ESARDA
European Safeguards Research & Development Association
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Connector

Issue 1 | Autumn 2019

EDITORIAL

by Willem Janssens (ESARDA President)

Dear reader,

Thank you for picking up the first issue of the Connector, the brand new communication tool of the European Safeguards Research and Development Association.

If you are interested in nuclear safeguards and nuclear non-proliferation, both in Europe and globally, the Connector will update you on the ESARDA developments through the reports of the Working Groups.

The Connector also reports on News, Events and dedicated presentations of the new partners of ESARDA and the editorial team warmly invites all of you to actively contribute to these sections for future issues.

The plan is to issue the Connector twice a year, complementary to the ESARDA Bulletin, which now contains only peer reviewed articles and is expected to receive the formal recognition by indexation through SCOPUS in early 2020.

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Group picture outside the Regina Palace Hotel in Stresa, during the 2019 ESARDA Symposium

...continued from front page

With the expanding ESARDA partnership, both in Europe and abroad, the Connector aims to continue strengthening the networking and information exchange between partners, attract new ones, reach out to the young generation and keep track of its achievements and successes.

In the recently published 2019 Reflection Group paper, ESARDA indicates to strive towards enhanced awareness and visibility, both to the public and at political level, so as to increase also the recognition and impact of the work on nuclear safeguards, promote the collaboration between inspectorates and state authorities and engage with non-traditional partners.

Also at the occasion of the ESARDA 50th Anniversary in May 2019 in Stresa, Italy, during the lively and dynamic World Café, to which many of you participated, a number of wishes, challenges and actions were discussed and the enthusiasm to keep ESARDA fit for future tasks was fantastic!

The Connector thus plans to regularly update you on the progress made in the implementation of both the 2019 Reflection Group and World Café action plans.

When you participate in an interesting conference or meeting, you discover a new promising technology, you plan a big event and seek to enhance participation or you just have a brilliant idea you would like to share with the ESARDA community, please inform the editors of the Connector to have it included in the next issue.

The landscape in nuclear safeguards and non-proliferation continues to be in constant movement. New technical challenges, geopolitical issues, support to nuclear newcomer states or preparing for first signs of potentially rising nuclear interest - also in a number of European countries - looking to SMRs or other innovative technologies, requires ESARDA to stay at the cutting edge of the R&D, to prepare for new challenges and to assure close collaboration between operators, authorities and inspectorates in preparing for the future.

The Connector you have in your hands relies entirely upon your contributions to fulfil its ambitions and the ESARDA Executive Board, who highly welcomes this initiative, likes to thank you already in advance for your interest, feedback and your future input!

Enjoy the reading.

Willem Janssens

ESARDA President

ESARDA
European Safeguards Research & Development Association

secretary's corner

A message from the former Secretary, Filippo Sevini, and the hand-over to the newly appointed Secretary, Veronique Berthou.

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SECRETARY'S CORNER

by Filippo Sevini
(Former ESARDA Secretary)

Past and present ESARDA Presidents and Secretaries celebrating 50 years of ESARDA in Stresa. From left to right: F. Sevini (former Secretary), J. Oddou (Vice-President), W. Janssens (President), I. Niemeyer (former President), V. Berthou (Secretary)

As anticipated, after exactly 10 years in the role, I will leave the position of ESARDA Secretary to my colleague Veronique Berthou.

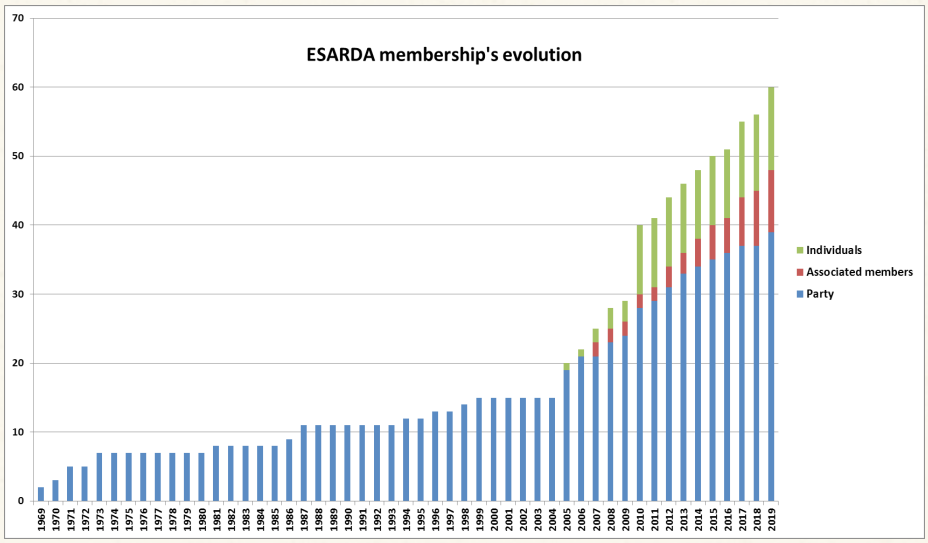
I would like to thank Willem Janssens for giving me the opportunity to undertake this task since 2009 and I would like to express my gratitude to the Steering Committee's Parties and Members for the intense cooperation over this long and exciting period, during which the membership of ESARDA nearly doubled as a consequence of the great work done by the Working Groups and the contacts established by its members, leading also to the accession of Associated Members from overseas.

In my ten years as Secretary, I had the great pleasure to collaborate with six successive ESARDA Presidents all along several challenges, including:

- The Reflection Group 2010 and the implementation of its recommendations, like the establishment of the Export Control Working Group, which I started also to nicely combine with my main job!;
- Five Symposia, modernising the symposium programme management by Easychair and the introduction of a dedicated Symposium Programme Committee… ensuring the (nearly) timely publication of the proceedings!;
- Five Annual meetings in Luxembourg in close cooperation with DG ENER;
- 10 Steering Committee meetings and more than 20 Executive Board meetings with countless actions which Filippo hardly accomplished according to deadlines!
- Introducing the bi-annual rotation of Working Group chairs and vice-chairs…regularly losing track of who's who!;
- Introducing new knowledge management tools like the brand-new ESARDA web-site and the document repository on the platform CIRCABC, which finally became user friendly now that I am leaving;
- Contributing to the Reflection Group 2019, principally as main surviving author of the Reflection Group 2010 report, which I was still fine tuning…

After careful considerations, I am happy to say that ESARDA has been a great learning experience for me! For this, I would like to thank also my team colleagues at JRC for the great support and ideas they provided me with for the implementation of the Secretariat management, in particular Andrea De Luca and the new Editor Elena Stringa, as well as all the colleagues involved in the ESARDA course, Veronique Berthou and Kamel Abbas, the Bulletin, Hamid Tagziria, and the colleagues in the Nuclear Security Unit management and administration for the organisation of countless meetings!

I would lke to express to my successor Veronique Berthou all the best wishes and support for the further successful development of ESARDA!



ESARDA
European Safeguards Research & Development Association

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.

Connector

Participants discussing during the World Café session at the 2019 ESARDA Symposium in Stresa, Italy

NEWS

ESARDA Course Registration Open

Registration for next year's 2020 ESARDA Course are open, all interested parties are invited to send back the registration form by Friday 24th January 2020. The registrations will be scrutinised by the TKM Working Group, who will then confirm participation by the end of February. The Course will take place from Monday 30th March to Friday 3rd April at the Joint Research Centre of the European Commission in Ispra, Italy.
[Read more]

New Group on Education and Training on Linkedin ESARDA account

ESARDA has set up a new Group dedicated to Education and Training, since the closure of the NuSaSET portal, last September. The Education and Training Group is managed by the ESARDA Training and Knowledge Management Working Group, which guarantees a continuation to divulge information related to job opportunities, training courses, scholarships, and so forth. If interested, please join us at the following link.
[Read more]

The World Café report has been released

The Report on the World Café that took place during the 2019 ESARDA Symposium is now available to download. The report outlines the results of the World Café sessions that allowed participants to interact and exchange ideas on topics regariding nuclear safeguards, non-proliferation, and security.
[Read more]

Call for Manuscripts ESARDA Bulletin June 2020 Issue

The ESARDA Bulletin Editors invite you to submit academic manuscripts to the ESARDA peer-reviewed journal. For more information on the topics covered and the submission deadlines, please visit the following link.
[Read more]

ESARDA 41st Annual Meeting Symposium Proceedings available for download

The Proceedings of this year's Symposium have been published on the European Commission Pubsy publication library, and can also be downloaded from the ESARDA website. All manuscripts submitted have been published, apart from those where it has been specifically asked not to be included. When citing the work included in this publicaiton please make sure to reference it correctly.
[Read more]

Introduction to Safguards Online Course on SCK•CEN Academy Youtube Channel

The MOOC (massive open online course) on "Introduction to safeguards" is based on the ANNETTE course on Nuclear Safeguards. For each module of the course, a short video has been or is being developed. Therefore, the MOOC can be seen as a condensed version of the ANNETTE course.
The MOOC is aimed to provide an introduction to nuclear safeguards and the non-proliferation of nuclear weapons. The videos cover both technical aspects of nuclear safeguards inspections such as radiation detectors and nuclear fuel cycle facilities, as well as the history of nuclear non-proliferation and the relevant legal frameworks.
The ANNETTE project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 661910.
[Read more]

EVENTS

2019 November 27

27th November 2019

MetroDECOM II stakeholder workshop

Joint Research Centre of the European Commission, Ispra (VA), Italy

The project aims to provide nuclear site operators with measurement techniques that can be used to measure radioactivity for planning decommissioning, for segregating and checking waste materials during demolition, and for monitoring the condition of waste packages in radioactive waste repositories. [Read more]

2019 December 3-4

3rd - 4th December 2019

ANNETTE Workshop on Proliferation Resistance Methodologies

Joint Research Centre of the European Commission, Ispra (VA), Italy

The goal of this workshop is to apply and compare different proliferation resistance methodologies in a case study of a nuclear installation. [Read more]

2019 December 4-6

4th - 6th December 2019

ESARDA Working Group Meetings (EXP, EdComm, C/S, DA, VTM, TKM)

Joint Research Centre of the European Commission, Ispra (VA), Italy

The annual ESARDA Working Group meetings will take place at the JRC to discuss achievements and future activities. [Read more]

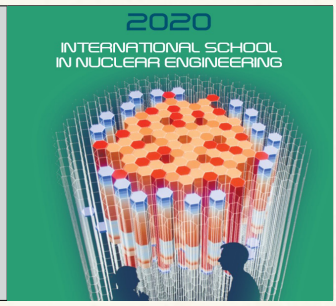
2020 Jan Feb 13-7

13th January - 7th February 2020

International School in Nuclear Engineering (INSTN/CEA Saclay)

INSTN locations in Saclay, Cadarache and Marcoule, France

The 2020 edition will offer six one-week advanced courses in nuclear engineering to be held in France (Cadarache, Marcoule, or Saclay), in January and February 2020. [Read more]



2020 March April 30-3

30th March - 3rd April 2020

19th ESARDA Course

Joint Research Centre of the European Commission, Ispra (VA), Italy

The JRC announces the 19th ESARDA COURSE on Nuclear Safeguards and Non Proliferation to be held in spring 2020. Organised by the Training, Knowledge Management Working Group. [Read more]

EVENTS

2020
May
4-7

4th - 7th May 2020

42nd ESARDA Annual Meeting

Luxembourg Congrès, Luxembourg

The 2020 ESARDA Annual Meeting will be held at the Luxembourg Congress Conference Centre, Luxembourg, from 4-7 May 2020. As usual it will be a closed meeting reserved for the ESARDA Steering Committee, Executive Board and Working Groups' members. [Read more]

2020
July
12-16

12th - 16th July 2020

INMM 61st Annual Meeting

Baltimore Marriott Waterfront, Baltimore, Maryland, USA

The INMM Annual Meeting is a nonprofit technical organisation with worldwide membership of engineers, scientists, technicians, managers, policymakers, analysts, commercial vendors, educators, and students. [Read more]

INMM
INSTITUTE OF
NUCLEAR MATERIALS
MANAGEMENT

2020
November
19-20

19th - 20th November 2020

ICOMS 2020: 14th International Conference on Operations Management and Strategy

Paris, France

ICOMS 2020 is the premier interdisciplinary forum for the presentation of new advances and research results in the fields of Operations Management and Strategy.
[Read more]

WORLD ACADEMY OF SCIENCE, ENGINEERING AND TECHNOLOGY
WASET

ESARDA
European Safeguards Research & Development Association

new partners

New partners have the opportunity to present their organisation's activities and how they can cotribute to ESARDA.

Connector

LOS ALAMOS NATIONAL LABORATORY

NUCLEAR SAFEGUARDS
LOS ALAMOS NATIONAL LABORATORY

Los Alamos National Laboratory (LANL) is one of three National Nuclear Security Administration laboratories within the U.S. Department of Energy (DOE) complex. LANL executes work in all of DOE's missions: national security, science, energy, and environmental management. With these responsibilities comes the expertise needed to tackle many of the challenges facing the world today in the area of nuclear materials. Located in beautiful northern New Mexico, our mission is to solve national security challenges through scientific excellence. LANL is operated by Triad National Security, LLC with a $3B/year budget employing approximately 12,000 scientists, researchers, engineers, and other individuals.

The LANL Global Security Directorate focuses on integrating research and development solutions to achieve the maximum impact on global security priorities, and international nuclear safeguards is a critical part of that work. Most of the safeguards tools being used today, including unattended and remote monitoring, portable detectors for in-field measurements, material hold-up and modelling for optimising safeguards equipment, all have their origins in instrumentation pioneered in Los Alamos in the 1960s and 1970s. The first international safeguards programme in the United States was launched in Los Alamos over 50 years ago on December 1, 1966. Since that time, LANL experts have provided end-to-end support to the International Atomic Energy Agency and other multilateral and bilateral partners, to meet evolving safeguards needs. This support includes development of safeguards technologies and approaches, training IAEA inspectors, supporting international engagements, developing new safeguards professionals, and serving as an integral part of the IAEA's Network of Analytical Laboratories (NWAL). The International Safeguards Programme has benefited greatly from strong synergy between the needs of the IAEA and other international partners for safeguards technology and the needs of Los Alamos for better material control and accountancy for its own nuclear material, as well as the material accountancy needs at other U.S. nuclear facilities.

An important key to our success is our international partnerships. We work with our safeguards colleagues all over the world including Japan, Republic of Korea, Sweden, Ukraine, and of course our many other European friends.

At Los Alamos National Laboratory we are proud of our legacy in international safeguards and focusing on tomorrow's challenges with the ever-evolving nuclear threat. We look forward to continuing our close collaborations with the European Safeguards Research and Development Association and are proud to be an associated member of ESARDA.

View of the Los Alamos Naional Laboratory site in New Mexico, USA

working group updates

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.

DESTRUCTIVE ANALYSIS WORKING GROUP (DA)

by Rožle Jakopič
(DA Working Group Chair)

The objective of the ESARDA Working Group on Standards and Techniques for Destructive Analysis (WGDA) is to provide the Safeguards Community with expert advice on relevant standards, destructive analysis procedures and members' capabilities in support to Nuclear Material Accountancy and Safeguards. The WGDA provides a forum for exchange and addresses measurement issues arising from new challenges in safeguards and related areas. The WGDA is supporting the development of DA methods and determining their reliability by promoting the use of appropriate quality control tools, including inter-laboratory measurement evaluation programmes and reference materials, and is recommending and promoting the use of target values for uncertainties in measurements of nuclear material. Currently, the group consists of 65 members and 30 observers from European and international safeguards authorities, nuclear plant operators, nuclear measurement laboratories, research institutes and universities.

The WGDA held a meeting in May in conjunction with the 41st ESARDA Annual Meeting Symposium. In this year`s meeting, discussions focused on current use of CRMs, recently produced CRMs for the analysis of various types of samples, the status of reference materials providers and future needs. In support to fissile material control and accountancy for industry and safeguards authorities, the successful implementation of the exploratory research (INS-CRM) was presented. This research focused on developing an improved organic layer for the large-sized dried (LSD) spikes to extend their stability and shelf-life, thereby preserving their high quality. For the development and improvement of methods for the determination of nuclear signatures in environmental and special samples, the first uranium particle reference material (IRMM-2329p) was produced and certified for the isotope amount ratios and U content per particle. A complementary NUSIMEP-9 proficiency test was organised to evaluate the measurement capabilities of laboratories in particle analysis worldwide. Combustion analysis used as a tool for carbon and nitrogen impurities determination in uranium bearing material was also a new topic of interest to the group. With regard to training and education activities in the specific area of destructive analysis, a technical sheet on "Electronic valence properties of minerals for nuclear forensics" was presented. The group has also revised the current status and identified other technical sheets to be prepared. The WGDA also developed DA and forensics modules for training and education, which were presented at the annual ESARDA academic course on Nuclear safeguards and Non-proliferation in Ispra, Italy.

In preparation for the revision of the international target values for measurement uncertainties in safeguarding nuclear materials (ITV) for ITV2020, a joint DA-NDA meeting was held in Stresa. The purpose of this meeting was to initiate discussions on the review of the ITV values towards ITV2020 by bringing together the experts of both communities (DA and NDA). Both groups agreed to review the current ITV values, to identify any new methods and types of samples and to provide this input to the IAEA.

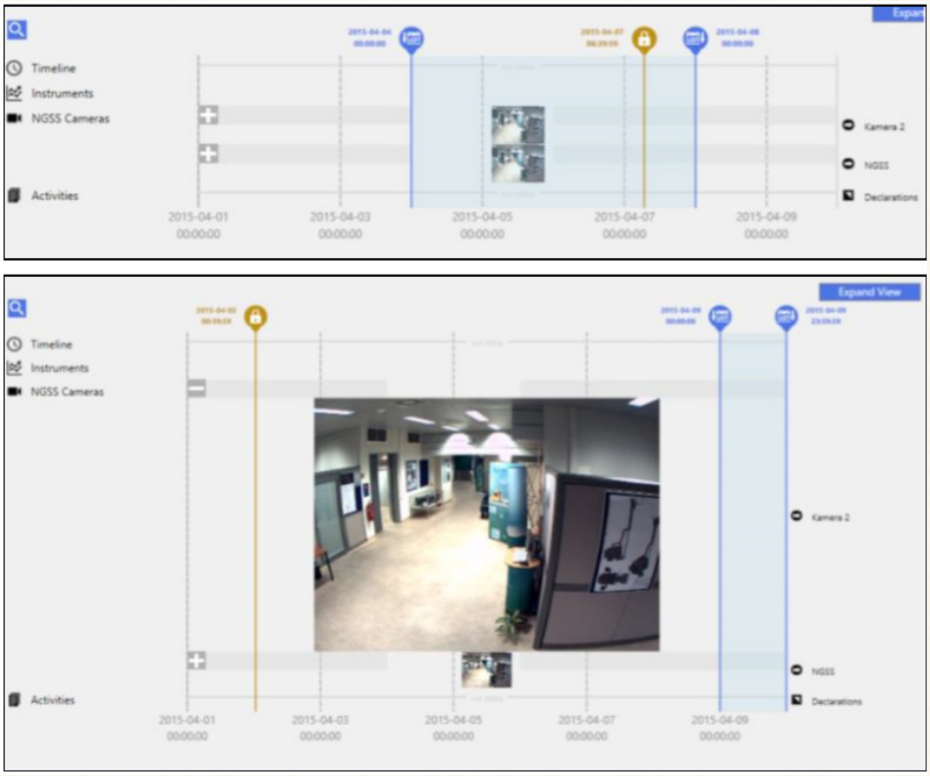
The ESARDA WGDA was represented in the ESARDA Reflection Group 2019, reflecting on ESARDA's relevance for the next decade, and provided significant input to respective meetings, the final RG2019 report and the World-Café on the implementation of the RG2019 actions and roadmap.

CONTAINMENT & SURVEILLANCE WORKING GROUP (C/S)

by Juha Pekkarinen
(C/S Working Group Chair)

IRAP and NGSR video review development

IRAP, the joint IAEA/EC Integrated Review & Analysis Programme now features integration of NGSS / DCM -14 image data. The surveillance images related to other sensor events can be visualised in a one-page evaluation window. NGSR, the New Generation Surveillance Review, is a joint IAEA/EC review software for NGSS and DCM-14 image data. The first release is expected by end of 2019.



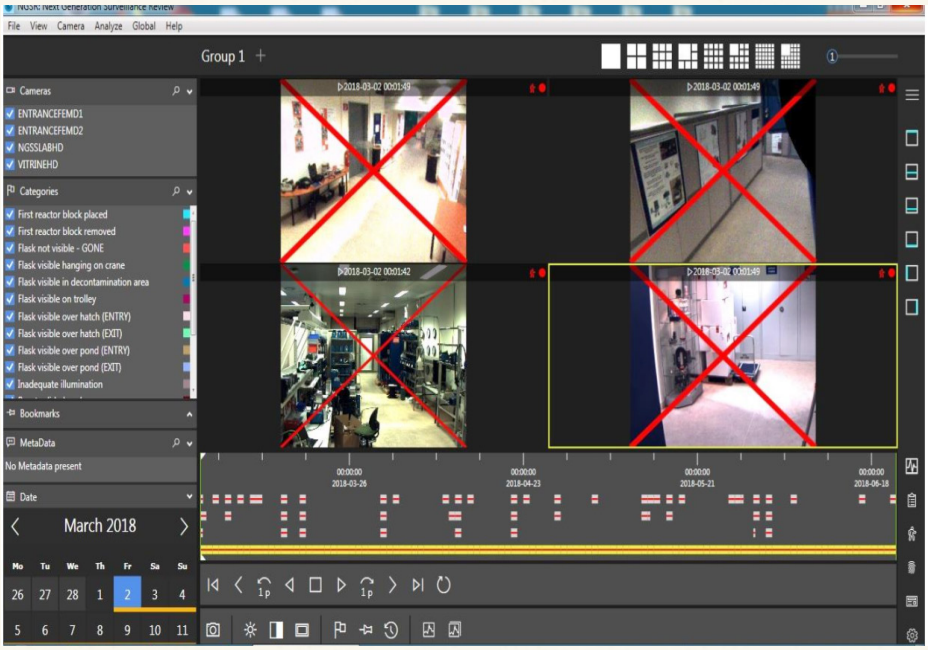
NGSS / DCM-14 surveillance images interface

Concept on new safeguards techniques for SFSF

IAEA and EC are exchanging new ideas for safeguarding dry spent fuel storage facilities. The goal is to develop a toolbox for more efficient safeguards techniques together with re-verification method for the dry storage casks.

Operator Applied & Removed Seal

Following high demand from the safeguards community, especially related to spent fuel handling, JRC Ispra is developing sealing systems allowing both applying and removal of the seal by the facility operator while safeguards inspectorates perform remote verification. This type of seals are particularly important for the future final disposal processes with high throughput.



NGSR, the New Generation Surveillance Review screengrab of the software interface


Picture of dry storage casks


Picture of operator applied & removed seal

EXPORT CONTROL WORKING GROUP (EXP)

by Christos Charatsis
(EXP Working Group Chair)

41st Annual Meeting and panel on Strategic Trade Controls

ESARDA celebrated its 50th anniversary with a successful Symposium in Stresa, Italy (41st Annual Meeting). This provided the impetus to include a panel on Strategic Trade Controls on the programme of the Symposium. The panel represented a rare opportunity to bring together officials and experts from the International Atomic Energy Agency (IAEA), the Nuclear Suppliers Groups (NSG), the academia and national authorities with a view to a better understanding of the interconnections between safeguards implementation and export controls in nuclear and nuclear related material and equipment.

11th ESARDA EXP-WG Meeting

The mutually reinforcing role of safeguards and export controls in attaining nuclear security and non-proliferation objectives was discussed also during the 11th Export Control Working Group which took place on 17 May, in the premises of the JRC in Ispra, Italy. The participants represented as usual a diverse audience including representatives from industry (the German Fraunhofer, the Dutch Nuclear Research and Consultancy Group) national authorities (Swedish Radiation

Strategic Trade Controls Panel at the 2019 ESARDA Symposium

Safety Authority, French Euratom Technical Committee and the Swiss Federal Office of Energy), international organisations (IAEA, NSG) as well as the research community and academia (US PNNL, King's College and the University of Liège). The EXP-WG members and its active supporters had an opportunity to exchange views on topics such as risk analysis for identifying countries that might be primarily concerned by proliferation activities, the history of multilateral export control regimes and more.

C. Charatsis (Project Officer, EU P2P Outreach Programme, JRC) who took over the chair of the EXP-WG from Professor Q. Michel, provided an overview of the topics that could shape the outlook of the export control policy making and implementation in the coming years.

The State Office for Nuclear Safety of the Czech Republic expressed its intention to actively participate and to contribute to the future activities of the Group.

Forthcoming: 12th ESARDA EXP-WG Meeting

The ESARDA EXP-WG will convene its second meeting for this year on 4 December (tentative date) in Ispra, Italy. The main theme of the meeting will be "Making sense of available data and gauging the usefulness of systematic approaches for export control risk assessment". The discussion will be put into perspective in order to identify possible areas of convergence with data/approaches gathered and used by other stakeholders for safeguards implementation purposes.

On the occasion of 12th EXP-WG meeting, Ms Anneguus Dirkzwager, Corporate Export Control Officer at the Nuclear Research and Consultancy Group (NRG) will formally undertake the role of co-chair of the Group for a period of two years.

IMPLEMENTATION OF SAFEGUARDS WORKING GROUP (IS)

by Walid M'Rad Dali
(IS Working Group Chair)

IS WG organises at least twice a year two full-day meetings. This year, the Implementation of Safeguards Working Group (IS WG) met on April 2019 and is expected to meet again on November 2019. While the first meeting was hosted by the SSM in Stockholm (Sweden), the second will be hosted by the HAEA in Budapest (Hungary). Twenty persons participated to the first meeting of the year which was successfully conducted considering the level of participation, the high involvement of each part and the content discussed. During this meeting, the following main topics were addressed:

- Feedback and discussions from the last Executive Board meeting;
- Feedback and discussions from the last meeting of the ESARDA "Reflection Group" ;
- The 3S (Safety Security Safeguards) interface(s);
- Inspection regime in each ESARDA country and Safeguards by Design;
- Potential contribution from the IS WG to the next ESARDA symposium.

This meeting was also the opportunity to learn more about the SSM missions and activities, particularly in terms of safeguards (a visit to the laboratories of the SSM was also organised) and to exchange on the safeguards experiences, especially on the 2S/3S experiences at LOF's in Czech Republic and Romania.

It is during this first meeting that the working process on the two main themes in which the IS WG is currently involved was launched: the "Inspection regime in each ESARDA country" theme and the "Safeguards by Design" (SBD) theme.

For each of these themes, the WG is willing to publish papers on the topics concerned after having conducted surveys :

- The purpose of the "Inspection regime in each ESARDA country" theme will be to present and to share with the safeguards community information on the different inspections models that exist throughout the world (mainly Europe) and to underline the most important existing trends.
- The purpose of the "Safeguards by Design" theme will be to present and to share with the community information on the different ways SBD concepts and principles are considered and applied throughout the world (mainly Europe) and to underline the most important existing trends in the different countries.

In this regard, the IS WG members will discuss during the next meeting in Hungary about the work already performed on these two themes, especially considering the numerous comments gathered during the fruitful meeting held in Sweden.

Progress has also been conducted on the 3S topic: After having performed a comprehensive survey, the IS WG has drafted a report the external version of which is supposed to be published as a paper in 2020. The last version of the internal report, gathering the results of the survey and outlining the trends in terms of 3S in many ESARDA countries, has been substantially improved considering the discussions held in the group in 2018. This version will be discussed during the next meeting in November.

It is also worth mentioning that the standing topic on the agenda of the IS WG is the so- called "roundtable". During the roundtable each participant from authorities, facilities or research institutions can present the latest developments in the safeguards fields in its respective country/facility/institution. This is always a fruitful opportunity to exchange experiences, to present best practices and to comment/ discuss about verification activities performed by the international authorities (IAEA and EC).

TRAINING AND KNOWLEDGE MANAGEMENT WORKING GROUP (TKM)

by Kamel Abbas
(TKM Working Group Chair)

Some facts of ESARDA TKM Working Group in 2019

ESARDA is the European Association established 60 years ago with the main objective to promote not only worldwide R&D in nuclear safeguards and non-proliferation, but also in E&T in these fields. In fact, the Training and Knowledge Management Working Group of ESARDA (TKM) plays an important role in this respect. TKM promotes nuclear safeguards and non-proliferation education and training by various initiatives, organises yearly the ESARDA course and manages and upates the Linkedin ESARDA Group on Education & Training.

The several tens of members of TKM are from European and international R&D and E&T nuclear safeguards and non-proliferation organisations. TKM meets regularly (mostly twice a year) to discuss and exchange achievements and progress so far achieved in safeguards, as well as new strategies, either on the current internal safeguards or on new challenges and needs in Education, Training and Knowledge Management. Over almost the last two decades the ESARDA Course has taken place in Ispra, Italy, and is open to audiences of an average of 50 students, in particular nuclear engineering students, but also to young professionals in nuclear regulations or operations and International Relations. The course aims at complementing not only nuclear engineering studies by including nuclear safeguards and non-proliferation in the academic curriculum in Europe, but also to contribute to efforts of international and regional organisations, such as the IAEA, JAEA, ABACC, to enhance and harmonise safeguards and non-proliferation approaches. Due to its success, during the last years, the ESARDA Course has successfully outreached to several worldwide regions such as South East Asia, including China and Africa.

2019 ESARDA Course participants group photo, at the Joint Research Centre in Ispra (Italy)

Another initiative taken with TKM was the reinforcement of the collaboration ESARDA-ENEN (European Nuclear Education Network) where a project was set up to assess the development of a master programme in nuclear safeguards, which seems to be missing in academia, as a tool for the determination of carbon and nitrogen impurities in uranium-bearing material. This was also a new topic of interest for the group. With regard to training and education activities in the specific area of destructive analysis, a technical sheet on "Electronic valence properties of minerals for nuclear forensics" was presented. The group has also revised the current status and identified other technical sheets to be prepared. The WGDA also developed DA and forensics modules for training and education, which were presented at the annual ESARDA academic course on Nuclear Safeguards and Non-proliferation in Ispra, Italy.

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The ESARDA WGDA was represented in the ESARDA Reflection Group 2019, reflecting on ESARDA's relevance for the next decade, and provided significant input to respective meetings, the final RG2019 report and the World-Café on the implementation of the RG2019 actions and roadmap.

K. Abbas and W. Janssens at the ESARDA Course organised in Pretoria (RSA)

Participants from 13 South African Region countries at the Course in Pretoria.

Group picture of the ESARDA Course organised in Pretoria (RSA)

Some of the recent activities accomplished bt TKM during the period 2018-2019

1. Organisation of the ESARDA course in Ispra. As is customary, the course included lectures, case studies, classroom exercises and lab visits of the JRC research infrastructure. A course App phone was developed and successfully used for the first in the course which is somehow a sign of a need for a digital orientation. As usual, the ESARDA course exams were organised as well.

2. Organisation of the Outreach ESARDA Course for two Southern African regions, with the participation of 13 countries, organised in Pretoria, 11 February 2018.

3. Course organised in Algiers, Algeria, 22-26 October 2018, with the participation of 8 countries of the northern African region.

4. Contribution to international events, conferences and meetings.

5. Contribution to education and training initiatives: Participation in the project Advancing Safeguards Networking in Europe (ANNETTE).

6. Contribution to International Conferences INMM 2018 (July 2018, Baltimore, USA) Safeguards 2018 (Nov 2018, IAEA) Examples of other JRC activities for SFG.

VERIFICATION TECHNOLOGIES AND METHODOLOGIES (VTM)

by Keir Allen
(VTM Working Group Chair)

The VTM Working Group met on 13 May, on the margins of the ESARDA Symposium in Stresa.
Thomas Kreiger of Forschungszentrum Juelich GmbH presented a very interesting piece of work entitled “Optimal Sampling Plans for Inventory Verification of Spent Fuel Ponds”.

The focus of the meeting was to begin discussions regarding the use of ‘data analytics’ for improving the efficiency and effectiveness of

ESARDA Course organised in Algiers (Algeria)

safeguards. The discussions were intended to inform the development process of a technical meeting on the topic, to be held on 5 December 2019 in Ispra.

The May meeting in Stresa was used to solicit participants views on key questions related to the use of data analytics in safeguards and to establish any specific analytical techniques or technologies of particular interest.

Two distinct perspectives on the opportunities and challenges of new data analytic capabilities emerged. One perspective focussed on the potential to analyse very large data sets generated by improved sensing capabilities – thus generating the potential to deploy and exploit data-rich technological advances, such as ubiquitous overhead satellite coverage by automating much of the analysis of the resultant data. The other perspective focussed on data analytical techniques that might be thought of as 'business analytics' – how might existing datasets and plant operating data be combined, analysed and mined to provide richer or more comprehensive safeguarding capabilities than is currently the case. For both perspectives, the issue of creating suitable training data and of standardising data arose. The upcoming Ispra meeting has now been scheduled to take place on 5 December the.

Participation in the project Advancing Safeguards Networking in Europe (ANNETTE)

A call for participants has been distributed to working group members to prepare short remarks or presentations covering their research, development and use of data analytics in support of verification objectives. Topics could include:

Machine-learning and deep-learning models
- Graph analysis
- Statistical approaches and modelling
- Data integration and data fusion
- Data visualisation
- Cloud computing
- Artificial intelligence
- Multiparty computing
- New and emerging data sources

In the afternoon, the Working Group will develop a 'data analytics challenge' to be submitted to the broader ESARDA community. Further details of the challenge will emerge following the meeting.

ESARDA
European Safeguards Research & Development Association

technical articles

An article on 'Floating Nuclear Power Plants and the Challenges they Present' by Anna Wagner, past participant of the 17th ESARDA course, selected student essay.

Connector

FLOATING NUCLEAR POWER PLANTS AND THE CHALLENGES THEY PRESENT

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(Participant of the 17th ESARDA Course, selected student essay)

Abstract

Small Modular Reactors (SMR) represent one of the most promising developments in nuclear energy. More and more countries turn to new and innovative designs to keep up with the global market of more affordable sources of clean energy. Several states went beyond land-based SMRs. Countries, such as Russia and China, are developing the technology behind floating nuclear power plants (FNPPs). Critics call it "Chernobyl on ice," supporters see a potential delivery of energy to the farthest corners of the earth. This paper looks into the potential challenges of such an enterprise. It highlights current FNPP developments, regulation matters, nonproliferation issues, and environmental concerns.

Introduction

One of the greatest challenges of our generation is climate change. While scientists search for ways to slow down the process of global warming, the demand for electricity continues to rise. Thus, more countries turn to cleaner and renewable sources of energy to reduce their carbon output. Today, a growing number of nations express their interest in civilian nuclear power. According to the World Nuclear Association [1], nuclear power plants provide about 11% of the world's electricity and are the second largest low-carbon source of energy. However, some nations face many obstacles when they decide to implement a domestic nuclear power structure. For example, island nations are not always able to develop a centralized power transmission infrastructure. Moreover, building a nuclear plant can take an extended period of time. Governments will encounter long-term planning, enormous investments, and, sometimes, political opposition. Furthermore, countries need to ensure the safe and secure operation of a power plant, including, but not limited to, developing substantial human capital, revisioning of a national legal system to include nuclear-related regulations, and establishing regulatory agencies. Another potential and common problem is high upfront costs. For nuclear newcomers, such infrastructure will cost several billion dollars before the plant begins to produce energy. Meanwhile, the market for generating energy at lower costs is becoming more competitive. Renewable energy sources, such as wind and solar, can be more affordable, while natural gas prices are relatively low. Finally, the 2011 Fukushima accident has contributed to the anti-nuclear movement around the world. For instance, in the aftermath of the disaster, the German government reviewed its policies with regards to nuclear power plants. Before the Fukushima accident, Germany was only gradually phasing out nuclear power, but after 2011 eight power plants were shut down and nine were limited in their operation till 2022 [2]. Surely, the German anti-nuclear movement did not start in 2011, yet, the nuclear disaster in Fukushima gave it a new impetus.

Transportable land-based small modular reactors can address some of the aforementioned challenges. Today, several states are exploring new and innovative designs. Argentina, for instance, is in the last stages of building CAREM-25, which will be the first nuclear power plant (NPP), designed and built by a Latin American country [3]. South Korea has already obtained international approval on commercializing its design called SMART (System-integrated Modular Advanced Reactor) [4]. Saudi Arabia is one of the first countries that has shown an interest in obtaining such power plants.

Some of the transportable SMRs' designs include floating nuclear power plants. In comparison with land-based SMRs, floating plants might encounter more regulatory challenges, stronger opposition of environmentalist groups, as well as design and waste management difficulties. Exporting an FNPP will involve many stakeholders, as well as consideration of various international treaties and agreements. However, if FNPPs are well-designed to withstand accidents and are closely managed by both the host and the supplier state, they can become an asset to the international community and help to bring cleaner energy to places where stationary power plants are too costly or difficult to build.

Current and past developments

Both land-based and floating SMRs are factory-built and can be transported to another site. They can produce heat, electricity, and desalinate water. They are more cost-effective in comparison with large stationary NPPs. They will not require the same level of construction and human resources. A normal stationary nuclear plant requires around 5,000 employees from construction to operation [5]. In the case of a transportable SMR, these numbers can be considerably less as the plant's components are factory fabricated. Moreover, the time span between introducing a nuclear plant and beginning its operations will be less. It typically takes 5-8 years to build an NPP for a country with existing nuclear energy, whereas for a nuclear newcomer it might take 10 to 15 years [6]. For an SMR, it can take approximately four years [7]. The timeline also depends on the decision-making process in a host country and how quickly regulatory bodies are established. An FNPP can provide power in remote areas where a stationary power plant option is not viable. An FNPP can also be used to desalinate water in the regions where there is a limited or no fresh water access. A supplier state can also lease a transportable SMR to a host state, which means the supplier will be responsible for operating it.

The idea of floating nuclear plants is not new. In the 1960s, the United States transformed the SS Charles H. Cugle Liberty ship into a floating power plant. It was named Sturgis, after General Samuel D Sturgis, Jr. It was run by the U.S. Army Corps of Engineers. The ship was split into two parts, and the MH-1A nuclear reactor was placed in between them. The Sturgis provided power to an onshore grid in the Panama Canal Zone till 1976, when it was transferred to Fort Belvoir, Virginia [8]. The Sturgis was not intended for commercial purposes, but rather military operations or emergencies. Since it was meant to stay at its destination, it did not have a propulsion system. The reactor was also protected by a 112-foot barrier on either side of the hull to avoid contamination. The MH-1A was a small reactor

MH-1A Sturgis, world's first floating nuclear power plant
(source: Wiki Commons)

and could generate 10 MW which could supply energy up to 20,000 people [9].

While FFNPs are rare, nuclear-powered submarines and ships, such as icebreakers, are fairly common. Marine propulsion started in the 1940s and the first nuclear-powered submarine, USS Nautilus, became operational in 1955 [10]. Countries that operate nuclear ships and submarines are in charge of their safety and comply with international marine regulations and nuclear-related laws. However, if FNPPs become commercialized in the near future and are sold to countries with no previous experience with nuclear reactors at sea, the global nuclear safety and security regime will need to adjust to address such changes.

Recently, interest in floating nuclear power plants has reemerged. Akademik Lomonosov, the Russian FNPP, is widely discussed in the media. The reactor is the main project of mobile transportable units of low power in the Russian Federation [11]. Akademik Lomonosov has no propulsion system of its own and is equipped with two KLT-40C reactor systems which are similar to those Russia uses on icebreakers [12]. Each of these reactors has a capacity of 35 MW and uses low-enriched fuel. The main purpose of Akademik Lomonosov is to supply power to remote port cities, as well as gas and oil platforms located in the open sea. Construction began in 2009 at Baltiyskiy Zavod in St. Petersburg. In 2018, the vessel was transferred to Murmansk where it was loaded with fuel and all systems were tested. Rosatom, the Russian state nuclear agency, plans to tow Lomonosov to the town of Pevek in Chukotka in summer of 2019. There, it can supply power to a town of 100,000 people. When the plan to build an FNPP was introduced, several countries have expressed their interest in this initiative. For instance, Russia and Sudan signed a Project Development Agreement which aims to look into possibilities of an FNPP in Sudan [13]. Such an agreement is not legally binding but rather indicates future cooperation. Meanwhile, Rosatom is already developing a new concept of second-generation FNPPs, which have a smaller size and higher power capacity of 50 MW [14]. The Russian government claims that FNPPs' designs are safe, meet all International Atomic Energy Agency (IAEA) requirements, and are protected from any natural disasters. For Russia, FNPPs represent potential contracts in the future, and its nuclear entities are working hard to secure their place on the market. Russia is a large exporter of natural gas and oil, but prices for these commodities are not stable and considerably low. Thus, it also maintains a strong position in the nuclear energy sector.

China is also working on its own FNPP concept. At first, it had plans to collaborate with Russia on barge-mounted and self-propelled plants, but later on, China announced that it will be developing new designs [15]. This decision coincides with current policies of China to reduce energy consumption and promoting more sustainable production. According to its Energy Development Strategy Action Plan (2014-2020), China highlights innovation and advanced nuclear power amongst other clean energy sources. The main nuclear operators, China National Nuclear Corporation (CNNC) and China General Nuclear Power Group (CGN), are developing two different types of reactors. China aims to construct 20 nuclear power platforms in the next several years. One of the reasons for building so many reactors is to assist its operations on the islands in the South China Sea [16]. In 2016, CGN began the construction of its first offshore plant, ACPR50S. It plans to start generating electricity in 2020. CGN also signed an agreement with the China National Offshore Oil Corporation to provide power for offshore oil and gas exploration and production [17]. CNNC is in preparation for construction of its ACP100S design which was approved by the Chinese State Agency, the National Development and Reform Commission, in 2016 [18]. The South China Sea remains a contentious territory. By bringing in FNPPs, the Chinese Government might further exacerbate its relations with its neighbors.

At the Massachusetts Institute of Technology in the United States, Professor Jacopo Buongiorno and his team are researching an offshore floating nuclear plant (OFNP). It encompasses features such as long-term cooling of the nuclear fuel, it can be anchored in deep water and can be fully built in a shipyard [19]. While an FNPP is only a concept in the United States, land-based SMRs are undergoing developments. A private company, NuScale Power, introduced a unique design of an SMR. It has a single integrated unit called the NuScale Power Module (NPM), which combines components of steam generation and heat exchange and can generate 60 MW of electricity [20]. The plant can uphold 12 individual modules. The U.S. Nuclear Regulatory Commission has already completed its first phase of the review [21]. The NuScale SMR can soon compete with other nations on the energy market. Competition in the energy sector is fierce and nuclear power has been gradually phased out in the United States. SMRs like NuScale can bring positive changes to the US nuclear industry.

Selling FNPPs by Russia and China in the

near future will likely spur other countries into developing their own designs. It is important to remember that FNPPs represent a unique situation that will require a new robust regulatory system and a comprehensive approach. One accident can have dire consequences on the communities, as well as marine ecosystems. Such plants will also require newly trained personnel and the number of IAEA inspectors would need to grow accordingly.

Akademik Lomonosov non-self-propelled power barge (source: Wiki Commons)

Laws and Regulations

The global nuclear regime is a well-established system of international laws and regulations. The same rules that are applied to stationary nuclear power plants will be applicable to FNPPs. Operations of civilian nuclear facilities are strictly controlled around the world. Any related trade or transfer of nuclear material, nuclear-related equipment or technology is closely regulated by many entities. The reasons behind tight controls are apparent since such trade has national and international security implications, potential environmental impacts, risks of a material diversion for military purposes, and nuclear terrorism.

The International Atomic Energy Agency (IAEA) oversees the implementation of nuclear safeguards, while the cornerstone of the non-proliferation regime, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), provides the IAEA with legal authority. Under Article III, each non-nuclear weapon state (NNWS) undertakes to accept IAEA safeguards. The international nuclear regime also includes multilateral export control arrangements, trade laws, UN Security resolutions, sanctions, embargoes, etc. For example, the Nuclear Suppliers' Group is a non-binding multilateral regime that implements guidelines for nuclear-related exports. Trade covers the whole nuclear fuel cycle. Thus, any state that seeks to introduce nuclear energy would have to adhere to IAEA safeguards and other multilateral arrangements. It will also require establishing a national system of regulations that will include education, training of personnel for plant operations, licensing, customs, border controls, etc.

In the case of FNPPs, introducing nuclear laws and regulations can differ from stationary power plants. There are several different scenarios based on who operates the plant, owns it, and regulates it. As a result, responsibility for safety, security, and transportation will differ case by case. Russian FNPPs, for instance, will be built, operated, maintained once in 12 years, and decommissioned by Russia (build-own-operate concept) [22]. In this case, safeguards arrangements, such as information about the design of the plant, has to be provided by Russia, since it builds and operates the plant. Also, since Russia is a nuclear weapon state (NWS), it is not obligated to have IAEA inspections on its facilities, unless it agrees to cover FNPPs under voluntary offer agreements. Furthermore, under Article II of the NPT, "each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this Article" [23]. Moreover, under NSG guidelines, a Comprehensive Safeguards Agreement (CSA) should be concluded by a non-nuclear weapon states (NNWS) to receive any nuclear material or reactor [24]. Therefore, the receiving state has to provide the information about the design of the plant to the IAEA under CSA, which, in fact, has to come from the supplier – an NWS in this case. The host state must ensure that all necessary information to fulfill its safeguards obligations is provided by the supplying state [25]. The NWS should ensure that the IAEA can verify the design of the plant before it is transported to the host state. Such arrangements would be a part of the initial agreement between both states.

Furthermore, in any scenario, the host state will still have to adjust the existing legal system with regards to nuclear liability and safety, even if it does not operate the plant. The host will still be responsible for the security of the actual site, as well as provide authorization for any activities related to the plant. Further, the host state will need to establish emergency plans. For instance, in case of an accident that does not allow transport of the plant to the supplier state, it is important to ensure that the host state is able to provide timely response to avoid potential radioactive release. In the case of an FNPP, an accident can be more difficult to mitigate. Both states have to decide who is responsible for external accident events. This can include natural disasters such as tsunami and earthquakes or potential terrorist attacks.

Different maritime laws should be taken into consideration during the transportation of an FNPP, especially if the core has fuel in it.

There are clearly defined standards for transporting fresh and spent fuel, as well as NPP components [26]. A stationary NPP is assembled on-site. Transportation of a fully-assembled nuclear power plant is a unique case. If the reactor is fueled and then transported, the countries through which it passes will also be involved in the process because of potential accidents in their territorial waters. For instance, due to concerns of several states, Russian Akademik Lomonosov was not fueled at Baltiyskiy Zavod in St. Petersburg as it is usually done with ice-breakers [27]. Russia has experience in operating ships and nuclear-powered icebreakers, however, next-door countries did not want to take such risks. Also, while the plant was transported through Denmark's internal waters, Greenpeace activists approached the plant and demanded more regulations [28]. This case demonstrates that future transportation of a fueled FNPP might be scrutinized by many stakeholders, including non-governmental organizations. Consider, for example, transportation of an FNPP in the South China Sea, where territorial disputes are on the rise. In this case, it might be difficult to accommodate all involved countries.

Non-Proliferation Issues

One of the concerns of a floating nuclear plant is potentially more opportunities for radical groups or terrorist organizations stealing nuclear material or taking control of the plant. It is particularly important in countries where terrorist groups' activities are on the rise. A government facility, such as an FNPP, moored at the shore, can be an attractive target for a terrorist group. Additionally, supplier states would have to rely on the host state to provide adequate physical protection of a power plant site and related facilities. Furthermore, piracy continues to pose a significant threat in places like the Red Sea which makes FNPP transportation through its waters dangerous. Other regions, such as Southeast Asia are also known for piracy. Even if the plant has a sophisticated security system, an attacker does not necessarily need to take control of a facility to inflict damage. Instead, malicious actors can destroy it using explosives. Such a catastrophic situation is unlikely, but if it happens, it will have short- and long-term radiation impacts and potentially negative effects on the economies of states involved.

There is always a possibility for a host state to divert nuclear material for military purposes. If a supplier is a nuclear weapon state, such as Russia or China, there are no concerns for the diversion of the material on their side. Moreover, since Russia plans to lease its plants, it will have control of all nuclear material from delivery to its disposal. Such an arrangement decreases risks of diversion by a host state. There are still some concerns since the receiving side will also have responsibilities to secure the actual site. If the leasing agreement is between two NNWSs, the chances for clandestine activities might be higher. The IAEA will implement safeguards and conduct inspections as for any other type of NPP. As of now, only NWSs consider pursuing FNPP designs. As mentioned, several NNWSs are working on the designs of stationary SMRs.

Environmental Impact and Accidents

The environmental impact should be taken into consideration in case of an accidental radiological release. There are some concerns that floating plants are more harmful to the environment and more prone to accidents than stationary ones. Nuclear accidents may be infrequent, but if they happen, they can have unprecedented long-term effects. In 1985, an explosion on Soviet submarine in Chazhma Bay resulted in 290 people exposed to radiation, ten killed and a large bay area contaminated. The explosion happened after a nuclear reactor was opened, and the wave caused fuel rods to move which then led to a spontaneous chain reaction [29]. Even today, this submarine is a source of radiation. In 2011, a Russian icebreaker, the Taimyr, had a leak in the primary cooling system. It resulted in increased levels of radiation, the reactor was shut down, and the vessel returned to Murmansk [30]. The situation was brought under control and the accident did not cause any major disruption. Surely, modern designs are more sophisticated and ensure maximum safety. However, no one is protected from natural disasters, such as tsunamis, earthquakes, or harsh conditions in regions such as the Arctic. Besides, there is a potential risk of collision during the plant's transportation. If an FNPP in a remote location faces a serious problem, it will be challenging to respond fast and mitigate adverse consequences.

Some critics also point out that since cooling of the plant will create a lot of heat, it can negatively impact marine life in the Arctic. Thermal effects of an operating FNPP can be significant. The temperature of large amounts of water (5400 м3 per hour) dropped into the environment ranges from 23 to 27 °C, while the temperatures outside can be as low as -2 °C [31]. Ecological conditions in several territories of the Arctic region of Russia are already unfavorable. The reasons behind this are nuclear weapon test sites and nuclear naval bases in the region [32]. It is important to keep tabs on all such activities in the Arctic. The ice in this region helps to moderate climate by reflecting the sunlight which prevents temperatures from rising. Environmental groups are highly critical of FNPPs. Greenpeace, for instance, demands an independent assessment of all stages of transportation, construction, and operation, as well as a stop on the introduction of FNPPs in the Arctic [33]. Bringing FNPPs into the Arctic might also further exacerbate the fragile environmental situation due to oil and gas exploration.

Both supplier and recipient states should agree on what responsibilities each side takes in case of an accident. There are various agreements and treaties that both states have to adhere to, such as Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency, Convention on the Physical Protection of Nuclear Material, Convention on Nuclear Safety, etc. States would also have to follow a comprehensive regulatory framework for shipping put in place by the International Maritime Organization (IMO). Moreover, more regulations have to be developed and implemented to adjust the existing system to new types of reactors and emerging technologies.

Other Issues

Another problem is that by sharing nuclear capabilities so rapidly with other countries, suppliers might not be able to maintain the quality of their operations, create effective nuclear

safety and security cultures, as well as train new experts. Nuclear security culture is an important part of successful national security programs facilitated by international guidance. It includes various regulations, government institutions, and general public awareness [34]. The host state will be able to pass on its experiences, but creating effective mechanisms will take some time. Russia, for example, has experience in operating nuclear-powered icebreakers which can be shared with nuclear newcomers. However, Russia also has a history of accidents. One of the most prominent examples is the accident at the Chernobyl Nuclear Power Plant on April 26, 1986. One of the four reactors melted down and subsequently exploded due to not only a flawed design but also an operator failing to follow safety tests procedures. In 1997, due to a violation of safety rules, a technician at the Nuclear Centre in Sarov was severely exposed with an assembly of high enriched uranium [35]. It is important to note that Russia has taken steps in addressing safety issues at its nuclear facilities, however, creating a safety culture is a challenging task for any country.

The competition between suppliers can result in cutting corners on safety and security measures. Since FNPPs will be transferred through territorial waters of other states, they are no longer a concern of only two parties. In the case of FNPPs, it is important to oversee technology developments on a global scale. Creating joint independent research groups and establishing conferences can provide more transparency, improve security and safety measures, and facilitate international cooperation. One example of successful multilateral cooperation is the Nuclear Security Summit. It helped secure vulnerable nuclear material in countries such as Ukraine, Kazakhstan, and Italy [36].

More concerns come from the design of plants and potential difficulties in operation. FNPPs must adhere to international requirements for vessels and nuclear power plants to ensure safety [37]. For example, Akademik Lomonosov has a flat bottom and no propulsion system. This design makes it a potentially dangerous facility that must be accompanied by special towing vessels at any time [38]. Towing an FNPP over a long distance, especially if it is loaded with fuel, will require special technical procedures and difficult manoeuvring.

The resiliency of the supply chain is another aspect to consider. The host state can be fully dependent on the supplier to provide all required equipment, fuel, maintenance, etc. Such a situation might also lead to political influence on a supplier side.

Conclusion

This article highlighted several obstacles that FNPPs will pose to the existing nuclear regime. Recent developments in FNPPs serve as a reminder that in the near future this technology can be exported to many countries. Times have changed since the Sturgis was anchored at the Panama Canal Zone.

There are many compelling arguments against floating NPPs to consider. The non-proliferation and environmental advocates perceive floating power plants as more dangerous than beneficial. Potential implications can also include socio-economic and political aspects. The stakes are high, and one mistake can lead to unprecedented and irreversible consequences. Yet, the demand for electricity is growing and soon enough FNPPs could become a part of the nuclear energy market.

More countries are expressing their interest in developing and exporting SMRs, including FNPPs. If they are commercialized, the international community will face unique challenges in creating new security measures and restructuring the nuclear framework. Both the suppliers and the host states must adhere to many safety-related treaties and agreements to prevent radiological accidents, as well as implement effective security measures to avert terrorist attacks. Additionally, the international community should be able to independently verify new designs. Cooperation between many stakeholders will be the key to success. A comprehensive approach and adequate attention to potential challenges of the emerging technologies, such as FNPPs, will help improve and advance current nuclear regime, while simultaneously avoiding pitfalls.

Disclaimer

The views expressed are the author's and do not necessarily reflect those of CRDF Global.

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