

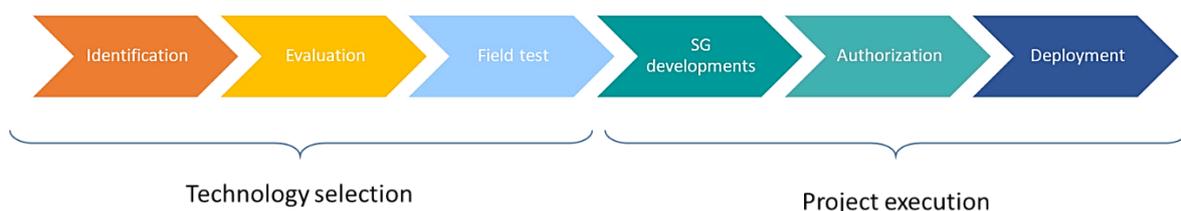


Figure 1: The Technology Foresight innovation pipeline.

Technologies are evaluated and prioritized at each step using the following 5 criteria:

- Relevance (Does it solve a safeguards problem?)
- Maturity (Does it work?)
- Applicability (Can be it adapted for safeguards verification?)
- Operational convenience (Will it be used by IAEA? Are there any competing, less cumbersome alternatives?)
- IAEA readiness (What are the current obstacles preventing its deployment?)

A thorough selection is made throughout the innovation pipeline: during the early stages (technology selection), many of the initial technologies are discarded or placed on stand-by, when the level of effort to adapt them is not proportionate to the value brought to Safeguard verification. This drastic selection ensures that IAEA resources are directed for the execution of the most promising projects leading to successfully authorized instruments. In the last five years, over 400 technologies were identified by the Technology Foresight programme, with only 5% being retained for project execution, leading to the authorization of 22 new instruments.

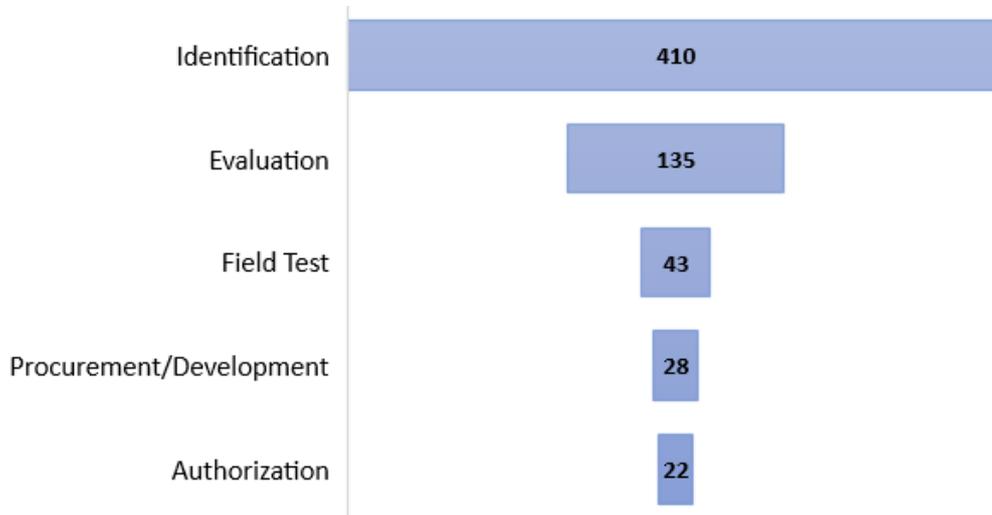


Figure 2: Technologies in the Technology Foresight innovation pipeline.

Technology Challenges

One effective mechanism to significantly accelerate this selection through the pipeline has been to organize Technology Challenges, a crowdsourcing approach to expand outreach. Technology Challenges offer multiple opportunities (as described below, in Outcome 2) for MSSPs to visibly contribute to the development effort of the Department providing immediate and measurable results that are widely communicated through the Office of Public Information and Communication.

The Technology Foresight Database

The creation of a searchable Technology Foresight Database ensures that the Department can efficiently re-evaluate a technology that had been previously discarded or when technological or operational factors have evolved. The long-term objective of the database is to progressively become a tool used to communicate the status of the Department's technology evaluations with MSSPs.

Flagship Development: Authorization of the Next Generation Cerenkov Viewing Device (XCVD)

Initiated over the course of a crowdsourced Technology Challenge (2016), the Next Generation Cerenkov Viewing Device (XCVD) has now matured into a safeguard instrument, authorized for gross defect verification of spent fuels. With a form-factor equivalent to the improved Cerenkov viewing device (ICVD), the new instrument sports a 20-time gain of sensitivity in comparison with its predecessor through the use of dedicated optical components and real-time image processing algorithms. Five pre-production units are presently used in the field; large-scale production of XCVD will commence in 2022.



Figure 3: Pre-production XCVD units under assembly.



Figure 4: XCVD used during field testing.

Flagship Development: Development of a Robotized Cerenkov Viewing Device (RCVD)

The 2018 Technology Challenge on robotics was concluded by the selection of two suppliers in charge of developing a hardware platform and a control command for an autonomous surface system capable of hosting the XCVD as payload. The advantages of a Robotized Cerenkov Viewing Device (RCVD) for spent fuel verification campaigns are numerous, both for the facility operators and for the IAEA: better consistency in the measurements, an improved safety and a higher efficiency. As of December 2021, 13 MSSPs have accepted MSSP Task Proposal 18/TND-001 (Field-testing of an Unmanned Surface Vehicle and neXt generation Cerenkov Viewing Device). The development of the robotics platform reached several key milestones in the last biennium:

- The RCVD hardware was fully redesigned around the concept of passive safety, in collaboration with multiple safety authorities and facility operators who performed iterative rounds of safety reviews, ensuring that the system will be accepted in the future.
- The RCVD software now integrates active safety features, enabling the robot to maintain a constant position even in strong current, and continuously avoiding obstacles present in the pond. Elements of autonomous behavior are progressively integrated in the control command.

A prototype is presently manufactured and tested in a non-nuclear environment; by Q1 2022, the IAEA hopes to have performed a test inside a nuclear facility. This would allow to:

- Increase the awareness and assurance of the project amongst facility operators.
- Integrate some actual feedback into the next phase of development.

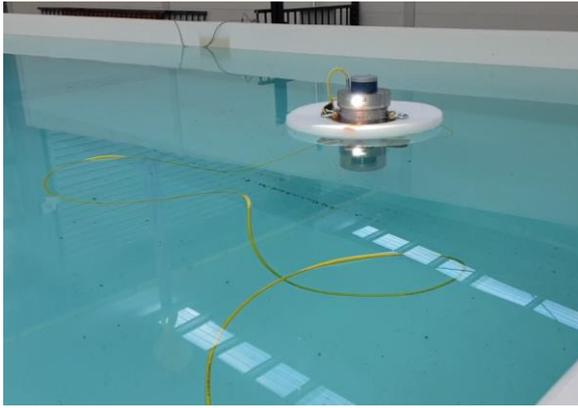


Figure 5: RCVD prototype during testing in a non-nuclear facility.



Figure 6: Detail of the platform of the manufactured RCVD prototype.

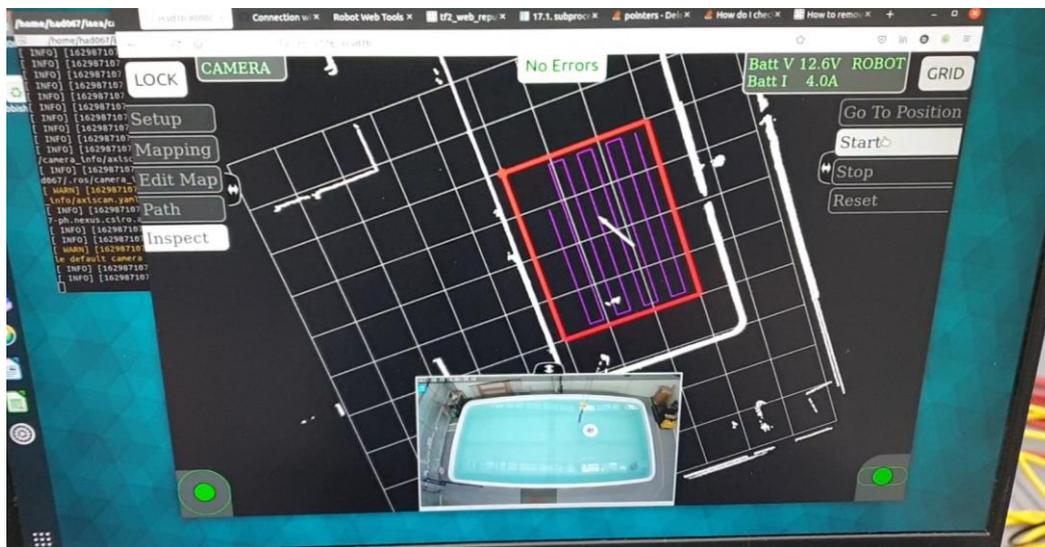


Figure 7: Visualization of the route autonomously followed by the RCVD in a test pond.

Flagship Development: Authorization of new Portable Chemical Substance Identification Instruments

A series of new instruments identified during a technical workshop on Chemical Identification (2014) were authorized in 2020-2021:

- A palmtop-size Raman (MiraDS)
- A handheld Laser Induced Breakdown Spectroscopy (LIBS) (Vulcan)
- A handheld XRF (X-MET8000)

These instruments complement the capabilities of IAEA Safeguards inspectors for identifying non-radioactive substance in the field under a very compact form-factor.

Most Needed Extrabudgetary Support in 2022–2023

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|---|---|---|---|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input checked="" type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Summary of support needed (more details in the Development Plan below):

- Financial support to organize challenges.
- JPO and consultants for specific developments.
- Equipment to replace ICVD and setting up the IT infrastructure for XCVD data processing.
- Facility access for testing RCVD.
- Scientific studies for expanding the use of XCVD to partial defect verifications.

Plan Resource Mobilization Priority Linkages

- T.1.C1** Ability to more efficiently verify and maintain knowledge of spent fuel in shielding/storage/transport containers at all points in their life cycle, including through remote means
- T.1.C4** Ability to perform partial defect verification of spent fuel with the digital Cerenkov viewing device (XCVD)
- T.1.C5** Ability to develop, deploy and maintain new sealing system technologies with improved security and efficiency
- T.1.C10** Ability to rely upon an integrated system of instrumentation data (for example, spectra) processing and review, with high level of automation and with unified user interface
- T.2.C1** Ability to reliably and quickly deliver sample analysis results for special and high priority demands
- V.6.C1** Ability to implement effective and efficient safeguards for geological repositories

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Improved and more efficient safeguards verification activities in the field through the use of innovative technologies.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> 1. ★ 30 Next Generation Cerenkov Viewing Device (XCVD) unit to replace the improved Cerenkov viewing device (ICVD) and Digital Cerenkov Viewing Device (DCVD) used for gross defect verification. 2. Conclusions on XCVD applicability for partial defect verification of spent fuel. 3. Setup of the IT infrastructure for post process and storage of XCVD data. 4. ★ Deployment of Robotized Cerenkov Viewing Device (RCVD) in at least one significant spent fuel verification campaign, including difficult-to-access and/or large quantities of items. 5. Finalization of the development of a portable MMXRF (micro-focusing X-ray fluorescent spectroscopy) in close collaboration with SGAS. 6. Expand use of Instrument Record Integrator for Safeguards (IRIS) in the Integrated Safeguards Environment (ISE), currently restricted to a few test users, through further integration with SG IT Tools. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.1.C1

T.1.C4

T.1.C10

T.2.C1

Planned Activities

The focus for 2022–2023 is to start mass production of XCVD units based on a design validated during the previous biennial cycle; the XCVD will progressively supersede the other Cerenkov Viewing Devices (ICVD and DCVD) used for gross defect verification of spent fuel. Additional studies and tests will be conducted to determine how XCVD could be used for quantitative measurements, paving the way to its potential usage as a partial defect verification tool.

A new data workflow supported by an IT infrastructure, comprising both processing software and local servers, will be required to fully exploit the data recorded with XCVD; it is planned to use the existing Centralized Automated System for Correlated Analysis and Data Evaluation (called CASCADE) platform to manage the access of XCVD data across IAEA Safeguards inspectors and scientific support staff.

The development of a robotized platform hosting the XCVD (RCVD) will be nearing completion by the end of 2023, bringing significant gains in efficiency and consistency for Cerenkov light measurements in the field. The ability to regularly test RCVD in the field, over the course its development, is essential to ensure that the final design will be acceptable to facilities and useful to IAEA Safeguards inspectors.

The development of a portable micro-focusing X-ray fluorescent system (MMXRF) was initiated during the previous biennium under MSSP Task ROK A 2512 (Portable Monochromatic Micro-Focusing X-Ray Fluorescence System (MMXRF) for Field Use); the performances of the new instrument have been already greatly improved, both in sensitivity and spectral resolution, with the perspective of becoming a valuable tool for swipes analysis.

The Instrument Record Integrator for Safeguards (IRIS) has already been successfully tested under ISE; it will become accessible and will be further integrated within SG IT Tools for streamlined reporting of field instrument data.

The Department would benefit greatly from the continued support through MSSP Tasks ARG A 1637; AUL A 1856; BEL A 1615; BRZ A 1601; CAN A 1622; EC A 1634; FIN A 1628; FRA A 1641; GER A 1633; HUN A 1597; JPN A 1798; NET A 1850; ROK A 1894; RSA A 2010; UK A 1599; and USA A 1616 (Support for Instrumentation Technology Foresight) to continue the following initiatives:

- Fund XCVD components, aiming at the replacement of CVDs.
- Fund the infrastructure supporting the data workflow of XCVD.
- Support scientific studies assessing the potential of XCVD for partial defect verification.

In addition, MSSPs can support the development of RCVD through MSSP Task Proposal 18/TND-001 (Field-testing of an Unmanned Surface Vehicle and neXt generation Cerenkov Viewing Device), currently supported by MSSP Tasks ARG A 2571; AUL A 2520; BEL A 2474; BRZ A 2545; CZ A 2451; EC A 2406; FIN A 2390; FRA A 2409; GER A 2565; JPN A 2539; RSA A 2459; SWE A 2618; and USA A 2487 including the following initiatives:

- Facilitate technical exchanges with facility operators and safety authorities.
- Support the testing and deployment of RCVD in the field.

Outcome #2: Ability to develop, design, and enhance safeguards solutions faster and with fewer resources by using external technologies from relevant R&D fields.

Outputs	<ol style="list-style-type: none"> 1. Identification of at least 4 new, external, non-traditional technology suppliers that have demonstrated an ability to develop specific solutions applicable to the domains of non-destructive assay, containment, surveillance, and destructive analysis (in close collaboration with SGCP-004: Strategic Planning and Partnerships). 2. At least one Technology Challenge for improving SG instrument data analysis. Prospective topics include machine learning applied to improvement of spectral analysis, improvement of inertial positioning capabilities, and Cerenkov image analysis. 3. Expanded usage of the Technology Foresight database for stakeholders external to Technology Foresight: support to SGTS scientific panels and generation of external technology reports for MSSPs.
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Supporting Resource Mobilization Priorities

V.6.C1	T.1.C4	T.1.C5	T.1.C10
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Planned Activities

Organizing Technology Challenges has proved to be an advanced and effective mechanism to quickly identify new suppliers or technologies outside the traditional horizon of Safeguards. The IAEA will seek to sustain and expand this outreach effort, momentarily on hold due to the pandemic, with new challenging topics focusing on innovative processing techniques that could be applied to the analysis of safeguards instrument data.

MSSPs have been essential to the organization of Technology Challenges. MSSP Tasks ARG A 1637; AUL A 1856; BEL A 1615; BRZ A 1601; CAN A 1622; EC A 1634; FIN A 1628; FRA A 1641; GER A 1633; HUN A 1597; JPN A 1798; NET A 1850; ROK A 1894; RSA A 2010; UK A 1599; and USA A 1616 (Support for Instrumentation Technology Foresight) can provide support specifically in the following areas:

- Advertising the Technology Challenges.
- Funding a dedicated crowdsourcing platform.
- Identifying potential suppliers.
- Directly supporting its organization(s) by funding candidates, hosting challenges, and/or providing technical observers.

The Technology Foresight Database stores knowledge gathered during the technological outreach activities using a taxonomic categorization and summarizing technology evaluations. It was developed by the JPO recruited under MSSP Task USA A 2344 (Junior Professional Officer - Associate Instrumentation Engineer). The database will continue to be populated, and it will be expanded to support IAEA (for example, the Scientific and Technical panel) and external (for example, MSSPs) stakeholders.

SGTS-011: Unattended Measurements Techniques

Optimizing unattended measurement techniques for monitoring declared or detecting undeclared nuclear material and activities.

 Not available as of March 2022



Plan Acronyms

CFM	Coriolis Flow Meter
COTS	commercial off-the-shelf
FDET	Fork Detector
FPGA	field-programmable gate array
GCEP	Gas Centrifuge Enrichment Plant
OLEM	On-Line Enrichment Monitor
OLEMDAQ	On-Line Enrichment Monitor Data Acquisition module
OLEMR	On-Line Enrichment Monitor Review
PGET	Passive Gamma Emission Tomography
TDR	Time Domain Reflectometry
UCVS	Unattended Cylinder Verification System
UMS	Unattended Monitoring Systems

Context Highlights

Importance of Unattended Measurement Systems (UMS) During the Covid-19 Pandemic

Travel conditions have been extremely challenging during the pandemic, with many IAEA Safeguards inspectors' trips cancelled or delayed. The trips that did take place came at a much higher cost—both human and monetary—due to quarantine requirements. In these uncertain and adverse conditions, unattended monitoring systems have demonstrated their full potential, continuing to seamlessly acquire safeguards data on a 24/7 basis in nuclear facilities around the world. By preventing IAEA SG from having delays or anomalies in drawing their conclusions, UMS played a role of paramount importance in maintaining safeguards measures and continuity of knowledge (CoK). UMS staff also were affected by the pandemic, having experienced some delays in maintaining equipment onsite.

However, due to the robust redundancy and uptime measures built into UMS instruments (including recent design enhancements in terms of power management and modularity), even travel delays did not impact the IAEA's ability to fulfil its mandate. All facilities under remote monitoring transmitted data through a secure VPN tunnel to IAEA HQ on an ongoing basis and all other data were recoverable at the sites once SG staff were able to travel to the facility. Thus, the quality and resilience of UMS (both systems and staff) successfully contributed to achieving SG commitments in facilities where UMS instruments are installed.

Two-Year Focus Areas

The strategy for the next two years and beyond will focus on:

- Identifying new facilities where UMS could reduce IAEA Safeguards inspector efforts by implementing or increasing more robust safeguards approaches;
- Continuously improving UMS reliability, usability, and maintainability leading to longer preventive and corrective maintenance intervals;
- Developing more sophisticated measurement techniques, in particular non-nuclear (optical, magnetic, vibration etc.) to address a wider variety of verification methods; and
- Studying new types of (fast) neutron and gamma detectors combined with pulse shape discrimination techniques with the goal of achieving more sensitive, more reliable, simpler measurements.

Extrabudgetary Support

The SGTS-011: Unattended Measurements Techniques plan for 2022–2023 is ambitious, and continued MSSP support is welcome to address some of the aforementioned objectives. The type of support depends on the proposed projects and ranges from a CFE to manage MSSP Tasks (and whose main duties would include task development coordination, in-house testing, and field implementation) to R&D from national laboratories that would conduct research in new fields, where the necessary expertise is missing from the IAEA.

Most Needed Extrabudgetary Support in 2022–2023

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|--|--|--|--|
| <input checked="" type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input checked="" type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- T.1.C1** Ability to more efficiently verify and maintain knowledge of spent fuel in shielding/storage/transport containers at all points in their life cycle, including through remote means
- T.1.C3** Ability to more effectively and efficiently verify spent fuel from on-load reactors
- T.1.C8** Ability to detect HEU production in real time at declared LEU enrichment facilities
- T.1.C10** Ability to rely upon an integrated system of instrumentation data (for example spectra) processing and review, with high level of automation and with unified user interface
- T.1.C11** Ability to rapidly detect, characterize and address breaches to unattended systems, and evaluate their vulnerabilities more broadly, particularly from threats arising from technology advancements (for example conduit integrity verification)

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Faster (and potentially real-time) detection of highly enriched uranium production in low enriched uranium enrichment facilities through improved tools and techniques.

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| Outputs | <ol style="list-style-type: none"> ★ On-Line Enrichment Monitor software suite, including final versions of On-Line Enrichment Monitor Data Acquisition module (OLEMDAQ), AnalyseN42, and On-Line Enrichment Monitor Review (OLEMR) software tools. ★ Identification of new facilities for OLEM installation in collaboration with Operations Divisions. Electrically cooled high purity germanium (HPGe) detector to achieve continuous enrichment (including ²³⁴U) assay, including a cooling circuit to trap UF₆ into a sample bottle. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.1.C8

Planned Activities

This plan will use internal resources only.

- Obtain the latest source code of all three programs. Contract with an outside vendor/organization to provide stable versions of all software within current software standards.
- The OLEM system will be presented to Operations Divisions to elicit requests for installation in candidate facilities (end of 2022).

3. UMS will address this Operations request by designing a commercial off-the-shelf (COTS)-based unattended system prototype to be completed by the end of 2022, ready for field testing in a suitable enrichment facility.

Outcome #2: Implementation of the Unattended Cylinder Verification Station at an operating enrichment plant.

- Outputs**
1. ★ Successful installation of an Unattended Cylinder Verification System (UCVS) at a safeguarded gas centrifuge enrichment plant (GCEP).
 2. Measurement and analysis of feed, product, and tails cylinders.

Planned Activities

1. Receipt of UCVS at IAEA HQ.
2. Application of specific IAEA hardware and software security measures to ensure data and hardware integrity according to the IAEA standards (expected end of 2022).
3. Implementation of UCVS at the chosen enrichment plant. Analysis of data from feed, product, and tails cylinders.

Support Needed

CFE, JPO, financial support for travel, and a facility to implement the Unattended Cylinder Verification System for testing purposes.



Figure 1: UCVS: Mechanical frame showing where the cylinders will be seated (yellow frame) and all surrounding slab detectors for UF₆ characterization.

Outcome #3: Established and maintained knowledge of spent fuel in shielding/storing/transporting containers, at all points in their lifecycle, by developing safeguards equipment.

- Outputs**
1. ★ Advancing Unattended Fork Detector Monitor data analysis for improved partial defect verification.
 2. ★ Development of unattended Passive Gamma Emission Tomography (PGET).

Supporting Resource Mobilization Priorities

T.1.C1

T.1.C3

Planned Activities

1. Simulate the IAEA's fork detector (FDET) with Monte Carlo N-Particle transport code and deduce the B-10 and fission chambers response functions for BWR, PWR, VVER-1000, and VVER-400 spent fuel type.
2. Define a concept for unattended operation of PGET which responds to the user requirements, apply specific IAEA hardware and software security measures to ensure data and hardware

integrity, build a test bench in laboratory, install in a facility (most probably in Finland) and check performance for 6 months in remote, attended operation.

Support Needed

The simulation of the FDET response would require support from nuclear experts that already have experience with FDET response functions.



Figure 2: New portable UFD for Nuclear Spent-Fuel Characterization with FDET – Method F.

Outcome #4: Development of UMS based on new measurement technologies and increasing proportion of deployed unattended systems that are sustainable, standardized and modular, with increased use of COTS products.

Outputs	<ol style="list-style-type: none"> 1. ★ A time-domain reflectometry (TDR) device based on UMS requirements is expected to be installed for field testing, following the acceptance of MSSP Task Proposal 21/TUS-001 (Development of Time Domain Reflectometer (TDR) Devices for Use Along Unattended Monitoring Systems (UMS) Detector Cabling Pathways). 2. ★ Proposed sensors to confirm operational or non-operational status of facility. 3. ★ Coriolis flow meter (CFM)-based unattended measurement system for mass and density determination of liquid flowing through a pipe. 4. ★ Feasibility of COTS Raman spectroscopy technique for unattended measurement of uranium concentration in liquids. 5. ★ COTS non-nuclear measurement methods for characterization of spent fuel. 6. ★ Survey on existing COTS techniques to address timely detection of tampering of UMS cabinets.
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Supporting Resource Mobilization Priorities

T.1.C11

Planned Activities

1. A TDR device shall be available by the end of 2022 and installed for field testing in mid-2023.
2. Survey of non-radiation-based sensors (vibrational, temperature, acoustic, etc.) that can indicate operational status of an industrial facility. Laboratory-scale testing of candidate technologies. Field test of promising technologies in a non-safeguarded facility. Final report on results.
3. The system utilizing COTS CFM to provide unattended measurement of mass and density of liquid flowing through a pipe in batches shall be designed in Q1 2022 and installed in a facility by the end of 2022. This plan will use internal resources.
4. As handheld Raman spectroscopy devices are available for performing *in situ* measurement of uranium concentration, the possibility of developing an unattended system to provide continuous monitoring will be investigated (mid-2023). If feasible with COTS equipment, a prototype will be built for field testing.

5. Survey of different well-established industrial methods currently available and their feasibilities, which could potentially be used to address output #5. A summary report shall be completed by the end of 2022.
6. The current method used to detect tampering of UMS cabinets is obsolete, therefore new technologies shall be investigated to address this urgent need. A report summarizing potential techniques to be tested is expected by the end of 2022.

Support Needed

On point #1, an SP-1 was issued to request support for the experts who already provided a prototype as proof of concept.

Points #2, #5, and #6 require experts to carry out thorough surveys on existing COTS technologies that could potentially be applied to Safeguards. MSSP Task Proposals will be issued in this regard in 2022.

Outcome #5: Identification of new (fast) neutron and gamma ray spectroscopic sensors and associated nuclear instrumentation electronic for use in unattended systems.

Outputs	<ol style="list-style-type: none"> 1. ★ Low-power gamma ray spectroscopic detectors with better resolution than sodium iodide. 2. ★ Low power fast neutron sensors (semiconductor- or scintillator-based) with very good pulse-shape discrimination. 3. ★ Development and maintainability support (hardware and software) of UMS standard electronic modules. 4. Multi-Channel Multiplicity Counter Shift Register software to run on COTS hardware for unattended shift register applications requiring many separate inputs.
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Supporting Resource Mobilization Priorities

T.1.C1	T.1.C10
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Planned Activities

1. Survey commercially available technology. Perform laboratory testing with radiation sources that are common to safeguards (uranium, plutonium, spent fuel). Analyse power consumption as a function of count/dose rate. Perform stability testing for temperature and humidity. Perform a long-term study to determine degradation of performance, if any. Produce a final report.
2. Continuous technical support is required to maintain and improve electronic modules developed by LANL (Unattended Dual Current Monitor, ALMM, etc.) and BOT Engineering (ADM2).
3. A proof-of-principle multiplicity shift register software programme has been developed on a COTS platform based on National Instruments field-programmable gate array (FPGA) card(s) with Labview FPGA module. It is planned to have a company develop a configurable, modular software application according to UMS specifications. This plan will use internal resources.

Support Needed

Continuous technical support (planned activity #2) is already covered by existing MSSP Tasks, whereby this support is expected to be extended in 2022–2023.

SGTS-014: Remote Data Transmission and Processing Systems

Collecting, transmitting, and reviewing data from safeguards equipment installed in facilities around the world.

 Angelo ALESSANDRELLO



Plan Acronyms

CASCADE	Centralized Automated System for Correlated Analysis and Data Evaluation
CDMS	Containment Data Management System
CIOSP	Common Inspection Onsite Software Package
CSFSF	Central Spent Fuel Storage Facility
EDM	Enterprise Data Model
EPGR	encapsulation plant and geological repository
INCC	IAEA Neutron Coincidence Counting
IRAP	Integrated Review and Analysis Package
ISE	Integrated Safeguards Environment
JRC	A facility code for the Rokkasho Reprocessing Plant in Japan
NGSR	next generation surveillance review
NRTS	Near Real Time System
RAINBOX (device)	Rainstorm BOX
RAINSTORM	Real-time And INtegrated SStream-Oriented Remote Monitoring (RAINSTORM) interface
RDT	Remote data transmission
RKB	A facility code for the Centralized Spent Fuel Storage Facility (CSFSF) in Ukraine
ROOGLE	An application to view the status of remotely connected systems.
RRP	Rokkasho reprocessing plant
SAFIRE	Safeguards Inspection Reporting and Evaluation
SDP	State Declarations Portal
SEQUOIA	Safeguard equipment asset management tool
SMT	SGTS ticketing system
UI	user interface
VPN	Virtual Private Network

Context Highlights

Importance of Remote Data Transmission in Safeguards

Remote data transmission (RDT) and remote data review of Safeguards equipment data are supporting more efficient safeguard verification activities by reducing the need for IAEA Safeguards inspectors to collect the data on-site and enabling them to allocate the spared time to other activities while having the assurance that all Safeguards equipment systems are operating as expected.

Additionally, RDT provides information on equipment performance (in other words, state-of-health data), allowing remote systems diagnostics and troubleshooting. It also facilitates predictive maintenance activities, which potentially reduces duty travel related to maintenance as well as replacing a few inspection activities associated with servicing unattended systems.

With data collection, review, and evaluation at a remote location, RDT allows for the remote timely detection and resolution of issues and reduces field efforts for IAEA Safeguards inspectors. Due to the above-mentioned features, RDT significantly improves both the efficiency of Agency safeguards implementation and the effectiveness by facilitating attainment of the timeliness component of the inspection goal through earlier data review and evaluation. Additionally, the use of RDT decreases radiation exposure of IAEA Safeguards inspectors and facility personnel.

RDT and the Covid-19 Pandemic

The Safeguards Remote Data Transmission infrastructure proved to be a key element during the Covid-19 pandemic. The extension and upgrade of the Safeguards RDT network was impeded during this period and had to be rescheduled to a later date due to the travelling limitations and the fact that some technical experts were immobilized during longer periods in certain Member States in order to adhere to quarantine requirements.

Challenges

As the RDT network usage has risen, there has also been a continual increase in the maintenance effort and the networking costs; the data volume received monthly in IAEA headquarters has doubled in the last three years, reaching about 1 Terabyte per month in 2021. The real challenge is not in operating the RDT network but in producing adequate data processing applications that can properly handle the current data volume and the data diversity features (very different file formats from instruments, data streaming, documents, etc.). In fact, IAEA Safeguards inspectors often need to analyse these different data to verify nuclear activities quickly (for example, less than 48 hours). To do so, they need applications capable of properly highlighting/aggregating the relevant information.

Therefore, it is crucial to extend the software tools introduced in the previous biennia:

- Integrated Review and Analysis Package (IRAP),
- Centralized Automated System for Correlated Analysis and Data Evaluation (CASCADE),
- Near Real Time System (NRTS),
- ROOGLE3, the application to view the status of remotely connected systems, and
- Others.

and integrate them with other applications such as:

- Safeguard Equipment Asset Management Tool (SEQUOIA),
- SMT, the ticketing system of SGTS
- Safeguards Inspection Reporting and Evaluation (SAFIRE),
- Containment Data Management System (CDMS), and
- Others.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|--|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- S.2.C1** Ability to strengthen the capacity of SSACs/SRAs and monitor and measure progress
- S.3.C1** Ability to identify and address the needs of designers and operators of modified or new facilities in the early preparation for efficient implementation of safeguards
- T.1.C10** Ability to rely upon an integrated system of instrumentation data (for example spectra) processing and review, with high level of automation and with unified user interface
- T.1.C11** Ability to rapidly detect, characterize and address breaches to unattended systems, and evaluate their vulnerabilities more broadly, particularly from threats arising from technology advancements (for example conduit integrity verification)
- T.3.C2** Ability to assist SRAs with the creation and submission of accountancy reports and additional protocol declarations with an IT tool
- T.6.C1** Ability to develop and deploy improvements to the next generation surveillance review (NGSR) software (for example by leveraging machine learning to improve imagery review)
- V.1.C1** Ability to synthesize and evaluate disparate sets of verification data from the field through data analysis methods and tools

- V.1.C2** Ability to process and integrate the variety and volume of safeguards-relevant information in a timely, user-friendly and cost-effective manner
- V.4.C1** Ability to leverage statistical methodologies to evaluate verification data, to assess verification performance (detection probability, timeliness and deterrence) and the associated level of confidence, at the facility and State levels
- V.6.C1** Ability to implement effective and efficient safeguards for geological repositories
- V.6.C3** Ability to implement effective and efficient safeguards at J-MOX
- V.6.C4** Ability to perform process monitoring and associated data analysis for safeguarding facilities, particularly advanced reactors with liquid or pebble fuel

Development Plan for 2022–2023

★ Indicates top priority

★ **Outcome #1:** More efficient data review and evaluation tools for IAEA Safeguards inspectors and SGTS technicians.

Outputs	<ol style="list-style-type: none"> 1. ★ Integration of CASCADE in the Integrated Safeguards Environment (ISE) with the State Declaration Portal (SDP) and SAFIRE-CIOSP. 2. ★ Integration of ROOGLE3 data with CASCADE, SMT, SEQUOIA, and SAFIRE. 3. ★ Integration of hand-carried data with remotely transmitted data and move of the relative storages into ISE. 4. ★ IRAP and next generation surveillance review (NGSR) deployment in ISE and on IAEA Safeguards inspector laptops for in-field use. 5. ★ Complete IRAP/NGSR deployment and configuration for facilities in RDT.
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Supporting Resource Mobilization Priorities

V.1.C1	V.1.C2	V.4.C1	T.1.C10	T.3.C2	T.6.C1	S.2.C1
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Planned Activities

The first three outputs are crucial to achieving an effective and efficient handling of the data needed to verify nuclear activities during in-field inspections.

To meet the expected outcome, ROOGLE3 and CASCADE applications need to be integrated together with other major SG equipment-related applications such as SEQUOIA and SAFIRE. In particular the additional features will be:

1. ROOGLE3 will collect the equipment status information from attended equipment data, not just from equipment connected through RDT.
2. The ROOGLE3 data source configuration (in other words, the configuration from equipment in the field) will be inherited from SEQUOIA daily through an already-agreed interface.
3. Therefore, ROOGLE3 will be able to update SEQUOIA on installed equipment statuses, allowing SEQUOIA to identify equipment installation configuration errors.
4. Furthermore, ROOGLE3 will automatically generate equipment-related tickets by sending the relevant information to SMT (the SGTS ticketing system) and by using the common SEQUOIA-installed equipment configuration.
5. CASCADE will be configured to contain all the NGSR and IRAP facility configurations in its database as used by IAEA Safeguards inspectors to perform data review.
6. ROOGLE3 will be able to associate, from the received file content, the measurement systems by facility, as configured in CASCADE, with the installed equipment by facility as configured in SEQUOIA.

As the measurement systems configured in CASCADE/ROOGLE3 are the authorized systems reported by IAEA Safeguards inspectors in SAFIRE, implementing all the above features will improve the verification process effectiveness and efficiency, correctness of inventory reports, and generate more comprehensive equipment performance reports.

In addition to the above-mentioned features:

1. CASCADE will become the secured storage for the facility operator declarations documents and will provide a user interface (UI) for IAEA Safeguards inspectors to review these declarations.
2. Therefore, CASCADE will be able to associate the Safeguards equipment data relevant to a certain inspection to the corresponding facility operator declarations data.

In the future, the infrastructure generated by the integration of all the applications mentioned above could be further exploited by aggregating any data collected during an inspection (for example, the measurements produced by a portable instrument) through proper tagging.

The last two outputs are related to the configuration and deployment of IRAP and NGRS and they are relevant to gather the knowledge needed to properly configure the interfaces described above. This knowledge can be obtained by configuring the "basic" review systems (IRAP and NGRS) for all possible nuclear facilities either connected through RDT or for which the data are hand-carried to IAEA headquarters repositories.

Giving the importance of this outcome, this plan would greatly benefit from the following support:

- Approximately €100 000 in financial support to buy equipment (servers, fast network devices, disk storages).
- In-kind donations of equipment valued at approximately €100 000 (servers, fast network devices, disk storages).
- Approximately 120 000 EUR/year in Financial Support for IT.
- 1 CFE.
- 1 JPO.
- Training for specific software packages like IAEA Neutron Coincidence Counting (INCC).

SGTS already benefits from two active MSSP Tasks under this plan:

- USA E 2582 (Expert - Remote Monitoring), who will join the Agency in the 2022–2023 biennium and provide software development and software engineering expertise.
- USA D 2386 (Junior Professional Officer - Associate Remote Monitoring Engineer) is heavily involved in developing ROOGLE3 features, especially the ones related to network devices (Virtual Private Network (VPN) boxes).

Moreover, there were two tasks completed in 2021:

- USA E 1998 (Expert - Remote Monitoring) who contributed significantly to IRAP deployments for several facilities.
- USA B 2555 (SCALE Training at IAEA) that enabled the proper use of SCALE in IRAP.

MSSP Task Proposal 21/TSI-001 (Expert Support for IRAP, INCC5/6, COMBIT and LANL Rad Review Suite), which is related to IRAP and INCC integration, is pending a MSSP's decision as of February 2022.

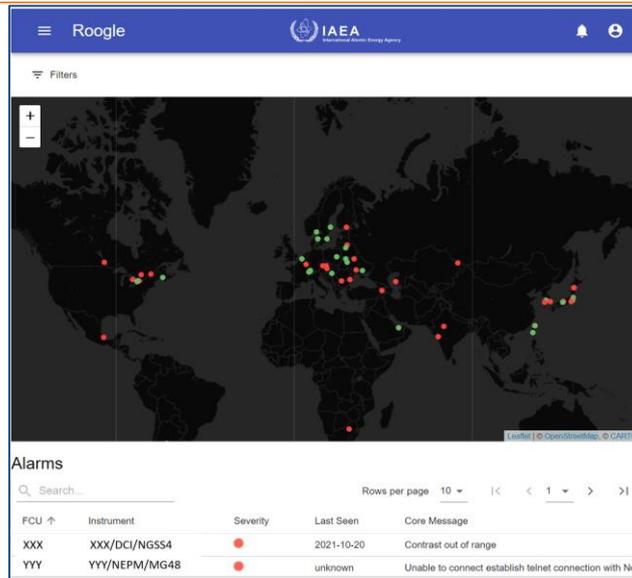


Figure 1: ROOGLE3 Map View prototype.

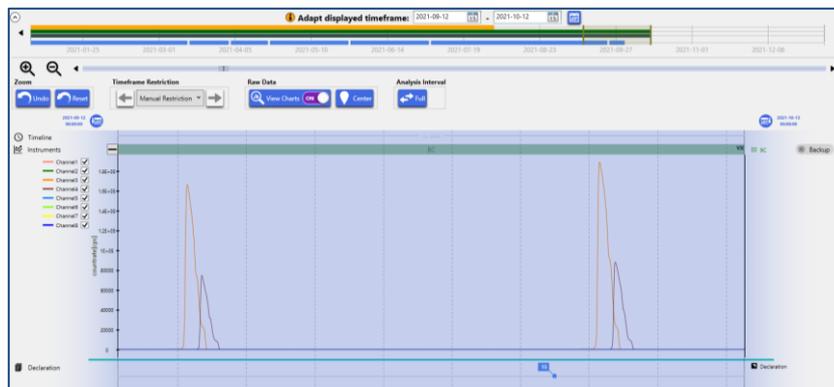


Figure 2: The Integrated Review and Analysis Package (IRAP) User Interface. IRAP is adequate for investigating events in non-complex measurement systems.

Outcome #2: Continuous improvement of the RDT network.

- Outputs**
1. Implementation of RAINBOX device.
 2. An assessment of the RDT Network.
 3. An upgraded RDT network capabilities.

Supporting Resource Mobilization Priorities

T.1.C10

S.2.C1

Planned Activities

148 nuclear facilities in 33 Member States are in the Safeguards remote data transmission network. More facilities join each year (about a 5% growth rate per year), but the increase of entry data points does not greatly impact the SG RDT network—it's the volume of data that impacts the network most as cameras and other devices send higher resolution and bigger data files compared with previous generation devices. IAEA's priority shall be given to maintaining (and ideally continuously strengthening) the security and speed of the network.

Therefore, the plan is to implement three outputs in next biennium through the following activities:

1. The development of a RAINBOX device to be used both as a VPN device using an open source VPN software (pfSense) and as a reliable and robust device to locally sign the equipment data using cryptographic algorithm so that a local collect computer would not be necessary

in conjunction with the modern Safeguards data acquisition devices (UDL1). The IAEA is already very well supported under MSSP Task USA E 2384 (Remote Monitoring VPN Hardware Support).

2. The RDT network needs to be checked minimum every two years to verify the overall integrity and security. The SG RDT network had two vulnerability checks in 2019 and 2020, and another in 2022 or 2023 would be prudent. The Department would seek financial contributions of approximately €100 000 and/or a CFE to support this effort.
3. The Equipment Data Management (EDM) Team, responsible for the SG RDT network, is committed to analysing the market for VPN technologies to replace the current one: both for specific installations, where more features are needed than available, and also to be aware of possible replacement technologies to mitigate obsolescence. In this regard, recently, the Stormshield VPN was approved for use in EC Member States by EURATOM authorities, and it shall be adopted in those areas. As such, the EDM Team would need training on the use and configuration of this new VPN for installations related to UMS equipment. For this activity, EDM Team does not seek any specific MSSP support, but, nevertheless, MSSP Task GER E 1859 (Testing and Implementation of Data Remote Transmission Security) supports installations of Stormshield VPNs in Germany.

Outcome #3: Enable rapid verification of activities in complex facilities.

Outputs	<ol style="list-style-type: none"> 1. Develop a NRTS instance for the Central Spent Fuel Storage Facility (CSFSF) (RKB facility in Chernobyl, Ukraine). 2. Develop a NRTS instance for the Rokkasho reprocessing plant (RRP) (JRC in Rokkasho, Japan). 3. Develop a NRTS instance for the encapsulation plant and geological repository (EPGR) (WOLE/WOLF in Onkiluoto, Finland).
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Supporting Resource Mobilization Priorities

V.1.C1	V.6.C1	V.6.C3	V.6.C4	T.1.C10	T.1.C11	S.3.C1
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Planned Activities

In 2020, the EDM Team built the first instance of NRTS running for the ISF-2 facility (RKCY/RKCX) in Chernobyl. NRTS is a high-level verification system that simultaneously makes use of Safeguards equipment and facility operator declaration data to support cases where rapid verifications are needed and to provide facility operators with “proceed” or “hold” messages for processes where onsite IAEA Safeguards inspector presence is not practical, for example, welding casks following loading and remote verification.

In this regard, three more facilities are expected to need a customized version of NRTS implemented in 2022–2023:

1. CSFSF (RKB, Chernobyl, Ukraine) by Q1 2022.
2. RRP (JRC, Rokkasho, Japan) by Q1 2023.
3. EPGR (WOLE/WOLF, Onkiluoto, Finland) by Q2 2023.

The activities to customize an NRTS are complex. They are:

- Analyse the facility key measurement points (KMPs) as identified during the safeguard by design process.
- Analyse the nuclear material flow in a given facility in relation with the measurement obtained by the KMPs and the data to be provided in a corresponding facility operator declaration.
- Build a swim-lane analysis chart to define interactions between facility operators, the NRTS system, and the IAEA Safeguards inspectorate.
- Implement the needed algorithm to mediate and facilitate the interactions between facility operators and IAEA Safeguards inspectors to quicken the relevant verification process.

Giving the complexity of this outcome, this plan is seeking support from MSSPs in terms of CFEs, JPOs, and financial contributions for IT development of about €120 000/year, especially for the

development of the Encapsulation Plant and Geological Repository (EPGR) NRTS that is more complex.

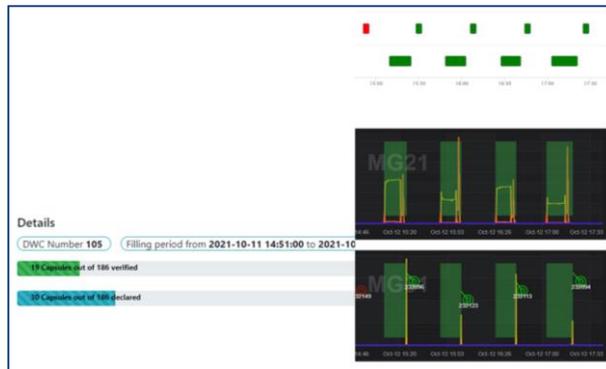


Figure 3: The Near Real Time System (NRTS) User Interface. NRTS is adequate for rapid analysis of complex Safeguards measurement systems. NRTS is particularly useful anytime a facility operator is waiting for a notification from IAEA Safeguards inspectors to proceed in a nuclear process (in other words, the notification can be provided through this system between 2 and 48 hours).

SGTS-016: Occupational Health and Radiation Safety

Managing safety matters, ensuring compliance with regulations, and enforcing radiation safety measures.

 Virginia KOUKOULIOU



Plan Acronyms

ERML	Equipment Radiation Monitoring Laboratory
HQM	Equipment Handling, Storage, and Quality Management Team
LAM	Large Article Monitor
NSRW	Radiation Safety and Monitoring Section
OEW	occupationally exposed worker
PPE	Personal Protection Equipment
SEQUIOA	Safeguard equipment asset management tool
SHS	Safeguards Health and Safety Sub-Committee
TID	tamper identification

Context Highlights

Introducing the Newest Development and Implementation Support Plan

IAEA staff members face risks such as radiation exposure from beta/gamma/neutron fields, contamination, radioactive sources and radioactive materials, X-ray generators, and industrial hazards around world, in different nuclear facilities, and in IAEA nuclear laboratories. Safety requirements—provided not only by Member States—but the will of the public and IAEA staff members collectively, become stricter and more important every year. Regulatory requirements around the world regarding release of contaminated material become stricter. Therefore, it is vital that the Department is able to match the occupational health and radiation safety requirements of the strictest Member States.

Furthermore, the increase in decommissioning projects will necessitate proper low-level contamination measurements. More accurate and precise low-level contamination measurements will be required and therefore the improvement of the existing measurement capabilities of radioactive contamination by the Equipment Radiation Monitoring Laboratory (ERML) is crucial.

In this context, the formulation of a departmental safety policy is extremely important and it creates an extremely good impression about the organization from the employee perspective. Having such a policy reflects how much an organization takes the Occupational Health and Radiation Safety of its employees seriously and this contributes to a respectful and healthy work environment.

The work of this D&IS plan aims to restrict the spread of contamination and strengthen radiation safety of Safeguards activities worldwide.

Managing Entity: The Equipment Radiation Monitoring Laboratory (ERML)

The Safeguards Health and Safety Sub-Committee (SHS Sub-committee) coordinates, communicates, and advises on matters related to a safe working environment and to radiation safety. The SHS Sub-committee reports to Safeguards Senior Management. The Director of SGTS chairs the committee and the Technical Secretary is the Radiation Protection Health and Safety Coordinator who is also the Team Leader of the Equipment Handling, Storage, and Quality Management Team (HQM) where ERML belongs, located in the Vienna International Centre, at the International Atomic Energy Agency (IAEA) main headquarters in Vienna, Austria. Therefore, the Team Leader of HQM manages this new D&IS plan.

Importance of Investment in Occupational Health and Radiation Safety

Staff is more productive in workplaces that are committed to health and safety. By investing in more modern equipment and improving existing safety infrastructure, the Department demonstrates the importance of Occupational Health and Radiation Safety. A strong occupational health and safety culture builds trust in the IAEA's reputation, while poor health and safety performance would directly affect the mandate of the Agency. Ensuring and promoting occupational health and radiation safety at work secures long-term benefits for the Department and the wider community.

ERML Purpose

The ERML's primary purpose is to identify and eliminate radioactive contamination on items used in the field in order to protect the health of the public, IAEA staff members, and Member State facility operators.

The contamination measurements performed by ERML can assure both its customers and the public that equipment leaving the laboratory has been properly, effectively, and safely measured and returned. The ERML also performs measurements on any personal items requested by travelling staff. There have been several instances where contamination has been found on staff clothing, for example, due to a tool being placed in the staff member's personal suitcase. In these cases, the ERML is able to send the clothing to the special wash at Seibersdorf before returning it to the staff member.

Items Measured for Contamination

Every year the ERML measures around 30 000 items comprised of approximately:

- 15 000 seals
- 10 000 items inventoried by Safeguards individually
- 5 000 non-inventoried items

Data is represented by Figure 1, and a more relatable representation of this data can be seen in Figure 2.

All passive seals returned to IAEA headquarters are also measured for contamination at the ERML before assessment for seals integrity and identity verification. Passive seals may be in the field for many years in a various environmental condition (high radiation containment, spent fuel ponds, spent fuel storage containers, etc.), and can easily become contaminated.

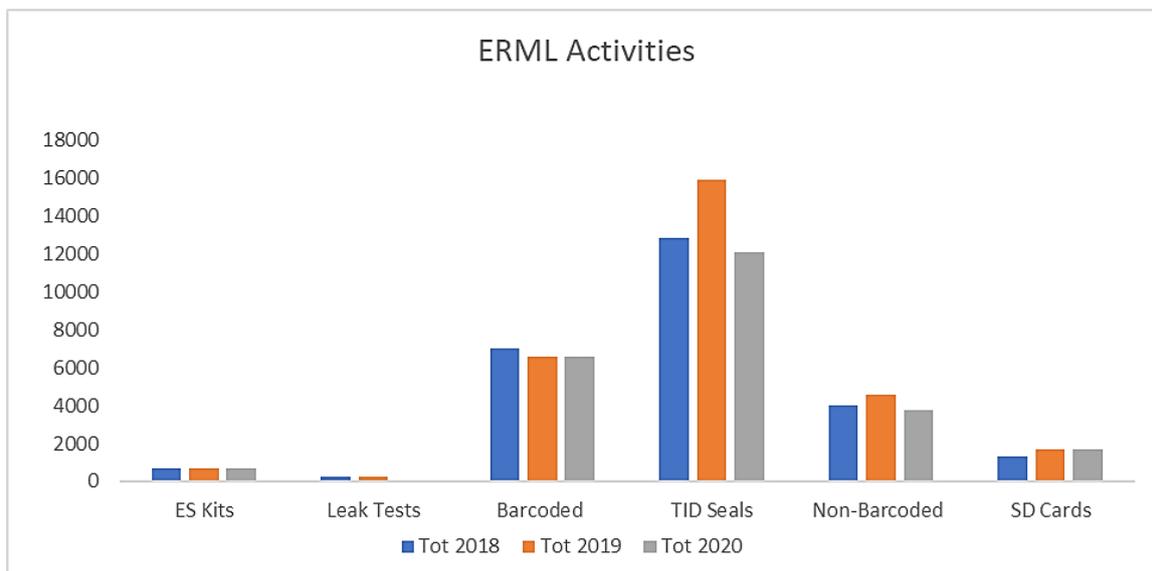


Figure 1: ERML Contamination Monitoring Activities.



Figure 2: An ERML staff member performs measurements.

Importance of Occupational Health and Radiation Safety's to Nuclear Verification

Occupational Health and Radiation Safety is a key component in the nuclear industry from mining to verification. The ERML performs contamination monitoring of all equipment returned from the field, which ensures that there is no undue influence from radioactive material from a previously visited facility going forth to another facility. While each facility has contamination controls, it is possible for individual facilities to have more or less stringent contamination release requirements. As such, ensuring that the ERML has the most updated measurement methods available is advantageous to verification efforts.

Ensuring the safety of departmental staff members on duty travel is also a vital part of the Agency's verification schema. Beyond the actual health and safety of the staff, a strong, accurate, and encouraging safety analysis programme gives staff peace of mind. When travelling to a facility, staff members will be more focused on the measurements and not on safety risks.

ERML's Extrabudgetary Support Experience

ERML is not entirely new to extrabudgetary support. Currently, work is augmented by a Junior Professional Officer (JPO) who aids in measurement verification techniques and a new, state-of-the-art Large Article Monitor (LAM) that will replace the existing, aging LAM. The Covid-19 pandemic has also caused a steep increase in the amount of Personal Protection Equipment (PPE) and a limitation on staff availability.

Given the immensely positive impact of the JPO and the in-kind support (and the need to properly classify them) and the new challenges brought on by the Covid-19 pandemic, the IAEA decided to formalize the development and implementation support mechanism through this D&IS plan.

Challenges in Occupational Health and Radiation Safety

Occupational Health and Radiation Safety will face several challenges in the next few years. Some of these challenges are expected in any technical field as time passes, such as aging equipment and updating standards, for example, ISO standard revisions.

Contamination control is getting stricter. Because of this, it is paramount that the Department meets the strictest requirements of any facility involved in the Agency's verification schema. If the Department is unable to do this, then it will have failed its mandate.

A challenge unique to the nuclear industry writ large is the risk of loss of safety culture credibility. A single failure can permanently tarnish the trust in the Agency. Supporting Occupational Health and Radiation Safety helps the Department prepare for a safety incident. Included in this is the knowledge and expertise of staff that can accurately assess risks when incidents occur and respond to emergencies.

Impact of the Covid-19 Pandemic

From the beginning of the pandemic, it was clear that a strong communication strategy had to be implemented in order to better disseminate the constantly-evolving information on Covid-19 safety. A dedicated webpage was created in the internal Department portal with continuously updated information, answers to frequently asked questions, links to international and national announcements, instructions on safety tips, travel recommendations, and PPE availability information. This allowed departmental staff members to quickly and efficiently access trustworthy information throughout the pandemic and strengthen staff morale.

ERML management ensured a surplus of all necessary personal protective equipment was available to ERML staff at all times. During the first wave, the supply of several items was limited due to the global shortage; Safeguards used their own capacity (Safeguards Analytical Services Nuclear Chemistry Team) to produce disinfectant liquid for the laboratories and travelling staff.

Throughout the pandemic, and still, the ERML remained/remains fully operational. The ERML has been able to meet the demands of IAEA Safeguards inspectors and other departmental staff members who go on duty travel.

Department Health & Safety

According to IAEA Radiation Safety Regulations, it is necessary for each division to appoint a Radiation Protection Officer(s) who has professional expertise and thorough knowledge of radiation safety principles, and operational safety practices to oversee the implementation of the Divisional Radiation Protection Programme. Through the Safeguards Health and Safety Sub-Committee (SHS), where the Divisional Radiation Protection Officers participate, SGTS is responsible for promoting a positive health and safety culture in the Department.

The Team Leader of HQM/SGTS is responsible for overseeing and coordinating the implementation of radiation protection regulations and for the Department Health and Safety Programme. By facilitating internal communications among different stakeholders, this coordinator provides clear and documented guidance on matters involving radiation safety and the general application of health and safety following up on accidents/incidents and emergencies, and coordinating the provision of dosimetry services in a harmonized approach and in accordance with IAEA rules and regulations.

ERML

When departmental staff members take items out of a facility, they are encouraged to check these items for contamination; facility operators also must measure items that leave their facilities for contamination to ensure that they do not violate local radioactive material release laws. Because of differing local laws, the IAEA must guarantee a common standard for all its items and assure Member States and their facility operators that IAEA items are free of contamination before entering their facilities.

The ERML scans and measures all items delivered to IAEA headquarters from the field for contamination before the items are returned to the proper custodian.

In accordance with the IAEA's safeguards mission and those set forth in ISO 17025, the ERML practices impartiality regarding all items that are delivered, regardless of facility of origin or personnel delivering.

ERML uses the following methods to measure surface area contamination on items:

- Directly with portable monitors put forth in ISO7503-1(2016).
- Indirectly with area wipe samples with a Low-Level Alpha-Beta counter put forth in ISO7503-2(2016).
- Nuclide identification using gamma spectrometry with a High Purity Germanium (HPGe) detector and gross total beta/gamma counting using a Large Article Monitor.

The ERML team provides Radiation Safety Training for occupationally exposed workers (OEWs). The training includes practical instruction on the use of surface contamination monitors, environmental sample kits, and survey meters such as the RadEye and HM5, as well as the regulatory limits for transporting potentially radioactive equipment or samples by hand. During the trainings, the proper use for a variety of PPE is also demonstrated. The training is mandatory for all OEWs, which represents 60% of SG staff.

Occupational Health and Radiation Safety Plan Objectives

- Strengthen departmental Occupational Health and Radiation Safety culture.
- Improve measurement capabilities of radioactive contamination management, for example:
 - With new instruments such as a high purity germanium detector.
 - By strengthening the quantification of contaminants.
 - By digitizing non-barcoded items, for example, an IAEA Safeguards inspector's clothes.
 - By improving decontamination techniques.

- Develop ability to independently assess the dose received by SG staff in cases of incidents, accidents, and emergencies (for example, intake of radionuclides), and adequately assess follow-up actions.
- Establish a departmental safety policy.

Most Needed Extrabudgetary Support in 2022–2023

- | | | | |
|--|---|---|--|
| <input checked="" type="checkbox"/> Financial Support | <input checked="" type="checkbox"/> Consultants | <input checked="" type="checkbox"/> Equipment | <input checked="" type="checkbox"/> Training |
| <input checked="" type="checkbox"/> Financial Support for IT | <input checked="" type="checkbox"/> CFEs | <input type="checkbox"/> Reference Materials | <input type="checkbox"/> Studies |
| <input checked="" type="checkbox"/> Financial Support for Travel | <input checked="" type="checkbox"/> JPOs | <input type="checkbox"/> R&D | |
| <input type="checkbox"/> Expert meeting participation | | <input checked="" type="checkbox"/> Facility Access | |

Plan Resource Mobilization Priority Linkages

- M.2.C2** Ability to enhance equipment reliability through improvements to the Safeguards Equipment Management System and monitoring of equipment performance
- T.1.C9** Ability to detect and quantify contamination in equipment returned from the field with heterogenous matrices and shapes
- W.3.C3** Ability to improve safety culture by enhancing staff skills and expertise related to radiological and industrial safety
- W.3.C4** Ability to effectively utilize knowledge and expertise already existing with the Department

Development Plan for 2022–2023

★ Indicates top priority

Outcome #1: Improved ability to identify and quantify radioactive contamination.

- | | |
|----------------|--|
| Outputs | <ol style="list-style-type: none"> ★ A modern replacement of the aging High-Purity Germanium gamma. A report on the current condition of the portable surface contamination monitoring system that includes a list of existing systems that should be replaced. An automated system that replaces the low-level alpha-beta counter contamination monitor. |
|----------------|--|

Supporting Resource Mobilization Priorities

T.1.C9

M.2.C2

Planned Activities

1. Replacement of the aging High-Purity Germanium detector and shielding

The Department's ability to properly identify and quantify gamma emitters is limited. ERML's gamma spectrometry unit's shielding (made of lead bricks) does not discern well enough whether an item is below established release limits and needs to be replaced.

Support Needed

- Financial Support: Approximately €220 000.
- Equipment: High purity germanium detector, possibly one that also measures low gamma energy gamma emitters, has modern shielding, and has electronic cooling systems.
- Reference Materials: Different reference materials (matrixes, nuclides, geometry) for the efficient calibration of the detector.

- Training:
 - 2 ERML staff members to be trained in advanced spectrometry using software with numerical calculations for 1 week in a laboratory that uses advanced gamma spectrometry.
 - 1 ERML staff member to be trained in a 2-week ISO 17025 for gamma spectrometry testing laboratory that performs gamma spectrometry measurements.

2. Portable surface contamination monitors

Surface contamination measurements using portable monitors is the one of the main measurement methods that is used to monitor equipment and items returned from the field and to declare that they are free of contamination. The monitors should be able to discriminate between beta/gamma and alpha emitters and be able to detected contamination below 1Bq/cm². Especially for alpha emitters, the release limit is 0.1Bq/cm².

The surface of the equipment and items monitored by ERML have different shapes and are made from different materials. Self-absorption and geometry play a crucial role in the accuracy of the measurements.

Support Needed

- Financial Support: Approximately €150 000.
- Equipment: Surface contamination monitors.
- Reference Materials: Reference materials for surface contamination measurements, low activity alpha, beta, and gamma emitters.
- JPO: Extension of USA A 2477 (Junior Professional Officer - Associate Radiation Physics Engineer) in order to complete the validation/verification of the methods for surface contamination using new monitors.

3. Low alpha/beta counter

The measurement of leakage test of radioactive sources and wipes from contamination checks and decontamination activities are measured in a total alpha beta counter that is over 13 years old. The aging of ERML equipment and the decrease of the measurement capabilities (increased minimum detectable activity, increased background, difficult to accurately measure alpha emitters, frequent repair of the instrument, obsolete instrument) is a risk to the Department.

Support Needed

- Financial Support: Approximately €150 000.
- Equipment: Low level gross alpha/beta counter.
- Training: 2 ERML staff to be trained for 2 weeks in gross alpha beta counting and uncertainty assessment in a laboratory that performs accredited gross alpha beta measurements.

ERML will continue to optimize the contamination measurement with or without extrabudgetary support. Validation of the methods using the existing infrastructure is ongoing and opportunities for improvement are continuously evaluated and action plans are implemented.

ERML will continue to participate in inter laboratory comparison and proficiency tests in order to ensure the validity of the methods and the accuracy of the results.

Outcome #2: Improved ability to verify dose assessments as per regulations and mandates and to respond to exposure emergencies quickly and effectively.

- | | |
|----------------|---|
| Outputs | <ol style="list-style-type: none"> 1. Acquisition of a commercial off-the-shelf Dose Assessment Software. 2. Available software training for radiation protection officers. 3. Draft procedures for dose assessment activities in case of accident/incident. |
|----------------|---|

Supporting Resource Mobilization Priorities

T.1.C9

W.3.C3

Planned Activities

Safeguards Radiation Protection Officers currently rely on the Radiation Safety and Monitoring Section (NSRW) in the Department of Nuclear Safety and Security to perform dose assessments and amendments. In the case of dose reassessments, the Department must currently interface with both the personnel being reassessed and NSRW to perform the reassessment. In case of an emergency (contamination accident), the accurate and timely assessment of the dose is crucial, and the possible treatment and the medical response is highly related to the initial dose estimation. Any delay must be avoided. Therefore, Safeguards Radiation Protection Officers need to have the capacity to perform the initial draft dose estimation without any delay and also to be able to verify the dose assessment performed by the dosimetry service provider.

Support Needed

- **Financial Support:** Approximately €100 000.
- **Equipment:** Purchase of a specialized software for the assessment of internal contamination.
- **Consultant:** The Department seeks support in the form of a consultant proficient in dose assessment for 6 months to create the procedures and train departmental staff members on the procedures and software.

The Department will continue efforts to have a clear and direct communication with the service provider and attend trainings whenever possible and follow up the international standards and publications related to the evaluation of dose.

Outcome #3: More efficient and effective ability to meet IAEA's mandate from a procedural and preventative level.

Outputs

1. ★ A Safety Policy for Safeguards.
2. The necessary approvals to distribute and implement the Safety Policy.
3. Implementation of the Safety Policy in the Department.

Supporting Resource Mobilization Priorities

W.3.C3

W.3.C4

Planned Activities

A Safety Policy is vital in setting the safety culture within an Organization. It outlines the way in which safety is managed, by whom, and how it is measured. The Safety Policy would be endorsed by departmental managers, which would make them accountable to the ongoing success of the safety system. A Safety Policy needs to be established in accordance with international standards, IAEA policies, and national legislation. The Safety Policy should refer to the Department activities and associated risks.

Support Needed

- **Financial Support:** Approximately €100 000 for a consultant.
- **Consultant:** A consultant proficient in Occupational Health and Radiation Safety policies to create the Safety Policy and assist on the implementation process for 1 year.

Outcome #4: Awareness of safety risks at facilities.

Outputs	<ol style="list-style-type: none">1. ★ An upgrade of the existing Facility Hazard Database from the existing access database to an IT system.2. Classify facilities per risk based on known work performed at each facility.3. Basic instructions per class of facility, for example, spent fuel repositories.4. Updated facility instructions based on IAEA Safeguards inspector field observations in the Facility Hazard Database.
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Supporting Resource Mobilization Priorities

W.3.C3

W.3.C4

Planned Activities

One responsibility of the Radiation Protection Officers is to inform departmental staff members preparing for duty travel about the potential safety risks at facilities. Currently, this information is stored in a Microsoft Access database and needs to be updated to reflect current situations at facilities, changing requirements, and applicable local regulations. The Health and Safety Subcommittee has created a unique database of information and experience on the safety hazards in each facility that departmental staff members visit. This is a unique and very detailed archive of specific facility risks.

Planned activities include:

- The creation of a more robust database or the addition of this information to an existing database system like SEQUIOA to help Safeguards Radiation Protection Officers more accurately inform staff of the live status of the facilities.
- Duty travel of some SG Health and Safety experts to randomly-selected facilities to estimate the actual risks in order to keep the database consistently updated and to help create an "observation form" that can be distributed for each future duty travel.

Support Needed

- Financial Support: Approximately €150 000.
- Financial Support for IT: Approximately €100 000 for the creation of a more robust database or the addition of this information to an existing database system like SEQUIOA.
- Facility Access: 1 Safeguards Radiation Protection Officer with expertise in radiation safety to shadow existing duty travels.

Progress from 2020–2021 Outcomes and Outputs

Possible statuses are:

- Completed
- Completed and work continues
- Delayed and nearing completion
- Delayed and work in progress
- On hold
- Cancelled

DDGO-001: Overall Safeguards Management and Coordination (Malik DERROUGH)

Outcome #1: Department-level strategy and tools for managing the lifecycle of SG assets based on prioritized needs and in alignment with the Agency rules and strategy.		
Outputs	Status	Comments
Departmental strategic safeguards asset management plan with updated procedures, guidelines and policies.	Completed	The Departmental Asset Management Strategy was completed in early 2021.
Asset Management Plans (AMP) for key assets, as per ISO 55000-55002.	Completed and work continues	The Department created 5 asset management plans for specific assets.
High-quality inventory data and information systems, to enable data-driven analysis in support of the Department’s recapitalization strategy.	Completed and work continues	The Department reviewed and updated information in SEQUOIA and put in new procedures to ensure continued data quality.

Outcome #2: Enhanced foresight and decision support on funding needs and budgeting decisions for replacement of safeguards assets.		
Outputs	Status	Comments
Draft Departmental strategy for funding renewals of critical safeguards assets.	Delayed and nearing completion	The funding is linked to the critical asset management plans, recently completed.
Long-term safeguards capital asset replacement plan to communicate effectively with safeguards stakeholders, including Member States, on potential extrabudgetary needs.	Completed and work continues	The Department created a mechanism to forecast resource needs beyond 2023 and communicated this to Member States.

Outcome #3: Increased capability for information sharing and greater collaboration.		
Outputs	Status	Comments
Implementation of a Department-specific internal communication strategy to enhance senior leadership and departmental staff member communication capabilities.	Completed and work continues	Internal communication strategy is revised annually.

Updated and implemented internal communication strategy, including review and updated use of Safeguards Portal and new or improved communication channels for feedback, sharing and relationship building.	Delayed and work in progress	The internal communication strategy continues to be revised. There is a dedicated project to improve the internal departmental portal, and new or improved communication channels are always being sought.
Initiation of communication capacity-building training for departmental staff members.	Cancelled	Communication is now built into ICAS, and the need for separate capacity building training has not been evident otherwise.
Coordinated development of published communication to ensure consistency of messages conveyed to departmental staff members and to Member States.	Completed and work continues	The communication team is more established, and relationships with IAEA (OPIC) communication team continue to improve.

Outcome #4: Increased departmental staff member engagement and satisfaction.

Outputs	Status	Comments
Results of spot/pulse surveys and communication surveys.	Completed and work continues	The 2021 Survey to be launched in October. Regular pulse surveys continue to show increased engagement and satisfaction.
Facilitation of departmental staff member focus groups regarding communication.	Delayed and work in progress	This output is expected to take place in 2022, following results and analysis of 2021 Communication Survey.

SGAS-001: Destructive Analysis of Nuclear Materials (Mika SUMI)

Outcome #1: Independent verification of Pu amount in control samples and in-house reference materials through new DA software.

Outputs	Status	Comments
Installation, testing, validation and training on new software for controlled potential coulometry (CPC) system for Pu assay in NML.	Delayed and work in progress	LabVIEW software design and testing of CPC system at SRNL is almost complete, and installation and testing in NML is postponed due to the Covid-19 pandemic. Work continues in the 2022–2023 biennium.
Development, testing and implementation of new evaluation software for HKED at the On-Site Laboratory (OSL), Japan.	Completed and work continues	Development of new evaluation software for the Hybrid K-Edge Densitometry (HKED) systems in On-Site Laboratory (OSL) continues. Oak Ridge National Laboratory (ORNL) delivered a standalone version of Multi-Element K-Edge Densitometry (MEKED) software to IAEA for testing. The standalone Multi-Element X-ray Fluorescence (MEXRF) analysis software is still under development by ORNL and will be delivered to IAEA in 2022 for further validation.

Because full commercial operation of the Rokkasho reprocessing plant is expected to start in the next few years, the evaluation of new analysis algorithms using MEKED and MEXRF software must be completed in the 2022–2023 biennium. A second HKED workshop was held in February 2020 supported under the joint task.



Figure 1: The second HKED workshop held in February 2020.

Outcome #2: Continued independent information for making safeguards conclusions through new analytical methodologies for DA.

Outputs	Status	Comments
Developed and validated plutonium/americium-241 age determination method for nuclear samples containing Pu.	Completed	Age dating methodology for Pu/Am-241 was established at the IAEA NML. Valuable plutonium reference materials and Am-243 spike solutions were provided through MSSP support. The outcome of this work identified the need to expand LIMS capabilities for reporting age dating analysis results.
A tested, validated and implemented third generation Combined Procedure for Uranium Concentration and Enrichment Assay (COMPUCEA).	Completed	Implementation of COMPUCEA equipment and software is completed. SGAS also supported implementation of COMPUCEA for in-field UF ₆ sample analysis. This task is kept open in order to synchronize the system at JRC-Karlsruhe and validate the performance of the IAEA system after the latest hardware update.



Figure 2: COMPUCEA (Combined Procedure for Uranium Concentration and Enrichment Assay) for uranium enrichment and assay measurement at NML.

Implementation of a new scrubber for the OSL that removes radioactive ruthenium gas, which is released during dissolution of high-active liquid waste samples.	Completed	New scrubber set and supporting design drawings and operating procedures were delivered to the OSL. The IAEA will test the functionality of the new scrubber.
Implementation of a new stirrer system for the OSL that determines Pu from undissolved particles in high-active liquid waste samples.	Delayed and work in progress	Implementation of a new stirrer system is delayed due to technical problems and the Covid-19 pandemic. Work continues into the 2022–2023 biennium.
New and tested microcalorimetry techniques for determining isotopic mass ratios in nuclear material samples, including very small plutonium samples (sub-nanogram range).	Completed and work continues	Los Alamos National Laboratory and Lawrence Livermore National Laboratory developed new types of microcalorimetry sensors for the decay energy and high-resolution gamma spectroscopy applications.
Testing of the Cristallini UF ₆ sampling method in commercial uranium enrichment plants for safeguards samples.	Delayed and work in progress	Sample taking is delayed because of the Covid-19 pandemic; work continues in the 2022–2023 biennium. Different subsampling protocols for processing and analysis of ABACC-Cristallini UF ₆ samples in NML were tested on 29 field samples collected at two different enrichment plants. In the frame of the ITV 2020 project, three presentations were given by the IAEA to share summaries and to propose ITV values.

SGAS-002: Environmental Sample Analysis Techniques (Matthew KILBURN)

Outcome #1: Provision of external quality control and reference materials, as well as technical expertise, through optimized utilization of the expanded NWAL.		
Outputs	Status	Comments
Reports from Technical Meetings, the Working Group and 'Friends of SAL' containing recommendations for the provision of particle QC material.	Completed and work continues	The Agency continues to receive valuable feedback and advice from the Working Group and participants of Technical Meetings.
Additional reference and QC materials (about one per year) to be made available for internal and external quality control programmes administered through the NWAL.	Completed and work continues	During the last biennium, the Agency has received 3 particle reference materials from MSSPs. The ESL has produced both bulk and particle QC swipes to be used in external QC exercises. One QC particle producer has become a member of the NWAL, with two others in the qualification phase. This output is listed again in the 2022–2023 plan.

Outcome #2: Improved detection of signatures of undeclared nuclear activities in environmental samples through the development, implementation and improvement of techniques, methods and equipment.

Outputs	Status	Comments
Implementation of the laser ablation-inductively coupled plasma mass spectrometry (LA-ICP-MS) technique to analyse Pu and mixed U/Pu particles in environmental samples.	Delayed and work in progress	Implementation of the LA-ICPMS method was slightly delayed by the Covid-19 pandemic, but will continue in the 2022–2023 biennium.
Implementation of identification methods to find and isolate Pu-containing particles for analysis by LA-ICP-MS, including Fission-Track techniques, LG-SIMS and SEM.	Completed and work continues	Procedures for the identification of particles by the Fission-Track method are now implemented in the SGAS quality management system. Implementation of more procedures are planned in the 2022–2023 biennium.
Development and implementation of a methodology for the elemental analysis of particles using the ToF-SIMS capability of the ESL's TESCAN Lyra SEM.	Delayed and work in progress	Development and implementation of the SEM capabilities will continue in the 2022–2023 biennium under Outcome #2.
Development and implementation of methodologies for the age determination of particles using LG-SIMS.	Delayed and work in progress	Development of age determination methodologies was delayed due to the Covid-19 pandemic, but will continue in the 2022–2023 biennium.
Report on a feasibility study to enhance the sensitivity of detection of U and Pu isotopes using mass spectrometry methods.	On hold	This project has been deprioritized as the ESL focuses on core activities.

Outcome #3: Ensured sustainability of the ESL's operations in terms of capabilities and capacities by establishing a plan for infrastructure replacement and resource utilization.

Outputs	Status	Comments
Action plan for the replacement of analytical and ancillary equipment with strategy for fund mobilization.	Completed	SGAS implemented an Asset Management Plan. Extrabudgetary support for a new LG-SIMS was provided by Member States, and the new instrument will be commissioned in 2022.

SGAS-003: Analysis Support and NWAL Coordination (Veena TIKARE)

Outcome #1: Broader capabilities and increased capacity of the IAEA Network of Analytical Laboratories (NWAL) for timely, high-quality analysis of safeguards samples.		
Outputs	Status	Comments
Qualification of one or more additional NWAL member(s) for the analysis of DA safeguards samples.	Delayed and nearing completion	Belgian Studiecentrum voor Kernenergie – Centre d’Etude de l’Energie Nucléaire (SCK-CEN) has demonstrated that it can analyse U and Pu isotopic ratios in NM samples. IAEA is waiting for Covid-19-related travel restrictions to be lifted to perform the lab visit required to complete this task. Canadian Nuclear Laboratories (CNL) is nearing completion of the test analyses required for qualification.
Outcome #2: Strengthened quality assurance of IAEA Network of Analytical Laboratories (NWAL) analytical services.		
Outputs	Status	Comments
Qualification of one additional NWAL member for the provision of reference materials.	Completed and work continues	High-quality reference materials in the form of U-containing particles with specified amounts of U isotopes are needed for assessment of the analysis quality of the NWAL. Thus, qualification of the Forschungszentrum Jülich, Germany for reference materials for Environmental Sampling (ES) particle analysis was completed in October 2020. Qualification of Pacific Northwest National Laboratory and Savannah River National Laboratory, both of the United States Department of Energy (US DOE), is progressing well.
Organization of one to two inter-laboratory comparison exercises per year.	Completed and work continues	Several inter-laboratory comparison (ILC) exercises have been delayed due to Covid-19 restrictions. However, the IAEA 2020 blind ILC for ES bulk analysis was completed in April 2020; the 2021 US DOE-sponsored ILC exercise for ES bulk analysis was prepared; and the IAEA initiated preparation for a new ILC exercise on ES particle analysis.
Outcome #3: Enhanced operational efficiency of safeguards analytical services through maintained and upgraded Safeguards Analytical Laboratory Information Management System (SALIMS).		
Outputs	Status	Comments
Re-engineering of Mass Spectrometry Data Evaluation System (MSDES).	Completed	Both phases to add functions to MSDES are completed.
Re-engineering of the NWAL Coordination application (Phase 1, core functionalities deployed).	On hold	This project is pending allocation of resources. See Outcome #1 in the 2022–2023 plan for more information.

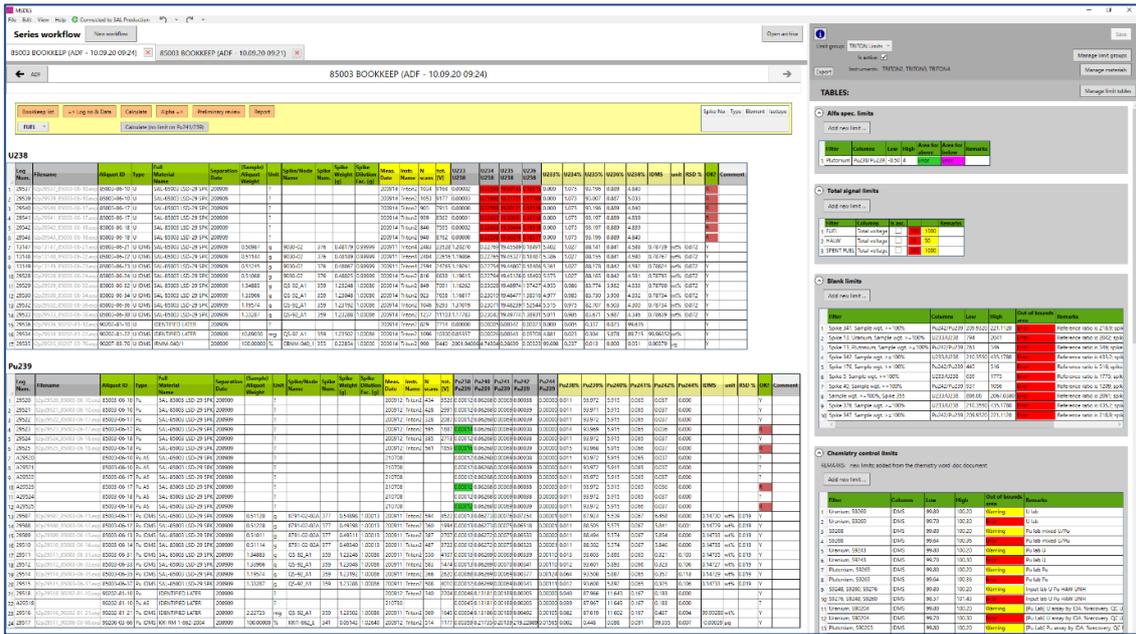


Figure 1: New functions in the Mass Spectrometry Data Evaluation System (MSDES).

Outcome #4: Increased capacity for the safe and secure shipment of nuclear material samples and analytical residues.		
Outputs	Status	Comments
Provision of Type B Shipping Containers for shipment of large U and Pu samples.	Completed	This need has been addressed using regular budget funds.

SGCP-003: Safeguards Approaches (Jay DOO)

Outcome #1: Improved ability to fully implement the State Level Concept through the development of internal guidance documents and additional tools for the development of State Level Approaches.		
Outputs	Status	Comments
Methodology and guidance for assessing acquisition path steps, including a State's technical capability to develop nuclear fuel cycle technologies and facilities as well as nuclear material diversion and facility misuse scenarios.	Partially completed and work on hold	MSSP consultancy meetings have been organized to assess steps involving undeclared NFC technologies during acquisition path analysis.
MSSP consultancy meetings on guidance for assessing steps involving undeclared facilities during acquisition path analysis:	Partially completed and work on hold	<p>Consultancy meetings for the nuclear fuel cycle technologies (sub-tasks) were put on hold, awaiting feedback from the IAEA departmental working group.</p> <p>Five nuclear fuel cycle (NFC) technologies have been assessed:</p> <ul style="list-style-type: none"> • Gas centrifuge enrichment • Hot cell facility to separate Pu from irradiated fuel using PUREX technology • Reactor up to 100MwTh

		<ul style="list-style-type: none"> • Conversion and fuel fabrication technologies • Uranium mining and ore processing technologies
		<p>Technical guidance reports were drafted for assessing steps involving undeclared NFC technologies during acquisition path analysis. The consultancy meetings for the remaining nuclear fuel cycle technologies (sub-tasks) were put on hold, awaiting feedback from the IAEA departmental working group.</p>
Reprocessing and hot cell technologies.	Completed	Meetings about PUREX reprocessing and hot cell technologies were held in 2020.
Reactor technologies (graphite/heavy water/light water moderated reactor types).	Completed	Meetings about reactor technologies (up to 100 MWth) were held in 2020.
Fuel fabrication technologies.	Completed and work continues	Meetings about conversion and fuel fabrication technologies were held in 2020.
Conversion technologies (HEU & Pu metal).	Completed and work continues	Meetings about conversion and fuel fabrication technologies were held in 2020.
Completion of detailed technical guidance reports for assessing steps involving undeclared facilities during acquisition path analysis: To be determined on the basis of experiences gained in 2020. The consultancy meetings for the remaining NFC steps (sub-tasks) will continue in 2021.	Completed and work continues	<p>Meetings about uranium mining and ore processing technologies were held in 2021. The technical report has been finalized.</p> <p>The assessment of the remaining nuclear fuel cycle technologies (sub-tasks) was put on hold, awaiting feedback from the IAEA departmental working group.</p>

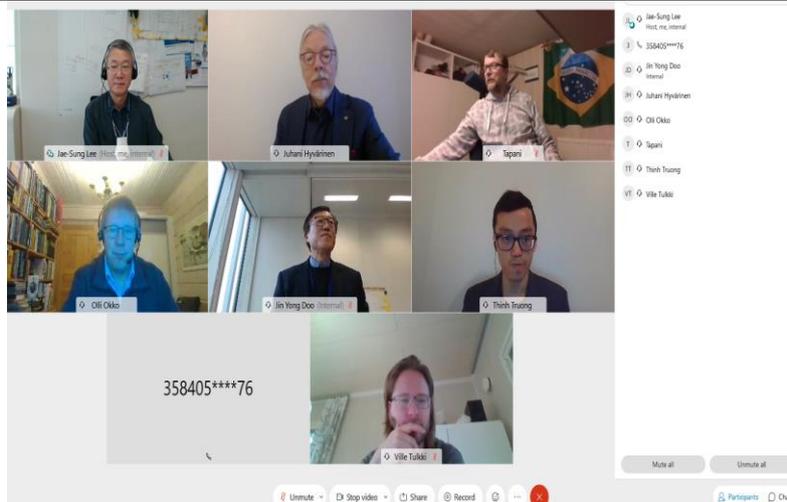


Figure 1: As was common, Consultancy Meetings continued virtually in 2020–2021.

Outcome #2: Increased ability to detect undeclared nuclear material and activities through update and improvement of the 'Physical Model'.

Outputs	Status	Comments
Updated Physical Model (all volumes)	Delayed and work in progress	MSSP expert's consultancy meetings were completed. The IAEA is internally improving the consistency and coherence of all the volumes prior to finalization.
Volume 1 (Mining and ore processing)	Completed and work continues	The IAEA is internally improving the consistency and coherence prior to finalization.
Volume 2 (Conversion)	Completed and work continues	CAN SP provided support in 2021. The IAEA is internally improving the consistency and coherence prior to finalization.
Volume 3 (Uranium enrichment)	Delayed and work in progress	The IAEA is editing these volumes.
Volume 5 (Fuel fabrication)	Delayed and work in progress	
Volume 6 (Reactor and neutron sources)	Completed and work continues	The IAEA is internally improving the consistency and coherence prior to finalization.
Volume 7 (Heavy water)	Completed and work continues	CAN SP provided support in 2021. The IAEA is internally improving the consistency and coherence prior to finalization.
Volume 8 (Reprocessing and recycling of spent fuel)	Delayed and work in progress	A third MSSP Experts Meeting has been scheduled for mid-2022.
Volume 9 (Spent fuel management)	Completed and work continues	
Volume 10 (Radioactive waste)	Completed and work continues	The IAEA is internally improving the consistency and coherence of Volumes 9, 10, and 11 prior to finalization.
Volume 11 (Hot cells)	Completed and work continues	

Outcome #3: Enhanced ability to safeguard new types of facilities through development of safeguards concepts and approaches for pyroprocessing plants and small modular and/or Gen IV reactors.

Outputs	Status	Comments
Model safeguards approaches for new types of facilities.	Work in progress	Safeguards application to various types of SMRs and a pyroprocessing plant have been reviewed early in the design process.
Model safeguards approach for a pyroprocessing plant.	Work in progress and nearing completion	ROK SP is supporting. The IAEA feedback was provided to the ROK draft report in January 2021. The IAEA is awaiting the ROK's revised report.

Model safeguards approach for a transportable (floating) nuclear power plant (KLT-40S).	Work in progress	Russia SP is supporting. Details of updated design information including drawings were delivered to the IAEA in 2021. The next task progress review meeting will be held in mid-2022.
Model safeguards approach for a pebble-bed modular reactor (HTR-PM).	Delayed and work in progress	China SP is supporting. The Department has identified specific areas for improved application of safeguards.
Model safeguards approach for a passive small modular pressurized light water reactor (SMART: System-integrated modular advanced reactor).	Work in progress and nearing completion	ROK SP is supporting. The ROK has prepared the final report. The next task progress review meeting will be held in early 2022.
Model safeguards approaches for new types of small modular reactors to be determined by States.	Work in progress	<p>MSSPs proposed new types of small modular reactors for the development of model approaches:</p> <p>France SP proposed a SMR model NUWARD in 2021. A kick-off meeting will be held in early 2022.</p> <p>Canada SP proposed two SMR models in 2021. Design information on Moltex Stable Salt Reactor Wasteburner 300 (SSR-W300 of Moltex) was delivered in January 2021. A brief summary of design information was presented to the IAEA in June 2021.</p> <p>Design information on Integral Molten Salt Reactor (IMSR of TEI) was delivered in March 2021. With regard to IMSR, details of technical presentations from TEI were delivered for the IAEA staff in November and December 2021.</p> <p>Finland SP proposed two micro modular reactors for district heating in 2021. A preliminary design information was delivered to the IAEA in April 2021. The next task progress review meeting will be held in early 2022.</p> <p>USSP accepted the task. The IAEA has waited for USSP to select the certain types of SMRs.</p>

Outcome #4: Improved ability to verify facilities under the decommissioning phase through the development of safeguards implementation guidelines and concepts.

Outputs	Status	Comments
Updated DIQ templates and safeguards guidelines to incorporate post-operation information at facilities under decommissioning.	Completed	<p>Design Information Questionnaire (DIQ) Completion Guidelines were completed and distributed to MSSPs in October 2021.</p> <p>International Safeguards Guidelines for the Post-Operational Phases of Nuclear Facilities and Locations Outside Facilities were completed and distributed to MSSPs in October 2021.</p>
Updated DIQ templates for all types of facilities to incorporate post-operation information at facilities under decommissioning.	Completed	All DIQ templates were updated.

DIQ completion guidelines and DIQ examples.	Completed	STR-398 part 1&2 (DIQ Completion Guidelines and Examples) were completed and distributed to MSSPs in October 2021.
Safeguards guidelines for facilities under decommissioning.	Completed	STR-396 (International Safeguards Guidelines for the Post-Operational Phases of Nuclear Facilities and Locations Outside Facilities) was completed and distributed to MSSPs in October 2021.
Safeguards guidelines for post-accident facilities.	Delayed and work in progress	The MSSP expert consultancy meeting has been scheduled for mid-2022.

SGCP-004: Strategic Planning and Partnerships (Gary DYCK)

Outcome #1: Support to MSSP coordination and effective administration to address the R&D needs of the Department.

Outputs	Status	Comments
SPRICS-hosted database of R&D needs and progress, to enable the system with visualizing capabilities of how R&D needs are being met by MSSP Tasks.	Delayed and work in progress	Delayed pending an update to the R&D Plan (now known as Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (STR-399)) with content that can serve as the basis for this database.
Ability for SPRICS users to view status report and action history for the previous 2 years (as a first step) of active tasks on task summary pages (with an intention to add more historical data in future biennium plans).	Completed and work continues	SPRICS users can view status report and action history for the previous several years, and historical data is added continually.
SPRICS-generated agendas, meeting packages and summaries of decisions and agreed actions of annual and bi-annual review meetings with MSSPs.	Completed	SPRICS-generated meeting materials have significantly reduced preparation time and errors in meeting materials.

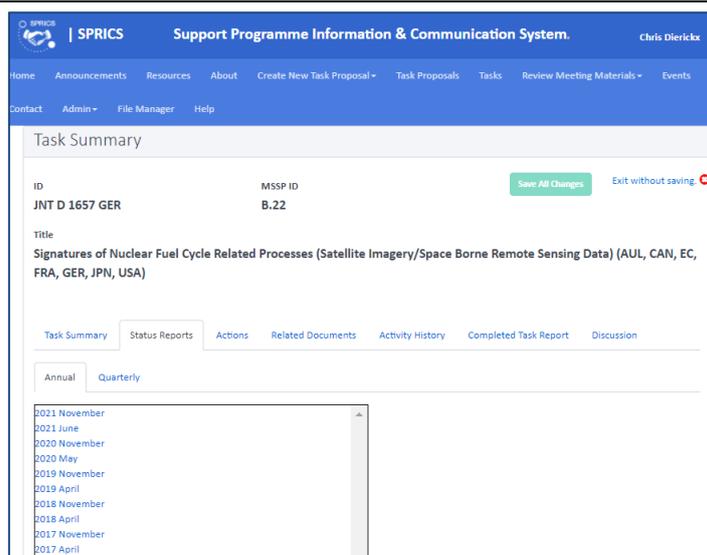


Figure 1: As an example, MSSP stakeholders can find status reports from April 2017 onwards for MSSP JNT Task D 1657 GER (Signatures of Nuclear Fuel Cycle Related Processes (Satellite Imagery/Space Borne Remote Sensing Data)) in SPRICS.

[Download Meeting Agenda](#)
[Download Meeting Package](#)
[Download Meeting Summary and Actions](#)

Figure 2: SPRICS automatically pulls MSSP metadata to generate the three core meeting products with far greater accuracy and efficiency.

Outcome #2: Improved organizational ability to monitor, identify and adjust to changes in the operating environment in a timely manner.		
Outputs	Status	Comments
2020 Emerging Technologies Workshop.	Completed	The Department held the Emerging Technology Workshop on 27–29 January 2020. The programme consisted of 5 'Incubators' focused on artificial intelligence; imagery and multimedia data; innovations for spent fuel verification; visualization of data and information; and advances in additive manufacturing.
2020 Emerging Technologies Workshop Report.	Completed	The Department published the 'Emerging Technologies Workshop – Insights and Actionable Ideas for Key Safeguards Challenges' in spring 2020 as STR-397 and made it available online on the Agency website, along with other outputs.
Explore feasibility of adapting existing Artificial Intelligence (AI)-based or automation-based capabilities to support continuous environmental scanning of the Department's operating environment.	On hold	The Department explored the idea internally, but is not pursuing it at the moment. It continues to benefit from the Department's open source collection products to support environmental scanning.

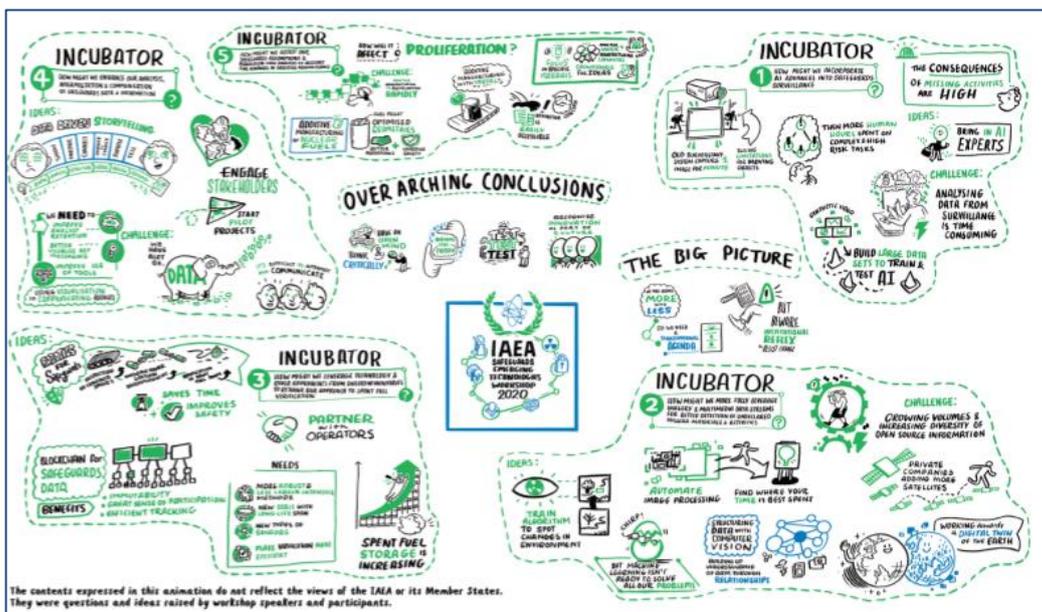


Figure 3: 2020 Emerging Technologies Workshop Summary Illustration capturing the key takeaways; the scribing was sponsored by the UK Support Programme.

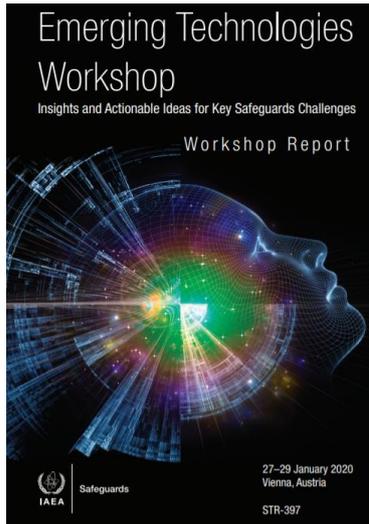


Figure 4: The Department published the '[Emerging Technologies Workshop – Insights and Actionable Ideas for Key Safeguards Challenges](#)' in spring 2020 as STR-397.

Outcome #3: Support to the Department’s ability to fulfil its mission is augmented through vetted non-traditional partnerships.

Outputs	Status	Comments
Development of a strategy for enhancing non-traditional partnerships.	Completed	An internal strategy was prepared in August 2021 to complement the initial concept on non-traditional partnerships. Department plans for non-traditional partnerships were presented to MSSPs at the 2020 MSSP Coordinators’ Meeting, as well as the 2021 Joint ESARDA-INMM Meeting.
Development of a non-traditional partnerships coordination programme that facilitates contributions from vetted non-traditional partners.	Completed and work continues	The implementation of the non-traditional partnerships is well underway with 5 framework agreements initiated and concluded by the Department in 2021, and work plans have been initiated to support monitoring of implementation.
Development of partnerships with other IAEA Departments.	Completed and work continues	In 2021, the Department joined two non-traditional partnerships led by IAEA Department of Nuclear Energy and is an active member of two IAEA interdepartmental committees on the development and inter-departmental coordination of external partnerships.

Outcome #4: Strategic management processes are sustainable and integrated into the Department’s management systems and enable enhanced management capabilities to predict, manage, communicate, prioritize and align resources to execute Departmental strategic objectives and priorities.

Outputs	Status	Comments
Strategy Execution Application (SEA) on the Strategy Portal with integrated KPIs exists.	Completed and work continues	The SEA is in use by the Department. Work to integrate KPIs is ongoing and additional maintenance is required for keeping the software updated.
Living Strategic Plan management facilitated by Strategy Portal.	Completed and work continues	The most up-to-date Strategic Plan is available for staff on the Strategy Portal. The processes to govern the review and updating of the Plan have been developed and efforts are ongoing to further the practices as defined.

A biennial strategy implementation plan is published and in use.

Completed and work continues

Priority projects and actions were identified in January 2020 and were reviewed and updated in Spring 2021. Projects and actions needing extrabudgetary support were included in the Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (STR-399) (formerly known as the R&D Plan) and in this D&IS Programme.

SGCP-101: Quality Management (Roy FITZGERALD)

Outcome #1: Enhanced integration of quality management principles into the implementation of safeguards activities.

Outputs	Status	Comments
A QMS training curriculum to be followed by focused instructor-led training as part of the CTR training catalogue.	Completed and work continues/Delayed and nearing completion	Quality management training was developed and delivered to quality managers and document coordinators. Training to support the introduction of a new condition reporting system is underway.
A more formal and rigorous means for identification, management and mitigation of risk, as part of the Department's QMS.	Delayed and nearing completion	Concepts and procedures for more rigorous risk management have been developed. Further refinement and the implementation of these practices are forthcoming.

Outcome #2: Improved process governance and an enhanced process framework, to support consistent implementation of departmental processes.

Outputs	Status	Comments
Integration and use of Business Process Model and Notation (BPMN).	Completed and work continues	Business Process Model and Notation has been introduced as part of new interactive web-based process maps.
A documented business process maturity model baseline.	Completed and work continues	An assessment of the maturity of the Department's process framework was completed using Michael Hammer's Process Enterprise Maturity Model (PEMM).
A roadmap for improving business process maturity in the Department.	Completed and work continues	Specific opportunities for improving and enhancing process management have been identified and documented in an assessment report on the Departments process framework.

Outcome #3: Effective quality management activities are enabled in the Department, through robust IT software, tools and applications.

Outputs	Status	Comments
Implementation of an upgraded document manager software application and interface.	Delayed and nearing completion	SGIS is currently in the process of testing a COTS application to replace the Department's document management software.
Implementation of an enhanced software application for condition reporting.	Completed	Completed in 2021.

A process performance dashboard, which can be used by process owners and CPD to monitor and improve the effectiveness of processes in the Department (this effort is complementary to an existing prototype, which has been developed internally).	Delayed and work in progress	A rudimentary dashboarding indicating process state of health has been developed. Additional work and support are needed to complete this task.
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Outcome #4: A more robust knowledge management programme, which closes gaps identified in a recent self-assessment against the ISO 30401 standard for knowledge management.

Outputs	Status	Comments
A process for optimizing knowledge development and sharing, as part of the Department's induction process.	On hold	The Department's knowledge management programme has been transferred to SGCP-102: Training. Further evaluation and consideration will be given to incorporating knowledge management activities into the induction process.
Promotional activities accompanied by educational material to further support the awareness of and commitment and support to the knowledge management programme.	Delayed and work in progress	The Department's knowledge management programme has been transferred to SGCP-102: Training. A series of sessions has been arranged to promote the awareness and importance of the Department's knowledge management programme.

Outcome #5: Enhanced financial transparency and accountability for safeguards implementation, through the continued development and refinement of the cost calculation methodology.

Outputs	Status	Comments
Enhanced capabilities for modeling and estimating costs associated with safeguards activities.	Completed and work continues	Responsibility for the Department's cost calculation methodology has been transferred to the office of the Director of SGCP. Work continues on the development and refinement of the Department's cost calculation methodology with dedicated internal financial analysts evaluating and analyzing how the fidelity of the methodology can be improved.

SGCP-102: Training (Susan PICKETT)

Outcome #1: Competent and confident departmental staff members (including support staff, analysts, inspectors and managers) who have the knowledge and skills to conduct safeguards verification activities at headquarters and in the field and have the analytical, technical, communication and leadership skills to implement safeguards.

Outputs	Status	Comments
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Training in fundamental safeguards competencies and associated safeguards processes (skills associated with safeguards measures and activities, such as nuclear material accountancy, non-destructive assay, design information verifications, etc.).	Delayed and work in progress	CTR held 97 training offerings (45 which were distinct) between 1 July 2020 and 30 June 2021. Approximately 70% were offered remotely and about 30% in-person. The in-person courses adhered to guidelines.
Initial training offerings for new, emerging and/or unexpected NFC and safeguards technologies (for example, Design Information Verification (DIV) training in SMRs or facilities undergoing decommissioning).	Work continues	This is ongoing.
Development of a comprehensive industrial safety curriculum/programme for inspectors.	Delayed and work in progress	The USSP accepted the task proposal in 2020, however finding the appropriate expert has been challenging. This remains a high departmental priority.
Training in the State Evaluation process and associated skills.	Work continues	This is a critical task and is progressing together with Departmental wide initiatives.

Outcome #2: Competent and confident departmental staff members within the organizations of an SSAC, with the knowledge and skills to effectively implement safeguards and fulfil safeguards obligations.

Outputs	Status	Comments
An implemented training programme for Member States that addresses international, regional and national requests and needs as identified through State evaluations and operational requirements.	Work continues	The Department, along with Member States, trained 118 participants at the national, regional, and international levels. The Agency continues to increase online offerings via the Open Learning Management System (CLP4NET) (elearning.iaea.org), which has over 1 100 active/registered users for Safeguards-related online learning.
Updated IAEA SSAC Advisory Service (ISSAS) guidelines and outreach campaign to States, to increase awareness of ISSAS missions.	Completed and work continues	The State Systems of Accounting for and Control of Nuclear Material (SSAC) guidelines have been updated and are in publication. The Department has started an outreach initiative to encourage ISSAS missions.
Development of State SSAC self-assessment guide (for example, a 10-point review guide).	Delayed and work in progress	This will be developed and included in the Open Learning Management System (CLP4NET) (elearning.iaea.org).
Development of two or three e-learning modules for States with a Comprehensive Safeguards Agreement (CSA) on State obligations and NMA for Small Quantity Protocol (SQP) States.	Completed and work continues	The Agency continues to increase online offerings via the Open Learning Management System (CLP4NET) (elearning.iaea.org), which has over 1 100 active/registered users for Safeguards-related online learning.

Outcome #3: Bolstered awareness/interest/passion/knowledge of importance of safeguards in the international community (for example, university professors teaching law or Nuclear

Engineering, Member States with safeguards agreements, “next generation” university students).

Outputs	Status	Comments
Gap analysis of outreach materials (inventory of existing material and identified priority materials requiring development).	Work continues	This is ongoing.
Development of sample curriculum of IAEA SG basics.	Completed and work continues	The Department developed a self-study course for SG basics on Open Learning Management System (CLP4NET) (elearning.iaea.org). Improvements are being made.
Packaged assortment of SG materials (such as a starter kit in SG knowledge, including recommended reading for educational purposes).	On hold	This is on hold while the Department must reconsider priorities and limited resources.

Outcome #4: Increased quality and accessibility of training and learning through modernization of facilities in and modes of course offerings.

Outputs	Status	Comments
“Train-the-Trainer” courses available to CTR staff for training in best practices.	Completed and work continues	Many CTR staff members have taken training to improve their training development and delivery.
Inventory of all courses and assessment of which courses are suitable for e-learning or an e-learning component.	Completed and work continues	This has been done and e-learning components of Staff training courses are being developed, in particular Complementary Access Roles and responsibilities and Legal Refresher.
E-learning modules and blended courses available for internal and external staff.	Completed and work continues	This has been done and e-learning components of Staff training courses are being developed.
A training material database.	Output changed.	While a training material database would be useful, resources are not available for maintenance. The Department has instead made all material from SSAC courses in master form available on the portal page.

Outcome #5: Increased knowledge of safeguards and aspects of the nuclear fuel cycle in Member States with limited or no nuclear fuel cycle technologies.

Outputs	Status	Comments
Yearly implementation of the Safeguards Traineeship Programme.	Completed and work continues	The now-annual programme has 9 trainees. Funding and in-kind contributions are critical to its success.

SGIM-002: Satellite Imagery Analysis (Marc LAFITTE)

Outcome #1: Enhanced analytical capability through evaluation and use of new satellite sensors, imaging capabilities, software tools, analytical/processing techniques and provision of expert personnel

Outputs	Status	Comments
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Incorporation of new multi-sensor satellite imagery analysis (SAR, TIR, SWIR, hyperspectral) into imagery analytical products.	Completed and work continues	
Diversify commercial sources of satellite imagery to ensure the integrity and authenticity of satellite imagery as an independent source of information for the Agency.	Completed and work continues	Support needs to be sustained during 2022–2023 biennium through expected outcome #1.
Enhance satellite imagery acquisition and analysis through the exploitation of satellite vendor streaming services.	Completed and work continues	
Provision of personnel with a strong technical background in satellite imagery analysis, geospatial analysis or image processing.	Completed and work continues	<p>Current support needs to be sustained and reinforced in order to maintain existing capabilities, cope with tasking requests (through expected outcome #2 in the 2022–2023 plan) and investigate new capabilities (through expected outcome #1 in the 2022–2023 plan):</p> <ul style="list-style-type: none"> • UK D 2442 • CAN D 2018 • USA D 2313

Outcome #2: Enhanced staff skills in processing and analysing satellite imagery, improved analysis of nuclear fuel cycle imagery signatures and increased awareness of satellite imagery analysis throughout the Department.

Outputs	Status	Comments
Attendance at satellite imagery and geospatial international conferences (GEOINT and ESRI).	Completed and work continues	Support needs to be sustained through expected outcome #2 in the new 2022–2023 plan.
Onsite familiarization visits to nuclear fuel cycle sites.	Completed and work continues	Current support needs to be sustained and reinforced through expected outcome #2 in the new 2022–2023 plan. <ul style="list-style-type: none"> • JNT D 1657 CAN • CAN B 1484 • GER D 1457 • SWE B 1504 • USA B 1442
Satellite imagery and geospatial training courses and workshops.	Completed and work continues	Current support needs to be sustained through expected outcome #2 in the new 2022–2023 plan.

Outcome #3: Enhanced collaborative analysis through enabling the analysis of safeguards-relevant information from other relevant applications (for example, Additional Protocol System (APS) and Safeguards Master Database) and exposing geospatial information to other applications in Integrated Safeguards Environment (ISE) (for example, Collaborative Analysis Platform (CAP) and Geo-Based Data Integration (GDI)).

Outputs	Status	Comments
Enhance processes and workflows for the collection and dissemination of satellite imagery and geospatial data.	Completed and work continues	Current support needs to be sustained and reinforced through expected outcomes #1 and #3 in the new 2022–2023 plan.

SGIM-003: Information Analysis (Woan Jin KIM)

Outcome #1: Enhanced assessment of nuclear programmes and detection of inconsistencies in States' declarations through the development of optimized tools and methods for the collection, processing and management of currently utilized safeguards-relevant open source information.

Outputs	Status	Comments
A developed capability within the current automatic collection system, OSIS, to provide autonomous browsing of the Internet to identify and return safeguards-relevant information.	Completed and work continues	Development of OSIS has continued throughout the plan period.
An enhancement to the automatic collection, processing and management of safeguards-relevant open source information, including mechanisms for adding structure to unstructured data.	Completed and work continues	Development of OSIS has continued throughout the plan period.
A review and optimization of current open source information search and collection methodologies and techniques.	Completed and work continues	Collection methods are under constant review.

Outcome #2: Enhanced assessment of nuclear programmes and detection of inconsistencies in States' declarations through the development of optimised tools and processes to update and diversify the pool of safeguards-relevant open source information.

Outputs	Status	Comments
Deployed tools, methods and procedures for the optimised use of multimedia information analysis under the SG-Multimedia Project.	Completed	Multi-media tools and work stations are available for use.
Develop and implement a modern software package to facilitate the assessment of potential safeguards-relevant activities and procurements associated with the provision of Agency technical assistance.	Delayed and nearing completion	TARS is in the final stages of implementation.
Enhancement of tools and methods to optimise the continuous monitoring of new sources of information.	Completed and work continues	Development of methods is ongoing throughout the plan period.

Outcome #3: Improved State evaluation process through continuously improved open source information analysis methods and computerized tools to aid the analysis of large amounts of structured, semi-structured and unstructured data.

Outputs	Status	Comments
Deployed tools such as the Big Table, developed in conjunction with JRC, to enhance the analysis of safeguards-relevant information on trade and industrial capabilities of States, including through the use of data visualization.	Completed and work continues	Continued work with JRC. In-house deployment of The Big Table requires further collaboration.
Utilization of data visualization and network analysis on structured and semi-structured open source information (including trade data).	Completed and work continues	Maps of States' nuclear related industrial capabilities now used to support the State evaluation process.
Development, deployment and enhancement of any additional tools, following above strategy.	Cancelled	New tool development to be reviewed as part of 2022-2023 plan.
Training for trade and technology analysis teams.	On hold	No dedicated training during 2020-2021, but planned for the future.

Outcome #4: Improved integration of open source information in 'all source' information analysis, contributing towards collaborative analysis.

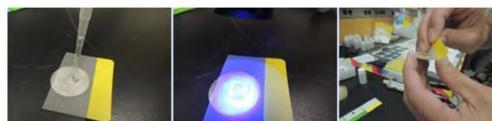
Outputs	Status	Comments
Integration of open source information collections with Integrated Safeguards Environment (ISE) State Files, commercial link analysis software and other applications.	Completed and work continues	The project was carried out to integrate the OSIS collection system with ISE.
Integrate a commercial reference manager with commercial link analysis software to facilitate structuring of science and technology information.	Delayed and work in progress	Integration of data into link analysis software is in progress, but ongoing technical difficulties have limited progress.

SGIM-007: Evaluation of Data from ES and Material Characterization (Mika NIKKINEN)

Outcome #1: Improved understanding of elemental and isotopic signatures of nuclear fuel cycle (NFC) activities and processes (for example, uranium conversion, uranium enrichment, and reprocessing).

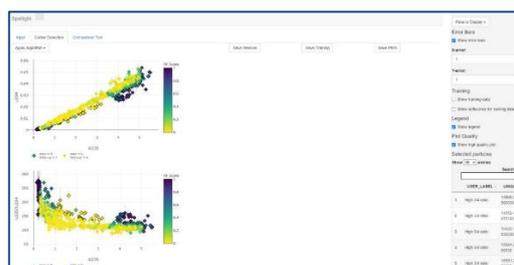
Expanded understanding of detectable signatures of NFC activities (in other words, isotopic, elemental, and morphological characteristics of key materials), including the formation, transport and transformation of particles in the environment and improved methods for the collection of such material through ES.

Outputs	Status	Comments
Collection of uranium impurity data and fuel burn-up inventories obtained from studies completed by Member States for integration into existing SGIM-IFC evaluation libraries.	Completed and work continues	New samples were collected for impurity analysis. No new reactor burn-up calculations were received from MSSPs, but the IAEA calculated some of its own using SCALE. The IAEA will continue both efforts.
Development of beta software for aICHEMy: an evaluation software for cross referencing isotopic and elemental data with NFC (Physical Model) signatures.	Delayed and work in progress	There was no MSSP support, but the scope of the isotopic and elemental data analysis was changed, as aICHEMy was too complex to manage. A simplified, in-house approach (LLAMA) is currently being developed.
Initiated studies for developing alternate sampling methods and media for more effective particulate collection.	Delayed and work in progress	Alternate methods were studied (in other words nuGoo) but laboratory analysis of the sample matrix was challenging. More studies are being carried out to determine if chemical processing of the matrix is possible. Any new sample material has to be compatible with analytical requirements.



Outcome #2: Optimized evaluation of ES results and improved safeguards verification.

Outputs	Status	Comments
Statistical approaches to evaluate particle data from enrichment facilities have been explored.	Completed and work continues	US DOE LLNL provided multiple engines (in other words, algorithms) within the "Spotlight" tool, which provides ES evaluators guidance on whether the current findings are similar to (or different from) previous results. Additional engines and further enhancements to the tool will be delivered.



Visual Sampling Plan software for providing detection/non-detection confidence levels of ES results has been assessed.	Delayed and nearing completion	US DOE Pacific Northwest National Laboratory completed a yearlong feasibility study for application of their statistical model to ES. A final report is imminent.
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Outcome #3: Continuity of knowledge and best practices in data evaluation is maintained.		
Outputs	Status	Comments
ESDB is migrated to Oracle 12c.	Completed	Work was completed with in-house resources.
ESDB accepts measurement data associated with age-dating of uranium particles.	On hold	Work has been postponed. Currently, age-dating results are managed outside the ESDB.
Best practices for ES evaluations are documented.	Delayed and work in progress	Further work has been postponed to wait for the ESEE project, as the evaluation environment will change.

SGIM-008: Statistical Analysis (Claude NORMAN)

Outcome #1: Standardized methodologies in support of State Level Approaches for calculating detection probabilities achieved through verification activities at facility and State levels, with the aim of supporting the determination of frequencies and intensities of quantitative verification activities and of evaluating the effectiveness thereof.		
Outputs	Status	Comments
Finalized development and technical documentation on methodology to calculate detection probability achieved through verification measurements at facility level.	Completed and work continues	The intermediate documentation exists in a US Department of Energy Report and several Institute of Nuclear Materials Management (INMM) papers.
Development and technical documentation on expanding detection probabilities from facility to State level.	Completed and work continues	A document describing initial results was produced describing work accomplished by the University of Massachusetts under a DOE Project in collaboration with the IAEA.
Technical documentation on randomized inspection schemes to address quantifiable misuse scenarios and associated prototype software to calculate frequencies and achieved detection probabilities.	Completed and work continues	Extensive progress was made in the context of the State-level approach improvement plan (SLAIP). The Tool for Random Inspection Planning in Safeguards (TRIPS) was implemented. It is still being tested and evolves as the SLAIP is being finalised.

Outcome #2: Improved and harmonized random inspection schemes (including short notice random inspections (SNRIs)) and methodologies developed to evaluate their effectiveness.		
Outputs	Status	Comments
Development and documentation of a set of standard random inspection schemes, including standard evaluation methodologies, as a basis for a more harmonized approach to implementing and evaluating such schemes in verification activities.	Completed and work continues	The development work had to concentrate on the review of specific schemes in relation to the priorities of the SLAIP.

Outcome #3: Further developed sampling methodologies described in STR-381 and practical implementation procedures for these methodologies.

Outputs	Status	Comments
Produce prototype software implementing basic safeguards sampling procedures described in STR-381.	Completed and work continues	The prototype software is in an advanced stage and a first component was deployed to the Department in collaboration with the Office of Information and Communication Systems.
Produce documentation of practical implementation procedures, for inclusion in the Inspector Handbook.	Delayed and work in progress	Delayed until the completion and deployment of the prototype software.

Outcome #4: Reviewed, updated and consolidated algorithms for the determination of measurement error uncertainties from operator-inspector paired-data, 3-laboratory data and calibration data.

Outputs	Status	Comments
Publication of peer-reviewed STR on Uncertainty Quantification.	Delayed and work in progress	This is a highly specialized Safeguards Technical Report (STR). MSSP Task Proposal 21/IFC-002 (Statistical Methodology Development) was created to find experts capable of providing adequate peer-review support.
Documentation of UQ algorithms employed for Verification Measurement Performance Evaluation in STEPS.	Completed and work continues	The STEPS software has been deployed and is being tested. The documentation work has started and will be completed after the testing phase.

Outcome #5: Reviewed, updated and consolidated methodologies applied to the evaluation of material unaccounted for (MUF), D, IMUF and SRD in the context of material balance evaluation.

Outputs	Status	Comments
Technical documentation of statistical algorithms implemented in STEPS MBE module for statistical evaluations of MUF, D, IMUF and SRD.	Completed and work continues	The STEPS software has been deployed and is in a testing phase. The documentation work has started and will be completed after the testing phase.

Outcome #6: Methodologies reviewed, requirements documented and developed for a harmonized NRTA system for future implementation in, inter alia, the Rokkasho Reprocessing Plant (RRP) and J-MOX facilities.

Outputs	Status	Comments
Produce comprehensive NRTA methodology documentation in the form of a STR.	Delayed and nearing completion	Due to pandemic restrictions, in-person meetings were impossible and impacted the speed of the project. The final draft documentation will be discussed in an upcoming video meeting with all contributors, with the aim of publishing the documentation in the Q1 2022.
Produce requirements documentation for harmonized NRTA software system, for use as a standardized platform for NRTA evaluation systems at RRP and J-MOX.	Delayed and work in progress	Due to the delays in producing the final methodology documentation, work on the requirements documentation has only recently been initiated.

Outcome #7: Enhanced data visualization software for nuclear material flow analysis and additional capabilities of the software to represent acquisition path analysis results, verification requirements and achieved verification results, using structured nuclear material accountancy and verification data (in collaboration with SGIS-003: Safeguards Information Systems and System Usability).

Outputs	Status	Comments
Migration of SNAKEY nuclear material flow visualization software into ISE (as a component of STEPS) and implementation of access management system to SNAKEY to allow appropriate operations division access.	Delayed and work in progress	For both outputs, this effort continues, albeit with intermittent developer resources. SGIS support would be needed.
Implement enhancements to include verification requirements and achieved verification results in nuclear material data visualization.	Delayed and work in progress	

Outcome #8: Developed Bayesian approaches making use of historical verification data in the evaluation of safeguards information.

Outputs	Status	Comments
Issuance of peer-reviewed technical documentation on Approximate Bayesian Computation for UQ.	Delayed and work in progress	This is a highly specialized topic. MSSP Task Proposal 21/IFC-002 (Statistical Methodology Development) was created to find expert support capable of providing adequate peer-review support. Several papers have been published.
Incorporation of appropriate methodology from technical documentation into statistical evaluation software for UQ.	Delayed and work in progress	Approximate Bayesian Computation for UQ has been tested in prototype software.

Outcome #9: Investigate accountancy and measurement requirements and gather experience with factors affecting material balance evaluation at pyroprocessing facilities (see also SGCP-003: Safeguards Approaches).

Outputs	Status	Comments
Model material balance approach for a pyroprocessing facility using results from the USA/ROK Joint Fuel Cycle Study.	Completed and work continues	Progress is dependent on the evolution of an overarching IAEA (SGCP) project in collaboration with the USA and ROK.

SGIM-009: State Declared Information Management (Zana KONECNI)

Outcome #1: More efficient information exchange, saving time and effort through State Declarations Portal enhancements.

Outputs	Status	Comments
NMA Reports may be validated by the Member State users so that corrective action can be taken. Validation will include the full Quality Control (QC) against historical data. Validation results, as reports, will be returned to the Member State.	Delayed and nearing completion	Development work is complete and a release is planned in Q1 2022.
A test country mock-up exists for training and demonstration purposes.	Completed and work continues	Resources were not available to complete this task, however there is a demonstration site available for training purposes. Enhancements, such as multi-lingual versions and a test country mock-up have been carried over into Outcome #5 in the 2022–2023 plan.
Improved or new internal workflows, to increase efficiency of information flows between SGIM/ISD and Operations divisions.	On hold	Changes to the workflow that affect how ARMS processes incoming correspondence for the Department were explored in the 2020–2021 biennium. While new and improved workflows are developed and operational, use is pending amendments to

		other Agency workflows and processes.
		Workflow improvements are carried over into Outcomes #1 and #4 in the 2022–2023 plan.
The graphical user interface (GUI) is translated into five additional languages (Chinese, French, Russian, Spanish and Arabic).	Delayed and work in progress	Delayed due to limited resources. See Outcome #3 in the 2022–2023 plan.
Training materials are translated into five additional languages (Chinese, French, Russian, Spanish and Arabic).	Delayed and work in progress	See Outcome #11 in the 2022–2023 plan.
Promotional material—in English, Chinese, French, Russian, Spanish and Arabic—is available to communicate system advantages and address user concerns regarding transmission security and/or infrastructure constraints within a Member State’s decision-making authorities. Possible translations into other languages, for Member States whose adoption of the SDP would generate a high added value.	Delayed and work in progress	Final versions of material ready for translation. See Outcome #11 in the 2022–2023 plan.

Outcome #2: Reduced cost of, and improved access to, e-learning lessons to support SRA training.

Outputs	Status	Comments
A new web portal, hosted by the IAEA’s learning management system, is established.	Completed	The e-learning modules are available on the IAEA Web site.
Ten 2- to 5-minute-long State declaration process e-learning modules that allow SRAs to collect and recall course material more efficiently and effectively.	Completed and work continues	E-learning modules are now available, and they must be regularly updated when new features are released in SDP.

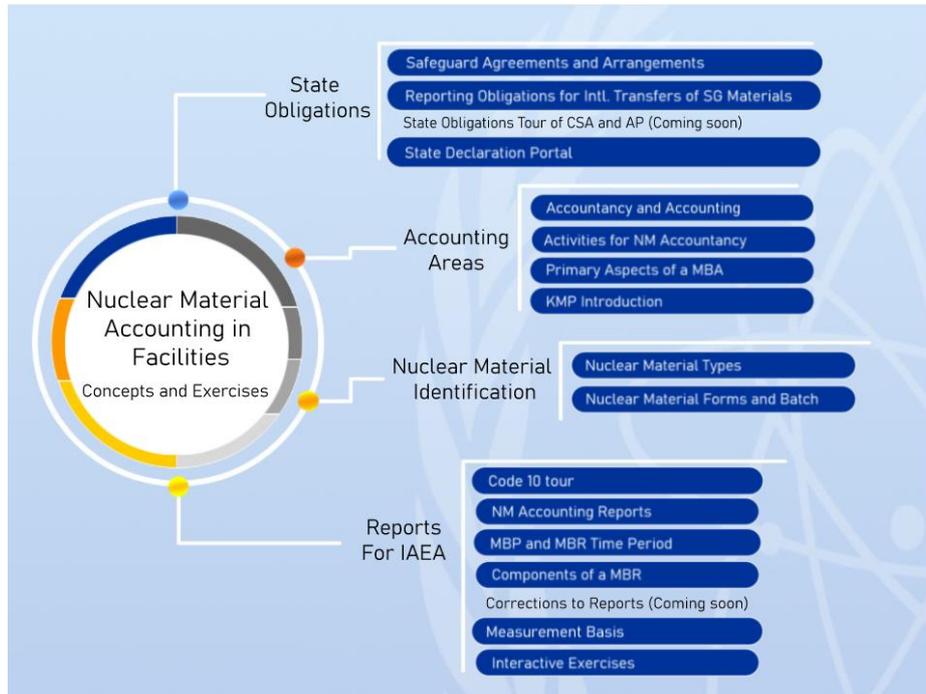


Figure 1: Nuclear Material Accounting in Facilities Basic Concepts Training Course is available at <https://elearning.iaea.org/m2/course/view.php?id=659>.

Outcome #3: More efficient creation of accountancy reports, additional protocol (AP) declarations and State-declared information, integrated with other safeguards-relevant information through software tools used by SRAs.

Outputs	Status	Comments
A developed software, "Reports Creation Tool" (RCT), for use by SRAs in creating and submitting accountancy reports.	On hold	Various options to move forward on this are being evaluated. Any solution should also include the "QCVS" functionality.
Stand-alone software "Quality Control Verification Software" (QCVS) for validating nuclear material accountancy reports will be maintained.	Completed	QCVS was updated to run on Windows 10.
Updated "Protocol Reporter 3" (PR3) software for users is widely deployed to States.	Delayed and work in progress	Due to the pandemic, test users from EURATOM States and States with bigger NFCs could not test the updated PR3 software. See Outcome #8 in the 2022–2023 plan.

Outcome #4: A system to enable the processing of Requests for Exemption, Terminations and Re-applications. The system will allow checking between State reports and records of exemptions and terminations of nuclear material with the nuclear material accounting database.

Outputs	Status	Comments
An implemented workflow for Exemption, Termination and Re-application requests of nuclear material. This will integrate with the nuclear material accounting system, to enable checking of State reporting.	Delayed and work in progress	The shell of this functionality exists in SSDH but further development is needed to incorporate the official correspondence and Operations workflow. Resources are limited. See Outcome #1 in the 2022–2023 plan.

Deployed quality control tool linking the decision-making process to the processing and evaluation of related inventory change reports.	Delayed and work in progress	n/a
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Outcome #5: Upgraded Safeguards Master Data (SGMD) application.

Outputs	Status	Comments
Integration in SGMD of the SRA addresses used for the different letters (NMA, TM, AP, 90 a/b, 10 a/b) sent by Safeguards to the State.	On hold	Limited resources were provided to aligning SGMD with the SGMD Guidelines. See Outcomes #3 and #9 in the 2022–2023 plan.
Deployment of related SGMD reports.	On hold	Limited resources were provided to aligning SGMD with the SGMD Guidelines. See Outcomes #3 and #9 in the 2022–2023 plan.

SGIS-002: Information Security and Infrastructure (Scott PARTEE)

Outcome #1: Sufficient security knowledge is reflected in policies, procedures, governance and staff culture.

Outputs	Status	Comments
The Safeguards Information Security Management System's (ISMS) policies, procedures and governance will meet the requirements of the Division of Nuclear Safety and Security (NSNS) as well as the Department's, and are based on International Organization for Standardization (ISO) standards.	Completed and work continues	Foundational ISMS is in place for SG and NSNS based on ISO 27001 series of standards. Work continues to address additional needs and to manage risks.
A measurable and coordinated information security management programme is in place.	Completed and work continues	The ISMS was put into place. Continued focus on assessing gaps, improving the process, and devising security metrics to measure the programme.
Security awareness training and testing is in place.	Completed and work continues	Security awareness training and security awareness testing is in place. Staff participation is mandatory. The Department, along with the Agency as a whole, plans to update the Agency-wide and Department-specific courses in 2022–2023.
Training is available for departmental staff members in new technologies, security metrics, security incident response, digital forensics, specific security products and secure software and systems development processes.	Completed and work continues	Training efforts have continued, although largely in the virtual sphere due to limitations on travel.

Outcome #2: Strengthened access control solutions.

Outputs	Status	Comments
Enhanced and integrated Authorization Management System, including extending the centralized authorization system to unstructured data stores and resources which are currently managed through other means.	Completed and work continues	The Authorization Management System is under continuous enhancement and improvement as it is foundational to ensuring appropriate access to information.
Access control solutions are in place that eliminate the risk of unauthorized access to systems and services.	Completed and work continues	Access control is fundamental to many of the Department's business processes. As such, there exists need to continue expanding managed access to additional systems—in particular systems outside of the secure environment.

Outcome #3: Increased trust in the Department's information and systems through enhanced cryptography and secure communication solutions.

Outputs	Status	Comments
Developed and deployed software is authenticated and trusted. Software developed by the Department will be digitally verifiable as authentic.	Completed and work continues	Software deployed by the Department is digitally signed. Additional cryptographic security mechanisms are planned for additional areas such as macros.
Ability to securely transfer between internal and external parties safeguards-relevant data, additional to that already accommodated within secure declarations, in accordance with agreed safeguards processes (for example, to securely share relevant information for projects, subject to statutory limitations).	On hold	This effort was put on hold during the pandemic, but work is expected to continue in 2022–2023.
Enhanced key management standards and solutions.	Completed and work continues	Improved encryption handling for in-field information. The expansion of the field encryption technology to cover additional information in processes outside of the secure environment is planned in 2022–2023.
Secure email for mobile devices.	Completed and work continues	A solution for secure mobile email was delivered to the Agency by the Department. Work continues to enhance the solution, add features, and expand availability to staff who need secure communications.
End-to-end secured solutions for communication.	Delayed and work in progress	This effort was delayed as resources shifted to the availability of pervasive communications during the pandemic. Efforts in this area are expected to be a D&IS need in 2022–2023.

Outcome #4: Enhanced security controls on operational systems and solutions.

Outputs	Status	Comments
Improved secure development lifecycle for SG products.	Completed and work continues	Major improvements to the security of the Department's software solutions were achieved, such as mandatory code scanning; dependency tracking; and regular AppSec security reviews.
Improved insider and external threat detection and "threat hunting" capabilities.	Completed and work continues	Worked closely with MSSPs to conduct activities. Roadmap developed to continue work in this area.
Security assessments and improved incident management solutions.	Completed and work continues	Conducted at least three security assessments per year as per plan.

Outcome #5: Increased trust in the Department through enhanced physical security and environmental solutions.

Outputs	Status	Comments
Enhancements to the physical security system.	Completed and work continues	Completed statement of work and initial vendor assessments for a physical security system pilot project. Pilot project results will be the foundation of the enhancements and the requirements for the "next generation" system.
Enhancements to the physical access control mechanisms.	On hold	Enhancements to the system will be based on the outcome of the physical security pilot project.
Development of potential next generation physical security systems.	On hold	Enhancements to the system will be based on the outcome of the physical security pilot project.

Outcome #6: Increased ability to remain operational after an adverse event through BC/DR capabilities including planning, equipment, IT solutions, facilities and regular exercises.

Outputs	Status	Comments
Plans, policies and procedures for continuity and recovery events.	Completed and work continues	Business impact analysis completed. Disaster recovery requirements defined and solution designs were created.
Arrangements for ensuring availability of critical equipment in the event of disruption, including detailed business continuity plans.	Completed and work continues	n/a
Identification and availability of alternate facilities.	Completed and work continues	Identified initial arrangements in Tokyo for work location capacity in the event the Tokyo Regional Office is unavailable.
Enhanced IT Disaster Recovery (DR) capabilities.	Delayed and work in progress	Initial requirements and designs completed. Implementation of capabilities delayed due to lack of funding.
Exercised and maintained BC/DR programme.	On hold	Pending enhanced IT disaster recovery capabilities.
Training for departmental staff members.	On hold	Pending the disaster recovery implementation.

SGIS-003: Safeguards Information Systems and System Usability (Remzi KIRKGOEZE)

Outcome #1: Improved Safeguards IT Products supporting IAEA Safeguards business more effectively and efficiently.		
Outputs	Status	Comments
Improved Safeguards IT Products supporting analytical, services, State cooperation and verification processes to enhance the user-experience and system performance with an increased number of IT features and business capabilities.	Completed and work continues	The Department enhanced IT support across all processes and improved the user experience for software applications covering the Safeguards Implementation Report, management of key performance indicators, the strategic asset management initiative, authorization management processes, the verification process and the State collaboration.

Outcome #2: Further optimization of departmental processes through the identification and development of new IT capabilities.		
Outputs	Status	Comments
New IT products in line with Departmental strategic priorities to optimize processes and improve the delivery of IT services with capabilities for the storage, retrieval and analysis of SG data.	Completed and work continues	The Department implemented new capabilities to support the consistent implementation of the State Level Concept, management of Safeguards reference documentation through a modern metadata-driven system, tracking of equipment incidents and problems, and support for the review and analysis of remote monitoring and surveillance data.

SGOA-002: Safeguards System for JNFL MOX Fuel Fabrication Plant (J-MOX) (Christophe CREUSOT)

Outcome #1: Developed effective and efficient safeguards approach and procedures for J-MOX.		
Outputs	Status	Comments
Safeguards approach for J-MOX, based on the elements agreed with Japan.	On hold	Pending the resumption of construction.
DIE/DIV procedures that assure that the facility is constructed and will operate as declared, while ensuring that the safeguards approach remains adequate and robust.	On hold	Pending the resumption of construction.

Outcome #2: Developed, tested and deployed verification systems at facilities to meet safeguards requirements.		
Outputs	Status	Comments
Designed, tested and installed safeguards equipment (NDA, C/S) that provides high quality, independent and reliable results.	Delayed and work in progress	Pending the resumption of construction.
Designed, tested and implemented integrated data collection and evaluation software for J-MOX, using synergies with the RRP Information System.	On hold	Pending the resumption of construction.

SGOA-003: Fukushima Dai-ichi Safeguards (Glen HORTON)

Outcome #1: Ability to provide credible and reliable assurance that nuclear material is not removed from damaged facilities; by designing, developing and deploying monitoring systems using surveillance devices, radiation detectors or other methods, with specialized support and expertise on monitoring systems. (In close collaboration with SGTS-001: NDA Techniques and SGTS-002: Techniques and Instruments for Sealing and Containment Verification).

Outputs	Status	Comments
Improve the OASM review software.	Work in progress with some delays	Opportunity to better integrate with standard Agency software.
Install/replace surveillance devices.	Completed	Second generation OASM system for installation in early 2022.

Outcome #2: Effective and efficient safeguards approaches are implemented for the Fukushima Dai-ichi site that include measures applicable to removed fuel-containing debris.

Outputs	Status	Comments
A drafted Safeguards Approach, with specific implementation procedures applicable to the new facilities and material handling involving the removal of nuclear fuel bearing debris.	Work in progress with some delays	Project impacted by Covid-19. New facility designs progressing.
A developed verification concept based on supporting facility preliminary design information and applicable to removed nuclear fuel bearing debris that may be containerized and processed through a hot cell.	Work in progress with some delays	Safeguards-by-Design approach for new facility advancing.

SGOC-001: Chernobyl (Faisal AJJEH)

Outcome #1: Safeguards are applied in an efficient and effective manner through finalized procedures for safeguards implementation at facilities under this project.

Outputs	Status	Comments
Implemented mailbox system for ISF-2.	Completed and work continues	Implementation started. Fine tuning as experience gained.
Approved verification procedures for ISF-2.	Completed and work continues	Safeguards Approach submitted to the Deputy Director General for Safeguards for approval. Verification procedure has been drafted.
Approved verification procedures for NSC.	Delayed and work in progress	Safeguards Approach is in final preparation stage before submittal to the Deputy Director General for Safeguards.

Outcome #2: Enhanced ability to carry out verification activities using equipment that is installed, adjusted and approbated for verification use (in close collaboration with SGTS-014: Remote Data Transmission and Processing Systems).

Outputs	Status	Comments
Equipment at ISF-2 is tested.	Completed	Hot functional test was completed. Facility is in operation now. Further fine tuning is ongoing.
Installation of equipment at the NSC is complete.	Delayed and work in progress	Statement of Work (SoW) is under review by the facility operator. Procurement process would start soon.

Equipment at NSC is tested, adjusted and approved.

Delayed and work in progress

Equipment has not been installed yet. The test may start in 2022.

SGVI-001: JCPOA Verification (Andy CATTON)

Outcome #1: Continued development and deployment of training, tools and techniques specific to supporting the JCPOA.

Outputs	Status	Comments
Conduct training in Carbon Fibre Mechanical Testing for SGVI Inspectors.	Completed	The training course has been well received by SGVI. If required in the future, a continuation is planned.

SGTS-001: NDA Techniques (Misha MAYOROV)

Outcome #1: Enhanced performance and usability of medium-resolution gamma spectrometry for nuclear material verification.

Outputs	Status	Comments
Acquisition and performance evaluation of the ultra-large volume (up to 29 cm ³) Cadmium-zinc-telluride (CDZT) probe.	Completed and work continues	Upon successful completion of the technical and functional evaluation of the H3D's M400 probes with an active CDZT volume of 16 cm ³ , the IAEA concluded a Blanket Procurement Agreement and procured 67 modules (Figure 1). <div> </div>
Authorization of a large-volume segmented CDZT-based Compton and coded aperture gamma camera.	Completed	The authorized large-volume segmented CDZT Compton and coded-aperture camera Polaris H420 provides reliable attribute test results comparable to other instruments authorized for such purposes for a single source at a stand-off distance.
Performance validation of the uranium enrichment determination codes for analysis of CDZT gamma spectra (NaIGEM, FRAM 6.0).	Completed and work continues	In-Field Non-Destructive Assay Verification Software MCA-Touch v.2.0 (with the support of MSSP Task GER A 2278 (Upgrading of the MCA-Touch Software)) was authorized in June 2020. It includes uranium enrichment and elemental content determination with a CDZT ($V \geq 1.5 \text{ cm}^3$). Evaluation of Gas Electron Multiplier (GEM) in conjunction with a 16 cm ³ CDZT probe M400 is ongoing.

Outcome #2: Improved NDA methodologies for verification of uranium at bulk facilities.

Outputs	Status	Comments
Determination of uranium concentration (up to 20 wt%) and enrichment of in-process material using high-resolution gamma spectrometry.	Completed	<p>A validation study of the "concentration meter" method was conducted towards establishing a usable NDA approach for in-field elemental assay of uranium in low-concentrated materials. The method validation was performed against well-characterized uranyl nitrate solutions in the range of uranium concentration from 1 wt% to 20 wt%.</p> <p>The method was shown to be suitable for partial defect verifications of low-concentrated material using portable gamma-spectrometric systems from the pool of the IAEA authorized safeguards instrumentation, including LaBr₃, CDZT and electrically cooled HPGe detectors. It was also shown to provide an adequate matrix correction for the measurement of U-235 enrichment in such material, when uranium concentration is known.</p> <p>This newly developed and validated capability was integrated into the recently authorized MCAT v.2.0 inspector field program.</p>
Determination of uranium concentration in aqueous uranyl sulphate solutions using Raman spectrometry.	Delayed and work in progress	Available R&D resources were allocated instead to complete other R&D tasks, such as conducting the International Workshop on U/Pu isotopics.
Assessment of capabilities of portable Laser Induced Breakdown Spectrometry (LIBS for impurity content determination in uranium-bearing materials).	Completed	The analytical capabilities of the portable LIBS system (LIBScan 25+) for impurity content determination in uranium-bearing materials meeting the requirements of ASTM C753 were assessed with the support of MSSP Task HUN A 2282 (Assessment of Capabilities of Portable LIBS for Impurity Content Determination in Uranium Bearing Materials). As a result, a list of prominent spectral lines useful for the impurity analysis in a uranium-oxide matrix was compiled, the instrumental conditions were optimized to maximize the analyte signals, a pressure-controlled ablation chamber for field use was developed and extensively tested, and the figures of merit and quantitative performance of the LIBS method were assessed in the dedicated experiments involving CRMs and working standards.

Outcome #3: Improved instruments and techniques to address verification of waste and scrap nuclear material with impure composition or heterogeneous isotopic composition.

Outputs	Status	Comments
Development of new data processing algorithm.	Delayed and work in progress	n/a
Performance evaluation and authorization of CTGS.	Delayed and work in progress	The Compact Tomographic Gamma Scanner (CTGS) was transferred to Pacific North-West National Laboratory for improvement of its analysis algorithms by a subject matter expert. The IAEA lacks the capacity to develop the algorithms required for analysis of the tomographic data.

Outcome #4: Development and testing of new PGET capabilities.

Outputs	Status	Comments
Development, testing and implementation of the algorithms and software modules required for the remote and unattended operation of PGET.	Completed and work continues	Quantitative analysis of nuclear material at nuclear fuel rod level is being performed for RBMK-1500 bundles.
PGET performance evaluation on VVER-1000.	Completed	Under MSSP Task JNT A 2453 RUS (Support for Testing of PGET New Functionalities in Attended, Remote, and Unattended Modes), twelve VVER-1000 Spent Fuel Assemblies (SFAs) with different burn-up and cooling time were used to assess performance of the PGET at Unit 4 of Balakovo NPP in Russia. The quality of tomographic images was sufficient to identify the structural elements of the assembly (end-cup, supporting structure, spacer grid) and count all 312 nuclear fuel rods. The PGET effectiveness with regards to its ability of detecting one missing fuel rod in a VVER-1000 SFA is evident (Figure 2 and 3).



Figure 2: Installation PGET for VVER-1000 measurements at Balakovo NPP.

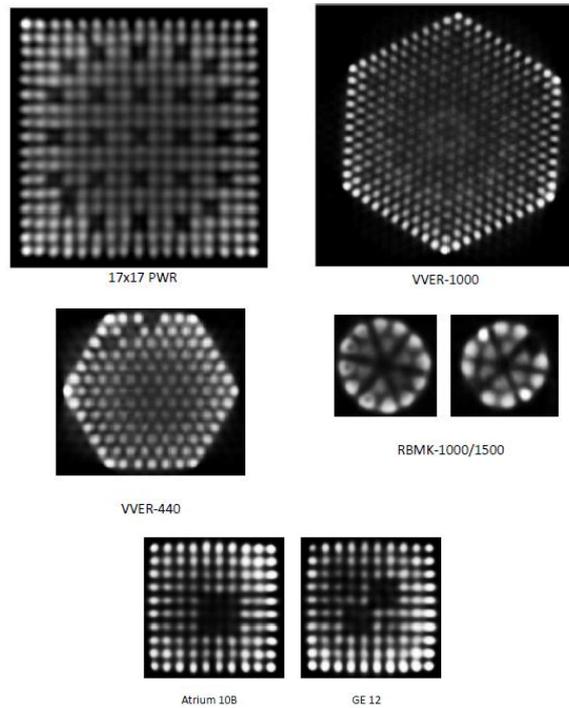


Figure 3: Tomographic images of PWR, VVER, RBMK and BWR SFAs.

Outcome #5: Capability to restore Continuity of Knowledge (CoK) on light water reactor spent fuel casks by fast neutron scanning & imaging techniques.

Outputs	Status	Comments
Confirmation of feasibility by simulation studies (including validation of the numerical model) and experimental proof-of-principle demonstration (Decision point 1).	Delayed and work in progress	Euratom is coordinating this work. Simulation was performed in a joint effort between European Commission Directorate General for Energy and European Commission Directorate General Joint Research Centres in Ispra, Italy and Geel, Belgium. Experimental proof-of-principle demonstration is planned for 2022.
Development of the user requirements; design and manufacturing of a prototype system.	On hold	The task depends on the successful implementation of the above task, which is in progress.
Field-testing (Decision point 2) and authorization for nuclear material verification, which is dependent on a successful performance evaluation.	On hold	The task depends on the successful implementation of the above task, which is in progress.

SGTS-002: Techniques and Instruments for Sealing and Containment Verification (Bernie WISHARD)

Outcome #1: Reduced inspector burden by demonstrating efficacy of LCCT.

Outputs	Status	Comments
Results of field testing of a Laser Curtain for Containment (LCCT).	Completed and work continues	The Laser Curtain for Containment (LCCT) was tested under MSSP Task ARG A 2318 (2D Laser Sealing System Test at RAD1) and in a second trial for functionality testing in collaboration with the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC). The IAEA has provisionally authorized the LCCT for field testing at Atucha-1 dry storage silos in Argentina.
Pre-Installation joint-evaluation of completed SG-authorized system and its data with ABACC/ARN at non-critical facility in Argentina.	Completed and work continues	The LCCT is provisionally authorized for field testing at Atucha-1 Dry Storage Silos (DSS) but delays in DSS construction has delayed installation. With final facility construction nearing completion, the LCCT was successfully installed at Atucha. Actual, spent fuel transfers will begin in Q2 2022 allowing a full assessment of the LCCT approach to maintaining CoK while saving IAEA Safeguards inspector effort. To evidence the effectiveness of the LCCT saving IAEA Safeguards inspector effort, the IAEA installed LCCTs at spent fuel storage facilities in Belgium and Germany. The IAEA is reviewing LCCT data to assure its most effective use and presentation. If evidenced, then more than 20 installations at Germany spent fuel facilities alone could be required. The successful field-trial will lead to full authorization of the LCCT.

An installation and field test of an LCCT at the dry storage silo array in Atucha-1, to demonstrate efficacy of wide area dual C/S for silos.	Delayed and nearing completion	Delays in finalizing construction of Atucha-1 DSS has in turn delayed installation of the LCCT. However, the IAEA continued radiation, environmental, and functional testing of the LCCT.
Joint-evaluation system in Germany storage facility to determine effectiveness in decreasing effort.	Completed and work continues	The IAEA installed a multiline system in a spent fuel facility in Germany to ascertain the effectiveness of the improvement from upgrading the light detection and ranging (LIDAR) head and decreasing IAEA Safeguards inspector effort of static dry storage facilities.
Broader authorization for other facilities.	Delayed and nearing completion	LCCT tests at the spent fuel facility in Germany began in June 2021 and will assess the LCCT concept for all other dry storage facilities in Germany; approximately 22. The LCCT technology is evolved from a single plane to multi-plane scanning system. This will improve functionality and security of the system.

Outcome #2: Maintain safeguards verification through seals by replacing the aging EOSS.

Outputs	Status	Comments
Obtain approval for implementing field tests.	Completed	Extensive field testing has been conducted in Argentina, Belgium, and is ongoing in Germany.
Completed radiation tests on Active Universal Asymmetric Seal (AUAS). Completed environmental tests on AUAS.	Completed	The AUAS has passed intensive radiation, electromagnetic compatibility (EMC), and environmental testing.
Commence vulnerability assessments.	Completed	The Vulnerability Analysis of the entire design (hardware and firmware) of the AUAS examined potential security vulnerabilities with a high-level of detail. This approach to mitigating vulnerabilities is cost effective, assures that the most recent attacks were considered, and that the process is expedited.
Initiate field tests at multiple locations.	Completed and work continues	Field testing in 2020 was initiated at facilities in Lithuania and Canada. Current performances are very positive.
Analyse results from completed field tests and mitigate deficiencies.	Delayed and nearing completion	Deficiencies were identified during laboratory tests in the software and hardware design. The deficiencies have been mitigated. However, waiting for the third-party vulnerability assessment has delayed mitigations in this final stage.
Authorize AUAS as a replacement for Electronic Optical Sealing System (EOSS).	Delayed and nearing completion	The AUAS will be presented for the authorization process no later than Q1 2022. After authorization this replacement of the obsolete EOSS, the Department will commence replacement of EOSS by the end of 2023.

Outcome #3: Effective, passive, verifiable-in-the-field seals that replace E-CAP (metal seals).

Outputs	Status	Comments
Finalized seal designs.	Completed	After evaluating and assessing numerous designs for a field-verifiable passive seal (FVPS), the IAEA identified two strong candidates.
Assessments of the designs, security features and vulnerabilities of the seals.	Completed	In the extensive assessment of two potential seals, the new seals were compared to the IAEA's main passive seal E-CAP.
Initial results from field-testing of the selected designs.	Completed	After extensive tests, departmental representatives selected the IAEA's in-house design as the most effective for a new field verifiable passive seal. A light-weight seal verifier has been developed and field-tested alongside the new field verifiable passive seal.
Selection of the final seal design.	Completed	IAEA's selection is complete. The in-house design has been selected.
Submission of the final seal design for Department authorization.	Completed	In Q4 2021, the Department authorized the new Field-Verifiable Passive Seal (FVPS), the successor of the CAPS (metal) seal, for safeguards use. Field deployments of the FVPS will start in Q1 2022. The old and new seals will co-exist for 2–3 years.

Outcome #4: Decreased efforts during DIVs by more efficient continuity of knowledge (CoK) for destructive analysis (DA) samples. This approach allows for CoK inside hot cells but verifiable from outside the hot cell. The system supports objectives required for pyroprocessing facilities in the ROK and elsewhere.

Outputs	Status	Comments
A finalized design of the Hot Cell Enclosure for Samples (HCES).	Delayed and nearing completion	The functionality of the Hot Cell Enclosure for Samples (HCES) was demonstrated at the pyroprocessing mock-up facilities at the Korea Atomic Energy Research Institute (KAERI). However, several modifications in the usage and security mechanism of the concept HCES were indicated. Delays due to the Covid-19 pandemic were experienced in continuing these tests at KAERI.
Results from continued field tests to prove efficacy of the HCES.	Completed and work continues	Field tests were extremely beneficial but are pending relaxation of Covid-19 pandemic travel restrictions.
Iterated designs and prototypes of HCESs as required.	Completed and work continues	Design changes have been made but are pending discussion in the working group.
A completed vulnerability review of the HCES.	Delayed and work in progress	Pending final design and field-trials.
Initiation of the Safeguards Authorization process for the new HCES.	Delayed and work in progress	Work on pyroprocessing has been indefinitely delayed.

Outcome #5: Mitigated safeguards vulnerabilities by exploration of alternative passive sealing technologies that enhance or replace current passive seals.

Outputs	Status	Comments
Assessment from reports and/or data on practical technologies emerging on the commercial market on high security Radio-Frequency Identification (RFIDs).	Completed	Assessments provided on security and vulnerabilities Project transferred to Project Engineering for development of Inspector requirements.

Outcome #6: Improve the security of data collected on the computers of mobile safeguards equipment by developing and improving cryptographic techniques in coordination with Departmental security objectives.

Outputs	Status	Comments
<p>A research paper on the latest relevant cryptographic techniques.</p> <p>Consult with Member State experts in cryptographic technologies.</p> <p>Expert consultations and sessions in cryptography to determine results and testing protocols (in other words, discuss testing researched work).</p> <p>Results from cryptography technique tests on safeguards equipment (in other words, assessing tests agreed in the Expert consultations).</p> <p>Implementation of cryptography techniques based upon the conclusions from the tests.</p>	Delayed and work in progress	All outputs here are delayed due to the Covid-19 pandemic.

SGTS-003: Surveillance Techniques (Melvin JOHN)

Outcome #1: Enhanced ability to deploy equipment at facilities, to meet safeguards requirements through development of highly effective and cost efficient optical surveillance measures with improved security features.

Outputs	Status	Comments
Working Next Generation Surveillance Review (NGSR) prototype for benchmark testing developed in collaboration with SGTS-014: Remote Data Transmission and Processing Systems (Assessment of Phase 1 NGSR surveillance review software).	Completed and work continues	Next Generation Surveillance Review (NGSR) was authorized for use by IAEA Safeguards inspectors for all surveillance reviews performed at HQ Vienna. Work is continuing to authorize NGSR to be used on (notebook) computers in the field in early 2022.
Initial performance assessment report of the prototype shape recognition module using relevant datasets.	Completed and work continues	Initial work was completed in 2020. Work to increase the database of manually tagged SG images to improve the deep-learning data analysis continues.
Assessment results report for the VideoZoom module.	Completed and work continues	The IAEA gave a draft assessment report to JRC (EC) in April 2021 for comment. Technical discussions between the IAEA, Euratom, and JRC on how to integrate VideoZoom into NGSR continue.

Create, refine and document the initial user requirements to guide the development of surveillance technologies intended to succeed NGSS.	Delayed and work in progress	The IAEA received information about potential architectures and available core technologies for an NGSS successor from several MSSPs. A workshop to present and review the options and obtain feedback from stakeholders is planned for mid-2022.
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Outcome #2: Improved ability to detect undeclared activities at nuclear facilities with tools and techniques.

Outputs	Status	Comments
Evaluation of advanced 3DLR and LiDAR technologies in relevant facilities in support of ongoing safeguards activities.	Completed and work continues	The IAEA received input and assessments from several MSSPs. Work continues, feeding valuable information into tasks described under Outcome #1 in the 2020–2021 plan, above.
Evaluation of the potential of 3DLR and advanced LiDAR technologies to support unique implementations of Dual Containment and Surveillance (C/S).	Completed and work continues	In close cooperation with SGTS-002: Techniques and Instruments for Sealing and Containment Verification, the IAEA installed enhanced versions of the LIDAR-based LCCT system for field testing in 2021. Work on authorizing the enhanced system continues.

Outcome #3: Improved real-time monitoring and flow measurement capabilities of nuclear material at nuclear facilities (for example, UF₆ cylinders and spent fuel casks) by developing tools and techniques.

Outputs	Status	Comments
A developed ultra-high frequency (UHF) Passive Tag monitoring and tracking system with advanced capabilities for persistent, real-time, non-optical surveillance of items of interest.	Delayed and work in progress	MSSP Task USA E 2483 (Passive Tag Technology) is targeted to provide the mentioned output. Upon presentation of typical use cases by the Department, potential solutions, based on passive UHF RFID technology were presented under this task. Several meetings were held to discuss initial concerns raised about the security and applicability of the presented technology. The task is continuing with the identification of a suitable Safeguards facility for testing and a preliminary Vulnerability Review (VR) of the proposed technology by Department experts.
A developed conceptual framework for an Ultra-Wideband (UWB) Passive Tag monitoring and tracking system with advanced capabilities for persistent, real-time, non-optical surveillance of items of interest.	Delayed and work in progress	MSSP Task USA E 2483 (Passive Tag Technology) is also targeted to provide the mentioned output. Work accomplished to date indicates that there is currently no suitable passive UWB tag technology available. Power requirements of currently available UWB tags require an additional energy source (battery) thus not meeting the requirements.

Outcome #4: Improved response to new threats resulting from technology advancements, through advanced intrusiveness and vulnerability analysis on current and future use of unattended systems.

Outputs	Status	Comments
An evaluation and vulnerability assessment of the DCM-A1, next generation analogue camera recording module, with respect to tamper indication efficiency and effectiveness.	Delayed and nearing completion	The IAEA is awaiting a MSSP's final report on the work that was completed in 2020.

SGTS-008: Instrumentation Technology Foresight (Dimitri FINKER)

Outcome #1: Improved and more efficient safeguards verification activities in the field through the use of innovative technologies.

Outputs	Status	Comments
Progressive roll-out of XCVD for spent fuel verification and transfer to SGTS-001: NDA Techniques	Completed and work continues	<p>The initial preproduction units have been manufactured, authorized, and transferred.</p> <p>Production of XCVD is planned for the next 5 years with the aim of gradually replacing all ICVD units.</p> <p>The IAEA plans to produce 30 XCVD units within the new biennium. See the 2022–2023 plan for more information.</p>
Deployable Robotized Cerenkov Viewing Device (RCVD) enclosed inside an autonomous surface vehicle.	Delayed and nearing completion	<p>A deployable version is under finalisation for a field test scheduled in Q1 2022.</p> <p>Pandemic travel restrictions have delayed some of the scheduled field tests.</p> <p>The IAEA plans to deploy RCVD in at least one significant spent fuel verification campaign. See 2022–2023 plan for more information.</p>
Inclusion of Chemical Identification spectrometers in the MCIK and expansion of their application in the field.	Completed	<p>Three instruments for chemical identification were authorized:</p> <ul style="list-style-type: none"> • Raman MiraDS • LIBS Vulcan • XRF X-MET8000
Integration of Instrument Record Integrator for Safeguards (IRIS) within MOSAIC tools, for streamlined reporting of field instrument data.	Completed and work continues	IRIS published within ISE for selected SG staff members. The IAEA plans to expand use of IRIS. See 2022–2023 plan for more information.
Completion of annual technology challenge for improving SG instrument data analysis.	On hold	2020 and 2021 technology challenges on hold due to the Covid-19 pandemic. See the new 2022–2023 plan for challenge information.

Outcome #2: Ability to develop, design and enhance safeguards solutions, faster and with fewer resources, by using external technologies from relevant R&D fields.

Outputs	Status	Comments
A list of new, external, non-traditional technology suppliers that have demonstrated their ability to develop specific solutions applicable to the domains of non-destructive assay, containment, surveillance and destructive analysis. (In collaboration with SGCP-004: Strategic Planning and Partnerships).	Completed and work continues	The list of suppliers engaged in new development continues to grow. In particular, a CZT technology initially identified during the Gamma Imaging Workshop was transferred as the building block for the new generation of portable gamma spectrometry instruments. Plans to grow this list are in the 2022–2023 plan.
Searchable Technology Foresight Database summarizing the results of technology evaluation.	Completed and work continues	The Technology Foresight Database is in routine use. Further improvements aiming at expanding the user base are in the 2022–2023 plan.
Quarterly Technology Preliminary Evaluation Report.	Delayed and work in progress	Contributions were made to several internal newsletters. Future contributions will be based on the entries of Technology Foresight Database.

SGTS-011: Unattended Measurements Techniques (POC not available)

Outcome #1: Faster (and potentially real-time) detection of HEU production in LEU enrichment facilities through improved tools and techniques.

Outputs	Status	Comments
Upgrades of On-Line Enrichment Monitor (OLEM) hardware and software.	Delayed and work in progress	Beta versions of the upgraded OLEM software suite have been received. IAEA testing is delayed. Hardware upgrades partially completed.
A report on overall OLEM performance enhancements.	Completed	A final OLEM report is expected 2022 Q1.

Outcome #2: Ability to take real-time flow measurements of nuclear material, including UF₆ at enrichment facilities and conversion plants and Pu at reprocessing facilities, through improved tools and techniques.

Outputs	Status	Comments
Installation of Unattended Cylinder Verification System (UCVS) at an IAEA-safeguarded gas centrifuge enrichment plant (GCEP) for field testing.	Delayed and work in progress	The fabrication of the UCVS instrument has been completed.

Outcome #3: Established and maintained knowledge of spent fuel in shielding/storing/transporting containers, at all points in their lifecycle, by developing safeguards equipment.

Outputs	Status	Comments
Completion of the user (Operations) requirements of new instrumentation to detect and deter the misuse of nuclear material.	Delayed and work in progress	Potential use case identified in Finland only. End users from Division of Operations C (Europe, Northern and Western Asia) are in the process of defining the user requirements to determine suitability of the PGET/UGET for this application.
Development of the instrumentation. The Unattended Gamma Emission Tomography (UGET) system being a potential candidate to address the need.	Delayed and work in progress	Development will follow from the finalized user requirements and will reuse 'core' design of PGET, but will introduce measures needed for unattended use (for example increased data and physical security features).

Outcome #4: Increased proportion of deployed unattended systems that are sustainable, standardized and modular, with increased use of commercial off-the-shelf (COTS) products.

Outputs	Status	Comments
Evaluation of a time-domain reflectometry (TDR) prototype from the USSP.	Completed and work continues	The IAEA received a prototype and continued internal tests after intensive initial testing by the developer. MSSP Task Proposal 21/TUS-001 (Development of Time Domain Reflectometer (TDR) Devices for Use Along Unattended Monitoring Systems (UMS) Detector Cabling Pathways) is pending a MSSP decision as of the publication date of this document for the development of a production version of the TDR device that can be implemented in the field (data analysis and review via standard SG means).
Development and maintainability support of UMS electronic standard modules (ADM2- and LANL-based modules).	Completed and work continues	The Unattended Dual Current Monitor (UDCM) developed by LANL was tested and selected as the replacement for the current module of the MiniGRAND. A license agreement was signed by CAEN to manufacture the device. The ADM2 (BOT Engineering) firmware and software have been improved.



Figure 1: UDL1- New UMS Data Acquisition System to replace MiniGrand and JSR-12.



Figure 2: New Low-Current Data Acquisition Module (UDCM) selected by the UMS Team, developed by LANL and manufactured under license.

SGTS-014: Remote Data Transmission and Processing Systems (Angelo ALESSANDRELLO)

Outcome #1: More efficient data review and verification by inspectors, through the development of CASCADE, adopting the current departmental software standards.		
Outputs	Status	Comments
NRT Application for ISF2.	Completed and work continues	The Near Real Time System (NRTS) for ISF-2 was completed as planned, but Operations has requested upgrades and an extension to NRTS to allow it to be used to verify all activities.
Triggered data evaluation for IRAP-authorized facilities.	Completed	n/a
Scheduled/on-demand data evaluation for IRAP-authorized facilities.	Completed	n/a
SGLAN applications and NGSR integration into CASCADE.	Delayed and work in progress	NGSR was delivered in Summer 2021, and work will continue in 2022–2023.
ISE applications integration into CASCADE.	Delayed and nearing completion	CASCADE is integrated with the State Declaration Portal (SDP) and is waiting for SDP to be ready to import in ISE Operator Declaration, expected early 2022.
Remote system analysis capability for the Fork Detector (FDET).	On hold	This output was implemented, but is not yet finalized. After the SCALE training, the Department is waiting for an opportunity to field test this output during the next installations of UFDM systems (mid 2022).
IRAP deployment and extension of CASCADE to other facilities.	Completed and work continues	Almost all facilities in Remote Data Transmission were addressed except in Japan. Some CANDU facilities not in RDT (for example, India, Pakistan, Argentina) were also configured.

Outcome #2: Improved VPN hardware for the RDT network.		
Outputs	Status	Comments
A tested and authorized Euratom-proposed VPN hardware for use in MSSP-provided test facilities in Germany.	Completed and work continues	The Stormshield VPN was accepted, and its deployment in EC Member States is ongoing.
Implementation of a new VPN hardware, developed using pfSense (open source VPN secure firmware), with support for smartcard cryptography tokens.	On hold	The implementation was delayed due to the delay of the RDT data centre installation, which is to be resumed in 2022.

Outcome #3: Improved efficiency of equipment maintenance, by upgrading ROOGLE.

Outputs	Status	Comments
Integration of ROOGLE3 data with the Access Management System (AM).	Completed	n/a
Integration of ROOGLE3 data with SMT and SEQUOIA.	Delayed and nearing completion	A working ROOGLE 3 prototype that adopts the SEQUOIA equipment model and is capable of interfacing with SMT to issue tickets connected to the relevant SEQUOIA asset number was released at the end of 2021, and the production version is expected in mid-2022.
Hand carried data monitored by ROOGLE3.	Delayed and work in progress	Rescheduled to late 2022.
Integration of ROOGLE3 data with CASCADE.	Delayed and work in progress	Rescheduled to late 2022.
Move ROOGLE3 to the production environment.	Delayed and work in progress	Rescheduled to late 2022.

SGTS-016: Occupational Health and Radiation Safety (Virginia KOUKOULIOU)

The 2022–2023 is the inaugural plan. Progress on the inaugural plan will be in the next D&IS Programme.

Appendices

RMP Capability by D&IS Plan

This table lists all plans that link to an RMP from the Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities. Each RMP is linked to one or more D&IS Plans.

◆ Denotes top priority capabilities from the Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities.

ID	RMP Capability	D&IS Plan Reference
Focus Area: Core Activities (V)		
V.1.C1	Ability to synthesize and evaluate disparate sets of verification data from the field through data analysis methods and tools	SGIM-007, SGIM-008, SGTS-014, SGVI-001
◆ V.1.C2	Ability to process and integrate the variety and volume of safeguards relevant information in a timely, user-friendly and cost-effective manner	SGIM-002, SGIM-003, SGIM-008, SGIM-009, SGTS-014, SGVI-001
V.1.C3	Ability to efficiently process and interpret multi-lingual safeguards relevant information, including within the Agency's secure air-gapped network	SGIM-003, SGVI-001
V.1.C4	Ability to apply machine learning for automatic selection or change detection in open source text and other media, commercial satellite imagery and cloud data streams, including a library of training data	SGIM-002, SGIM-003
V.1.C5	Ability to enhance the sharing, aggregation, visualization and analysis of geo-based information (e.g. verification data, satellite imagery)	SGIM-002
V.1.C6	Ability to apply optical character recognition/text extraction as a robust service to enable information integration into digital systems	SGIM-009
V.1.C7	Ability to effectively maintain situational awareness of safeguards relevant nuclear trade activities and developments	SGIM-003, SGIM-009
◆ V.3.C1	Ability to derive verification intensities and frequencies from performance targets and to determine detection probabilities	SGCP-003, SGIM-008
V.3.C2	Ability for safeguards information systems to assist analysts in identifying significant changes in a State's nuclear fuel cycle, which may trigger a need to update the APA, SLA, and AIP	SGCP-003, SGIM-009
V.4.C1	Ability to leverage statistical methodologies to evaluate verification data, to assess verification performance (detection probability, timeliness and deterrence) and the associated level of confidence, at the facility and State levels	SGIM-008, SGTS-014
◆ V.4.C2	Ability to comprehensively evaluate, record, and document safeguards effectiveness at the State level	SGCP-003
V.4.C3	Ability to better measure and analyse safeguards performance (of the Department and the safeguards system more broadly) through use of analytical and IT tools, including data visualization	DDGO-001, SGIM-003
V.6.C1	Ability to implement effective and efficient safeguards for geological repositories	SGCP-003, SGTS-008, SGTS-014
V.6.C2	Ability to implement effective and efficient safeguards for SMRs and microreactors	SGCP-003
V.6.C3	Ability to implement effective and efficient safeguards at J-MOX	SGIM-008, SGOA-002, SGTS-014

V.6.C4	Ability to perform process monitoring and associated data analysis for safeguarding facilities, particularly advanced reactors with liquid or pebble fuel	SGCP-003, SGTS-014
Focus Area: Technical Capabilities (T)		
◆ T.1.C1	Ability to more efficiently verify and maintain knowledge of spent fuel in shielding/storage/transport containers at all points in their life cycle, including through remote means	SGTS-001, SGTS-002, SGTS-003, SGTS-008, SGTS-011
T.1.C2	Ability to verify nuclear material in closed containers in spent fuel ponds during short notice or unannounced inspections	SGTS-001
T.1.C3	Ability to more effectively and efficiently verify spent fuel from on-load reactors	SGCP-003, SGTS-011
T.1.C4	Ability to perform partial defect verification of spent fuel with the digital Cerenkov viewing device (XCVD)	SGTS-008
◆ T.1.C5	Ability to develop, deploy and maintain new sealing system technologies with improved security and efficiency	SGOA-003, SGOC-001, SGTS-002, SGTS-008
T.1.C6	Ability to verify nuclear material in containers with heterogenous matrices	SGTS-001
T.1.C7	Ability to unintrusively monitor the flow rate of UF ₆ in cascades and at conversion plants	SGTS-003
T.1.C8	Ability to detect HEU production in real time at declared LEU enrichment facilities	SGTS-003, SGTS-011
T.1.C9	Ability to detect and quantify contamination in equipment returned from the field with heterogenous matrices and shapes	SGTS-001, SGTS-016
T.1.C10	Ability to rely upon an integrated system of instrumentation data (e.g. spectra) processing and review, with high level of automation and with unified user interface	SGOC-001, SGTS-008, SGTS-011, SGTS-014
T.1.C11	Ability to rapidly detect, characterize and address breaches to unattended systems, and evaluate their vulnerabilities more broadly, particularly from threats arising from technology advancements (e.g. conduit integrity verification)	SGOA-003, SGTS-003, SGTS-011, SGTS-014
◆ T.2.C1	Ability to reliably and quickly deliver sample analysis results for special and high priority demands	SGAS-001, SGAS-002, SGAS-003, SGTS-008
◆ T.2.C2	Ability to determine age of U and Pu in environmental samples through techniques and evaluation methods	SGAS-001, SGAS-002
T.2.C3	Ability to detect NFC materials and determine nuclear activities based on elemental and morphological analysis of particles in environmental samples, with emphasis on the recognition of anthropogenic particles using scanning electron microscopy techniques	SGAS-002
T.2.C4	Ability to perform mixed U-Pu particle analysis, including screening, isotopic and elemental composition analysis	SGAS-001, SGAS-002
T.2.C5	Ability to assure the quality of the NWAL, including SAL, in environmental sample analysis (specifically particle analysis) using fit-for-purpose quality control and quality assurance methods	SGAS-002, SGAS-003
T.2.C6	Ability to maintain and further enhance the environmental sample database and the process models, databases, and tools that support trace elements analysis (material characterization)	SGIM-007
T.2.C7	Ability to reliably manage and deliver safeguards analytical results, e.g. through SGAS laboratory information management system (LIMS)	SGAS-003

◆ T.3.C1	Ability to secure information and quickly detect and respond to security events that arise within the Department's information systems	SGIS-002
T.3.C2	Ability to assist SRAs with the creation and submission of accountancy reports and additional protocol declarations with an IT tool	DDGO-001, SGIM-009, SGTS-014
◆ T.6.C1	Ability to develop and deploy improvements to the next generation surveillance review (NGSR) software (e.g. by leveraging machine learning to improve imagery review)	SGTS-014
T.6.C2	Ability to deploy next generation capabilities to the cameras used in future surveillance systems (e.g. non-optical surveillance, climate insensitivity)	SGTS-003
◆ T.6.C3	Ability to leverage new types of space-borne sensor data from open sources, including the processing of synthetic aperture radar data, analysis of multi/hyperspectral data, and thermal imagery	SGIM-002
Focus Area: Management (M)		
M.1.C1	Ability to fully implement data-driven programmatic planning, monitoring and evaluation, to support managerial decision making	DDGO-001, SGCP-004, SGCP-101, SGIS-003
◆ M.2.C1	Ability to strategically plan, maintain and improve safeguards IT tools, information assets, and associated infrastructure	DDGO-001, SGIS-002, SGIS-003
M.2.C2	Ability to enhance equipment reliability through improvements to the Safeguards Equipment Management System and monitoring of equipment performance	SGIS-003, SGTS-016
M.3.C1	Ability to maintain an effective departmental communication framework and processes	DDGO-001
M.3.C2	Ability to enhance managerial decision-making processes, capabilities and competencies	DDGO-001, SGCP-101
M.3.C3	Ability to assess and improve the implementation efficiency of the Department's system of processes, procedures and supporting tools	SGCP-004, SGCP-101, SGIS-003
M.3.C4	Ability to deploy project management approaches to ensure effective execution of strategic priorities and projects	DDGO-001, SGCP-004
M.4.C1	Ability to enhance working practices, leveraging Covid-19 lessons learned (e.g. information architecture, secure cloud services, secure virtual meeting environment)	SGIS-002, SGIS-003
◆ M.4.C2	Ability to carry out mission-critical functions - needed for continued delivery of safeguards conclusions - in case of disasters (e.g. disruptive, massive cyber-attack or physical loss of critical infrastructure)	SGIS-002, SGTS-002
M.4.C3	Ability to maintain awareness of changes in the nuclear landscape and associated impact on safeguards implementation, including the impact of emerging technologies and non-State actors	SGCP-003, SGCP-004
Focus Area: Stakeholders and Partnerships (S)		
◆ S.1.C1	Ability to deploy data visualization and other methods and techniques to present safeguards findings and performance-related data in a clear and compelling manner	DDGO-001, SGIM-003
S.1.C2	Ability to more clearly and effectively communicate the value and importance of IAEA safeguards, and to reach a broader audience	SGCP-004
◆ S.2.C1	Ability to strengthen the capacity of SSACs/SRAs and monitor and measure progress	DDGO-001, SGCP-102, SGIM-009, SGTS-014
S.3.C1	Ability to identify and address the needs of designers and operators of modified or new facilities in the early preparation for efficient implementation of safeguards	SGCP-003, SGOA-003, SGTS-014

Focus Area: People and Knowledge (W)		
W.3.C1	Ability to train inspectors on spent fuel measurement techniques inside facilities	SGCP-102, SGTS-001
W.3.C2	Ability to further develop the expertise of the Safeguards Department's workforce and train the next generation of safeguards experts	SGCP-102, SGIM-002, SGIM-003, SGVI-001
W.3.C3	Ability to improve safety culture by enhancing staff skills and expertise related to radiological and industrial safety	SGTS-016
W.3.C4	Ability to effectively utilize knowledge and expertise already existing with the Department	SGCP-102, SGIM-002, SGIM-003, SGIM-007, SGTS-016
W.3.C5	Ability to preserve and disseminate critical organizational knowledge to overcome staff turn-over and other associated challenges	SGCP-102, SGIM-002, SGIM-007
◆ W.4.C1	Ability to attract and retain a geographically diverse and gender-balanced workforce	DDGO-001, SGCP-102

D&IS Outcomes by Resource Mobilization Priority (RMP) Capability

The chart counts instances of when managers linked their outcomes to a certain resource mobilization priority (RMP). Each RMP is linked to at least once in the 2022–2023 D&IS plans.

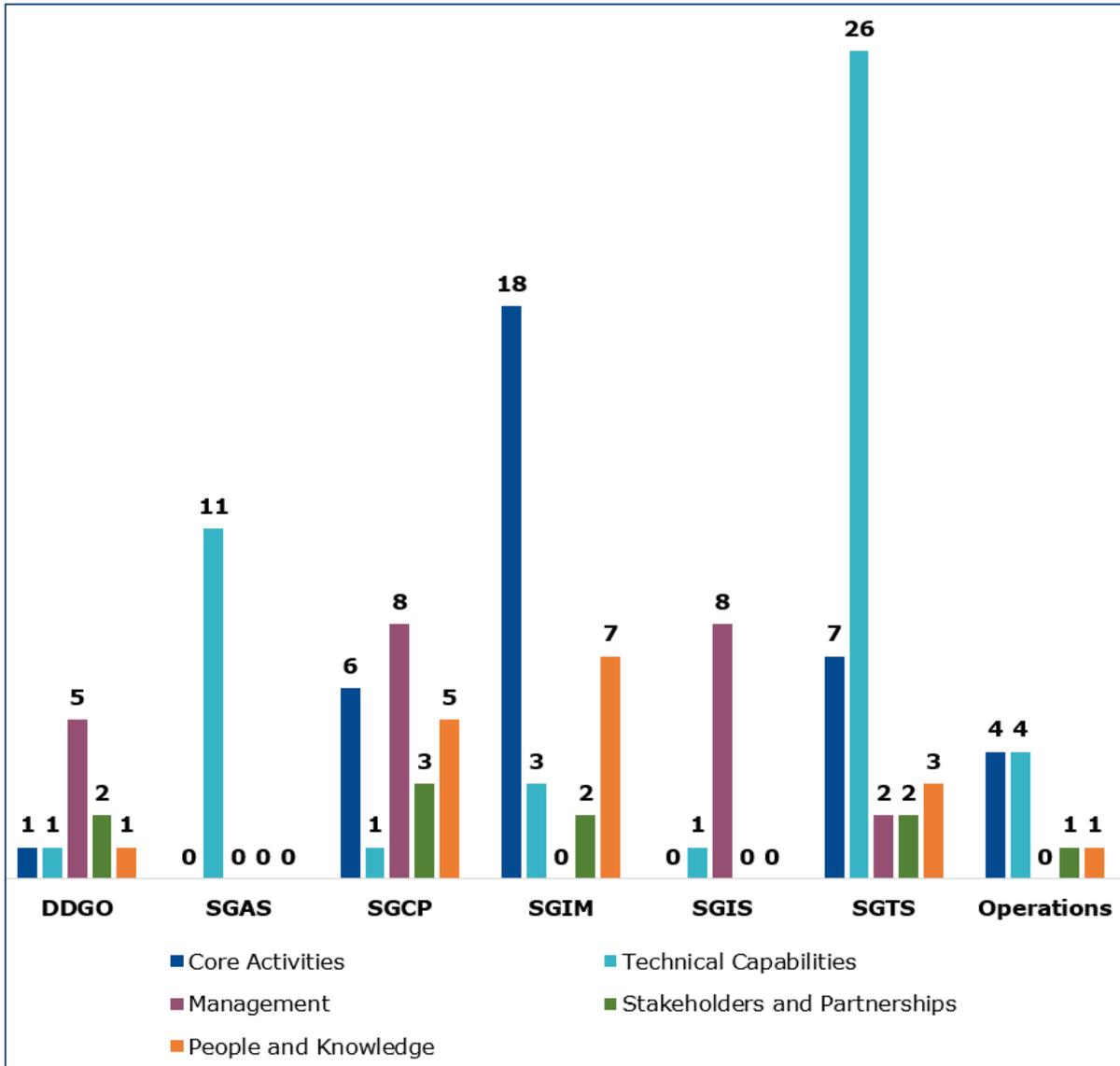


Linked Focus Areas by Division

When managers linked their 2022–2023 outcomes and outputs to resource mobilization priorities, the outcomes and outputs automatically link to one of the 5 Strategic Plan focus areas:

- Core activities
- Technical Capabilities
- Management
- Stakeholders and Partnerships
- People and Knowledge

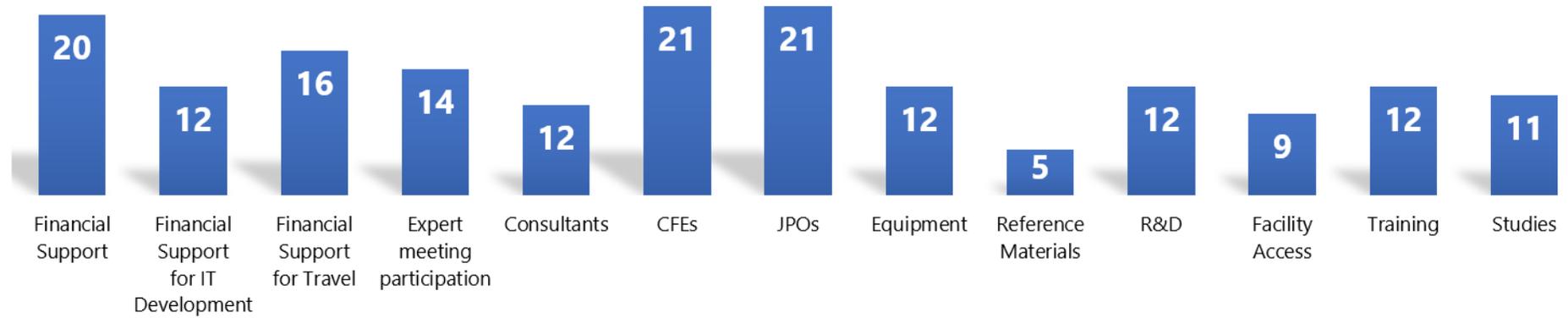
The chart below counts all linkages to the focus areas.



Support Need Type Infographics

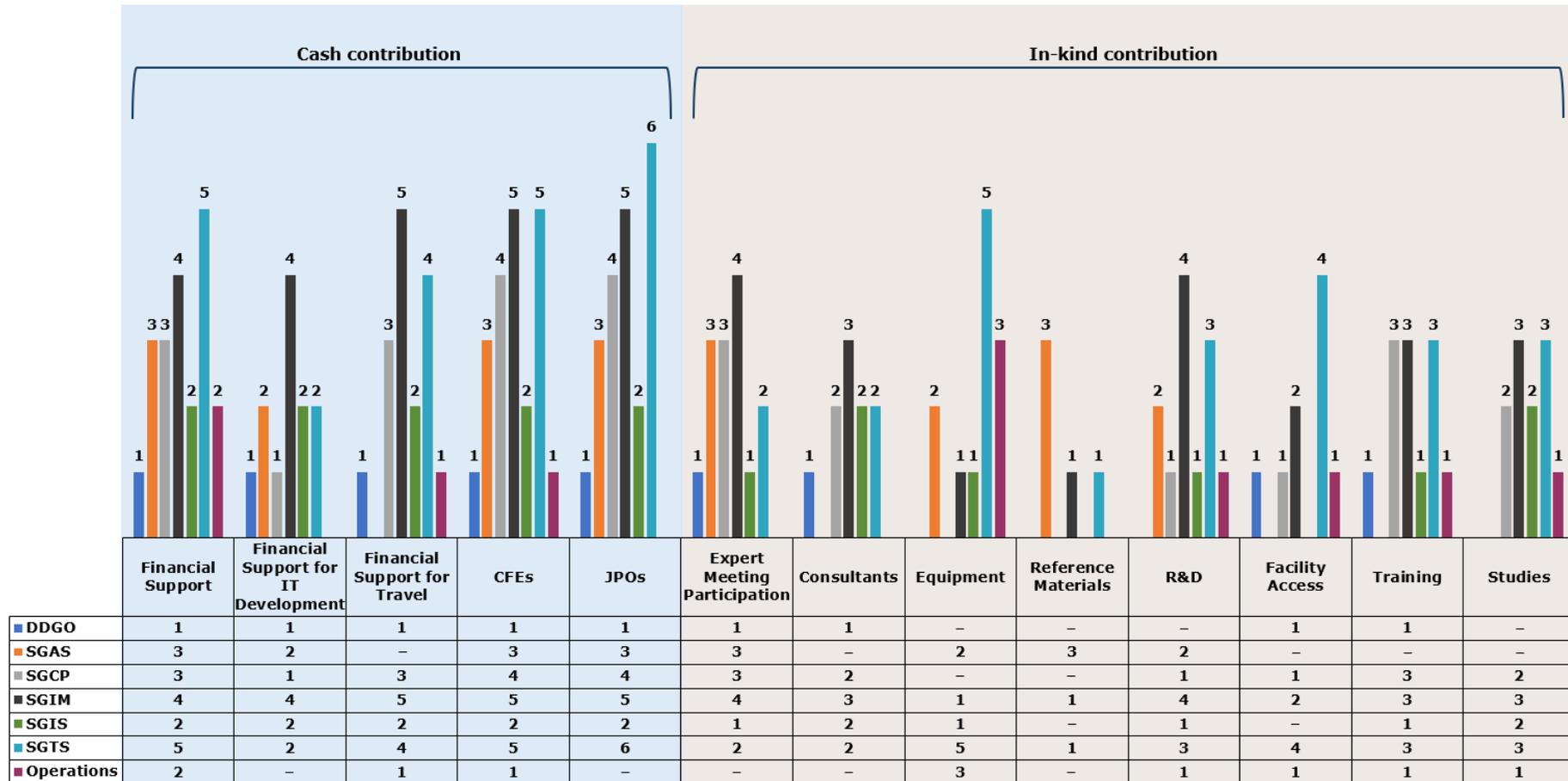
Overall Count of Most Needed Extrabudgetary Support Types

This chart shows how many times managers selected Most Needed Extrabudgetary Support Types across all 26 plans.



Count of Most Needed Extrabudgetary Support Types by Division

The chart below counts each instance when managers selected most needed extrabudgetary support types by division.



Definitions

This is a non-exhaustive list of terms and definitions from this document. For more terms and definitions, please find the latest version of the IAEA Safeguards Glossary.

Term	Definition
Development and Implementation Support (D&IS) Plans	Biennial descriptions of tasks in verification-relevant areas that require extrabudgetary support. Together, these plans comprise the biennial D&IS Programme document.
D&IS Manager	Departmental staff member in charge of the D&IS Plan.
D&IS Programme for Nuclear Verification	The biennial publication for Department staff and external partners (for example, Member States Support Programmes) of development and implementation plans that require extrabudgetary or other support from external and other partners to improve nuclear verification.
Enhancing Capabilities for Nuclear Verification – Resource Mobilization Priorities (RMP)	The publication identifying and communicating a set of needed capabilities that are of highest priority to the Department and especially reliant on extrabudgetary support. The RMP guides the Department’s collaborations with external partners and mobilizes resources for activities not funded through the IAEA’s regular budget.
IAEA Safeguards	The technical means by which the IAEA verifies legal undertakings not to acquire or use nuclear material, nuclear facilities and/or related items for proscribed purposes.
Member State Support Programme (MSSP)	A voluntary, structured collaboration between the IAEA and a Member State through which the Department requests and obtains financial and/or in-kind extrabudgetary support to help make its nuclear verification activities more effective and efficient.
MSSP Coordinators’ Meeting	A biennial meeting hosted by IAEA to give MSSPs opportunities to learn how their extrabudgetary support can contribute to the Department D&IS plans and to network among other MSSPs and IAEA staff members.
MSSP Task	After a MSSP accepts a MSSP task proposal, it is considered a MSSP Task. A MSSP Task is the specific activity undertaken by the IAEA and one or more MSSPs to deliver an output/contribute to the achievement of an expected outcome.
MSSP Task Proposal	A formal, written plan to deliver an output/contribute to the achievement of an expected outcome that requires one or more MSSPs. MSSPs can accept or decline MSSP Task Proposals.
Outcome	Benefits or changes that are expected, if the objectives and associated projects, actions and tasks are accomplished.
Output	A measurable product or service delivered or acquired as a direct result of the implementation of a task.
Strategic Plan	The Department’s management and communication tool that describes its priorities across 5 focus areas: Core Activities; Technical Capabilities; Management; Stakeholders and Partnerships; People and Knowledge.
Support Programme Information and Communication System (SPRICS)	The administrative IT platform supporting the Department of Safeguards’ Member State Support Programme. SPRICS stores task proposals, MSSPs decisions, and administrative details of the extrabudgetary support.

