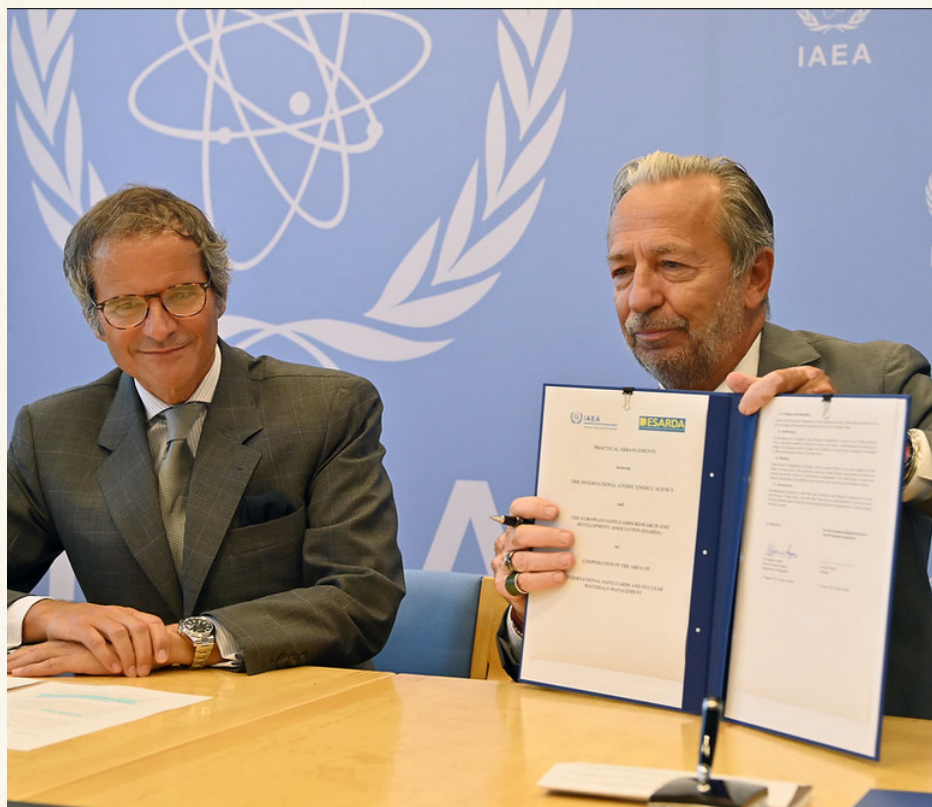


Connector

Issue 5 | Autumn 2021



Signing Practical Arrangements between IAEA and ESARDA, Mr Mariano Grossi, DG and Mr Aparo, DDG

EDITORIAL

by Julie Oddou (ESARDA President)

Dear Reader,

The 2021 Joint INMM/ESARDA Annual Meeting was a really big success. The result is above all our wishes and I would like to thank all the participants, in particular the ESARDA and INMM members who contributed to making this event a unique one.

In total, we had 1160 registrations and 13675 visits to the different booths!

The Keynote Address by DG Grossi should be mentioned with its 1132 connections! His

speech and the following exchange was the highlight of the meeting. He answered with great frankness and openness to the questions and insisted on the challenges that the IAEA is facing in terms of potential diversification of its activities with the fight against climate change challenges, the continuity of its verification tasks including in a pandemic or crisis context, the limitation of its resources and budget. He appealed to our contribution to find innovative tools, technologies and concepts to do always more with less. We will continue to work with INMM to answer his request on the outcome *continued on page 2...*

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The Editorial has been written by the ESARDA President giving us an insight on the latest activities of the association

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Articles on the latest news and topics of interest in the safeguards community. This issue presents:

- Joint INMM ESARDA Annual Meeting
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Technical articles covering the latest findings on fundamental issues. This issue presents:

- Safeguards by Design white paper (Finnish & Belgian experiences on contributing to peaceful use of nuclear material during the entire facility lifecycle)

...continued from front page

of the Annual Meeting and how to build on this for more efficiency and effectiveness in Safeguards.

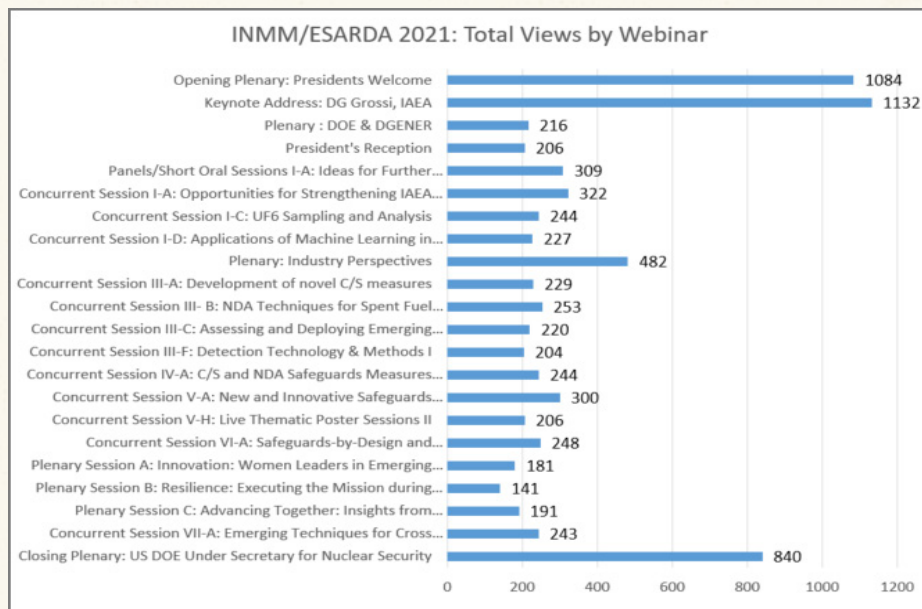
Having this meeting organised jointly with INMM was an important decision and obviously, its positive achievement is an important step for ESARDA. During its 50-year history, ESARDA has been contributing to build the Safeguards World and has reached a remarkable position in Europe. Today with more than 50 partner organisations from all over the world and with the INMM/ESARDA joint meeting, ESARDA makes a new step forward.

It was a great opportunity to present and promote ESARDA worldwide, to expand our knowledge, to share our experience and ideas, to confront views with our peers outside Europe and to join forces in Nuclear Materials Management. In addition, I hope it will also help us to better address the needs of the Safeguards Community in the future and, on top of it, to generate interest in our topics and to reach out to new experts and the young generation that could bring fresh ideas and new technologies into our domain.

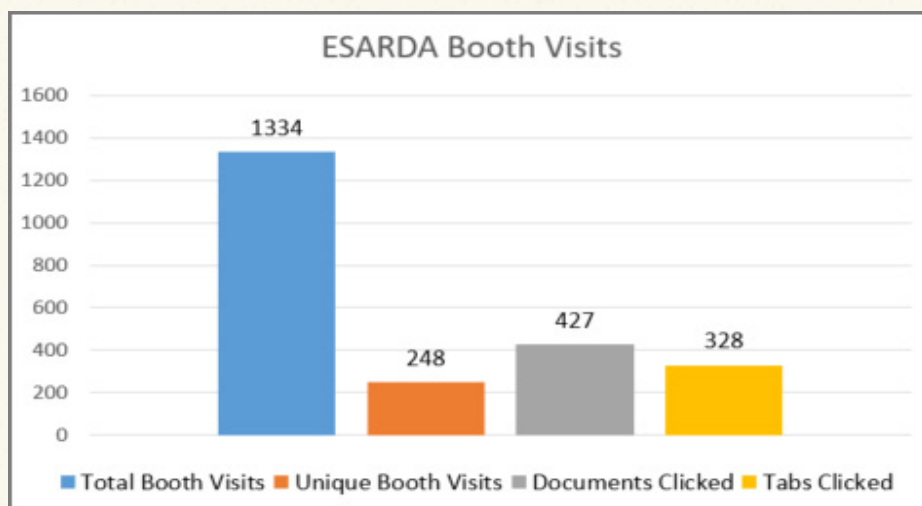
During the President's reception, I was pleased to offer the opportunity to our two new partners AFCONE and ENEN to present themselves. The inclusiveness was one of the objectives of this meeting and it offered indeed many occasions to discover potentially new partners. It was also the case, during the Closing Plenary co-chaired by Willem Janssens, our former President, and during the Mini-Plenary "Advancing Together" co-chaired by Mari Lahti, our Vice-President.

I was also invited by ABACC to participate in a panel on Cooperation in Safeguards Implementation. The exchange was fruitful (also with the contribution of the Director of Euratom Safeguards) and contribute to better understanding each other. I retained the conclusion that "understanding builds trust" and that ESARDA and INMM should also be used for this purpose across the continents.

Diversity and inclusiveness also means attracting more young people and women in our domain. I hope that the Career Fairs which



Graph with total number of participants per session during the 43rd INMM/ESARDA Joint Annual Meeting



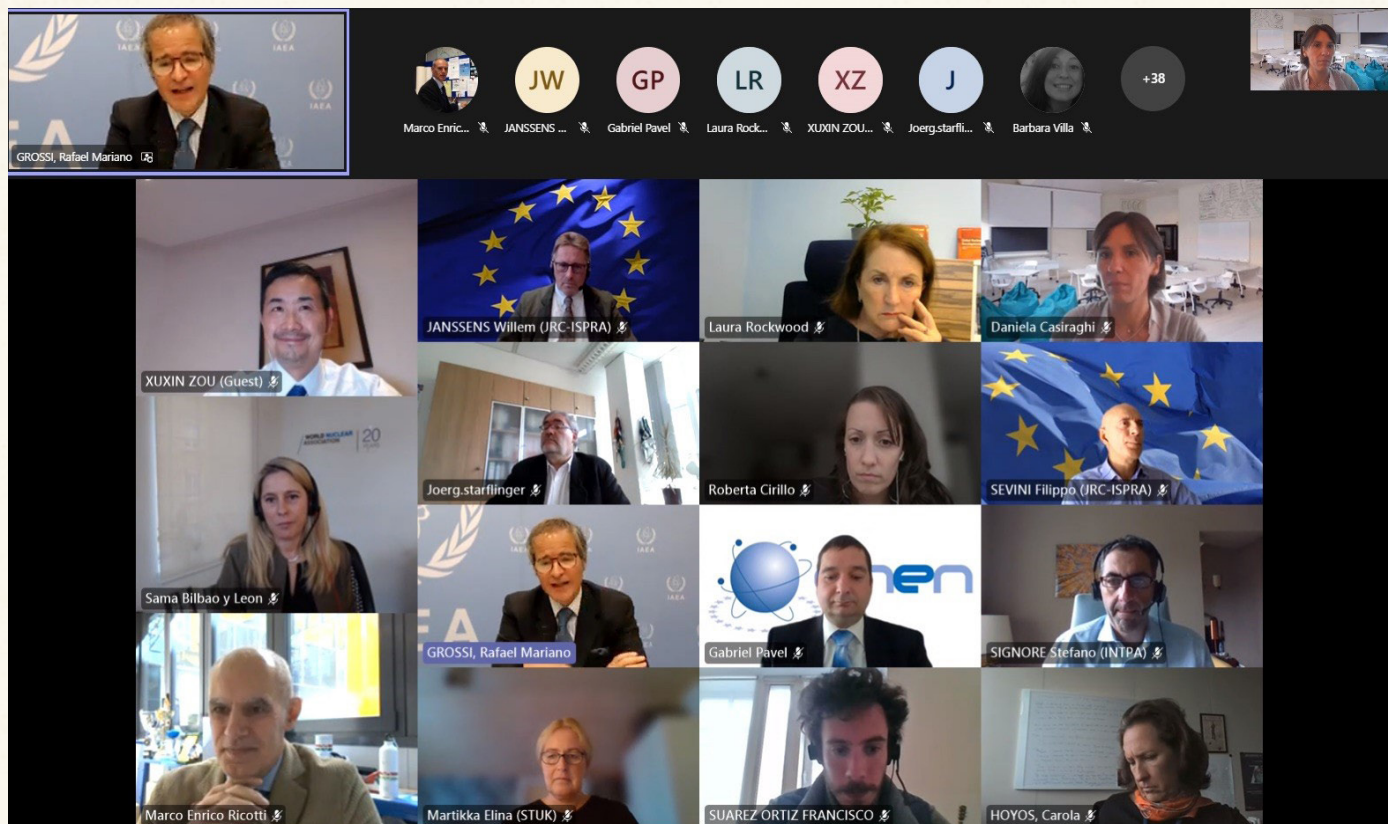
Graph with number of visits to the virtual booths during the 43rd INMM/ESARDA Joint Annual Meeting

were organised during the meeting and the two events of the Woman of Mass Distinction Initiative encouraged young people and women all over the world to join the community of ESARDA and INMM, and more broadly of nuclear science.

With regard to innovation, many parallel sessions were organised on new technologies, digital tools, machine learning, artificial intelligence, blockchain,... in a nutshell, innovative techniques that could be of interest for our community. We absolutely need to nurture the interest of experts of these new techniques in

our questions. This should be one of our objectives in future meetings; it will also help by appealing to the younger generation.

The recognition of the important contribution of ESARDA to Safeguards found also another concrete outcome with the signature of the Partnership Agreement with the IAEA during the Annual Meeting Opening Plenary. This document is more a recognition of our long history of cooperation than a real shift in our work. It will nevertheless help to better address the specific needs of the IAEA in terms of Safeguards implementation.



Screengrab of the Nuclear Safeguards University Programme launch event that took place on 14th October, 2021

In this Connector issue, you will also find information from the field of training and education in which the ESARDA partners are actively involved. As such, the 20th ESARDA Course has been announced to take place in May 2022, keeping the online format that was the case for the successful 2021 edition.

On 14th October, the first ever EC funded Nuclear Safeguards University Master Programme was officially opened by the European Nuclear Education Network (ENEN), the Politecnico di Milano and the EC Joint Research Centre. The introductory speeches were followed by invited talks of Ambassador Rafael Mariano Grossi, Director General of the

International Atomic Energy Agency, Sama Bilbao y Leon, Director-General of the World Nuclear Association, Stefano Signore, Head of Unit DG INTPA and Prof. Joerg Starflinger, President, ENEN.

Out of the 64 applicants, 24 students were finally selected to participate in the Master Programme with more than half being female. They come from across the globe (about half from the African Continent) and will have access to the lectures of close to 40 different experts, chosen from the European Safeguards community (mainly from ESARDA, the European Safeguards Research and Development Association) and beyond, including from JRC, IAEA and several NGOs.

Finally, I would like to end by encouraging you to make all efforts to participate in-person in the future ESARDA activities. I know that we are all facing many constraints in terms of duty travel but to keep the network alive and maintain the connections we also need to have face-to-face meetings (when of course it can be done in safe conditions taking into account the sanitary situation).

Enjoy reading this new edition of our Connector!

Julie ODDOU
ESARDA President

news & events

Keeping you up to date with all the latest news of the association and its partners, as well as all the upcoming events in the near future.



NEWS

ESARDA Upcoming Events

Whilst we are now almost two years after the beginning of the COVID-19 pandemic, we can proudly say that the ESARDA Community has remained very active and agile in adapting to the situation, in keeping up with its meetings and exchanges, in communicating and in advancing together, despite the distance and virtual settings. During this period, since March 2020, ESARDA held two Executive Board meetings, one Steering Committee meeting, several WGs meetings and its two Annual Conferences, the closed 2020's one and the open 2021's one jointly with INMM, all on virtual platforms. While the global pandemic situation remains uncertain, ESARDA hopes to move to hybrid gatherings in the near future. The upcoming planned meetings are the following ones:

- The ESARDA Steering Committee is typically held on the margin of our annual conference. However this year, due to the dense symposium programme and ten day calendar event, it was decided to postpone the Steering Committee meeting to a later date. It will be held virtually on November 29th. During this meeting, one candidate party, Westinghouse Electric, Belgium, will present its activities. The newly signed non-traditional partnership with IAEA will be discussed, as well

as the revision of the ESARDA rules and procedures and ESARDA agreement, and the role and support of ESARDA to the next IAEA 2022 Safeguards Symposium.

- The Executive Board will be held in a hybrid format on December 1st, in person in Paris (if the pandemic situation allows, and virtually for the members not able to travel) and will be hosted by the CTE and the ESARDA president Julie Oddou. The Executive Board will review the content of the ABACC and ESARDA Memorandum of Understanding (voted during the last Steering Committee). The status of the Editorial Committee and the revision of the ESARDA rules and procedures and ESARDA agreement will be on the agenda as well as a reflection on potential organisations to outreach to and the organisation of the next annual meeting. The WG chairs are expected to report on their 2021 activities and to provide feedback and set of recommendations from the 2021 Annual Symposium.
- The 2022 Annual Meeting to be held in Luxembourg on May 2nd till 5th and is planned to be held in person, if the situation allows.
- The 2023 Annual Symposium to be or-

ganised jointly with INMM and ESARDA in Vienna on May 22 to 26 2023.

More information will come in due time for the Annual Meetings and will be posted on the [ESARDA webpage](#).

ESARDA Bulletin Call for Manuscripts

The call for Manuscripts for issue 64 of the ESARDA Bulletin, due for release next June, has been published. Following the special issue on Data Analytics for Safeguards and Non-Proliferation, featured in issue 63, the Bulletin will focus on all the fields of interest of ESARDA.

The deadline for submitting a manuscript has been set for Monday 28th February, 2022. All parties interested in submitting a paper are kindly invited to read the [Call for Manuscripts](#) on the ESARDA website.

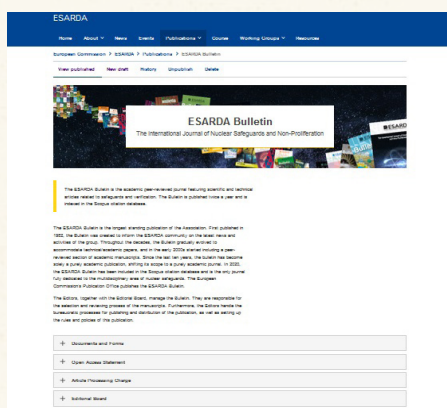
Indexing of past ESARDA Bulletin issues

In September, Scopus contacted the Bulletin editors to request the back issues to be indexed in the citation library. After a careful evaluation, Scopus was informed to index as far back to the 2006 issues, where the first

peer-reviewed articles appeared.

In the coming months these historic issues will become visible in Scopus, allowing the system to index the citations of a vast number of articles that span over a period of 15 years.

Since the migration to the new website, the ESARDA website has been updated with a [section dedicated to the Bulletin](#), in order to facilitate indexation of the files by Scopus.



ESARDA Bulletin webpage

EVENTS

<p>2022 February 7-11</p>	<p>7th - 11th February 2022 First International Conference on Nuclear Law: The Global Debates (#ICNL2022) Virtual Meeting Although a highly specialised field of law, nuclear law permeates the entire nuclear sector. Whether it be in the form of international treaties on the safety and security of nuclear power plants, agreements enabling the verification of nations' nuclear non-proliferation commitments. [Read more]</p>	<p>#ICNL2022</p>
<p>2022 April 5-7</p>	<p>5th - 7th April 2022 International Conference on Nuclear Fuel Cycle (GLOBAL 2022) Reims, France This new edition located in Reims during 3 days will provide an outstanding forum for high-level experts and stakeholders from around the world, to share recent technological advances, developments of new markets and applications that lead to enhance the positioning of nuclear power as well as its public support. [Read more]</p>	
<p>2022 April 25-28</p>	<p>25th - 28th April 2022 Conference on Fast Reactors and Related Fuel Cycles (FR22) Beijing, China The International Atomic Energy Agency (IAEA) once again brings together the fast reactor and related fuel cycle community by organizing the International Conference on Fast Reactors and Related Fuel Cycles: Sustainable Clean Energy for the Future (FR22). [Read more]</p>	<p>#FR22</p>
<p>2022 May 2-6</p>	<p>2nd - 6th May 2022 ESARDA 44th Annual Meeting Luxembourg Congress Conference Centre, Luxembourg The 2022 ESARDA Annual Meeting is planned to be held at the Luxembourg Congress Conference Centre, Luxembourg, from 2-6 May 2022. This annual meeting is a closed meeting reserved to ESARDA Steering Committee, Executive Board and Working Groups' members, i.e. Parties, Associated and Individual members and ad hoc contributors, as agreed by WG Chairs. [Read more]</p>	
<p>2022 May 16-20</p>	<p>16th - 20th May 2022 20th ESARDA Course Online Course The European Commission, Joint Research Centre announces the 20th ESARDA Course on Nuclear Safeguards and Non-Proliferation being co-organised by the European Commission's Joint Research Centre and the Training and Knowledge Management Working Group (TKM) of ESARDA. [Read more]</p>	

working group reports

This section of the Connector has the objective to inform the ESARDA Community about the latest undertaking of the Working Groups' activities during the last six months. Each Working Group Chair has been invited to provide a brief article describing their findings in their fields of interest.

CONTAINMENT AND SURVEILLANCE (C/S) & FINAL DISPOSAL (FD) WORKING GROUP JOINT PANEL

by Katharina Aymanns,
(C/S Working Group Chair),
Heidi Smartt,
(C/S Working Group Vice-Chair),
Klaas van der Meer
(FD Working Group Chair),
Mentor Murtezi
(FD Working Group Vice-Chair)

During the Joint INMM/ESARDA Annual Meeting in August 2021 the ESARDA Final Disposal (FD) and Containment & Surveillance (C/S) WG organized jointly a Panel on "C/S and NDA safeguards measures for facilities at the back end of the nuclear fuel cycle".

The panel was dedicated to discuss current approaches to verify spent fuel as well as planned and ongoing initiatives to improve verification technologies and concepts for facilities at the back end of the nuclear fuel cycle. At the beginning of the panel the following three presentations were held to set up the scene:

- "New developments for extended containment and surveillance of safeguarded materials in geological repositories", Christopher Ramos (US DOE/NNSA)
- "Investigations of Novel Technologies for Safeguarding Geological Repositories", Kirill Khurstalev (IAEA)
- "Safeguards verification concept for disposal of spent nuclear fuel", Tapani Honkamaa (STUK).

The presentations were followed by a discussion with six panellists from different safeguards organizations and disciplines such as IAEA, Euratom (DG ENER), STUK, Posiva, EC JRC and Sandia National Laboratories to address the major challenges of safeguarding the back end of the nuclear fuel cycle.

During the discussion, it was particularly highlighted that safeguards objectives can only be achieved by a collaborative and innovative-

communication between all parties involved in the process. It was further emphasised that safeguards equipment has to comply with special conditions, which must be taken into account during the development of these devices and can also complicate the development process. Safeguards equipment has to be particularly robust and very reliable in its operation over very long periods of time, since it is used in areas with high radiation and harsh environmental conditions (e.g. underground). The participants agreed that the development of automated and modular camera and sealing systems will play a decisive role for future C/S technologies. A special focus was laid on the integration of different sensor technologies of C/S, NDA (y,n- detectors) as well as seismic monitoring and other technologies. In this context, the further development of review software able to process data from different devices will become mandatory. In addition, the integration of machine learning and artificial intelligence in C/S and NDA systems will also become increasingly important in the future. About 70 people attended the panel.

EDITORIAL COMMITTEE WORKING GROUP (ED-CTEE)

by Joshua Rutkowski
(ED-CTEE Working Group Chair)

In the same spirit that brought many ESARDA working groups together with INMM technical divisions during the 2021 joint annual meeting, the Editorial Committee met with the Journal of Nuclear Materials Management Associate Editors on 8 September 2021. The hour-long virtual meeting provided a welcoming forum where members were able to introduce themselves and discuss experiences. After introductions, we examined the different publications produced by each organization including the ESARDA Bulletin, ESARDA connector, INMM Journal of Nuclear Material Management (JNMM) and INMM Communicator. By sharing experiences in the publishing process and the steps required to have an indexed journal, the meeting illuminated the unique aspects of each publication and demonstrated the benefit for closer collaboration in the future. The Editorial Committee looks forward to our next joint annual meeting with INMM.

EXPORT CONTROL WORKING GROUP (EXP)

by Christos Charatsis
(EXP Working Group Chair)

7th EU P2P Summer University on Strategic Trade Controls Online, 16-20 August 2021

Given the ongoing health crisis, the Summer University on Strategic Trade Controls was organised for second consecutive year in webinar mode and it brought together 25 participants from South East Asia, Eastern Europe and Caucasus, Middle East, Balkans and Latin America. The course spreads over five days and operates on the basis of interactive lectures and separate follow-up tutorials and Q&A sessions in the end of each day. It offers a full immersion to various export control topics and an opportunity to discuss EU and international best practices for effective implementation of trade controls.

This year's university was divided in five specialized sessions as follows:

- The revision of the EU trade control: what has changed?
- Drafting a trade control system: terminology and technicalities
- Evolution and new concerns of strategic trade controls: Foreign Direct Investment screening, non-proliferation financing, academic proliferation
- Customs and prosecution: tailoring controls to dual-use risks
- Data mining applications for dual-use export controls

Presentations and lectures were provided by distinguished practitioners and scholars while the University was honoured to have the EU's Special envoy for Non-Proliferation and Disarmament, Ambassador Marjolijn van Deelen to deliver the opening speech. Balazs Maar, the program manager of the EU P2P Export Control Programme for Dual-Use Goods and Benjamin Zalisko, Senior Program Analyst of the US Export Control and Related Border Security (EXBS) Program provided also presentations. Rosa Rosanelli, Export Compliance Officer and Senior Legal Counsel for Patria

Group contributed by sharing the point of view of industry.

The event met the expectations of the participants who were eager to learn, share their views and experiences with their colleagues coming mostly from licensing and customs authorities.

The Summer University on Strategic Trade Controls is organised in the context of the EU's Partner to Partner (EU P2P) Cooperation Program and it is funded by the EU. This year it was co-organised with the valuable contribution of the University of Liege. Participation is open to candidates from the EU P2P partner countries having a relevant role in trade controls implementation.

Advancing together in safeguards and export controls

On August 24th, an insightful panel discussion took place in the framework of the first ever Joint INMM-ESARDA annual meeting. The panel was organised under the joint efforts of INMM and ESARDA relevant Technical Divisions and Working Groups and it was chaired by Willem Janssens and Zoe Gastelum. The main aim of the panel was to highlight the mutually reinforcing and at times complementary role of nuclear safeguards and export controls for non-proliferation by discussing examples where export controls and safeguards main processes, activities and data can support one another. The discussion revolved around two papers prepared under joint ESARDA-INMM authorship and by the IAEA's Department of Safeguards, respectively. Both papers have become available in the INMM website.

- "Nexus Between Strategic Trade Controls And Safeguards: State Of Play And Current Challenges," available [here](#).
- "Analyzing Information On Nuclear-Related Trade, Industrial Capabilities And Technical Assistance In The Context Of Safeguards Implementation And State Evaluation," available [here](#).

IMPLEMENTATION OF SAFEGUARDS WORKING GROUP (IS)

by Walid M'Rad Dali
(IS Working Group Chair)
by Marko Hämäläinen
(IS Working Group Vice-Chair)

The Implementation of Safeguards Working Group (IS WG) is a horizontal issues working group of ESARDA. Its objective is to provide the Safeguards Community with proposals and expert advice on the implementation of safeguards concepts, methodologies and approaches aiming at enhancing the effectiveness and efficiency of safeguards on all levels. This WG is also a forum for exchange of information and experiences on safeguards implementation.

This year, the WG met in August 2021, at the margins of the INMM-ESARDA joint annual meeting. Considering the videoconference format of the meeting, the expected high level of attendance of members from INMM and ESARDA, and the associated limitations due to the security of the information discussed during the meeting, the meeting was organised in a short format without the possibility to hold the traditional roundtable during which members of the group usually share with their colleagues on the last safeguards updates within their respective organisations and countries. Hence, this meeting was the opportunity for the group to discuss the status updates of the projects it is involved in. In particular, the IS WG presented during the annual meeting its paper on the inspection regimes and also had the opportunity to lead discussions on the SbD theme in a specific roundtable event. In this perspective, a specific SbD paper will be released by the group soon, as well as a 3S paper.

During its meeting, the group also discussed the ways forward for the two main themes "Inspection regimes" and "SbD" in the future. The ESARDA President, Julie ODDOU, present during the meeting, welcomed the work performed by the group and the added values it can bring to the overall safeguards community and encouraged the team to move forward and to proceed to more targeted studies based on

the results gathered by the group so far, while insisting on the need to proceed in connection with the World Café actions.

A second meeting was organised in November 2021 in a virtual format. During this meeting, the group proceeded to the roundtable and agreed on the missions to be conducted in 2022-2023 during the mandate of Marko Hämäläinen who will be appointed as of January 2022 as the new Chairman of the group, in replacement of Walid M'Rad Dali, current Chairman. Discussions on the selection of a new Vice-Chairman was further conducted in order to nominate a member of the group.

MATERIAL BALANCE EVALUATION WORKING GROUP (MBE)

by Stéphane Puydarrieux
(MBE WG Chair)

In November 2020, ESARDA launched a new WG to share best practices and knowledge related to Material Balance Evaluation in bulk handling facilities.

The main objectives of this WG are :

- To establish guidelines on Material Balance Evaluation.
- To provide a reference and robust methodology for in-process inventory verification and Material Balance Evaluation within each Material Balance Area.
- To identify and share best practices and knowledge within the safeguards community (operators and inspectorates).
- To contribute to international reference through guidelines and ESARDA publications. It will provide a basis for relevant education and training.

The scope of this Working Group includes the Material Balance Evaluation, the determination of the related uncertainties and their interpretation.

The tasks of this Working Group will be distributed in 4 sub-WGs:

1. Regulations for Material Balance Evaluation.
2. Methodologies and statistical assumptions for Material Balance Evaluation as well as uncertainties, examples and tools.
3. Best practices for Material Balance Evaluation, Material Balance monitoring and Material Balance accuracy improvement.
4. Near Real Time Accountancy studies and perspectives.

This 4th Sub Working Group will be interested in the potential development made possible by machine learning algorithms, as well as the development made in the mathematical methods. The development in these fields allows to combine physical models and statistical models.

Preliminary work started in France a few years ago. The synthesis of this work was translated very recently and is now available for all participants of the WG.

STANDARDS AND TECHNIQUES FOR DESTRUCTIVE ANALYSIS WORKING GROUP (DA)

by Stefan Neumeier (DA WG Chair), Evelyn Zuleger (DA WG Vice-Chair) & Brian Ticknor (DA WG Chair, INMM)

This year for the first time the Working Group Meeting on Standards and Techniques for Destructive Analysis (WG DA) was jointly organised in the framework of the INMM/ESARDA Joint Annual Meeting with around 40 participants mainly from Europe and USA. 13 short presentations provided a snapshot of the status and perspective of DA activities in the last year. In addition to these short presentations 7 DA related sessions, incl. 2 special sessions with poster and oral presentations were organised within the joint annual meeting.

A lot of progress was achieved in the last year, despite of the still lasting pandemic situation, regarding the development and provision

of reference materials, the development of analytical techniques incl. the availability of state-of-the-art analytical tools as well as the organisation and conduction of international interlaboratory comparison exercises. Furthermore, a lot of DA members from INMM and ESARDA participated in several expert group meetings and contributed significantly to the revision of the International Target Values (ITV).

Last but not least, DA members are heavily involved in teaching and education, e.g. in the framework of safeguards courses and the recently launched Specialising Master Program in Nuclear Safeguards organised by the European Nuclear Education Network (ENEN). It turns out that comprehensive overlap and supplementation exist between the INMM and ESARDA activities and that both working groups as well as the IAEA will benefit from an intensive exchange between the experts. The DA WG will continue and strengthen the relationship between INMM and ESARDA by continuing the organisation of Joint INMM/ESARDA WG-DA meetings in the future.

The ESARDA WG DA will meet and discuss again together with the INMM counterpart at the ESARDA 44th Annual Meeting in May 02–06, 2022 hopefully in-person in Luxembourg.

TRAINING AND KNOWLEDGE MANAGEMENT WORKING GROUP (TKM)

by Thomas Krieger (TKM Working Group Chair), and Riccardo Rossa (TKM Working Group Vice-Chair)

The 19th ESARDA COURSE on Nuclear Safeguards and Non-proliferation was held from 12th–16th of April 2021 and co-organised by the European Commission's Joint Research Centre (Ispra) and the ESARDA TKM Working Group. With respect to the ESARDA Course in presence, the on-line course 2021 tripled its registration: 185 registrations from 55 countries out of four continents (Europe, Africa, America (North and South) and Asia were

filed in for the course. The participation from Africa to the course (40%) was high and was close to that from Europe. This high African participation is principally due to AFRONE (African Nuclear Energy Commission), which efficiently brought the course to the attention of the African nuclear organizations and universities. More details about the content, the preparation, the participation, virtual lab visits, quizzes and evaluation of the course by the participants can be found in the INMM & ESARDA Virtual Annual Meeting 2021 paper "Lessons learned from the first on-line international course on Nuclear Safeguards and Non-proliferation (ESARDA course) under the pandemic context" by K. Abbas, F. Raiola, R. Rossa and I. Maschio.

ESARDA TKM members were involved in the preparation and implementation of the INMM & ESARDA Joint Virtual Annual Meeting and were co-chairing 10 sessions regarding TKM topic.

In the context of the INMM & ESARDA Joint Virtual Annual Meeting a joint meeting of the ESARDA TKM WG with the Education and Training Committee (ETC) of INMM was held with about 30 participants. First, Jessica Rahim presented the "Human Capital Development (HCD) Program" and then Thomas Krieger presented "Current and future activities of the ESARDA TKM WG". It emerged from the discussion that the topic of knowledge retention is of great interest to ETC, ESARDA TKM WG as well as the IAEA. Therefore, we will continue to pursue this topic in joint meetings, probably twice a year.

VERIFICATION TECHNOLOGIES AND METHODOLOGIES WORKING GROUP (VTM)

by Zoe Gastelum (VTM Working Group Chair)

The Verification Technologies and Methodologies (VTM) working group is a horizontal working group which aims to evaluate the potential technical opportunities and challenges of new

or new-use technologies and methodologies to the verification of nuclear safeguards and other non-proliferation agreements.

The working group held a virtual meeting June 9th, 2021, with approximately 40 participants. The session focused on our new topical series of “What is...” for digital information technologies (See the Spring Communicator for more description on this new series). The topic for this session was machine learning. Erik Wolfart of the Joint Research Centre gave the plenary session explaining deep learning models. Multiple working group members provided short interventions about their experience using deep learning for safeguards and nuclear non-proliferation research, including:

- Nathan Shoman of Sandia National Laboratories (SNL) discussed how biases from multiple measurement campaign caused challenges for training machine learning algorithms;
- Maikael Thomas of the International Atomic Energy Agency (IAEA) described applications of machine learning for safeguards surveillance camera review;
- Cristina Versino of the European Commission’s Joint Research Centre (JRC) shared lessons from using supervised machine learning approaches on safeguards surveillance data;
- Grant Christopher of the Verification Research, Training and Information Centre explained Monte Carlo methods to simulate data for machine learning;
- Ricardo Rossa of the Belgian Nuclear Research Centre (SCK-CEN) described his use of k-nearest neighbors for detection of spent fuel pin diversion; and
- Carlos Sanchez Belenguer of the JRC discussed the use of deep learning image comparison to support indoor localization applications.

VTM members met again on August 27, 2021,

as part of a joint working group session virtually with the Institute of Nuclear Materials Management (INMM) International Safeguards Technical Division’s Open Source and Geospatial Information (OSGI) working group, on the sidelines of the INMM/ESARDA Joint Annual Meeting. The two working groups exchanged information about their research interests, scope of the working groups, and recent activities. Specific interests about the role of synthetic data and defining the role of the human in analysis and verification were discussed for potential topical workshops.

VTM hosted its working group meeting in November 16-17, 2021, virtually. Topics included a new “What is...” session on digital ledger technologies and member research updates. The working group also discussed the forthcoming special issue of the ESARDA Bulletin on data analytics, which was organized as part of the working group’s focus on data analytics as an outcome of the 2019 World Café.

featured articles

This section presents prominent articles on the latest news and topics of interest in the safeguards community

JOINT INMM ESARDA ANNUAL MEETING

by Willem Janssens
(European Commission -
Joint Research Centre)

The first ever Joint INMM and ESARDA annual meeting was originally planned to be held in person in Vienna, Austria, in the last week of August 2021, but had to be converted into a fully virtual meeting due to the ongoing COVID pandemic. To assure reasonable scheduling across different time zones, a spreading out of the meeting over one and a half week was opted for, also to find proper time for all presentations, posters, panels and special sessions corresponding to the about 660 abstracts received. The virtual setting allowed up to 1000 participants to register and contribute, which is a massive success and encourages both organisations to also in future meetings, hopefully allowing also in person presence, to include an option for remote participation.

A wide variety of contributions were received for this meeting, in line with the broad call for papers that was jointly developed by the INMM and ESARDA Programme Committee with the support of many INMM Technical Division Chair and ESARDA Working Group Chairs and quite a few additional colleagues that helped building a fascinating and multi-disciplinary program. National authorities, international organisations, inspectorates, industry, researchers, non-governmental organisations and academia all participated and allowed rich and very varied discussions throughout the conference.

The meeting plenaries helped also to reinforce the Annual Meeting's theme of "Advancing Together: Innovation and Resilience in Nuclear Materials Management" and set the agenda for the meeting's activities. The opening presentation by the IAEA Director General Rafael Mariano Grossi, which focused on the IAEA's roles in nuclear energy, safety, security and safeguards and, in particular, its efforts to maintain the necessary level of effectiveness during the COVID pandemic, was of great interest to the audience because much of the work of the community is done in support of



the IAEA and its stakeholders.

The signing of the Practical Arrangements between the IAEA and the INMM and the IAEA and ESARDA, by the IAEA Deputy Director General and Head of the Safeguards Department Massimo Aparo, and the respective presidents of INMM and ESARDA, Susan Pepper and Julie Oddou, were another highlight of the first day and confirm the strong interest to work even closer together in the future with IAEA.

Still on the first day a lively plenary discussion was held with speeches by Jill Hruby, Administrator of the National Nuclear Security Administration at the US Department of Energy and Massimo Garribba, Deputy Director General of the European Commission Directorate General for Energy, moderated by Debbie Gracio, Associate Laboratory Director, Pacific Northwest National Laboratory and Willem Janssens, Head of Department Nuclear Security and Safeguards European Commission Joint Research Centre. The topics covered included the geopolitical landscape, the role of nuclear in fulfilling climate change goals (like the net zero carbon by 2050) and key priorities like nuclear materials security, future nuclear safeguards priorities, non-electricity applications for nuclear technology, strategic trade control, the importance and potential of open source and artificial intelligence and regional outreach.

The speeches later in the conference of both Dr. Rita Baranwal, Vice President of Nuclear Energy and Chief Nuclear Officer at the Electric Power Research Institute (EPRI) and Dr. Sama Bilbao Y Leon, Director General of the World Nuclear Association (WNA), confirmed the strong interest of industry in the responsible nuclear materials management and both

INMM and ESARDA strive to further strengthen the interaction and collaboration with a variety of industrial partners.

A dedicated session was organised with Open Nuclear Network, Vienna Centre for Disarmament and Non-Proliferation, VERTIC and ESARDA to identify the opportunities for enhanced collaboration and strengthening ties. Specific elements were picked-up, such as the contribution of NGOs to the teaching in the 2021-2022 Nuclear Safeguards Master Program (co-organised by ENEN/POLIMI/JRC), the training for diplomats, support to disarmament related technical activities and open source analysis.

Also the special panels that were held like on Resilience (executing our mission during COVID) and Advancing Together (insights from collaborative leaders) gained lots of attention and allowed for inspirational talks and the opening up of new opportunities for enhanced collaboration in the future.

In the closing plenary, dedicated to "Answering the Challenge : Building Capacity and Ensuring the Workforce for the future", a lively debate was held based upon the invited talks of Karen Skubal, DoE Office of Science, Jessica Rahim US DoE - NNSA and Shaukat Abdulrazak, Director for Africa in the IAEA Department of Technical Cooperation. The discussion included also the elements of knowledge management, retention, training and education which continue to be key activities for both INMM and ESARDA.

What follows is a short overview of Highlights and Outcomes of the 2021 INMM/ESARDA Annual Meeting, as also communicated to the IAEA upon explicit request of the IAEA DG R. Grossi.

1. INMM and ESARDA Engagement with Industry

– We see this as an opportune time to engage with industry and have been taking steps, including the coordination of an Industry Plenary that included representatives from the World Nuclear Association, NuScale Power, and the Partnership for Global Security, and a planned future workshop to connect with the Advanced Reactor community. The speakers in the Industry Plenary offered their assistance in opening a dialogue with industry stakeholders, and we will appreciate the involvement and support of the IAEA (particularly safeguards, nuclear security, and nuclear energy) as well. INMM and ESARDA can also be a bridge between the IAEA and industry to facilitate informal technical discussions.

2. International Safeguards Professional Certification

– Stemming from a challenge made by Will Tobey on the 10th anniversary of the World Institute for Nuclear Security, a working group appointed by the INMM International Safeguards Technical Division unveiled the completed framework for the first International Safeguards Professional (ISP) Certification. The proposed ISP consists of a two-tiered certification program with a required safeguards fundamentals tier followed by a specialist policy or technical tier. Once implemented, the certification will increase the recognition of safeguards as a profession and a community of practice, while supporting certified safeguards professionals to demonstrate their knowledge and competence in the employment market. The ISP certification will be targeted toward a variety of roles and positions, including staff of State/Regional Authority (SRA) responsible for safeguards implementation, the IAEA, scientific and research communities, staff of nuclear facilities, non-governmental organizations, think-tanks, academia, industry, and the export control community. We would appreciate the opportunity to brief you on our concept for this program in detail.

3. Emerging Technology and Innovation

– Our annual meeting included sessions for sharing of information related to new technologies that can be applied to nuclear safeguards and security as well as advances in technologies that are well known to the community. One highlight was that these technologies are

very promising but require time to be analyzed with care, to avoid introducing new vulnerabilities. There were multiple sessions addressing data science, specifically artificial intelligence/machine learning, and its application across the nuclear disciplines, and robotics, including cyber needs and threats. As a result, the community was able to generate a better understanding of what constitutes an “emerging” technology, capability, and methodology, and how they may shape the industry going forward.

4. Resilience – The opportunity is here to optimize our future, learning from the past two years, with new ways of working, interacting, communicating, and engaging within our organizations and our community. Tools were discussed for measuring the resilience of our organizations and determining a sound course for the future. Reverting to former practices will leave us ill prepared for what lies ahead, and miss a chance to listen to the learnings and needs of our workforce.

5. Diversity and Inclusion – Our meeting included three sessions featuring the work of women in the nuclear security field, a networking event for women, and a session focusing on technical cooperation with countries in Africa. In addition, together with the Nuclear Threat Initiative, we offered complementary registrations to about 50 presenters who would not otherwise have the opportunity to attend our meeting and who are primarily from segments of our community that are underrepresented at our meetings. The INMM and ESARDA can play important roles in building bridges between continents, generations, and genders. These panels and sessions identified short-term/near-term actions that can be taken by individuals and organizations to improve diversity and inclusion, including recommendations for job postings and language in advertisements of events, webinars, workshops, etc., to encourage diverse response.

6. Capacity Building and Workforce Development

– Our closing plenary addressed a challenge from the INMM’s 2020 Opening Plenary speaker, then-NNSA Administrator Lisa Gordon-Hagerty, to help ensure sufficient education and experienced professionals to fill the vacancies that the United States’ Na-

tional Nuclear Security Administration expects to have in future decades. Our plenary panel addressed steps being taken in the United States, Europe and Africa to address these needs on a global scale, because this challenge faces all of us in the nuclear community. Issues raised included the need for knowledge management, as put forward by the Director of the IAEA Technical Cooperation Division for Africa. Moreover, as the nuclear industry explores and adopts advanced and non-nuclear technologies in the furtherance of performance, safety, safeguards, and security goals, a need is arising for cross training, collaboration, and awareness raising, for nuclear specialists and specialists from other advanced technology domains. Both the INMM and ESARDA will continue to deliver on a variety of education, training, and capacity building initiatives.

INNOVATIONS IN NUCLEAR DISARMAMENT VERIFICATION: A VIRTUAL SYMPOSIUM OF THE IPNDV

by Irmgard Niemeyer
(Forschungszentrum Juelich GmbH)



IPNDV Virtual Symposium logo

The International Partnership for Nuclear Disarmament Verification (IPNDV) includes technical and policy experts from more than 25 nuclear-weapon and non-nuclear-weapon countries working to identify challenges related to multilateral nuclear disarmament verification and to develop potential procedures and technologies to address those challenges. One of the key questions in IPNDV is how non-nuclear weapon states can join in verification without proliferation of proliferation-sensitive knowledge.

The aim of the IPNDV Symposium in September 2021 was to engage with the broader

nuclear verification community on IPNDV's progress and achievements in the past years. The event was a follow on from a planned in-person Symposium scheduled for March 2020 in Geneva that couldn't take place due to the COVID-19 pandemic. More than 100 people from 23 countries joined the event.

Following the Opening Remarks by Bonnie Jenkins, U.S. Undersecretary of State for Arms Control and International Security, and Ernest J. Moniz, NTI Co-Chair and CEO and former U.S. Secretary of Energy, the first day was dedicated to IPNDV's work to date. A panel of IPNDV experts looked at how IPNDV's work has led to a better understanding of concepts and approaches when it comes to nuclear disarmament verification and discussed the key lessons learned from the organizing/execution of practical activities.

The second day then focused first on technology as "An Enabler of Progress with Limitations". A panel of IPNDV technical experts discussed where technology is invaluable to the process of verifiable warhead dismantlement and what challenges of technology still exist in this regard. In addition, priorities for technology research and development were identified. Another panel addressed nuclear disarmament verification in the broader context. Policy experts from outside IPNDV presented their view on the different "pieces of the puzzle" of disarmament and how international forums like IPNDV and others help in creating the building blocks that support the goals of the Nuclear Non-Proliferation Treaty (NPT).

More information about the IPNDV Symposium, including agenda, list of speakers, recordings and summary report is available [here](#).

technical articles

Technical articles covering the latest findings of our
community of experts on fundamental issues

SAFEGUARDS BY DESIGN WHITE PAPER

Finnish & Belgian experiences on contributing to peaceful use of nuclear material during the entire facility lifecycle

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Safeguards by Design (SbD) is commonly understood as an approach whereby early consideration of international safeguards is included in the (pre-)design process of a nuclear facility or of a change within an existing nuclear facility, or of wherever safeguards considerations have to be taken into account during the construction, the operation and also the decommissioning phases. It is considered that it allows informed design choices that are the optimum confluence of economic, operational, safety and security factors, and of course of international safeguards.

In this framework, as the authors of this White Paper consider that the feedback generated from case studies can bring benefits to everyone, they are willing to share their experiences, points of view and reflections on the SbD implementation, hoping it will contribute to launch international cooperation initiatives towards the SbD approach in a continuous improvement vision.

In this regard, the Finnish Radiation and Nuclear Safety Authority (STUK) and Belgium's Federal Agency for Nuclear Control (FANC) have gained extensive knowledge of safeguards implementation in nuclear newbuild, plant modification and decommissioning projects over the past decades. They have independently observed the issues related to the traditional implementation of safeguards and



the benefits of the SbD approach and they are also aware that existing improvement ways still exist, and that they need to be explored. Since many years, STUK and FANC share a common interest in developing more efficient ways to adopt nuclear material accountancy and control measures, and other safeguards related matters during newbuild and plant modification projects. Carrying out a reflection on safeguards provisions and needs during the (pre-)design phases while considering the whole lifecycle of the facility eventually enables a better integration of safety, security and safeguards (3S). This also ensures that plant decommissioning and spent fuel disposal can be accomplished with no or few open questions on safeguards remaining. In this context, as nuclear regulatory bodies, STUK and FANC are determined to contribute by their own means to the general knowledge about the SbD. Therefore, we decided to collaborate on this matter by organising a virtual workshop in April 2021, in order to exchange experiences on the implementation of safeguards, and especially on the SbD.

Given the high success we achieved, we think that continuing to develop this collaboration is necessary in a way that it could be beneficial for spreading knowledge of SbD in the whole nuclear community. We are then willing to further increase international awareness of the SbD, to share our experiences and good practices, and to work together in an international framework.

Improvements of Safeguards implementation

STUK and FANC supervise that projects are carried out strictly in accordance with nuclear legislation and regulations relating to the 3S. Operators in Finland and Belgium have successfully contributed to the building and continuous developing of nuclear material accounting and control systems to fulfil their reporting obligations. Experiences in Finland

and Belgium have shown, however, that:

1. looking at nuclear material accounting and control measures only as provisions and measures to add to existing facilities as the consequence of necessary arrangements to adhere to, instead of as parts of a very design feature of the facility, and
2. starting safeguards by simply adhering to the time limits for submitting design information to the IAEA and European Commission, do not ensure an optimal implementation of safeguards at the facility.

In the European Union countries, operators of major facilities shall submit preliminary design information of their nuclear related projects to the Commission at least 200 days before the constructions of the concerned facilities begin and the design information at least 200 days before the first consignments of nuclear material are due to be received. In addition, changes in design information, such as plant modifications or preparing for decommissioning, are generally reported after the decision of their implementation has been made. Although such time limits generally allow nuclear material accounting and control systems to be started or adjusted in time, in the "traditional approach" of safeguards implementation, control of nuclear material considerations enters the facility concept at a phase where most design solutions have already been decided or construction may even have been started. Therefore, safeguards remain separate from the comprehensive facility design.

In these cases, each containment and surveillance solution for nuclear material has to be fitted into the existing design and already-built structures and the safeguards strategies may be limited as modifications of the design to better address safeguards needs are not always obvious. Furthermore, the synergies between safety, security and safeguards are then not promoted at their highest level following the

shared vision of STUK and FANC. Examples of synergies to address properly would be, for the security-safeguards interfaces, the minimisation of transfer routes and diversion paths for nuclear material and, for safety-safeguards interfaces, the physical separation of safeguards equipment from other plant systems. Furthermore, should the facility design be tweaked during planning due to safety or security considerations, the tailored safeguards solutions may not be compatible with the new design solutions. Problems of late introduction of safeguards apply similarly to plant modifications and decommissioning, as safeguards involve processes that continue throughout the whole existence of the facility, including during the end-of-life phase.

In that respect and following our shared vision, without SbD considerations, there is no sufficient motivation or obligation to introduce safeguards in the facility planning, design or construction phases. Therefore, any safeguards equipment to be installed, such as cameras or sealing, usually involves retrofitting, which is expensive, difficult and prone to causing delays. In extreme cases, safeguards involved retrofitting work can hold up the start-up of a reactor or the commissioning of a plant modification. Practical examples of consequences of late consideration of safeguards include seals in hard-to-reach places and difficulties in implementing remote data transmission due to strict IT security requirements in the Olkiluoto 3 project in Finland. In Belgium, a specific case for which SbD spirit and considerations were not applied during the operational phase of a fuel fabrication plant involved MUFs and CuMUF more difficult to justify at the end of the decommissioning phase. At that time, the FANC safeguards experts were reminded once again of how important it is to take into account the SbD approach for the whole life-cycle of a facility.

Benefits and added values of good SbD concept and provisions implementation

Key steps include early initiation of communication by the facility operator or licensee towards the national regulatory authority and the IAEA (and the regional regulatory authority

depending on the country), and inclusion of nuclear material safeguards requirements in the procurement and (pre-) design processes of the facility or of the facility modification. The former, legally mandated in Finland and informally mandated in Belgium, will allow the authorities to communicate general requirements to the licensee. The latter, on the other hand, will ensure that knowledge of the safeguards needs and requirements is spread to all parties (including designers and vendors) involved in the project. The requirements considerations should preferably be included in the bid specification for facility design and construction phases, but also for modification or decommissioning phases.

If the key steps towards SbD are taken, all stakeholders, including those not directly involved in the safeguards field (e.g., safety officers, security officers, engineering and maintenance teams, ...), can understand the role of nuclear non-proliferation and safeguards towards the safe and peaceful use of nuclear energy. They can also understand the necessity of considering safeguards in the project at its very early stage. As a result, the safeguards culture is strengthened and enhanced, and the licensee but also the other involved actors (e.g., designers and vendors) become understanding, more supportive and motivated to discuss safeguards requirements early. As already mentioned, this will help avoiding extra costs or delays caused by late equipment installations, additional inspection work or even mandated facility retrofitting modifications. The regulatory authority can then see the state's obligations and national objectives fulfilled efficiently and effectively, and the licensee benefits from timely and economical fulfilment of its obligations. The designers and vendors, on the other hand, can see a reduction in risks related to project schedule and budget. They also gain experience from an efficient implementation of IAEA safeguards, which can be valuable for future other nuclear related projects and can constitute a competitive advantage within the framework of their involvement in facility designs and changes.

In Finland, Fennovoima's nuclear power plant project organisation, currently working towards obtaining a construction licence, regularly ne-

gotiates with the plant supplier, RAOS Project Oy and Rosatom's design organisations, to integrate safeguards in the facility design. Fennovoima periodically reports to STUK on the progress in SbD work. In Posiva's spent fuel disposal project, on the other hand, SbD plays a central role in the facility design and construction process. The disposal facility consists of the encapsulation plant and the underground geological repository. The plant design has been revised twice after the licence application, thus the detailed plan for safeguards equipment has been modified after communication with the operator and according to the facility's needs. The SbD for the underground repository focuses on optimizing safeguards practices in different phases of the disposal process. In Belgium, for the SF² project, the purpose of which is to increase the capacity of the spent fuel elements storage at both NPPs of Doel and Tihange considering the former LTOs policies, early discussions have begun between the authorities and the operator ENGIE Electrabel. Before the launching of the pre-design phase of the project, FANC released a strategic note to the attention of the operator in which it explained its expectations in terms of safety, security and safeguards. Following this strategic note, the operator delivered during the pre-licensing phase of the project a Design Options and Provisions File (DOPF) in which it presented the selected nuclear safety, nuclear security and nuclear safeguards provisions derived from stated design and operational safety specifications as well as from technical and operational security requirements and safeguards obligations. During this phase, the discussions and comments on the safeguards parts were made in parallel to the work related to the Design Information Questionnaire (DIQ) / Basic Technical Characteristics (BTC) obligations. The DOPF, a complementary tool to the DIQ/BTC, has been a powerful asset that helped to initiate the safeguards related processes at a very early stage of the project from the operator side, but also it helped the operator to quickly communicate to the designers and vendors on safeguards related constraints and to spread the safeguards needs within the organisation. The spirit of the SbD approach followed for the SF² project was also strictly applied since the pre-licensing phase for the RECUMO project which is re-

lating to the development of future processing capacities to allow recycling of HEU (and LEU) residues initially located at the IRE facility as LEU base material for further use. It should be emphasised that the RECUMO project is far more challenging than the SF² project due to the very nature of the future RECUMO processes. In this perspective also, the MYRRHA project case could be mentioned. MYRRHA stands for Multi-purpose hYbrid Research Reactor for High-tech Applications. This project would lead to the construction of a research reactor that could work also on ADS mode. Two of the goals of this project are to demonstrate the ADS concept and the feasibility of transmutation at pre-industrial scale. Also for this project, a strong SbD approach will be followed, while also taking into account lessons learned on safeguards implementation from previous projects in Belgium.

Reflection points to explore for further improving the SbD concept implementation worldwide

As a consequence of the discussions and exchanges conducted during the virtual workshop organised jointly by STUK and FANC in April 2021, five Reflection Points for further improving the SbD concept implementation worldwide were identified. They are presented hereinafter.

RP1 - SbD concept and provisions in the legal and regulatory framework:

The Comprehensive Safeguards Agreement model (INFCIRC/153) stipulates that the design information of a new facility is to be provided to the IAEA as early as possible before nuclear material is introduced and not later than the time set in the Subsidiary Agreement which can be expressed in weeks to months prior to the start of the operation of the facility. The provision of this information in the form of the filled-in DIQ to the IAEA is the de facto starting point of the international safeguards implementation in many countries. A similar remark could be made for the earlier mentioned BTCs. It has been experienced that without separate national or regional legal requirements or intervention by, or guidance from the regulatory authorities, the operator finds it in most cases appropriate to provide the informa-

tion in one consignment close to the deadline. This is reasonable from the operator's point of view when safeguards awareness is not strong enough, as it can appear to them to be the economical solution in the short term. We believe that the national (and regional) nuclear legislation and regulation could offer a solid but practical foundation for the SbD concept. Legal and regulatory provisions (including non-binding ones) on SbD are an icebreaker for early consideration of safeguards. In this regard, the Finnish nuclear legislation was updated for the first time in 2008 to take into account the experiences gathered especially from the Olkiluoto 3 project. The provision of preliminary design information relating to any new nuclear facility project within 60 days of the date of ratification of the parliamentary decision-in-principle is now a requirement in Finland, included into STUK's regulations in 2011. The updated legislation and regulation aim at introducing safeguards considerations as early as possible and at encouraging the operator to include safeguards in the bid specification to eventually have it included in the facility design. In Belgium, SbD considerations are stipulated in non-binding recommendation level documents delivered by the national authority responsible for safeguards matters.

RP2 - SbD concept and provisions in the operators' policies and procedures:

In its practical work, the operator is often represented by a manager and a team responsible for safeguards matters, often having a core function relating to the management of the nuclear material (e.g., FUEL team for a nuclear power plant). Their responsibilities and duties in the organisation may vary from the upper management to the operating and engineering levels. These functions and responsibilities may clearly not be ideal for involvement of safeguards matters in the design process of any project if no other function with a clear view on safeguards needs is involved. In addition, in the absence of a strong safeguards culture, it is observed that the management and decision-making roles at operating facilities often have a limited understanding of safeguards concepts, practices and needs. Unfortunately, for most of the organisations they are for these roles a foreign subject. This issue is also observed in the management in-

volved in new facilities in project.

For efficient and effective safeguards, it is important to tear down the safeguards knowledge and responsibilities boundaries to spread it not only amongst the different actors of the operator directly involved in safeguards matters, but also at all the operator levels within the organisation in a balanced approach, including within the departments responsible for design and modifications matters. This remains, however, a challenge as long as there is no strong safeguards culture, in particular when safeguards are not properly understood and apprehended at the top management level.

For new nuclear facility projects, it is then highly crucial that safeguards culture and awareness already permeate the organisation at the pre-design phase. In a SbD spirit, timely awareness of safeguards in the organisation allows the operator to make safeguards an important part of its Integrated Management System before the facility exists. This will allow the operator to better identify and tackle safeguards challenges for any modification process to be conducted in the future (and even for the future decommissioning), as policies and procedures, including the ones not directly dealing with safeguards matters, will also take into account safeguards (including SbD) needs. It will also allow the operator to educate and train its staff on safeguards matters before final design decisions are made.

RP3 - SbD concept and provisions to be taken into account in the change management policies and procedures:

In line with the previously mentioned point and knowing that SbD approach should also be followed when modifications affecting material, systems, structures and components are to be conducted, it should be emphasised that the SbD concept and provisions should be included in the management system part dealing with the change and modification policies and procedures. In this regard, the operator could establish, following a graded approach, a system whereby modifications are categorised depending on their potential influence on the safeguards and then properly addressed for their safeguards part. For each change, this treatment could be initiated internally,

and if required, then discussed and treated with the national and international authorities. Also, as a result, the interface with the other “2S” might be better managed thanks to this early and timely consideration of safeguards needs in an effective integrated “3S” vision. In this perspective, the associated beliefs, processes, practices, and responsibilities should be clearly outlined in the affected policies and procedures.

RP4 - Reaching all stakeholders to be involved early in the (pre-)design and the (pre-)licensing phases:

In the SbD mindset, the involvement of all stakeholders, including the designers and the vendors, as early as possible in the process is of fundamental importance to eventually reach efficient and effective safeguards.

With the support of the national and international regulatory authorities, the operator should be able to reach all stakeholders when proceeding to the licensing phase and when the bid specifications are worked, and especially when the needs in terms of services, material and equipment are identified. In particular, the designers and vendors should be able to understand and apprehend the non-proliferation and safeguards needs, and they should understand the added values and benefits they can offer in the set of projects in which they are involved, and the competitive advantage it represents especially in the nuclear industry. The national and international authorities could also implement, jointly with other organisations involved in the safeguards (e.g., Research & Development organisations) industry, outreach programs in a more proactive way in order to promote the safeguards and SbD needs which have to be recognized as essential needs in the nuclear world. In this perspective, it is essential that the motivation for adopting the SbD approach is raised by presenting to all stakeholders, in a logical and clearly understandable manner, the benefits in terms of values, sustainable development, social responsibility and competitive advantages.

RP5 - Phasing the safeguards concept and provisions to work on during the facility lifecycle (from the pre-licensing to the decommissioning):

As already mentioned, the SbD approach should be followed for the entire lifecycle of any nuclear facility, from the pre-licensing stage up to the stage at which the declaration of the decommissioned status is released, also systematically when changes with potential influence on the safeguards within the existing facility are brought. In this perspective, three main phases can be defined: the commissioning phase, the operation phase and finally the decommissioning phase. We believe that there should exist a clear, well-defined and effective SbD phased approach and that many sub-phases could be identified for each phase (e.g., pre-licensing, licensing, construction,... permanent shutdown, closure,...) with defined associated safeguards tasks to be performed. Thus, each of these phases and sub-phases could be organised and conducted from a safeguards point of view following a structured step-by-step approach with validation and approval processes, also enabling the stakeholders to better understand the safeguards needs at each step even before they happen.

Ways forward

At the current stage of our collaboration in the field of the SbD, the five above-mentioned reflection points to be explored for further improvement of the SbD concept implementation worldwide have been identified. STUK and FANC are willing to work together in the future to first address these points as a follow-up of the previously performed joint tasks in order to contribute to the enhancement and the improvement of the safeguards worldwide, knowing that SbD is essential for efficient and effective safeguards during the complete lifetime cycle of a facility. To conduct this work, STUK and FANC will regularly exchange information on their progress made, organise meetings, and will probably organise specific workshops targeting one or more of the aforementioned reflection points. In this perspective, STUK and FANC would like to call on each potential interested party, not only regional or state Authorities, but also research and development associations, designers, vendors and operators involved in the nuclear world, that would have been informed about our collaboration and its purpose, to contact us whether to be informed about the progress made and the status of our work, or to be in-

formed about how to become part of this important joint venture. In addition, we would like to encourage each potential interested party, on their own or in collaboration with other parties, to address one or more of the reflection points identified and to report on it in order to spread knowledge within the safeguards and nuclear community. In this regard, STUK and FANC will openly report, at least once a year, on the progress they made in the framework of their collaboration.

Conclusion

Through the SbD White Paper, and as consequence of their fruitful collaboration, STUK and FANC aim at sharing their experiences, points of view and reflections on the SbD implementation, hoping it will contribute to launching international cooperation initiatives towards the SbD approach in a continuous improvement vision. Indeed, we are willing to further increase international awareness of the SbD, to share our experiences and good practices, and to work together in an international framework, as we are convinced that SbD can contribute to developing and implementing safeguards, safely and securely.

The five Reflection Points presented in this paper focus on the need to provide to the stakeholders legal and regulatory provisions on SbD, including non-binding ones, and the need to address the safeguards concept and provisions in the operators' policies and procedures, to promote, to raise and to sustain within the organisations safeguards awareness, and to spread the safeguards knowledge, which is of particular importance when designing new facilities or bringing modifications to existing ones. Also, the focus is on the need to reach as early as possible all stakeholders, including the designers and vendors, to be involved in all phases during the whole facility lifecycle, from the pre-licensing to the decommissioning.

Finally, STUK and FANC emphasise that implementing SbD is a way of ensuring more effective and efficient safeguards implementation during the whole facility lifecycle, enabling also a better integration of safety, security and safeguards needs and obligations.

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