Report

SYMPOSIUM
ON INTERNATIONAL SAFEGUARDS

Building Future Safeguards Capabilities

5-8 November 2018

IAEA
International Atomic Energy Agency

STR-392
July 2019

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Editorial note

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Foreword

Massimo Aparo
IAEA Deputy Director General and
Head of the Department of Safeguards

The IAEA Symposium on International Safeguards is a flagship event organized and hosted every four years by the IAEA for the nuclear safeguards community. As the only truly global mechanism of its kind, the Symposium provides the IAEA's partners with an opportunity to address safeguards implementation issues, showcase their research and share ideas for advancing safeguards. For the IAEA, it represents an occasion to draw on the collective perspectives, creativity, and dedication of the wider community to help address its safeguards needs.

As we approach the 50th anniversary of the Treaty on the Non-Proliferation of Nuclear Weapons entering into force, it is more important than ever that the IAEA should have the political, financial, and technical support it needs to maintain its ability to verify that nuclear material is used only for peaceful purposes.

Looking to our common future, the challenges we face are varied and dynamic. Our projections show that our workload will continue to grow. We will need to be prepared and able to respond to the unexpected. But where there are challenges, there are also opportunities. These opportunities are many - for modernizing and for partnering in pursuit of creative solutions. For this reason, the theme of this Symposium was 'Building Future Safeguards Capabilities', whereby we sought to identify innovative approaches and those emerging technologies with the potential to transform our work.

At the Symposium, together we generated new ideas on methods and technologies to strengthen the IAEA's technical capabilities and modernize the way we work. We learned that, through the mobilization of new partnerships, including with those beyond the traditional safeguards community, we can explore new ideas and find new solutions. And through sharing experiences, we can find ways to streamline, simplify and improve safeguards implementation—both in the field and at headquarters. As this report demonstrates, participants in the 2018 Symposium provided the IAEA with a wealth of ideas that we can carry forward.

To meet its legal verification obligations, the IAEA is always seeking improvements for fulfilling its mission. And we can achieve more as a joint effort. I am confident that working together, with our Member States, non-traditional partners, and others beyond, we can meet whatever demands and challenges the future holds and continue to ensure that the world is a safer place.

I thank you for your commitment to this common cause and for your contributions to a highly successful Symposium.

Executive summary

In November 2018, the IAEA organized its 13th International Safeguards Symposium. The theme was 'Building Future Safeguards Capabilities', and its technical sessions were organized around four tracks: 1) addressing emerging safeguards challenges; 2) leveraging technological advances for safeguards applications; 3) preparing for safeguards for new facilities, processes and campaigns; and 4) shaping the future of safeguards implementation.

Attended by some 800 participants from 90 States, industry and academia, the Symposium identified and discussed challenges and opportunities to strengthen the effectiveness and improve the efficiency of safeguards. Participants were encouraged to reflect in their discussions on the three objectives that the Symposium was pursuing: 1) innovate, 2) partner, and 3) improve.

Several insights emerged for each objective that collectively encapsulate some key needs of the safeguards community as a whole.

Innovate

- A number of technologies hold promise to address various safeguards implementation challenges and to conduct work more efficiently, including machine learning, virtual and augmented reality, 3D printing, data visualisation, and robotics. Some of these technologies have clearly emerged, while others require further research.
- While a technology may have capability to improve a particular verification challenge, the gap between technical readiness and adoption in the field is considerable, which can hinder R&D efforts.
- In dealing with new/emerging technologies, the IAEA needs to develop criteria for identifying which technologies are more promising for safeguards application. It also needs to consider means to encourage and accelerate adoption of new technologies by Member States.
- Maximizing the value of existing measurement data and techniques is needed, along with reductions in the time and cost required for in-field sample collection, conditioning and shipment.
- New methods for training could be used for strengthening SSACs.

Partner

- The safeguards community as a whole needs to improve communication of the purpose and importance of the IAEA's safeguards mission—in a manner that is more appealing and understandable.
- Non-traditional partnerships, particularly with actors not usually connected to safeguards, could help the IAEA increase technical and financial support for its verification mission as well as bring new cross-disciplinary perspectives and working methods.

- Enhanced strategies and new initiatives involving all stakeholders, including universities, are needed to ensure that future national and international safeguards expertise is developed and knowledge is maintained.
- More active engagement, cooperation, and information sharing between all partners and operating entities within the safeguards community, including industry groups, would help ensure the early consideration of safeguards requirements in new designs and nuclear projects—benefiting the IAEA, States, vendors and operators.
- Enhanced dialogue and information sharing between the IAEA and the strategic trade control community and licensing authorities could yield significant benefits, such as enhanced situational awareness.

Improve

- Besides IAEA-provided training and advisory missions, SSAC capacities could be strengthened through increased peer-to-peer interactions, exchange of good practices and support between SSACs.
- The safeguards community as a whole needs to continue assuring credible cooperation and assistance in capacity-building.
- Improved communication between the IAEA and a State could help resolve safeguards implementation issues at the technical level while enhanced IT tools could facilitate more efficient and secure ways of communication.
- There is a need to make better use of SSACs' capabilities in order to improve efficiencies while preserving the IAEA's ability to independently draw conclusions.
- There is a need to better measure, monitor and report on the effectiveness of safeguards implementation, in a way that all stakeholders have confidence in the validity of the performance information.

A number of suggestions and practical proposals were made to address the above needs, which are reflected in the 'Sessions' section of this report as 'Observations from the 2018 Safeguards Symposium' and 'Crosscutting Participant Observations'. By consolidating and distilling these participant insights, this report offers a set of practical ideas to guide future actions around innovation, partnering and improving communication and collaboration among States, industry, academia, non-governmental organizations and the IAEA. These ideas for action are summarised below and detailed in the 'Ideas for action' section of this report.

Ideas for action

- Rethink spent fuel verification for optimized safeguards
- Reinforce implementation of multisource data visualization for better integration, analysis and use of safeguards information
- Build national safeguards capacity by supporting the improvement of SSAC performance
- Bolster safeguards education to build the next generation of safeguards experts
- Proactively engage industry to ensure the early incorporation of safeguards requirements into nuclear projects
- Develop tailored communication on the role and importance of safeguards
- Expand and leverage non-traditional partnerships to broaden political, financial and technical support to the safeguards mission

The Symposium at a glance

Participants

93
Funded for grants

Sessions

51
Sessions

30
ESPACE presentations

16
Side events

Conference app

29
Polls raised in 18 Sessions

2060
Participants voted

110
Posts on Social Wall

Media

158 000+ Views

Background

International Atomic Energy Agency (IAEA) safeguards contribute a fundamental component to nuclear non-proliferation. Safeguards promote greater confidence within the international community by providing assurance that States are complying with their obligations under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and relevant safeguards agreements, strengthening collective security and helping to create an environment conducive to peaceful nuclear cooperation.

Every four years, the IAEA holds a Symposium on international safeguards in order to engage the broader safeguards community in addressing challenges and seizing opportunities to strengthen the effectiveness and efficiency of safeguards implementation. The 13th Symposium was organized against the backdrop of growing demands on the IAEA's safeguards system, while resources remain largely static.

There are three main ways in which the IAEA seeks to address these challenges: first, by working smarter, both headquarters and in the field, to improve effectiveness and efficiencies; second, by modernizing and finding innovative solutions to address challenges, as well as to seize opportunities; and third, through improvements by States themselves to their performance in safeguards implementation.

The symposium, entitled 'Building Future Safeguards Capabilities', was held in the Vienna International Centre from 5-9 November 2018 and was organized by the IAEA Department of Safeguards in collaboration with the Institute of Nuclear Materials Management (INMM), the European Safeguards Research and Development Association (ESARDA), and the Asia-Pacific Safeguards Network (APSN).

In designing the programme, the organizers considered:

- growing challenges in the areas of human resources, information technology (IT) security and the effects of globalization;
- promising technological advances that might impact upon safeguards implementation, building upon insights gained at the 'Emerging Technologies Workshop', held by the Department in February 2017;
- challenges in safeguards implementation related to new facility types/designs and new nuclear build; and
- improvements in daily safeguards business—streamlining and simplifying, building capabilities, resolving challenges and creating effective cooperation.

The Symposium sought to look ahead to emerging technologies and innovative approaches with potential for strengthening and streamlining the implementation of safeguards, and to explore the partnerships needed to apply these advancements to address safeguards needs.

The Symposium revolved around three objectives:

- **Innovate** – by generating and exploring new ideas on how processes and technologies might aid the work of the Department, 'crowdsourcing' the collective expertise of the participants;
- **Partner** – by mobilizing partnerships to explore further the ideas generated and support the needs identified in the Department's Research & Development Plan; and
- **Improve** – by providing a platform for the safeguards community to identify ways to work smarter together in daily safeguards implementation, addressing both challenges and opportunities.

These objectives were pursued through four thematic tracks:

Theme 1: Addressing emerging safeguards challenges (CHA)

Theme 2: Leveraging technological advances for safeguards applications (TEC)

Theme 3: Preparing for safeguards for new facilities, processes and campaigns (NEW)

Theme 4: Shaping the future of safeguards implementation (SGI)

Sessions

Opening plenary

Welcome and opening remarks

The Director of Concepts and Planning of the Department of Safeguards of the IAEA, Ms Therese Renis, chaired the Opening Plenary.

In his opening remarks, Deputy Director General (DDG) and Head of the Department of Safeguards, Mr Massimo Aparo, described the event as a "unique opportunity for the entire safeguards community to come together" and discuss the IAEA's safeguards work. The theme chosen for this 13th Symposium was 'Building Future Safeguards Capabilities'. The objectives highlighted for achieving this thematic vision were: 1) innovate, 2) partner and 3) improve. Referring to these objectives, DDG Aparo stated:

"Through innovation we want to generate new ideas on methods and technologies to improve the IAEA's technical capabilities and achieve further efficiencies in the way we work. Through the mobilization of new partnerships, including with those beyond the traditional safeguards community, we want to explore new ideas and find new solutions in support of long-term safeguards research and development needs. And through sharing experiences, we want to find ways to streamline, simplify and improve the effective and efficient implementation of safeguards—both in the field and at headquarters."

To set the context, DDG Aparo shared highlights from the Department's work and the challenges and opportunities involved in delivering on its core mission of drawing soundly-based safeguards conclusions. These highlights included the rising workload; the country-specific challenges of Iran and DPRK; increasing cyber threats; developments on State-level safeguards; and progress made on safeguards information technology (IT), equipment and techniques.

DDG Aparo thanked all the parties involved for their support to the Symposium, in particular the three organizations that had cooperated with the IAEA in organizing the Symposium. In that regard, the Opening Plenary included remarks from:

- Ms Irmgard Niemeyer (ESARDA, European Safeguards Research and Development Association)
- Mr Cary Crawford (INMM, Institute of Nuclear Materials Management)
- Mr Sok Chul Kim (APSN, Asia-Pacific Safeguards Network)

Ms Niemeyer noted that the three underlying objectives of the Symposium (partnering, innovating, improving safeguards implementation) are "also the basic principles of ESARDA", the Association itself being an example of partnership not limited to the European region. Though conscious of the national or regional differences, "we all face similar overarching challenges", so working together makes sense. Innovations must be sought not only in the technical field, but in partnership and collaboration, including with non-traditional sectors. She encouraged the

audience to take full advantage of this unique opportunity to interact with participants from so many countries and regions of the world.

Mr Crawford noted that INMM, "as a leading international professional association for the stewardship of nuclear materials", had a strong interest in further developing its collaboration with the IAEA and partner countries, and had recently identified increasing its diversity as a strategic objective. He felt that the audience of this Symposium was particularly well suited to share ideas to advance in those two areas with the Institute, for it to better serve the safeguards community, including in a regional setting.

Mr Kim indicated that the symposia organized by the IAEA had been a contribution "to the establishment of a comprehensive international safeguards regime", a regime which could also rely on enhanced situational awareness at a regional level. The APSN, as a successful regional cooperative network, would continue to play its role, including by a substantive cooperation with the IAEA and other partners.

Ms Renis, the chair of the Plenary, thanked the APSN and the Republic of Korea for having held their annual meeting in Vienna the previous week and for enabling the participation in the Symposium of many of the members of APSN.

Finally, Ms Carrie Mathews, Scientific Secretary of the event, introduced the Symposium organizing team and the Symposium Application ('App'). The latter was an initiative to enable interactive participation during the Symposium, through audience polling and questions to the speakers. To set the stage, the audience was invited to take part of the Symposium's first audience poll, measuring the level of interest in the Symposium's four tracks. The results of that poll are shown in the Figure below.

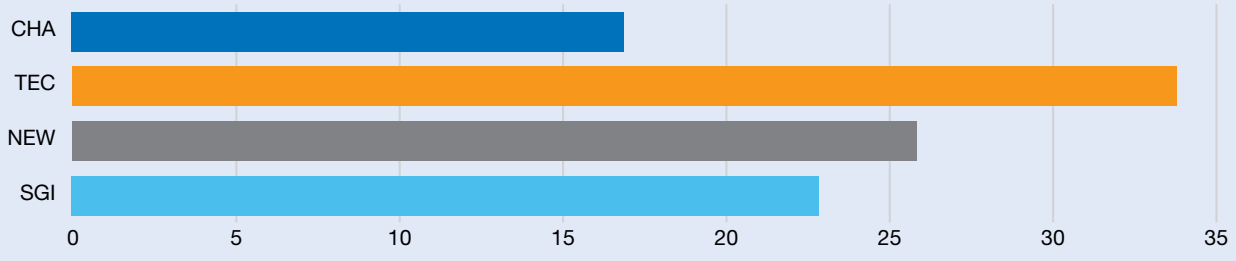
Technical Plenary

The Technical Plenary featured three keynote addresses, intended to orientate the audience towards the Symposium objectives and highlight connections between the thematic tracks.

- 'Opportunities and Challenges for the Safeguards Community', by Mr Stephan Lechner (Directorate General for Energy, European Commission);

Audience polling

Question: *Of the four thematic tracks featured in this Symposium, which one do you find most interesting/exciting?*



Session: PLE-S1 Percentage of votes (Total votes: 283)

- ‘IAEA Safeguards: Current Developments, Challenges, and Possible Solutions’, by Mr Oleg Rozhkov (Ministry of Foreign Affairs of the Russian Federation);
- ‘Cross-Sector Collaboration in Nuclear Risk Reduction: Elevated through Innovation’, by Ms Morgan Matthews (NSquare).

Mr Lechner addressed the delegates from the perspective of Euratom safeguards and the Member States of the European Union. Established technologies and the ‘digital boost of the 21st century’ were considered in the context of the general objectives of coverage, effectiveness, efficiency and transparency. Digitalization was seen as presenting opportunities that were not currently exploited, but needed to be so. He presented the question: “Have safeguards fully entered the 21st century?”

- The challenge was to embrace what others have been doing for 10 years: new engineering tools; automated data feeds; intelligent business analytics; feedback between processes;
- The requirement was for structured integration of data and results, rather than opportunity- or occasion-driven processes. This was technically possible, and the necessary secure environment was achievable;
- The proposal was to:
  - complement the current engineering focus of safeguards with data analytics;
  - embrace digitalization, with the caveat of exercising a degree of caution;
  - push for digital integration; and
  - change the mindset to accommodate the increased speed of digital vs. engineering implementation.

Mr Rozhkov recalled that the IAEA safeguards system had undertaken progressive development to adapt to challenges. Modification, improvement and optimization, in professional and technical terms, had been achieved in the past while maintaining objectivity. Today, several important challenges on the IAEA’s resources for the implementation of safeguards included: an expansion in nuclear material quantities; numbers and types of facility and process, including post-accident and decommissioning; State-Level safeguards implementation and training; and legal obligations and rights. The Department of Safeguards possessed impressive capabilities, such as its analytical laboratories and powerful new IT tools. These capabilities brought demands for the highest degree of professionalism, combined with objectiveness on the part of the staff of the Department.

- The challenge was to develop new verification capabilities that remained free from human biases and politicization;
- The requirement was to examine carefully the progress of technologies, to ensure that capabilities did not go beyond what was required for verification and did not interfere unduly with domestic affairs or commercial sensitivities;

- The proposal was to:
  - Develop clear-cut rules for validation of the credibility of information;
  - Develop new measures equivalent to the technical criteria of traditional safeguards, to be applied to State Level safeguards implementation;
  - Remain flexible in approach to sensitive cases, such as the JCPOA, without setting precedent for any future case; and
  - Deal with challenges without compromising existing standards.

Ms Matthews provided examples of frameworks and design methodologies that could be applied to safeguards, building upon the successes of N Square in bringing those with different perspectives together to work on discreet problems in the nuclear risk reduction space. The importance of cross-sector collaboration was emphasized as research shows that diverse groups are better at challenging assumptions, better at group decisions, and are more innovative and creative. Innovation was described as a process; a series of steps that begins with imagination and results in the creation of something of value to society. It was emphasized that innovation need not always be something new: it may be an old idea applied at the right time, a combination of existing solutions, borrowing solutions from another sector and applying them to safeguards, or simple changes in social capital structures. In practice, unlikely partnerships could yield considerable value. A key challenge was to develop and clearly articulate pathways for external engagement in safeguards.

- The proposal was to:
  - Embrace innovation as a process, beginning with a user focus;
  - Be prepared to take small steps: any time spent on innovation is better than no time;
  - Employ key tools for innovation such as:
    - design thinking and design strategy
    - scenario planning and futures emersion
    - awareness of jargon and developing new tools communication and
    - novel problem typologies and their corresponding approaches
  - Frame problems as a “How might we …” statements, that allows for more creativity in exploring and generating potential solutions.

Overview of the technical sessions

The 28 technical sessions of the Symposium were organised around four thematic tracks:

Theme 1: Addressing emerging safeguards challenges (CHA)

Theme 2: Leveraging technological advances for safeguards applications (TEC)

Theme 3: Preparing for safeguards for new facilities, processes and campaigns (NEW)

Theme 4: Shaping the future of safeguards implementation (SGI)

This section of this report contains (1) a further description of the topics discussed in each theme, (2) the topical challenges and needs identified, (3) suggestions made during the respective sessions, and (4) quotes from participants.

Theme 1: Addressing emerging safeguards challenges (CHA)

In a globalized environment, interconnectivity generates a set of competitive pressures and security vulnerabilities to which safeguards is not immune. As industries compete for talent and hackers seek to undermine information technology systems, maintaining information security and continuity of safeguards knowledge is an urgent priority. Moreover, the increased availability, affordability, and capability of technologies with proliferation potential in the global marketplace heightens the safeguards challenge. Yet interconnectivity also provides the safeguards community with opportunities to build new or expanded networks—including new partnerships—that increase capacity and involve a broader set of stakeholders for a more robust supply chain of knowledge, expertise, and goods.

Theme 1 of the 2018 Symposium engaged some of the safeguards challenges and opportunities this globalized environment creates, with participants exploring possible ways to effectively address them. Four topics were explored across six technical sessions:

- human resources and capacity-building;
- cross-sector engagement, i.e. reaching outside the traditional safeguards community;
- globalization of markets and knowledge; and
- information technology security.

Sessions

[CHA-S1]	Keeping Pace with Information Technology Security
[CHA-S2]	Human Resources – Taking the Initiative
[CHA-S3]	Globalization and the Changing Supply Chain for Knowledge, Expertise and Goods
[CHA-S4]	Non-proliferation and the Globalized Marketplace
[CHA-S5]	Engaging Non-traditional Sectors in Safeguards
[CHA-S6]	Capacity Building – National Initiatives

Human resources and capacity building

As the commitments for safeguards activities continue to grow and many established experts are retiring, the safeguards community is trying to build the next generation of practitioners. With the broader nuclear industry competing for similar skills and talent, participants explored how to best meet the international community's need for safeguards expertise and how States currently build and maintain their national safeguards workforce.

Challenges

- Building safeguards competencies, especially in areas not usually associated with safeguards.
- Integrating safeguards into a broader training curriculum.
- Improving knowledge management/retention, which remains a major issue within many organizations and has only slowly yielded results from remediation efforts.

Observations from the Symposium

- The development of skilled, young nuclear professionals should be the joint responsibility of everyone in the nuclear industry (i.e. regulators, operators, education establishments, governments, and the IAEA) and should be addressed as an effort common to all.
- Engagement with universities is required to include safeguards as part of their curricula in all nuclear-related degrees.
- Given the specificity of its functions, the IAEA should look for candidates with 'potential' to develop the skills needed to work in safeguards, rather than only those with actual 'expertise'.

Safeguards Champions are very important in resource-limited organizations. Long-term advocacy by a single person is often the only championing for safeguards in a country.

- Successful approaches/strategies on how to obtain/retain adequate safeguards expertise should be shared with the international safeguards community. Adequate fora should be identified, or established, and used effectively to share experiences and good practices.
- Training and qualification plans/metrics can assist managers and States in their assessment as to whether new safeguards staff meet the levels of performance necessary to be considered qualified.
- Knowledge management tools and practices, such as portals, which can hold a wide variety of documents and other media, provide significant opportunities for safeguards staff to learn outside a formal training environment.
- Further exploring the concept and development of 'Safeguards Champions' that provide a multiplier effect within their government/organization, could assist the safeguards community across its capacity building challenges.

Cross-sector engagement

While traditional partnerships continue to provide a strong foundation for the safeguards community, the growing complexity of challenges is driving interest in gaining new perspectives for safeguards innovation. Participants thus shared ideas on how to develop cross-sector engagements and knowledge-sharing with 'non-traditional' sectors that might have ideas or practices to offer, but are unaware of or detached from the world of safeguards implementation.

Challenges

- Communicating safeguards to non-safeguards professionals, academics, and the public at large in a manner that raises awareness and increases political support for the mission.
- Making technologists aware of the dual-use nature of products/technologies, especially items that have recently gone to market.

To engage people, safeguards practitioners need to tell good stories about how their activity fits within the broader security context.

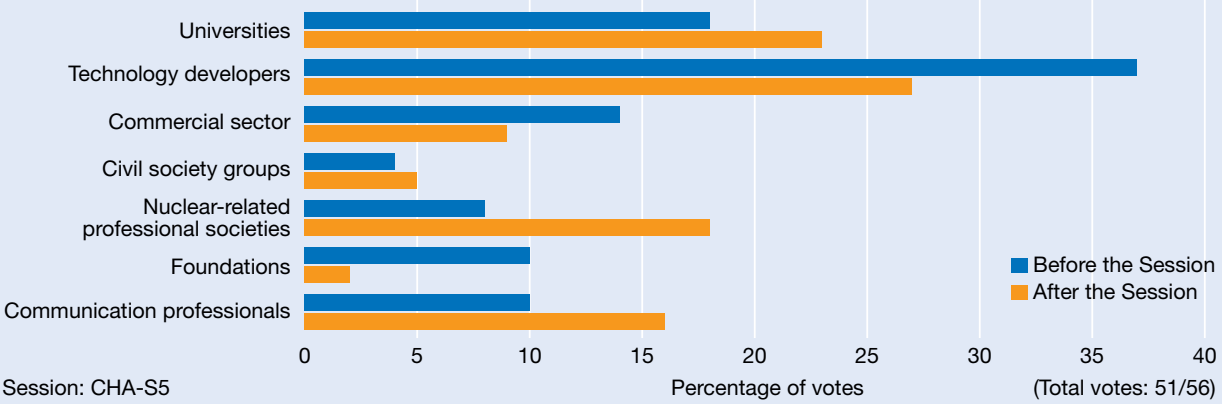
Using other language that is more accessible is necessary to engage non-safeguards people.

Observations from the Symposium

- To more effectively engage non-traditional sectors in safeguards, it is essential to communicate safeguards in a clearer, easier-to-understand way.
- To increase the effectiveness of their messaging, safeguards stakeholders need to think about who they wish to engage and tell a story tailored to the audience (for instance, TED talk style presentations for universities). Also, they should continue utilizing social media for outreach.
- Engaging the younger generation on the purpose and activities of the safeguards mission is beneficial for increasing non-practitioner engagement, especially within a university context.
- The value that non-safeguards professionals could provide to the IAEA's verification mission should not be overlooked; that mission may prove attractive to them.
- Synergies between safeguards, safety, and security could be further investigated in communication strategies.

Audience polling

Question: *Which partners could make the greatest contribution to the safeguards mission?*



Globalization of markets and knowledge

Globalization of the markets for knowledge, technology and materials relevant to nuclear non-proliferation adds to the complexity of the IAEA's work. The common challenges between safeguards and the strategic trade control community were explored in an effort to identify possible synergies and collaborative opportunities.

Challenges

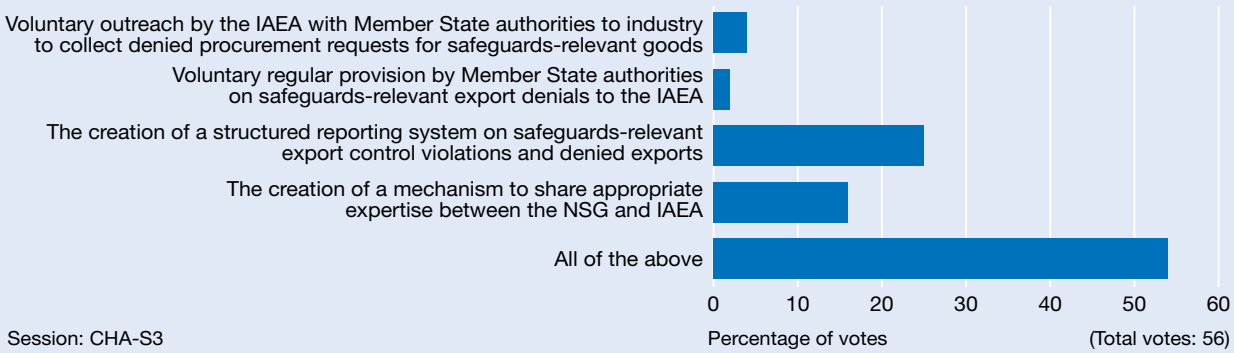
- Identifying possible areas of collaboration between the safeguards community and the strategic trade control community.
- Enabling cross-organizational engagement and information sharing while preserving the required confidentiality, mandates, and functional differences.
- Monitoring progress in additive manufacturing technologies involving materials which have nuclear uses.

Observations from the Symposium

- Analysis of nuclear trade-related information is now a well-accepted competence within the IAEA. Participants acknowledged the value of its analysis of trade information.
- Licensing authorities in States often have good knowledge of commercial entities dealing with commodities of safeguards relevance, and could engage in regular interactions with the IAEA in this respect.
- The strategic trade control community could provide valuable insights relevant to the acquisition path analysis, including assessing the indigenous capabilities of a country.
- There is now enhanced dialogue between the IAEA and the nuclear export control community. One example is through establishing an exchange of technical expertise in the field of emerging technologies.
- Enhanced information-sharing across organizations and outreach to all relevant stakeholders, particularly in industry—while respecting confidential information—could yield significant returns.

Audience polling

Question: *A number of methods have been proposed to strength the links between the strategic trade community and the IAEA's Department of Safeguards. Which one do you prefer?*



- The Model Additional Protocol annexes should be updated, so as to evolve with technological developments and adapt to current non-proliferation practices.
- There may be a need to track know-how and technology remaining when States decommission nuclear facilities, and also to monitor the technology transfer accompanying nuclear new-build projects.

Information technology security

Strengthening the security of the IAEA Information Technology (IT) infrastructure, and its protection against cyber threats, is critical to the broader safeguards community because hackers could compromise the systems and information underpinning safeguards. In addressing this IAEA challenge, participants discussed ways of strengthening safeguards IT resilience and learning lessons from other relevant organizations.

Threat information sharing is appropriate and useful, but the level of detail is the key challenge.

Challenges

- Building trust within the industry and with organizations facing similar information security issues; sharing issues and experiences which themselves are perceived as sensitive.
- Iterating and improving the IT security of safeguards equipment, due to the scale of equipment deployment and the unpredictable operating environment in which these improvements need to be conducted.
- Assessing and addressing, without loss to functionality, the security of legacy systems that are deployed in-field, for which there is often no simple way to update, upgrade or even patch.

Observations from the Symposium

- The IAEA has the opportunity and should take a leadership role in defining secure relationships and practices with its Member States and partners. It could insist on security standards and assist in their implementation, to the mutual benefit of all parties so as to not introduce additional vulnerabilities to information/data through interaction with environments where security standards are not to the same level. It is also important to work closely with and assist Member States in capacity building in this area.

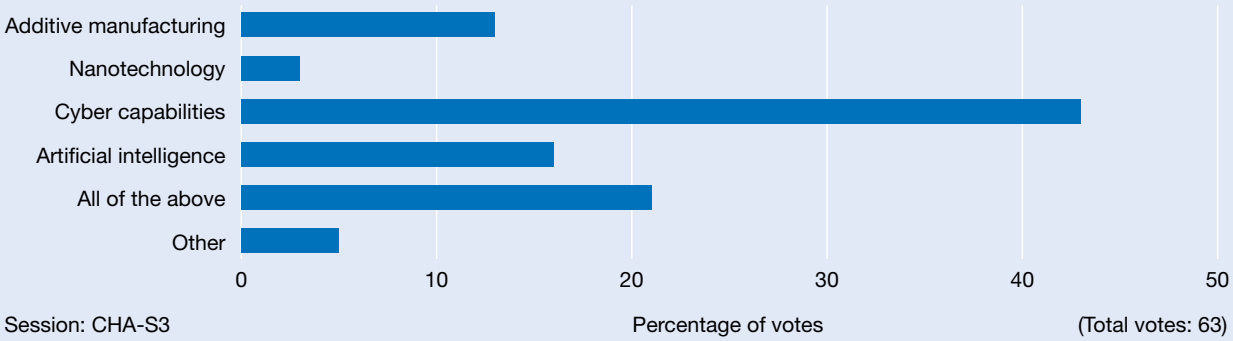
- The IAEA should interact more closely with groups related to IT Security in the energy/nuclear sectors, and share not only good practices and standards with them, but also lessons learned.

- Machine learning could be a means of assisting in analysing behaviour and predicting or warning of potential insider threats and/or potential incidents.
- Potential changes in the cryptography landscape should be considered.
- Building trust is key to strengthening security. However, trust among various stakeholders can only be achieved slowly. The IAEA could take the first step by starting as an observer in industry relevant computer emergency response teams (CERTs).

Finding a way to maintain a safe and secure communication between the IAEA and national authorities is key.

Audience polling

Question: *Which of the following technological developments/innovations/disruptive technologies do you judge to pose the greatest challenge to IAEA safeguards efforts and nuclear non-proliferation?*



Theme 2: Leveraging technological advances for safeguards applications (TEC)

The integration of new technologies into safeguards implementation is not only expected under safeguards agreements but underpins the ability of the IAEA to effectively and efficiently execute its mission. Promising technological developments are underway in several areas, including artificial intelligence, real-time 3D imaging, robotics and virtual reality/augmented reality. Such developments may provide the inspector/analyst with new tools that relieve them of simple and repetitive tasks and focus application of their expertise to key areas.

Building upon insights gained at the Emerging Technologies Workshop organized by the Department of Safeguards in February 2017, the nine sessions under Theme 2 sought to highlight how promising advances in emerging technologies could support safeguards objectives.

The sessions within Theme 2 covered the following:

- safeguards applications of advances in artificial intelligence;
- analysis, integration and visualization of multi-source data;
- distributed ledger technology;
- image processing and business analytics; and
- robotics, virtual and augmented reality.

Sessions

[TEC-S1]	Recent Examples of Innovation in Safeguards
[TEC-S2]	Automating and Optimizing Data Collection and Processing at HQ
[TEC-S3]	Advancements in Instrumentation, Data Processing and Analysis
[TEC-S4]	Visualization for Information Integration
[TEC-S5]	Improving Cooperation and Coordination in Safeguards R&D
[TEC-S6]	Integration and Evaluation of Verification Data
[TEC-S7]	Blockchain and Safeguards
[TEC-S8]	Collection, Processing and Analysis of Surveillance Data
[TEC-S9]	Collection, Processing, and Analysis of Satellite Imagery and Open Source Image Data

Safeguards applications of advances in artificial intelligence

Tools and methods utilizing artificial intelligence (AI) may provide opportunities to assist and complement the safeguards analyst's expert assessment by enabling the examination of larger data sets without increased burden on the analyst. The rapid evolution of AI and its capabilities underpinned a discussion among participants about how to appropriately harness and integrate the power of machine learning into safeguards.

Challenges

- Sourcing safeguards-relevant training data for machine learning that are appropriate and overcome confidentiality and/or complexity issues.
- Integrating machine learning methodologies and tools with human analyst interpretation and decision making for safeguards verification.

Observations from the Symposium

- A number of machine learning methodologies available now are being explored as part of the medium and long-term development process; some will influence many areas of safeguards (for instance, visual data collection and processing).
- Analysts need to develop professionally to take full advantage of new technologies. It is important for analysts to understand the principles and accuracy of algorithms and incorporate this into their analysis.

Machine learning systems can empower analysts to do things beyond their capabilities, first by broadening their field of view, and then allowing for narrowing it to a more manageable workflow.

- Machine learning should be used to define parameters, produce probabilities, and report confidence intervals, but should not be looking for black-or-white answers. The IAEA must decide for its purposes how many false positives or false negatives can be tolerated.
- Machine learning methodologies currently cannot provide yes/no answers for safeguards verification but only produce probabilistic intervals that need human analyst interpretation.
- Further empirical research is needed into how different tools are practically integrated into different safeguards processes, considering carefully if, how and why they enhance the analytical process.
- The real constraint is the availability of machine learning training data for the 'rare case' characteristics relevant to safeguards. Deep convolutional neural networks may generate candidate sites for human validation. Moreover, computer vision could assist with image pre-processing, object identification, and automated-change detection.

Analysis, integration and visualization of multi-source data

There are many constructive initiatives underway to better utilize data—both new and existing—in the safeguards community. These safeguards data efforts are integrating diverse data types and streams to strengthen analysis and support conclusions. Data integration/synthesis/fusion and visualization of equipment data are all parts of this integration effort, and participants explored ways to further this integration effort and generate even more robust analysis.

Challenges

- Increasing the inspectorate's capabilities to review and evaluate greater volumes of data in less time.
- Identifying the most relevant information for analysis amidst a near-endless stream of data.
- Developing automated multilingual data processing.

Observations from the Symposium

- Data acquisition systems are changing and allowing for more advanced processing and so more challenging measurements (for example List-Mode for neutron applications).
- Inspectors receive huge amounts of data, which need to be analysed and correlated. The Integrated Review and Analysis Package (IRAP) system automatically retrieves relevant codes and does the calculations to help verify the correctness of declarations. But the user interface is crucial for acceptance.

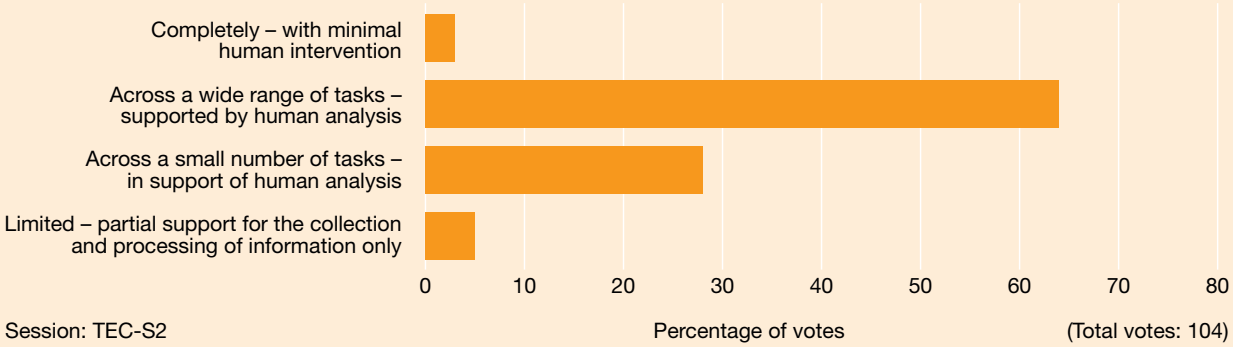
Geospatial organization of IAEA information enables contextualized knowledge management over the lifetimes of nuclear facilities, sites and locations—which may operate far longer than the career of any IAEA inspector.

It is time to use more generic tools to produce data visualization. If people use the same tools, this encourages communication between them.

- Automation programs that are well designed can aid the analyst in knowing where to search without precluding them from creating search strings or checking data streams ignored by the automated programs.
- Novel statistical approaches and tools can strengthen the efficiency and effectiveness of safeguards verification activities and help analysts collect, evaluate, integrate and visualize multi-source data.
- The improvements in 3D technologies are likely to lead to wider application of 3D technologies in nuclear safeguards; 3D imaging systems are getting smaller, faster and cheaper.
- 3D mapping and radioactive source visualization enhances the ability to verify the location of nuclear material and may reduce the amount of equipment that inspectors need to carry during the inspection.
- For multilingual data processing several approaches are available, but they all currently have significant limitations.

Audience polling

Question: *To what extent should future computer agents feature in the collection, processing and analysis of safeguards relevant information?*



Distributed ledger technology

Distributed ledger technology (DLT), commonly referred to as Blockchain Technology, is a relatively new technology used to reveal data tampering and to ensure information is consistent between databases. Participants engaged each other on interesting Research and Development (R&D) ongoing in Member States which simulates how DLT could be used for nuclear material accountancy reporting and other safeguards purposes.

Challenges

- Clarifying and communicating the safeguards purpose and application of DLT.
- Accelerating Member States adoption of new technologies in general, and addressing the legal implications if DLT were to be adopted.

If you are not aware of distributed ledger technology (DLT), one easy way is comparing it to the world wide web (WWW) which allows easy dissemination of data. DLT allows that in a tamper-proof way. That is the key benefit DLT and technologies in this space bring.

Observations from the Symposium

- DLT represents a new technology with promise for ensuring data integrity and building information trust through transparency and tamper indication.
- However, DLT does not solve the manual labour involved for consistency checks and other verification activities.
- There is still no conceptual framework within the DLT community for the final form of what is being built, which alludes to the newness of this technology.
- A potential safeguards use case could be to access nuclear material accounting information through DLT.
- A second potential use case relates to cybersecurity or cyber threats. A lone wolf attack on a declaration from the inside would be harder to carry out since all nodes on the chain would have to acknowledge the modification to the declaration.

Audience polling

Question: *Are there specific challenges in safeguards that blockchain can uniquely address?*

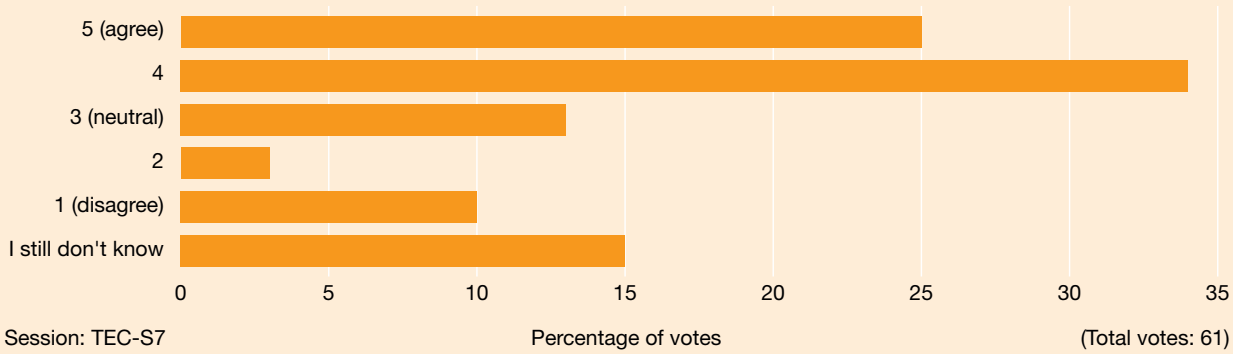


Image processing, business analytics

The opportunities offered by commercially available visual data processing tools are numerous and undoubtedly of benefit to the IAEA, but there are associated challenges. The wider adoption of business analytics was explored by participants as they sought to identify opportunities to improve data analysis, dissemination of information, and visual perception of data elements in a timely manner.

Challenges

- Overcoming complicated settings in nuclear facilities, time constraints in image/video review, limited computational resources in the field, and limited domain datasets for training machine-learning algorithms.
- Developing image processing and business analytics technologies suited for IAEA technical needs.
- Developing automation and optimization for safeguards analysis, from strategic theory development to implementation and analyst training.

Observations from the Symposium

- There are currently a host of efforts to address challenges in image processing and business analytics, with some showing significant promise.
- The 'You Only Look Once' (YOLO) technique is in the public domain, and was not developed specifically for safeguards. However, the training models are very specific, and are being developed for safeguards applications by using safeguards-realistic scenarios that include leveraging current surveillance camera employed by the IAEA within the Next Generation Surveillance System (NGSS).
- The VideoZoom (VZ) concept summarizes changes in the surveillance video and renders them on different layers of abstraction—so called 'storyboards'—revealing complementary information on changes.
- Improved simulation capabilities and data integration into detectors allow for more refined verifications (as well as validation of the acquired data) beyond simple 'pass/fail' tests of attributes.
- Establishment of data groups is essential for uncertainty quantification in safeguards applications, with inaccurate grouping impacting material balance evaluation. New data grouping methods can be based on moving average difference and cumulative sum of the operator-inspector differences.

Robotics; virtual and augmented reality

Innovative technologies such as robotics, virtual reality and augmented reality, have the potential to make routine inspection work more efficient and can address more complex verification challenges. Discussions on these technologies focused on how to further leverage these technologies to enhance promising or established safeguards applications.

Challenges

- Customizing for both on-site and post-inspection safeguards activities, commercially-available off-the-shelf augmented reality (AR) systems.

Commercial-off-the-shelf augmented reality (AR) systems evolve extremely fast—the safeguards community has to be prepared to use them soon after they reach an appropriate technology readiness level.

Observations from the Symposium

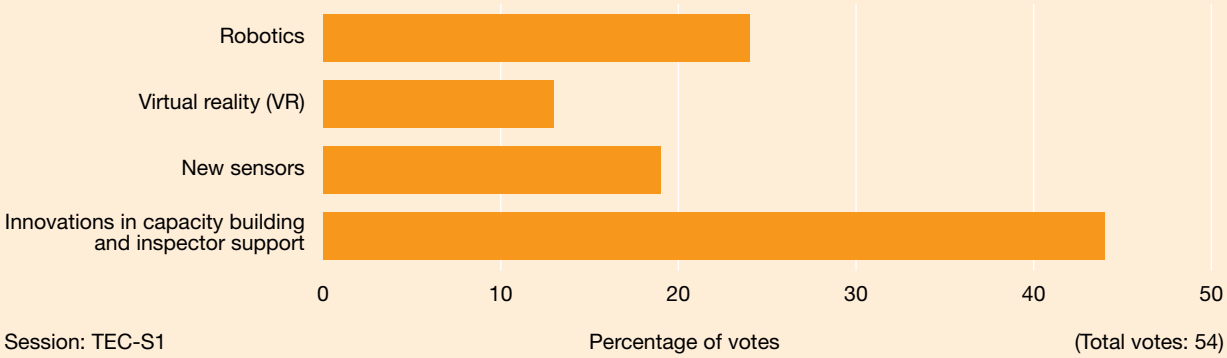
- AR technology is evolving fast, and although commercial systems still exhibit technical constraints the situation is expected to change in a few years.
- Virtual Reality (VR) technology has been used by the safeguards community for some time, and has now reached maturity to be used in safeguards-relevant training. VR training is cost-efficient (compared to traditional training), simplifying logistics, and can be used under a variety of confidentiality constraints.

Traditional safeguards training may easily escape from the memory. Virtual reality (VR) provides a uniquely vivid and thus memorable experience to the trainees.

- Demonstrated VR technologies provide very realistic (sometimes game-like) experiences suitable for training safeguards inspectors and nuclear facility staff.
- For robotics there are new ideas on using swarms of devices with directional neutron detectors to survey an enrichment plant and identify undeclared higher enrichments. Some intriguing technologies in soft robotics have also been demonstrated.
- A recent project for robotics devices to survey a stacked array of difficult-to-access waste drums demonstrated how the 'fast fail' approach to managing the development of a technology solution to a specific challenge can lead to promising results in a short timeframe.

Audience polling

Question: *Which topic will have the greatest impact on the IAEA Safeguards in the coming four years?*



Theme 3: Preparing for safeguards for new facilities, processes and campaigns (NEW)

In response to growing global demand for sustainable energy that reduces carbon emissions, the nuclear industry is developing a large number of new reactors and reactor designs. While some reactors leverage traditional designs, a number of new reactors are coming to market that are smaller in size and mobile, thereby allowing them to be less costly and deployable to more remote areas. Simultaneously, some countries are responding to post-Fukushima nuclear safety concerns by reducing or dismantling their nuclear energy production facilities in favour of developing other energy sources, leading to increasing decommissions.

In this context, Theme 3 focused on the following areas:

- front-end: safeguards implementation at new reactor designs and other facility types;
- back-end: decommissioning, spent fuel and nuclear waste management.

Sessions

[NEW-S1]	The Safeguards Challenges of New and Advanced Reactors- Partnerships
[NEW-S2]	The Safeguards Challenges of New and Advanced Reactors
[NEW-S3]	Experience in Safeguards by Design for New Facility Types
[NEW-S4]	Safeguards for New and Operational Facilities and Cooperation between States and IAEA in Safeguards
[NEW-S5]	Safeguards Techniques for New Facilities and Campaigns
[NEW-S6]	Nuclear Newcomers – Strategies and Experiences with Enhancing Safeguards Infrastructure to Support the Introduction of Nuclear Power
[NEW-S7]	Safeguards on Spent Fuel

Implementation of safeguards at nuclear new builds

Implementation of a safeguards by design approach is important to ensure that safeguards implementation can be effective, efficient, and will minimize the impact on facility operations. Broad involvement in, and communication and understanding of, basic safeguards concepts and safeguards by design is important for States, designers and operators. Participants discussed ideas for how these elements could be enhanced for each entity.

Challenges

- Increasing information sharing—including safety, security, and verification needs—among all safeguards stakeholders in support of incorporating safeguards into new facility designs.
- Enhancing existing safeguards infrastructure in nuclear newcomer countries in preparation for new nuclear power programmes.

Observations from the Symposium

- The IAEA Departments of Safeguards (SG), Nuclear Energy (NE) and Nuclear Safety and Security (NS), technology designers and operators need to engage earlier in safeguards by design discussions that consider safeguards alongside operational and safety needs; specifically, SG and NE should cooperate more actively in support of safeguards for new designs and new builds.

A milestone approach allows the IAEA to support the country in a more organized way.

Safeguards have been receiving less attention than safety.

- Member States and non-traditional sectors may help the IAEA understand how better to identify vendors and develop better ways to communicate with them.
- Better, more visual explanations of design information (DI), nuclear material accountancy (NMA) and containment & surveillance (C/S) should be developed to help those unfamiliar with safeguards concepts and/or implementation understand these measures and how they are used to achieve verification objectives.
- Specific IAEA guidance and cooperation in planning, designing, and safeguards implementation would assist nuclear newcomers. Roadmaps and structured plans are key for Member States preparing for safeguards on new builds.
- Safety, safeguards and security need to be considered together, not in isolation. Engagement of all stakeholders is important, including bilateral or regional partners where relevant.

Safeguarding selected new reactor designs

New and advanced reactors—including those for small modular and transportable reactors—are transforming the market for nuclear energy. Participants provided overviews of changes in nuclear fuel cycles, designs of new facilities, safeguards implementation for existing facilities, or descriptions of technologies being developed for safeguards at such new facilities. Their discussions identified safeguards challenges that need to be addressed, and how to more effectively incorporate safeguards into these new designs.

Challenges

- Developing verification techniques—especially nuclear materials accountancy, containment, and surveillance—in facilities using closed-core Small Modular Reactors (SMRs).
- Developing verification techniques for the thorium fuel cycle.
- Introducing novel ways of thinking to develop innovative and improved safeguards approaches for new facilities.

Nuclear material accountancy remains a key feature of the safeguards approach and design information verification plays a crucial role.

Observations from the Symposium

- Developers of new designs would greatly assist the safeguards community by working with the IAEA to concurrently develop and test safeguards approaches for those reactor designs.
- The IAEA should assist State authorities and domestic stakeholders of new builds that are unfamiliar with safeguards obligations by clarifying the concept of, and requirements for, a ‘safeguardable facility’.
- The IAEA should consider adapting the design information questionnaire (DIQ) forms to accommodate advanced reactor designs. Current safeguards capabilities should be updated, to ensure that they can be used for verification of new nuclear fuel cycles.
- The IAEA has already produced some general conceptual guidance regarding objectives/approaches for safeguards, so that designers can take such guidance into account in the conceptual design of new facilities. It could better disseminate such guidance to the targeted stakeholders.
- How to account for and report nuclear materials should be discussed with all stakeholders, including the IAEA, operators, designers and State authorities.

Decommissioning, spent fuel transfer campaigns, long-term disposition of spent fuel

The increase in decommissioning activities and long term disposition of spent fuel and waste entail specific safeguards challenges, both in the technical sphere and in relation to the resources they involve. These challenges were described and considered by participants with the goal of identifying promising ideas, technologies and methods that could be used to address the specific needs.

Challenges

- Revisiting and rethinking safeguards approaches for spent fuel transfers.
- Documenting and reporting site excavations, repository geological features and infrastructure.

Observations from the Symposium

- Revision of outdated safeguards approaches should be done on an ongoing basis. Member States should be consulted and their experience considered during the conceptual work.
- Closer collaboration, including wide sharing of existing approaches and solutions to challenges, should be encouraged between the Member States, and the broader safeguards, safety, and security communities.

Waste can be terminated and seen as irretrievable. Cost of doing so versus cost of having waste accessible must be evaluated.

Opportunities lie in integration of safeguards equipment, communication between parties, the use of the safeguards by design concept and the implementation of proper reporting systems.

- For safeguards implementation in long-term industrial-scale projects, lessons should be learned and industrial practices adopted for safeguards purposes. In addition, there should be a better understanding of governmental nuclear safety and security regulations and how to harmonize those with safeguards needs.
- The IAEA should provide guidance to Member States on safeguards during decommissioning and the role of the removal of essential equipment, as well as lessons learned and good practices.
- The IAEA should further exploit unattended systems and consider the potential for making use of process monitoring and equipment/instruments primarily used for safety or security. The IAEA and Member States might explore industrial equipment and techniques used in related fields, such as mining. The IAEA could monitor developments in this area, and investigate possible applications.

Theme 4: Shaping the future of safeguards implementation (SGI)

In an era of diminishing budgetary resources accompanied by growing safeguards obligations, it is vital for the safeguards community to 'do more with less'. Central to this need is finding ways to be innovative about the day-to-day implementation of safeguards to make the IAEA, regional, and State authorities more efficient and effective—including opportunities for additional partnerships and resource/information sharing.

Theme 4 of the Symposium included several topics on how to shape the future of safeguards implementation by streamlining and simplifying; building capabilities; resolving challenges; and creating effective cooperation. These discussions included exploring new and innovative ways of working smarter through:

- reporting tools optimization;
- innovations in training, capacity building and knowledge management;
- regional safeguards networks and sharing of experiences among such networks;
- preparations for and implementation of new safeguards obligations; and
- safeguards regulation and licensing.

Sessions

[SGI-S1]	Enhancements and Innovation in Sample Collection and Analysis
[SGI-S2]	Establishing and Strengthening State and Regional Systems of Accounting for and Control of Nuclear Material (S/RSACs)
[SGI-S3]	Establishing and Strengthening State and Regional Systems
[SGI-S4]	Tools, Approaches, and IT Systems for State Safeguards Reporting
[SGI-S5]	Streamlining Information-related Workflows: Small Holders/ LOFs and AP Declarations
[SGI-S6]	ISSAS Missions and SSAC Self-Assessment
[SGI-S7]	Insights and feedback from SSAC discussions
[SGI-S8]	Improvements in the Field: Enhancements to Measurement Techniques
[SGI-S9]	Performance Monitoring in Safeguards
[SGI-S10]	Partnerships, Networks and Regional Collaboration

Streamlining and simplifying

In a tightened resource environment, streamlining and simplifying the existing work and processes takes on added importance. Participant discussions focused on how to achieve these efficiencies through improved communications between stakeholders and better presentation of data.

Challenges

- Enabling Member States understanding of IAEA requirements in order to develop and maintain an effective, efficient, and mutually acceptable State Systems of Accounting for and Control of Nuclear Material (SSAC).
- Streamlining and simplifying information submittal to the IAEA.

Observations from the Symposium

- The IAEA could explore the deployment of visualization tools, to improve analysis and for communication between the IAEA and Member States.

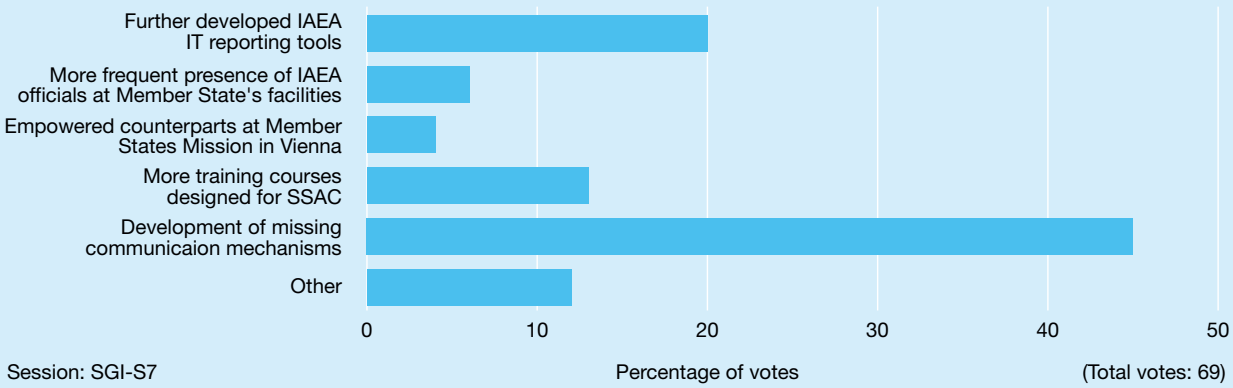
Visualizations provide a deeper understanding of the safeguards activities per country. They can be used as a tool for communication between the IAEA and Member States.

Communicating and sharing knowledge and experiences within and external to the organization are essential to establishing effective and efficient safeguards.

- The IAEA could explore building a web portal for site operators, with a long-term action to deploy Digital Declaration Site Maps (DDSM) in selected States.
- Improved training and handbooks should be provided to accompany the State Declarations Portal (SDP), to improve Member States' understanding of its use.
- The IAEA should consider expanding the role of the State Declarations Portal, to become the 'one-door' application for all secure communications between the State and IAEA, while remaining mindful of issues over Information Technology (IT) infrastructure and low bandwidth scenarios in some States.
- The IAEA should facilitate the sharing of Member State innovations in collecting, validating and submitting information from national licensees and declarants.

Audience polling

Question: *Looking to the future, what do you see as an important action to strengthen communication between the IAEA SG Department and SSAC's?*



Issues often require clarification—there is a need to an effective communication channel in place to solve problems quickly.

Building capabilities

The IAEA must fulfil its mandate against a background of resource constraints and technical challenges. The performance and effectiveness of State authorities significantly impacts safeguards implementation. Participants explored how to build and maintain an overall capacity and cooperation between States and the IAEA that provides effective and efficient safeguards while assuring the continued independence and validity of safeguards conclusions.

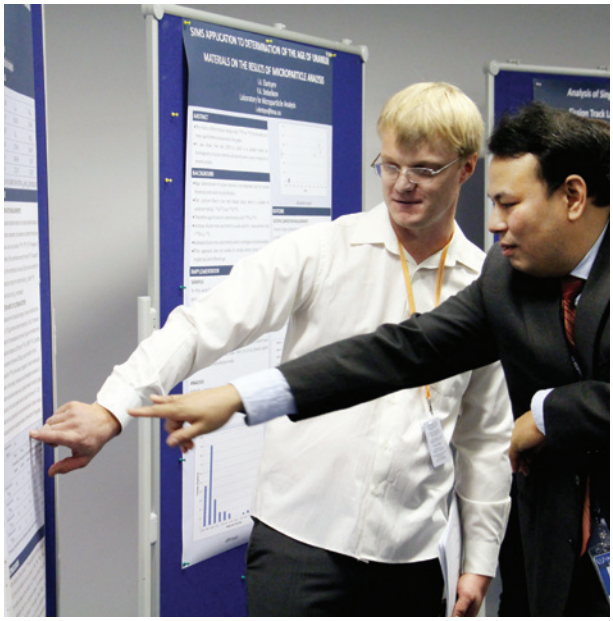
Challenges

- Building institutional capabilities of the entities responsible for safeguards implementation, including effective communication with all stakeholders.
- Measuring, monitoring and reporting on the effectiveness in safeguards implementation, in a way that provides all stakeholders with a clear understanding of the situation.
- Assuring credible cooperation and capacity-building while preserving the IAEA's ability to independently draw conclusions.

Observations from the Symposium

- All parties may make full use of State and regional systems; professional associations and institutions; and nuclear vendors, to supplement the essential support and training offered to SSACs by the IAEA.

A positive aspect of SSAC self-assessment is that it increases the awareness of safeguards amongst stakeholders and reminds SG staff of the importance of their work.



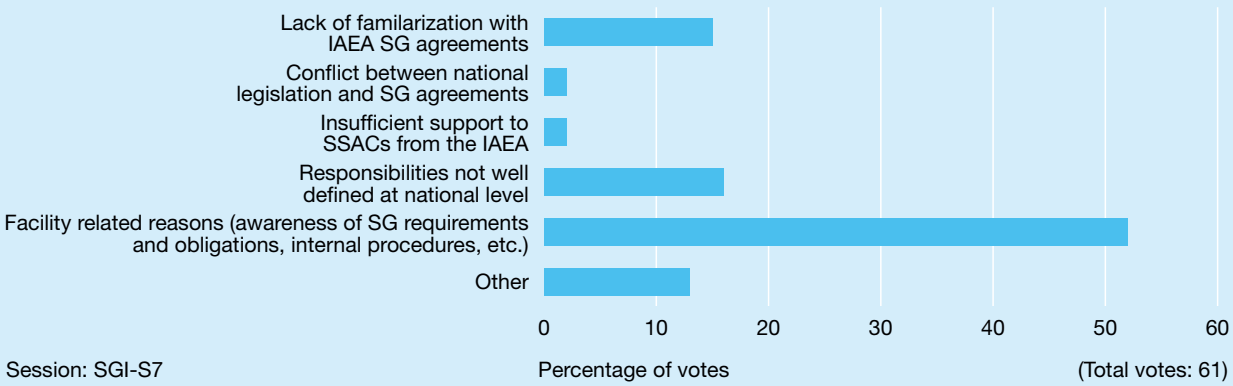
Preparation and implementation of IAEA International SSAC Advisory Service (ISSAS) is not a burden to the State.

- Member States may consider seeking international support, advice from the IAEA and other Member States with similar fuel cycles and other international initiatives, in order to establish an adequate and well-communicated legal framework.
- Member States could employ self-assessment as a way to identify potential gaps in their ability to sustain national resources and expertise.

- Member States and the IAEA could consider innovative ways to train SSAC personnel, for example on operating joint use equipment.
- Member States may consider making full use of the IAEA SSAC Advisory Service (ISSAS) Missions. The IAEA should promulgate good practices, such as identified through ISSAS Missions.
- The IAEA and Member States Support Programmes (MSSPs) would benefit safeguards by continuing to facilitate collaboration between analytical laboratories, because it provides an overall capability greater than that available within any one Member State, and promotes the continuous improvement of Member States' measurement systems.
- The MSSPs would benefit safeguards by continuing to support IAEA capabilities improvements for relevant measurement disciplines, including Non-Destructive Analysis (NDA), laboratory-based sample analysis, modelling and statistical methodologies.

Audience polling

Question: *Which are the main cause of Member States' reporting issue to the IAEA?*



Resolving challenges

A number of procedural and technical challenges currently impact safeguards implementation. Participants discussed the potential for addressing these issues through sharing and adoption of good practices and lessons learnt from other Member States, enhancing technical cooperation to fill current gaps in technology, and/or improving performance assessment and statistical evaluation.

Challenges

- Addressing specific safeguards implementation and reporting challenges posed by locations-outside-facilities (LOFs) and small holders.
- Reducing the time and cost required for in-field sample collection, conditioning and shipment.
- Reducing operator-inspector measurement bias.
- Maximizing the value of existing measurement data and techniques.
- Creating a common understanding of the meaning of 'effective safeguards implementation' that leverages performance metrics from adequate Quality Control (QC) programmes, both at the IAEA and within national authorities.

Observations from the Symposium

- Member States could meet the challenges of small holders and LOFs through a strong and well-communicated legal and regulatory framework, sensitising the Research and Development (R&D) community to the requirements of an Additional Protocol (AP) and facilitating State cooperation with the IAEA.
- Further application of in field-portable destructive analysis systems, and non-destructive analysis measurement systems, including refinement of legacy on-line instrumentation, should be pursued with support from the Member States for development and testing.

There is an inevitable danger of selecting performance indicators that 'make us look good'.

Early and regular engagement with stakeholders is a key element in the development of safeguards regulations.

- Member States could reduce operator-inspector measurement bias through enhanced collaboration, engaging operators in inter-laboratory comparison exercises. Results could contribute to the revision of the International Target Values, used to judging the reliability of analytical techniques applied to industrial nuclear and fissile material subject to safeguards verification.
- Collaboration in the production and certification of reference materials, to meet increasingly challenging requirements, should be continued and strengthened wherever possible.
- The IAEA could encourage assessment of improved statistical tools to increase the value of existing measurement techniques, including treatment of laboratory-censored measurement values.
- A broader quality control (QC) programme, with published results, would provide Member States with an enhanced level of confidence that the IAEA verification results are credible. QC can provide performance metrics from which the need for improvement could be identified.

Creating effective cooperation

Individual States maintain unique relationships with the IAEA through training and in-field interactions, State and regional authorities, such as ABACC and Euratom, and networks or professional societies such as AAEA, APSN, ESARDA and INMM. In this context, participants discussed ways to best utilize and build upon existing networks and partnerships to strengthen collaboration in safeguards.

Challenges

- Developing and maintaining an effective and efficient SSAC that meets the requirements and obligations of both national legislation and safeguards agreements with the IAEA.

- Enhancing cooperation between the IAEA and the SSAC/RSSAC, as well as between SSACs, to improve safeguards innovation and efficiencies.
- Optimizing State assistance and coordination to establish and/or strengthen their safeguards authorities.

The important consideration should be what the performance results mean to us and what do we do with them.

Observations from the Symposium

- Member States could continue their substantial efforts in developing and maintaining an effective and efficient SSAC that meets the national legal requirements of the State and the obligations under their safeguards agreements.
- The mechanisms and fora provided by Member State Support Programmes, and by technical and expert meetings, remain important contributions to the work of the IAEA.
- Regional networks could consider establishing a 'network of networks', to coordinate activities and enhance global coverage of safeguards support.
- The IAEA could consider acting as broker for assistance to Member States from regional networks, such as those engaged in basic safeguards training activities.

Crosscutting participant observations

Beyond the observations provided by participants for specific topics in a thematic area, there were a number of crosscutting observations that emerged as well. These were observations that emerged in numerous sessions and some in multiple thematic areas. Generally, these observations reflected on one of two broad challenges: (1) improving the connection between technological opportunities and real world applications; and (2) improving communications and engagements to energize and enhance the safeguards community. Specifically, participants noted:

- The safeguards community as a whole needs to provide better communications (including clearer and more visual information) to explain the purpose and importance of the safeguards mission.
- There must be more engagement, cooperation and information sharing between all partners and operating entities within the safeguards community, including industry groups.
- Going forward, ensuring trust in data, processes, and between stakeholders will only become more important.
- There is no technology that should substitute for human involvement in decision making for the inspector and analyst functions. But many technologies could complement and enhance the decision making.
- Numerous promising technologies could address various safeguards implementation challenges. Some of these technologies have clearly emerged, while others are intriguing but require further research.

One of the challenges in the area of information management is to ensure that the IAEA remembers all of the information it has.

- Although a technology may have the capability to improve a particular verification challenge, the gap between technical readiness and adoption in the field is large and hinders swift implementation. Therefore the following is important:
  - Gaining support from the operators so they see the benefit of a given technology and make adoption more straightforward.
  - Moving beyond identifying a use case and actually conducting a cost/benefit analysis to ensure its deployment is justified.
  - Accounting for field use when developing verification technologies, as to minimize any significant re-designs before deployment.
  - Managing and carefully coordinating various constraints in nuclear facilities with regulators and operators.
- Member State Support Programmes to IAEA safeguards are functioning well—both the IAEA and Member States agree—for implementing R&D programs.
- To further direct the R&D community's efforts, the IAEA could complement its MSSP coordination by regularly developing detailed and relevant use cases that highlight specific safeguards R&D needs to be addressed by external partners.
- The IAEA could more explicitly state the need to attract and sustain non-traditional partnerships in future R&D plans.

Closing plenary

Panel on key insights and outcomes from the thematic tracks

As part of the Closing Plenary of the Symposium, at this panel chaired by Mr Jacques Baute (Director of Information Management, Department of Safeguards, IAEA), the four thematic rapporteurs presented track-based highlights and observations.

Ms Cristina Versino (Senior Scientist in the Joint Research Centre, European Commission), speaking on the 'Addressing growing safeguards challenges' track, shared how track participants had focused much of their discussion on how actors outside safeguards could help address safeguards community challenges. Engaging with the strategic-trade-control community was noted as a means to obtain a better understanding of synergies and challenges stemming from globalized markets, knowledge management, and emerging technologies. Discussions also suggested that the IAEA could take a stronger leadership role in advising Member States and their partners on security best practices for Information Technology. Additionally, to enlarge the pool of qualified candidates to work in the safeguards field, participants discussed the need to incorporate safeguards as part of a broader nuclear training curriculum, particularly at universities. Finally, participants viewed communicating safeguards in a clear, easy to understand and attractive way as necessary for effective engagement with all non-traditional sectors.

Ms Yana Feldman (International Safeguards and Non Proliferation Analyst, Lawrence Livermore National Laboratory, USA), addressing the 'Leveraging technological advancements for safeguards applications' track, highlighted the promising advances in emerging technologies for addressing various challenges facing safeguards, with some technologies having reached a sufficient level of maturity for adoption by the IAEA, while others are still poorly understood. Visualization has long been recognized as a powerful technique for more effective exploration and presentation of different types of data. Despite its complexity, participants considered machine learning technology to be ready for

some specific safeguards applications, guided by and in support of a human analyst. While the fundamentals of physics have not changed, the technology for data acquisition and processing has advanced to allow more refined and challenging measurements of nuclear material. Distributed ledger technology's impact, benefits and risks are still not very well understood in a safeguards context, which tended to prompt divergent perspectives among participants on its potential to impact the mission.

Mr Kenji Murakami (Special Assistant to the Minister, Ministry of Foreign Affairs, Japan), addressing the 'Preparing for safeguards for new facilities, processes and campaigns' track, noted how discussions revealed that innovative safeguards approaches and verification technologies need to be developed for new and advanced facilities. Key to making such new approaches and technologies effective and efficient (and minimizing impacts on facility operations) is early communication and interaction amongst stakeholders. Broad involvement in, and communication and understanding of, basic safeguards concepts and safeguards by design is important for States, designers and operators. Safeguards as well as nuclear energy, safety and security experts should engage early in safeguards by design discussions, especially in nuclear newcomer countries, with technology designers and operators considering safeguards, as well as operational and safety needs. Such engagements can also help address the need for learning from industrial practices and for applying industrial methods for safeguards use.

Mr Robert Floyd (Director General, Australian Safeguards and Non-Proliferation Office), addressing the 'Shaping the future of safeguards implementation' track, noted that participants had provided the basis for optimism regarding the success of the non-proliferation effort as reflected in participant discussions on four crosscutting areas of opportunity. First, building partnerships at various levels (between people, States, regional networks, etc.) can expand and strengthen the foundation of the overall safeguards capability. Second, significant benefits can be derived from enhanced communication between State authorities, licensees and the IAEA. Third, increased recruiting, training and assistance, including outreach and education to raise safeguards visibility, can help the community better address current and future challenges. Finally, reinforcing collaboration and promoting technological innovation among the various parties could maximize the value of existing tools, techniques and approaches.

Innovation panel – mechanisms for future innovations in safeguards

In the closing plenary, the Symposium gained valuable insights from the experiences and approaches to innovation of representatives from three organizations outside the safeguards community. The panellists were:

- Mr Thomas Weis (Assistant Professor; Industrial Design Department at the Rhode Island School of Design);
- Mr Oliver Hoffmann (EU Council Presidency ICT Coordinator; Austrian Ministry for Transport, Innovation and Technology);
- Mr Abdulaziz Aljaziziri (Deputy CEO; Dubai Future Foundation).

During their opening remarks, the panellists emphasized that the starting point for innovation should be a question

The outcome depends upon the challenge: we need the right question in mind, or there will be a different outcome.

Create an environment in which ideas can take hold and take flight through incubating and prototyping.

or challenge, and that an organization should seek innovation with the purpose of achieving a clear and tangible outcome.

Innovation is essential in order to keep pace with the increasing speed of developments elsewhere, and to avoid an organization potentially becoming stale through focusing too much on its processes rather than their intended outcome. However, the panellists emphasized that innovation within an organization need not be grand discoveries or prominent efforts. Nor should it require taking significant risks. Instead, it was argued, innovations might involve specific process-oriented changes to help the organization reach its wider objectives.

The discussion that followed considered the environment required for innovation to flourish. A supportive culture and strong leadership, at every single level, were prerequisites to create conditions conducive for innovation. Staff should feel comfortable to fail, and to provide ideas that may not be promoted further: success should be rewarded but, equally, failure should not be punished. At the same time, an organization like the IAEA should not behave like start-up companies, which have a high failure rate, but should provide a stable base for innovation within a well-regulated environment, maintaining a balance between process for the organization and creativity for the individual. Such an environment should create trust and generate innovation

that flows both from the bottom up and top down—an environment where everyone in the organization is part of the innovation process, feels empowered to innovate, shares their ideas, and otherwise contributes in new ways.

Innovation requires regulation and funding, but also different viewpoints and understanding of constraints. Leadership must maintain a balanced view when evaluating whether innovations appropriately align with the organization's mission. Simply having excellent ideas is not sufficient: there must be the resources, to transform these ideas into something practical and tangible, and an environment in which to test and improve without the potential for failure to have a critical impact upon the organization's mission.

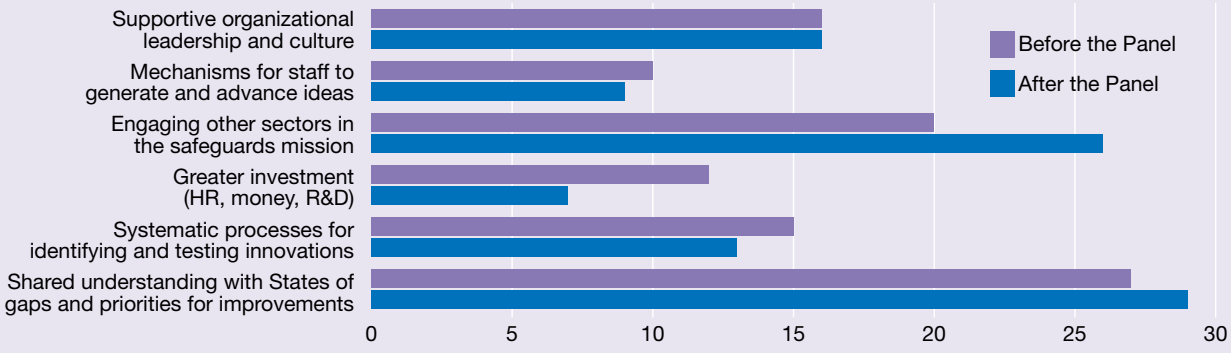
The panel concluded with participants discussing the importance of involving other perspectives and skillsets to facilitate innovation, including external collaboration. Engagement with stakeholders, international fora and global outreach to start-ups all have a role to play. The collaborations yielding some of the best innovations, the panellists argued, are those that involve appropriate non-traditional partners and people from outside traditionally cooperating sectors. While such collaborations may require additional effort to communicate and understand the constraints of both sides, such an investment is expected to bring long-term benefits. Innovations should be considered within a single long-term vision, and both the challenge and the innovation should be communicated to stakeholders in the context of an impact/outcome on that vision, rather than in terms of the innovation itself.

Before and after the panel, there was a poll asking the audience: 'What would make the biggest contribution to innovation in the Department of Safeguards?' The notable increase, following the session, in support for engaging other sectors in the safeguards mission highlighted the panel's emphasis on external collaboration, and how this resonated with the audience.

Collaboration takes time. Innovation takes commitment. Don't be afraid to try.

Audience polling

Question: *What would make the biggest contribution to innovation in the Department of Safeguards?*



Session: PLE-S10

Percentage of votes

(Total votes: 215/158)

Other sessions and events

Panel on improving gender balance

Women have been engaged in nuclear science since the very beginning. However, women remain underrepresented in the nuclear sector as a whole. The IAEA is committed to improve gender parity, especially to increase representation of female professional and higher categories for the Department of Safeguards; its female workforce in the professional and higher level categories currently stands at 23% in general while only 13% of managers are women.

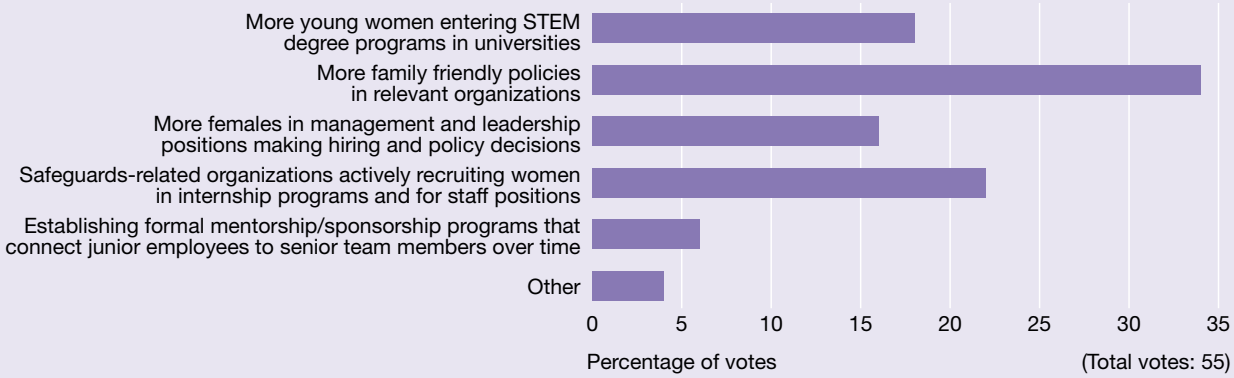
Two panel discussions were held on the issue of improving gender balance in the area of nuclear safeguards. Leading women, from various professions associated with nuclear safeguards, discussed strategies and steps to be taken to achieve gender parity and made recommendations for young women considering a career in safeguards.

The panels highlighted the broad range of career options in nuclear safeguards and verification: one focusing on policy, law and regulatory careers in safeguards; while the other focused on science, technology, engineering and mathematics (STEM) careers.

Panelists discussed the challenges that exist for women within nuclear safeguards and other nuclear-related fields, highlighting those stemming from gender-based societal expectations and stereotypes. Flexible work schedules and family-friendly policies, including paid maternity leave, were some of the solutions put forward, which the polling showed as resonating with the audience.

Audience polling

Question: *What do you think would have the greatest impact on increasing gender balance in safeguards?*



Recruiting events

A number of Symposium sessions provided interested participants with details about the IAEA's competency-based recruiting process. In addition, networking with IAEA staff working in Safeguards provided opportunities for learning about specific types of jobs in detail and for asking more questions on what it is like to work for the IAEA.

The series of sessions began with 'Launching Session: Working for the IAEA', which covered the IAEA's overall recruitment policy and its process.

A panel session followed, with five staff members from the Department of Safeguards discussing their experiences in working for the IAEA.

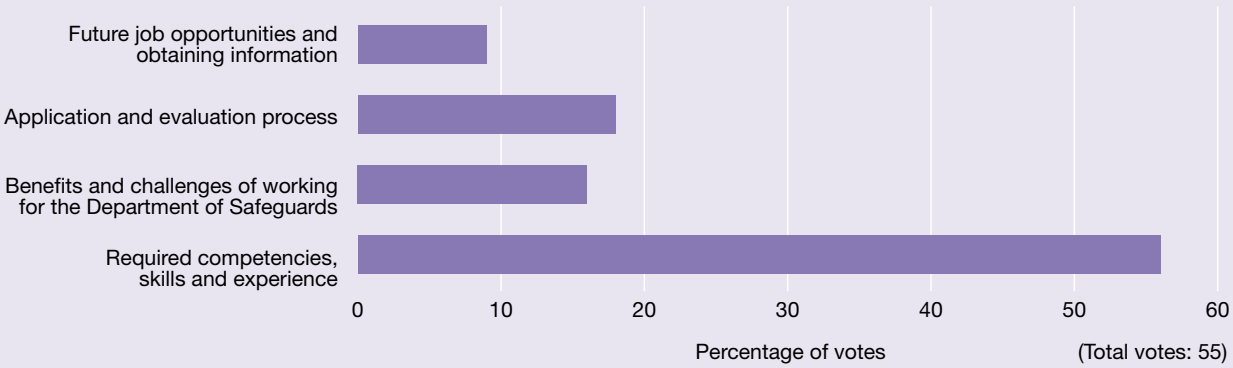
From the second day of the Symposium, daily one-hour sessions from the Department of Management were held to provide detailed information on the following topics associated with the application process:

- Competency based interview with IAEA;
- Planning and Preparation for a Job Application – Personal History Form (PHF);
- Preparing for Interviews and SONRU.

Audience polling suggested that potential candidates were most interested in learning more about what attributes the Department is looking for in successful applicants.

Audience polling

Question: *What are you most interested in learning about working in the Department of Safeguards?*



Workshop on safeguards analytical services

Fifty-six participants visited the IAEA Safeguards Analytical Laboratories in Seibersdorf. They participated in the following activities:

- Tour of the Nuclear Material Laboratory
- Tour of the Environmental Sample Laboratory
- Presentation on laboratory quality control
- Demonstration of sample collection, logistics and shipping

The programme continued with a keynote speech from Ms. Yetunde Agrebe, of the European Commission Joint Research Centre (EC JRC), which addressed the historical connections between the EC JRC and IAEA safeguards. The Workshop concluded with a panel session focused on women in the nuclear analytical sciences, during which panelists from Japan, France and the EC JRC discussed opportunities and challenges for women in laboratory-based work and encouraged the recruitment of women into the nuclear analytical sciences.

ESPACE presentations

The ESPACE areas were two dedicated open spaces, where contributions favoring a visual presentation or demonstration were made. One of these areas was intended for presentations by IAEA staff members, while the other one was for external participants (cooperating organizations, MSSPs, industries, institutions, etc.).

The ESPACE areas were employed on each day of the Symposium, with the overall Programme consisting of 30 presentations and demonstrations, including 16 prepared by IAEA experts.

Regional Mixers

The Regional Mixers took place to provide networking and discussion opportunities for participants from the same region. The sessions were designed to encourage information exchange and free discussion, with IAEA Staff available to support the discussions.

Side-events

In order to ensure that participants could use the opportunity of being at IAEA Headquarters to clarify any questions that may arise from working with the Agency, various side-events were organized. During these side-events, Symposium participants met with IAEA staff specialized in the relevant field, seeking answers to their questions.

Side-events included the following:

- Presentation – Collaborative Analysis Platform (CAP), prepared by staff members;
- Drop-in Session – Q&A on Safeguards Regulatory Framework with IAEA-Office of Legal Affairs, enabling individual/group consultations on safeguards legislative and regulatory topical matters with IAEA Office of Legal Affairs (OLA) staff.
- Drop-in Session – Support Programme Information and Communication System (SPRICS) for MSSP Task Administration: Demonstration and Q&A, providing a short tour and Q&A session on MSSP- and SPRICS-related questions. SPRICS (sprics.iaea.org) gives MSSP task officers access to proposals (SP-1s), tasks, review meeting materials, processes, FAQs, etc. Staff were also available for individual consultations to address any specific issues.
- Round Table Discussion – Safeguards by Design in Advanced Nuclear Reactors;
- Drop-in Session – Safeguards State Declarations Portal (SDP) and Protocol Reporter version 3 (PR3) for State Safeguards Reporting, providing the opportunity for individual/group consultations with IAEA staff on the SDP and PR-3.

Reception keynote speech

The Head of Digital Development of the Wiener Staatsoper, Mr Christopher Widauer, delivered a keynote speech on the experience of successfully incorporating innovation into the Vienna State Opera. The focus of his presentation was on how to introduce digital technologies in an otherwise ‘traditional’ setting, containing long-standing organizational and work practices. He indicated that obtaining a commitment to incorporate new practices from senior management had been a necessary first step. A dedicated effort to raise internal awareness on the potential and usefulness of new technologies also proved essential to building organizational support. Moreover, expectation from the State Opera’s external stakeholders (e.g. patrons, sponsors) that the institution adopt relevant new technologies and practices further helped drive the innovation effort. Collectively, these factors helped create a freedom to explore innovation options, including working with start-ups willing and flexible enough to explore and develop new paths for the Vienna State Opera.

Ideas for action

Ideas for action

This part of the report offers a set of ideas for potential action around innovation, partnering and improving communication as well as collaboration among States, industry, academia, non-governmental organizations and the IAEA. These ideas should be considered not only by the IAEA but by the safeguards community at large for further development as deemed necessary.

The ideas for potential action are based on Symposium participants' insights as reflected in Part I of this report. They resonated as matters that would deserve further consideration and were refined by the Department of Safeguards. The numbering does not imply any priority order.

It is to be noted that the ideas for action imply no commitment to be implemented, nor give rise to any obligations for the IAEA or other actors.

> *"… The new ideas and practical proposals generated during the symposium will be summarized in a report to be issued in 2019 and will guide future actions around innovation, partnering and improving communication and collaboration among States, industry, academia, non-governmental organizations and the Agency."*
>
> IAEA Safeguards Implementation Report 2018

1. Rethink spent fuel verification for optimized safeguards

Modern fuel designs, disassembly scenarios, increasing transfers of spent fuel and resulting increasing quantities in storage bring new challenges in maintaining effective safeguards verification. At the same time, IAEA capabilities for quantitative measurement of spent fuel are limited. A better understanding of these factors would contribute to optimizing safeguards approaches to spent fuel verification, in order to maintain cost-effective safeguards on the nuclear fuel cycle back end.

Potential actions

- Consider nuclear fuel designs, with respect to diversion and misuse scenarios in terms of evolving factors, including:
  - Reduced self-protection during long-term spent fuel storage;
  - Modern fuel designs offering pin replacement/ substitution options;
  - New nuclear fuel compositions; and
  - Improvements to measurement capabilities of spent fuel in casks.
- Explore areas for technology development that could enhance spent fuel verification, including measurement accuracy and reliability.

Expected benefits

Accounting for evolving factors affecting nuclear fuel verification could result in efficiency gains while improving safeguards effectiveness. Robust and optimized spent fuel verification, in particular prior to spent fuel transfers to difficult-to-access locations, should be beneficial to both the IAEA and States.

2. Reinforce implementation of multisource data visualization for better integration, analysis and use of safeguards information

The IAEA receives many types of data and streams, in different formats, requiring validation and evaluation. To make full use of available data and reduce the risk of missing signals indicative of diversion, misuse or undeclared nuclear material or activities, a number of techniques to visualize, integrate and analyse data are already underway within the IAEA. Reinforcing the integration of multi-format data sets for analysis, using innovative technologies, would enable both objectives. Such tools would maximize the effectiveness of expert reviews and relevant decision-making.

Potential actions

Accelerate and integrate initiatives in data visualization, making use of the latest developments, inter alia including:

- Establish or enhance collaboration between the IAEA, Member States and competent partners to identify and explore the most favourable means to utilize visualizations, including tools and best practices from other organizations;
- Make use of relevant existing, and/or develop customized, software based on well-defined Safeguards needs;
- Deploy relevant crowdsourcing to maximize opportunities from external perspectives; and
- Develop training for State Evaluation Groups and managers that accounts for aspects of behavioural science and human cognition in making decisions that use information from automated visualization tools.

Expected benefits

Enhancing use of data visualization could advance data interpretation for safeguards evaluation and relevant decision-making. Improved efficiency in data processing and analysis would enable full use of available information to support fact-finding and focused attention on areas requiring clarification.

3. Build national safeguards capacity by supporting the improvement of SSAC performance

The effectiveness of State and/or regional authorities is critical to the successful implementation of safeguards. An ability to identify weaknesses in SSACs would help focus relevant IAEA support to address areas for improvement. Direct collaboration between States to share experiences and identify best practices would effectively complement support provided by the IAEA.

Potential actions

- Further support SRAs with self-assessment tools and procedures for comparing against the requirements and obligations under their safeguards agreements;
- Use SSAC self-assessments and surveys to identify training needs and develop tools, such as the State Declarations Portal (SDP), to support SSACs in meeting their obligations;
- Promote the good practice of requesting IAEA SSAC Advisory Service (ISSAS) missions and implementation of follow up actions;
- Continue to develop and deploy new e-learning tools and other innovative ways to support SSAC personnel;
- Encourage collaboration between stakeholders (States, regional networks, non-traditional partners) to enhance SSACs' capacity-building, possibly with some role for the IAEA; and
- Promote the development of 'Centres of Excellence' and 'Safeguards Champions' to generate sustainable momentum in capacity building.

Expected benefits

Training and self-assessments are intended to enable SSACs' more consistent and robust performance, with early warning of issues that may adversely affect it. Greater understanding on the part of the Member States of their safeguards undertakings would result in more effective, efficient and consistent SSACs performance for the benefit of IAEA safeguards implementation. Self-assessments, when performed regularly, would inform on trends and progress made. The wider sharing between States themselves of good practices could further support effective safeguards implementation. Improved and consistent use of declaration tools such as the SDP has the potential to enhance consistent and secure communications between States and IAEA.

4. Bolster safeguards education to build the next generation of safeguards experts

Some academic institutions offer courses directly relevant to the nuclear field in general. However, the subjects of non-proliferation and safeguards are less frequently addressed. Outreach to academia could promote coherent, consistent and accurate safeguards curricula across States.

Potential actions

- Support the development of a robust curriculum on international safeguards and nuclear non-proliferation that could be offered to academia throughout the world;
- Introduce proven concepts and analytical techniques from behavioural science, as appropriate, into the curriculum to provide future safeguards practitioners with a broader skill set for application to diverse challenges;
- Foster increased gender and geographic diversity in STEM education, in order to attract a new generation to careers in the nuclear field, including international safeguards;

- Develop a forum to exchange experience about professional courses and the development of learning material for academia; and
- Expand safeguards education partnerships by facilitating interactions between SSACs/other stakeholders and academic establishments.

Expected benefits

Successful engagement with existing academic institutions and promotion of the IAEA's role and practices may result in more uniformly educated staff working in the nuclear field, with broader awareness of State obligations in terms of IAEA safeguards. This has a potential to provide an expanded pool of resources for recruitment by State authorities and the IAEA, and could benefit all parties by providing a consistent understanding of international safeguards while assisting in the development of a robust safeguards culture.

5. Proactively engage industry to ensure the early incorporation of safeguards requirements into nuclear projects

The IAEA, supported by several Member States, has prepared guidance to facilitate early incorporation of safeguards concepts into the design of new nuclear projects. With the nuclear industry continuing to evolve and many new designs now emerging, safeguards by design is gaining in strategic importance. By proactively engaging States' nuclear industry, costly retrofitting efforts to meet safeguards requirements may be avoided while facilitating development of effective and efficient safeguards approaches.

Potential actions

Continue to conduct proactive outreach to all relevant stakeholders on the integration of safeguards concepts into the early stages of new nuclear projects, including:

- Further develop safeguards awareness-raising initiatives among stakeholders (e.g. designers, vendors, operators, and new comer countries), and provide relevant training;
- Identify lessons learned from other industries and regulators on how to engage vendors, including how to ensure confidentiality of design aspects and develop effective approaches supporting safeguards by design; and
- Enhance active cooperation between the IAEA Departments (e.g. Department of Safeguards, Department of Nuclear Energy, and Department of Nuclear Safety and Security), and ensure effective engagement of relevant national and regional stakeholders and partners.

Expected benefits

Integration of safeguards concepts into the early stages of new nuclear projects may result in effective, consistent and attainable safeguards approaches, with early indication of legal or technical issues. The potential to harmonize safeguards, safety and security may reduce the impact on the operator, for instance by avoiding costly retrofitting.

6. Develop tailored communication on the role and importance of safeguards

To foster support for the safeguards mission across all sectors (governmental, financial, industrial, R&D, academic, public etc.) more proactive communication is required. This should have clear objectives, with messages tailored to the targeted audiences. Moreover, as a cooperative effort, it should improve lay audiences' awareness and understanding of safeguards as a fundamental component of nuclear non-proliferation.

Potential actions

- Develop tailored communication, which targets multiple audience types for building awareness about the purpose and value of safeguards;
- Actively approach various audience types such as newcomer countries, vendors, States holding small quantities of nuclear material, operators of locations outside facilities and the R&D community, to ensure they are properly informed about international safeguards; and

- Create and use simpler, less technical, messages that are understandable by public at large, and make full use of diverse media channels and modern presentation techniques to disseminate these messages.

Expected benefits

Tailored communication to targeted audiences could benefit the safeguards community through increased public awareness of the value of safeguards and therefore acceptance of safeguards requirements (both in terms of obligations and resources).

7. Expand and leverage non-traditional partnerships to broaden political, financial and technical support to the safeguards mission

The IAEA remains primarily focused on its existing partnerships, with limited insight into the wealth of opportunities that might be seized from engaging with a broader set of stakeholders. Closer engagement with the wider technical, social and academic communities, as well as with new non-traditional sectors, could provide opportunities to strengthen the political, financial and technical support for the safeguards mission.

Potential actions

Explore means of expanding and leveraging non-traditional expertise and partnerships, as appropriate, including:

- Develop means for engagement with non-traditional partners, drawing upon the IAEA's experience and best practices from other relevant sectors;
- Develop and set up a framework for mobilizing and directing support from non-traditional partners towards the IAEA's strategic priorities and needs; and
- Further develop crowdsourcing pilot outreach projects, such as the recent IAEA robotics challenge, to mobilize expertise and research that address specific IAEA needs.

Expected benefits

Expanding engagement with non-traditional partners could enhance the understanding of safeguards mission and related challenges, as well as provide greater access to actors holding valuable expertise (e.g. multilateral organizations, non-nuclear sectors, NGOs, start-ups, universities). This could result in a broader pool of resource providers, while increased crowd/expert sourcing may bring expanded perspectives and new ideas in support of safeguards.

Annex

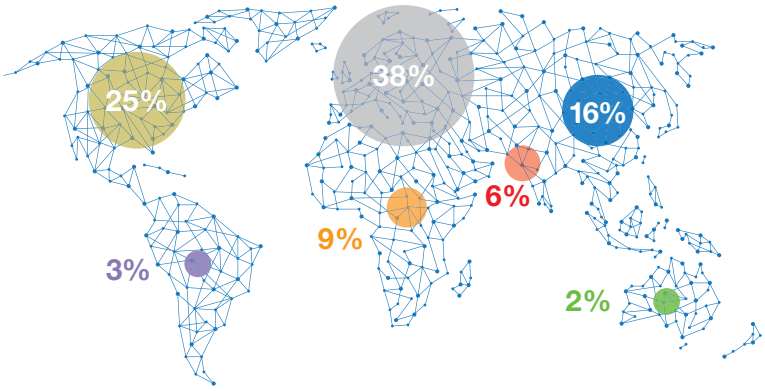
The Symposium in numbers

1. Participants

The 13th Symposium on International Safeguards was held with the largest number of participants to date. 802 participants joined from around the world, representing a 30% increase from the 615 participants in 2014.

Of the total number of participants, 517 were officially designated by Member States, 205 participants came from IGOs/NGOs (including 156 from the IAEA), and 80 were observers. The geographical distribution of officially designated participants was as follows:

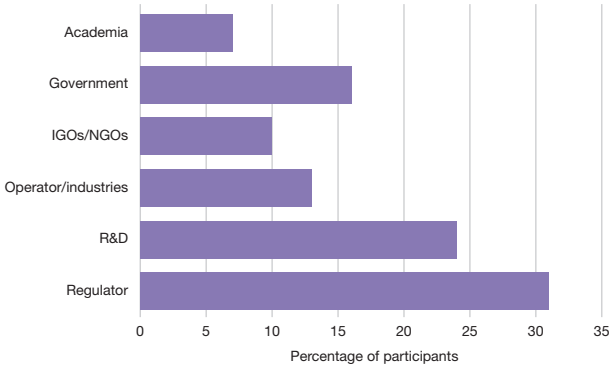
Geographical distribution of participants designated by Member States



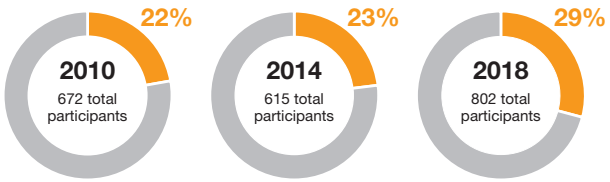
The Symposium provided travel grants for 93 individuals from developing countries. The grants contributed to furthering participant diversity, resulting in the number of participating countries increasing from 54 in 2014 to 90 at the 2018 Symposium.

The Symposium attracted participants from various sectors. One of the main objectives for the Symposium was to mobilize partnerships to further explore ideas, bring innovations into the work of the Department of Safeguards, and support long-term safeguards research and development needs. In order to achieve the objective, the Symposium actively approached academia and non-traditional sectors in the early planning stages to encourage their participation.

Engagement with Academia and non-traditional sectors



The 2018 Safeguards Symposium had the highest participation of women to date.



Women held roles as chairs, panellists, roundtable members, contributors, and poster presenters during the Symposium. Of the 425 roles during the Symposium, 148 (35%) were performed by women. Notably, 24 out of 58 Session Chairs were women (41%).

Representation of women in the nuclear sector, including safeguards, continues to be a challenge. The IAEA is committed to improving women's representation throughout the organization, including through a range of targeted outreach and awareness-raising activities. In order to improve gender balance in nuclear safeguards, the Symposium had two dedicated panels focused the issue. (Please refer to page 39 for detail.)

2. Participant feedback

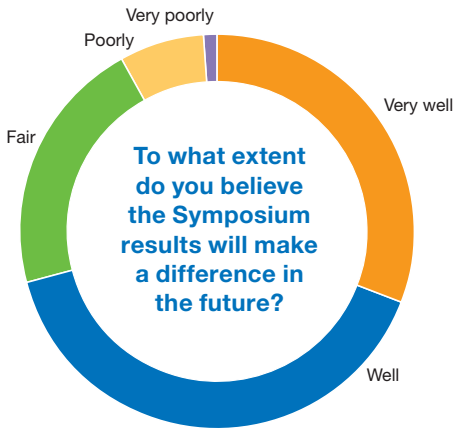
Of those who participated in the post-Symposium feedback survey, 80% responded that the Symposium met their personal expectation, and 86% responded that she/he would recommend this event to colleagues.[1]

The Symposium sessions were all connected to the three key stated objectives of innovations, partnerships, and improvement. 85% of respondents confirmed that the event met these objectives.

Technical sessions at this Symposium followed a new format, emphasizing interaction and dialogue, the generation of new ideas and the achievement of results. Technical Sessions were streamlined to examine in greater depth into a smaller number of topics. Out of those that participated in the feedback survey, 85% responded that the event covered the relevant topics.

The feedback survey also measured the expected impact of the Symposium. Of those that participated in the survey, 73% replied that what they have learned in the Symposium would be applicable to their work, and 71% replied that the Symposium results would make a difference in the future.

Impact of the Symposium in the future



1 Percentage of participants who replied “very well” or “well” on post-symposium survey. The same implies to the result of other survey questions hereafter.

Symposium documents

All documents from the Symposium can be accessed from the ‘Event’ page of the Symposium website (www.iaea.org/events/symposium-on-international-safeguards-2018).

- Programme
- Programme Overview
- Book of Abstracts
- Papers, Posters, Presentations

Video streams

Recorded video streams are available for some of the plenaries and sessions from the ‘Live Video Stream’ page of the Symposium website (http://streaming.iaea.org/20937).

[PLE-S1]	Opening Plenary
[PLE-S3]	Panel on Improving Gender Balance: Policy, Law and Regulatory Careers in Safeguards
[PLE-S4]	Panel on Improving Gender Balance: Science, Technology, Engineering and Math (STEM) Careers in Safeguards
[PLE-S8]	Keynote Speech on Innovation
[PLE-S10]	Closing Plenary
[REC-S1]	Launching Session: Working for the IAEA

Acknowledgements

The Symposium was the result of the hard work of the Symposium Organizing Team from the Department's Section for Strategic Planning and External Coordination, and continuous support from the Directors of all the Divisions within the Department of the Safeguards. The Symposium would not have been possible without generous support from contributing organizations.

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Asia-Pacific Safeguards Network (APSN)

European Safeguards Research & Development Association (ESARDA)

Institute of Nuclear Materials Management (INMM)

Member State Support Programmes (MSSPs)[1]

Other contributors

Carnegie Corporation of New York

International Nuclear Safeguards Engagement Program (INSEP)

Nuclear Threat Initiative (NTI)

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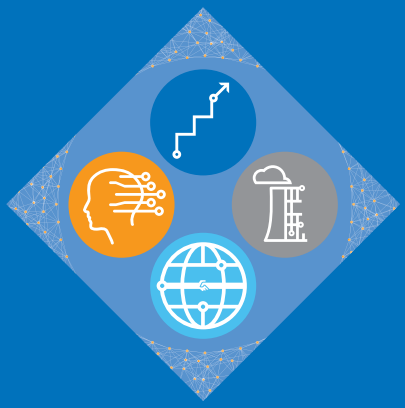

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CN-267
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