NEA NUCLEAR SAFETY RESEARCH JOINT PROJECTS WEEK:
Success Stories and Opportunities for Future Developments

9-13 January 2023
Welcome
Day 5 – Friday 13 January
NEA NUCLEAR SAFETY RESEARCH JOINT PROJECTS WEEK:
Success Stories and Opportunities for Future Developments

9-13 January 2023

Questions: Questions, feedback and suggestions
Event public page: Nuclear Energy Agency (NEA) - NEA Nuclear Safety Research Joint Projects Week: Success Stories and Opportunities for Future Developments (oecd-nea.org)
Form: Questions, feedback and suggestions link available in the registration confirmation email

Webinar (Online Event)
To address the challenges announced, please write here your questions to the speakers and we will do our best to include as many of them as possible in the discussions.

Please enter your questions in the dedicated spaces below for each session.
Section 1: Nuclear Safety Research Joint Projects: Benefits and Challenges for the Future
Questions for session 1

Section 2: Joint Projects for Safety in Design, Learning and Perspectives
Questions for session 2

Section 3: Joint Projects for Safety in Operation, Learning and Perspectives
Questions for session 3

Section 4: Joint Projects for Safety in Accidental Situations, Learning and Perspectives
Questions for session 4

Section 5: Future Needs for International Co-operation in Nuclear Safety Research
Questions for session 5

Please suggest specific topics you consider to be priorities for future joint safety research projects.
Topics for future joint research projects

If you already know the NEA joint projects framework, please suggest specific areas for future initiatives.

If you are not familiar with the NEA joint projects framework, please share with us what you consider to be key elements to incorporate in the framework of future NEA joint safety research projects.

Professional information
First name: ___________________________
Last name: ___________________________
Email: ___________________________

Thank you very much for your most kind contribution to the successful outcome of this event.

NUCLEAR SAFETY RESEARCH JOINT PROJECTS WEEK
Success Stories and Opportunities for Future Developments
9-13 January 2023
Session 5

Future Needs for International Co-operation in Nuclear Safety Research
SESSION MODERATOR

Mr William D. Magwood, IV
Director-General
OECD Nuclear Energy Agency (NEA)
Mr William D. MAGWOOD, IV, is the Director-General of the OECD Nuclear Energy Agency (NEA) since September 2014. Prior to this position, he served from 2010 to 2014 as one of the five Commissioners appointed by the US President and confirmed by the US Senate to the US Nuclear Regulatory Commission (NRC). From 2005 to 2010, he provided independent strategic and policy advice on energy, environmental and technology policy issues. From 1998 to 2005, Mr Magwood was Director of Nuclear Energy at the US Department of Energy (DOE). During his tenure, he launched several important initiatives including the Generation IV International Forum (GIF) and the formation of the Idaho National Laboratory (INL). He began his career working as a scientist for Westinghouse Electric Corporation and managing electric utility research and nuclear policy programmes at the Edison Electric Institute. Mr Magwood, a US national, holds Bachelor’s degrees in Physics and English from Carnegie Mellon University and a Master of Fine Arts from the University of Pittsburgh.
SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research

Post-Fukushima Daiichi Co-operative Safety Research Projects and Opportunities for Future Research

Dr Toyoshi FUKETA
Advisor, Nuclear Regulation Authority (NRA), Japan
Dr Toyoshi FUKETA was sworn in as a Commissioner of the Nuclear Regulation Authority (NRA) on 19 September 2012, when the NRA was established as a new regulatory body of Japan after the Fukushima Daiichi nuclear accident. After five years as Commissioner, he served as the Chairman of the NRA for another five-year term from September 2017 to September 2022. Prior to becoming a Commissioner of the NRA, Dr Fuketa engaged in nuclear safety research programmes at the Japan Atomic Energy Research Institute (JAERI) and Japan Atomic Energy Agency (JAEA) for 25 years and performed various experiments regarding reactor fuel behaviour – particularly during reactivity-initiated accidents, loss-of-coolant accidents and severe accidents. Numerous data and findings from these studies have directly and indirectly provided the technical basis for regulatory standards. He was honoured by ASTM international with the William J. Kroll Zirconium Medal. At the NEA, Dr Fuketa was a long-standing member of the CSNI and its Working Group Fuel Safety (WGFS), and chaired the committee and the working group, respectively. He contributed to the Halden Reactor Project, the CABRI International Project, the LOFC Project, and other joint projects as a member of their respective organising committees. Dr Fuketa received a PhD (1987), a MS (1984) and a BS (1982) in Mechanical Engineering Science from the Tokyo Institute of Technology.
Post-Fukushima Daiichi
Co-operative Safety Research Projects
and Opportunity for Future Research

Toyoshi Fuketa
Nuclear Regulation Authority, Japan

OECD/NEA Nuclear Safety Research Joint Projects Week
*Success Stories and Opportunities for Future Developments*
Zoom Webinar (Online)
January 13, 2023
This presentation will cover;

F-1 accident investigation

✓ NRA’s second-phase investigation
✓ FACE project

Opportunity for Future Research

✓ LWR severe accident
✓ Advanced technologies
✓ Post-HRP (Halden Reactor Project)
✓ Possible different project
F-1 Accident Investigations

Within several years after the TEPCO's Fukushima Dai-ichi NPS accident, investigations by international organizations, research institutes, industries, regulatory agencies and academic societies have produced many findings and understandings about the causes and progress of the accident. However, due to high radiation levels, entry into the reactor building was extremely restricted and further investigation remained difficult. Accordingly, there exist numerous pending questions regarding, e.g., in-vessel and ex-vessel core melt progression, fuel debris formation and composition, FP leak paths, etc.
Nearly ten years after the accident, improved access to the reactor buildings and past high-dose areas has allowed NRA staff to obtain new information. September 2019 the NRA started the second-phase of investigation and analysis. In 2021 to 2022,

- Shielding plugs and PCV vent lines highly contaminated with Cs-137 were investigated and analyzed to identify leaks of radioactive materials from the PCV and contamination pathways.
- The deflagration and the generation of flammable organic gases were examined through a detailed study of the video footage.
- The event transition after the core meltdown was investigated based on the damage to the piping and concrete around the PCV pedestal and the accumulation of core debris.
The OECD/FACE (Fukushima Daiichi Nuclear Power Station Accident Information Collection and Evaluation) project has started as a constructive extension of BSAF, PreADES and ARC-F projects, and enables:

- In-depth discussions for accident progression and associated FP behavior and H2 combustion
- Characterization of U-bearing particles and establishment of techniques for future fuel debris analysis for D&D (decontamination/deactivation and decommissioning/dismantling)
- Collection and sharing of data and information
Synergies between FACE and NRA’s investigation

FACE Project
- International communities

Facts & Information

Analysis results

NRA’s Investigations

✓ Unify the domestic structure in Japan.

✓ NRA will serve as the single point of contact for participating countries, carefully listening to the requests of each country and reflecting them in the project.
Opportunity for Future Research

For examples;

✔ LWR severe accident
✔ Advanced technologies
✔ Post-HRP (Halden Reactor Project)
✔ Possible different project
On-going investigations on the F-1 accident keep providing insights on possible research project for the better understanding of LWR severe accident, severe accident countermeasures and accident management in existing reactors.
R&Ds of new technologies, such as accident tolerant fuel (ATF), SMR, HTGR, off-shore floating NPP are technical answers from researchers and engineers to the occurrence of the F-1 accident.

- Cr-coated, FeCrAl, SiC cladding,
- Doped pellet, higher burnup, HALEU, UN pellet
- Passive cooling systems, such as, passive RHR, safety condenser, elevated gravity drain tank, natural circulation in operation, and submerged metal containment.
Halden Reactor Project (HRP) with Halden boiling water reactor (1958-2018) is definitely the most successful international research project. HRP provided opportunities of fuel and material irradiation with state-of-the-art technologies and affordable spending.

HRP also provided forums for international experts to have scientific and technical discussions and information exchanges. Halden secondeees became technical experts in each member country.

FIDES initiative is beneficial and successful, but not enough to fill the big shoes.

Numerous opportunities for steady-state irradiation and ramp testing are required to demonstrate long-term operation of NPPs and for the development and deployment of ATFs.

We need to address these demands before we can have new reactors like JHR and VTR.
The F-1 accident gives lessons not only regarding engineering safety but also regarding radiation protection, emergency preparedness and response, etc.

New severe accident countermeasures are likely to significantly lengthen the time between the start of core damage and the release of significant radioactive material, but emergency response plans do not necessarily take this into account.

A well-designed project might facilitate discussion and collaboration between the different standing committees.

Possible project regarding health effects of low doses of radiation. It is very difficult, controversial, time consuming, but why not?
Some ongoing NEA projects have close relationships with WGs and/or WPs under the Standing Committees, while others do not. There may be room for discussion and improvement in the relationship between individual projects and WGs and WPs.

The knowledge and experience gained from the management of the project are being used in other projects and new projects through the NEA secretariat staff, but is there any possible mechanism to further enhance the sharing of this experience? Good practices and failures in projects could be presented more frequently at the standing committee meetings.
Thank you for your attention.

With thanks to
Kohei Iwanaga
Satoshi Abe
Koji Konishi
Yuichi Sato
Masashi Hirano
Dr Fiona RAYMENT, OBE FREng
Chief Science and Technology Officer, National Nuclear Laboratory (NNL), United Kingdom
Dr Fiona RAYMENT OBE, FREng. has dedicated 30 years to the nuclear sector with extensive strategic and operational experience. She is a chartered chemist and engineer with a PhD in chemistry from University of Strathclyde, Glasgow and is a fellow of the Royal Academy of Engineering, the Royal Society of Chemistry and of the UK Nuclear Institute. She has an MBA from Manchester Business School. She has recently served as a member of Euratom’s Science and Technology Committee, the Idaho National Laboratory’s Nuclear Science and Technology Advisory Committee, the American Nuclear Society Board, the UK Nuclear Institute and is immediate past chair of the UK Nuclear Skills Strategy Group. Her other roles across the sector include being a member of the Nuclear Industry Council and the Office of Nuclear Regulation Chief Nuclear Inspector’s Independent Advisory Panel. She is chair of the Scientific Advisory Committee of the Energy Division at CEA – the French Alternative Energies and Atomic Energy Commission, a Non-Executive Member of the UK Space Agency Steering Board and patron of Women in Nuclear UK. In addition to representing the UK at a variety of international meetings, she is a regular keynote and plenary speaker at international nuclear conferences and is a vice chair of the NEA Steering Committee Bureau and Policy Director of the Generation IV International Forum. She has long advocated widening participation in science and engineering and champions our sector-leading approach to diversity and inclusion. She was awarded an OBE in 2017 and the French Légion d’Honneur in 2020.
Fiona Rayment

- **UK NNL.** Chief Science and Technology Officer at National Nuclear Laboratory
- **OECD NEA** Steering Committee Vice chair

NI2050 is a broad NEA initiative aimed at accelerating market deployment of nuclear innovations in support of global emissions reduction targets for 2050.

To achieve such broader strategic objectives, NI2050:

- Applied an innovation lens Agency-wide with input from an Innovation Advisory Panel
- Fostered deeper collaboration along the supply chain with input from an Innovation Advisory Panel
- With a dual focus on technology readiness and regulatory readiness
Nuclear Innovation 2050 background

Outcomes:
- Survey: R&D budget
- Selection of 11 Priority areas & target topics with potential for innovation
- Templates/roadmaps » for each selected topic
- Involvement of all stakeholders to draft detailed Implementation plans and Management

NI 2050 - Phases I and II
## Innovation Advisory Panel (IAP) Members during Phase I and II

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<th>Innovation Advisory Panel Members</th>
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<tr>
<td>Idaho National Laboratory (INL)</td>
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<td>World Nuclear Association (WNA)</td>
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<td>Central Research Institute of Electric Power Industry (CRIEPI)</td>
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<td>Commissariat à l’Energie Atomique et aux énergies alternatives (CEA)</td>
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<td>National Nuclear Laboratory (UK NNL)</td>
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<td>Oak Ridge National Laboratory (ORNL)</td>
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<td>Rosatom</td>
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<td>Korea Atomic Energy Research Institute (KAERI)</td>
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<td>The European Commission</td>
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<td>Nuclear Decommissioning Authority (UK NDA)</td>
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<td>Center for Energy, Environmental and Technological Research (CIEMAT – Spain)</td>
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<td>US Department of Energy (US DoE)</td>
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<td>Poland National Centre for Nuclear Research (NCBJ)</td>
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<td>Nuclear Energy Agency (NEA) (*)</td>
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<td>Fortum Power and Heat Oy – Finland</td>
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(*) All relevant NEA standing technical committee chairs and heads of division were part of the dialogue.
Three main recommendations

• Better alignment of Technology & Licensing Readiness Levels

• Interaction of all stakeholder all along the innovation chain

• Integrate advanced technologies from other industrial sectors.

- Advanced Manufacturing & Assembling,
- Innovative Concrete,
- Digitalization & Data Management
- ….
Priorities for Phase III of NI2050

NTE is preparing for the launch of the **third phase of Nuclear Innovation 2050 (NI2050)**, an Agency-wide initiative to support member countries that aim to accelerate market deployment of nuclear innovations in support of global emissions reduction targets for 2050.

**Motivations & ambition for NI2050 have changed:**

- There is a need to start adopting a **systemic and holistic approach** to address the **urgency of nuclear innovation** for broader **strategic objectives on climate change & energy security**.
- There is a need to **leverage both nuclear and non-nuclear technologies** (e.g., **Digital Technologies, AI, Advanced Manufacturing**).

This will include the creation of a **new multidisciplinary “Innovation Advisory Panel (IAP)” to drive the appropriate focus and provide strategic review and advice on strategic documents concerning innovation at the NEA**.

- The IAP would act as the **convening body** to bring all the **right players together** in a particular **innovation ecosystem to develop the roadmaps and paths to market**.
- For the IAP’s advice to be complete, relevant and actionable, there is a **need to engage with a broader community**, including industry, NGOs, academia and national laboratories, but also actors from outside the nuclear sector.
From **nuclear technical innovation**

11 Technical Priorities:

- **Safety** *(Severe Accident, Passive systems, AT Fuel)*

- **Nuclear life cycle** *(Fuel, Fuel cycle, New build (materials & components), LTO, D&D)*

- **Tools** *(Modelling & Simulation, Measures & Instrumentation, Infrastructures & Demos)*

- **Heat production & Cogeneration**

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**Phase I & II**

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*To wide “nuclear” innovation to reach net Zero & supply security objectives*

**Technical innovation priorities:**

- Implement LTO and New GEN III build
- Devt. & deployment of innovative reactor such as GenIV & SMRs
- Energy convergence between nuclear energy and renewables,
  - flexible nuclear & hybrid designs
  - new uses of nuclear energy & heat
  - with innovation in necessary enabling conditions
- Enhance Safety – Security
- Improve Fuel cycle & backend
- Ensure talent pipeline, Education & Training,....

while globally

- Run adequate R&D
- Integrate advanced technologies from other sectors
- Improve Qualification- Demonstration – Simulation
- Collaborate all along the supply chain with all stakeholders,....

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**Phase III**
IAP objective: drive the appropriate focus of NI2050

**Membership**
- The new IAP will be limited to ~ 12 persons
- The IAP will ensure **diversity** from a disciplinary, sectoral, geographical and gender standpoint
- It may include **diverse representatives** from labs, universities, regulators, industry, governments from **nuclear and outside**

**Mandate – Functions of the IAP**
**Provide strategic review and advice on:**
- special **strategic documents concerning priorities in innovation** at the NEA
- other **NEA key products** (e.g. Strategic Briefings for NEA Steering Committee)
- **proposals**, providing insights on NEA Strategic Plans, Programs of Work or project proposals.

**Timeline – Potential work plan**
- First meeting early 2023
- Potential topics:
  - **Inputs & review of NEA strategic documents**: Program of Work, Strategic plan, SMR strategy, Strategic Technical reports, Potential new projects, Innovation events,…
The Global Forum for Nuclear Innovation (GFNI)

- GFNI is a joint effort between:
  - The initiative is hosted at the NEA under the umbrella of NI2050.
  - The objective is to bring together likeminded people all over the world, from within & outside the nuclear sector, to accelerate nuclear innovation.

- GFNI 2019 held in Korea focused on technical innovations
- GFNI 2022 held in London focused on the cultural and behavioral transformation that is necessary for the nuclear industry to play its critical part in tackling the global climate crisis.

- 4 key behaviors (being a challenger, embracing diversity, being a role model & having courage)
- 2 immersive days: 200 delegates heard updates on the GFNI 2019 follow-up actions, experienced inspirational keynote presentations, and took part in interactive breakout sessions dedicated to the 4 behaviors.
- 4 grand challenges were identified (Nuclear beyond electricity, no talent – no sector, safety doesn’t have to be slow, operating a lean machine)

GFNI 2024 will be held in northern America, hosted by EPRI
NEA is working with partners to explore options for hosting GFNI 2025
Example NI2050 initiative: Disruptive Technologies for Nuclear Safety Applications

Conceptual diagram:

11 Selected priorities

3 main recommendations
- Better alignment of TRLs & LRLs
- Interaction of all stakeholder all along the innovation chain
- Integrate advanced technologies from other industrial sectors.

From NI2050 to Disruptive Technologies for Nuclear Safety Applications: 16th March

Using Disruptive Technology for Nuclear Safety Applications
Data Innovations for the Future of Nuclear Safety
Cyber Security Enhancements for Nuclear Safety Applications

Focus on nuclear safety applications

Spring 2021 teaser webinars

Disruptive technology for Nuclear Safety Applications Workshop (Korea 16-17 May 2023)

Sessions:
- Framing: Using Disruptive Technology for Nuclear Safety Applications,
  1. Data Driven Technologies
  2. Robotics,
  3. Advanced Modelling,
  4. Cyber Security,
  5. Advanced Manufacturing,
- Closing: Promoting Disruption to Enhance Nuclear Safety Application
Thank you for your attention
Addressing Future Research Prioritisation under the NEA Committee on the Safety of Nuclear Installations (CSNI) Auspices

Ms Vesselina RANGUELOVA
Deputy Head of the Division of Nuclear Safety Technology and Regulation, OECD Nuclear Energy Agency (NEA)
Ms Vesselina RANGUELOVA is Deputy Head of the Division of Nuclear Safety Technology and Regulation at the Nuclear Energy Agency (NEA) since October 2021. Ms Ranguelova is leading the NEA support to the NEA Committee on the Safety of Nuclear Installations (CSNI), responsible for the safety research implemented under the auspices of the NEA. Prior to joining the NEA, she was the Head of the IAEA Safety Assessment Section defining and implementing IAEA activities on nuclear power plant design safety and safety assessment. She is also the only woman to have led an IAEA operational safety review team (OSART), leading over ten of the around 200 OSART missions that have been conducted to date – in particular several of those performed for nuclear power plants in Canada, China, France, Finland, Russia, the UK and the US. Prior to her assignment to the IAEA she worked for the European Commission and contributed to the development of Euratom research programmes on nuclear power plant safety, the EU directive on Nuclear Safety and Post-Fukushima stress tests for EU nuclear power plants. Altogether, Ms Ranguelova has more than 35 years of experience in nuclear safety assessment. Ms Ranguelova, a Bulgarian national, has a Master’s of Science in Nuclear Engineering from Moscow Power Engineering University, Russia and also obtained a Post-Graduate Diploma in Probabilistic Safety Assessment from Manchester University, UK.
Addressing Future Research Prioritisation under the NEA Committee on the Safety of Nuclear Installations (CSNI)

Vesselina Rangelova
Deputy Head of the Division of Nuclear Safety Technology and Regulation, OECD NEA

January 13, 2023
NEA committees (as of 1 January 2023)

8 standing technical committees
1 management board
74 working parties and expert groups

The NEA's committees bring together top governmental officials and technical specialists from NEA member countries and strategic partners to solve difficult problems, establish best practices and to promote international collaboration.
NEA Areas of Focus for Safety: Five Major Challenges

- Adequate nuclear skills and infrastructure
- Efficiency of activities related to safety
- Safe operation of current nuclear installations
- Safety in new nuclear installations and in advanced reactor designs
- Human aspects of nuclear safety

Committee on the Safety of Nuclear Installations (CSNI)

- CSNI Programme Review Group (PRG)
  - Working Group on Human and Organizational Factors (WGHOF)
  - Working Group on Fuel Safety (WGFS)
  - Working Group on Fuel Cycle Safety (WGFC)
  - Working Group on External Events (WGEV)
- Working Group on Risk Assessment (WGRISK)
- Working Group on Analysis and Management of Accidents (WGAMA)
- Working Group on Integrity and Ageing of Components and Structures (WGIAGE)
  - Subgroup on the Integrity of Metal Components and Structures
  - Subgroup on the Ageing of Concrete Structures
  - Subgroup on Seismic Engineering
- Expert Group on Small Modular Reactors (EGSMR)
  - Working Group on Electrical Power Systems (WGELEC)
  - Senior Group on Preservation of Key Experimental datasets (SEGPD)
- Expert Group on Fire (EGFR)
Working and Expert Groups Support Safety Research Prioritisation

- PIRTs
- SOARs
- ISPs, benchmarks
- Technical opinions papers, status reports
- Joint projects summaries
- Workshop summaries

Recommendations on safety research, on infrastructures, on data preservation in safety technical areas addressed by committees

Expert groups
SMRs
Fire research
SESAR/SEGPD, ...
Challenge 1: collect, analyse recommendations from WGs and provide priorities

WGs and projects would benefit from high-level directions

Challenge 2: ensure good interfaces between committees for research prioritisation

Integrate at best priorities from all relevant committees (e.g. safety research supporting regulation)

Challenge 3: enhance WGs and projects interactions

Integrate in projects, whenever of interest to project partners, work prioritisation, views of WGs and international experts

Ensure, as far as possible, that WGs are amongst the end users of the main project results
Distribution of joint projects related to the different CSNI WGs activities

Number of completed and ongoing projects per technical area

- Fuel performance and safety
- Thermal-hydraulics in circuits
- Severe accident (SA): containment
- SA: progression in and ex-vessel
- SA: source term
- SA: major accidents
- Structural integrity and LTO
- Fire research
- Human Technology and Organization
- Risk assessment
- High Temperature Gas Reactor

Challenge to find for the future the right balance between various safety technical areas and between current LWR needs and advanced reactors needs

Specific reactor designs (PWRs, BWRs, VVERs, HTGRs) and systems

Advanced reactors needs to be addressed

10 technical areas
Main objectives

• Long term operation (LTO) of existing plants
• Safety of advanced nuclear technologies
• Support to regulators and industry in licensing
• Preservation and use of existing knowledge and data for future safety demonstration

Opportunities

• Increased international focus on the benefits for use of nuclear power in the energy mix
• Ongoing global nuclear safety harmonisation for new reactors
• NEA exclusive and unique framework for generating data through international joint safety projects
• NEA CSNI WG amassed expertise in key safety areas to support regulatory decision-making

Challenges

• Effective mechanisms to define key knowledge gaps and set the right balance between operating and advanced plants
• Sustainable financial support for maintaining/adapting key nuclear safety research platforms
• Decrease of research capabilities due to closure or unavailability of key research facilities (e.g. PKL, MIR)

Limitations caused by export control, IP and commercial interests
• Maintaining highly skilled experts
### Possible ways forward

#### Stakeholders

- Establish an international **safety research board** with members from CSNI, CNRA, EC, IAEA, GIF, .. to advise on CSNI research programme
- Reinforce **interactions** with Regulators to ensure JP support Regulator’s needs, as appropriate
- Increase **visibility** of international safety research by engaging with key success entrepreneurs and participating in key regulators’ conferences
- Involve **industry** and create public–private partnerships to finance safety research with shared benefits

#### CSNI and WGs/EGs

- Ensure **expertise amassed through WGs** is used for the development of concrete, actionable proposals for new JPs
- Organise, wherever beneficial (e.g. LTO), R&D under a framework model to leverage **key facilities** and address a variety of related topics under a single mandate and technical community (e.g. FIDES-II)
- Reinforce link between **CSNI WGs and JPs** by assigning relevant WG as end-user for each project
- Review existing **databases** for applicability to advanced designs
- Complete **Phenomena Identification and Ranking Tables (PIRTs)** for innovative reactors to identify the safety knowledge gaps
WGAMA: Advancing the understanding of accident phenomenology and enhance accident management (1)

**Technical reports**
CFD supporting an enlarged use, Good Practices DEC-A, Status Report IVMR, SOAR H2

**Code Benchmarks**
CFD T-junction, ISP advanced Core Cooling, Inverse Uncertainty Quantification, PERSEO, FSI

**Knowledge Transfer and Data Preservation**
Methodologies Meta-Data preservation, Collection and Qualification, THICKET seminars, CSNI Code Validation Matrix (CCVM)

**Technical meetings**
Specialist Meeting on Transient TH in WCR, CFD4NRS

**Opportunities**
NEA Safety Research Joint Projects

**Co-ordination and Collaboration**
NEA, IAEA, EC, ETSON ...

**CSNI Status Report & Priorities**
Advances in the analysis and management of accidents and future challenges

Thermal-Hydraulics, CFD, Severe Accident

Accident and Phenomena
Experiments and Data
Modelling
Codes
WGAMA: Advancing the understanding of accident phenomenology and enhance accident management (2)

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<tr>
<th>Opportunities</th>
<th>Challenges</th>
<th>Possible ways forward</th>
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<tbody>
<tr>
<td>• Amassed expertise in TH, CFD, SA with large knowledge base, needs for existing reactors identified</td>
<td>• Extend <strong>WG expertise</strong> to new needs</td>
<td>• Expand <strong>scope/applications</strong> to advances reactors</td>
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<tr>
<td>• <strong>Advanced</strong> simulation and modelling under development</td>
<td>• <strong>Secure resources:</strong></td>
<td>• <strong>PIRTs</strong> for advanced reactors, fuels and materials (including SMRs)</td>
</tr>
<tr>
<td>• <strong>Innovation</strong> in SA management (e.g. new systems and response)</td>
<td>o to maintain / adapt / develop key research capabilities for future needs in TH, CFD and SA</td>
<td>• <strong>CCVM</strong> review/update of databases for advanced designs</td>
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<tr>
<td>• <strong>New questions</strong> for accident analyses for advanced designs, fuels and materials</td>
<td>o to review/revise knowledge base for future applications</td>
<td>• <strong>Status reports</strong> and research priorities in TH, CFD, SA</td>
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<td>• Lessons from <strong>Fukushima-Daiichi</strong> accident analyses</td>
<td>• <strong>Prioritising</strong> research efforts with the right <strong>balance</strong> between existing and advanced designs</td>
<td>• <strong>Support projects</strong> to secure needed resources and addressing priority needs</td>
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**WGFS: Advancing the understanding of fuel and clad behaviour in accidents and methods, tools for fuel safety analysis**

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<th>Challenges</th>
<th>Possible ways forward</th>
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<tr>
<td>• Large international research efforts to establish <strong>technology readiness</strong> of ATFs</td>
<td>• Extend <strong>WG expertise</strong> to new materials (e.g. TRISO)</td>
<td>• <strong>Invite experts</strong> in advanced materials to join WGFS</td>
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<tr>
<td>• <strong>Amassed expertise</strong> for safety of conventional fuels and clads with large <strong>knowledge base</strong>, needs for ATFs, HBU/HALEU and doped fuels safety identified</td>
<td>• <strong>Secure resources</strong> to maintain key research capabilities for future needs, in particular research reactors for irradiation tests</td>
<td>• <strong>WGFS to provide directions on research priorities in relation with FIDES II</strong></td>
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<td>• <strong>Advanced simulation</strong> and modelling under development</td>
<td>• <strong>Prioritising</strong> research efforts to support establishing licensing readiness for ATFs with near-term deployment</td>
<td>• <strong>Accelerate testing</strong> in established projects on ATFs with near-term deployment</td>
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<td>• <strong>Established frames</strong> for irradiation testing (FIDES II) and other projects (QUENCH-ATF, SCIP)</td>
<td>• <strong>Data preservation and dissemination</strong> with export control/proprietary issues</td>
<td>• <strong>Continue ongoing actions on data preservation</strong> (Halden F&amp;M legacy data, FIDES II data preservation project)</td>
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### WGIAGE: Advancing understanding of ageing mechanisms and ageing management of SCC

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<tr>
<td>• LTO of operating plants (60 years or above) planned in a number of countries</td>
<td>• <strong>Different interests</strong> related to different structures, components, materials and history of operating conditions</td>
<td>• Engage further industry in collaborative research on LTO, Advanced Manufacturing Technology, new materials and innovation in NDE</td>
</tr>
<tr>
<td>• <strong>Harvesting opportunities</strong> from decommissioning plants increasing in many countries</td>
<td>• <strong>Extend <strong>WG expertise</strong> to new materials and innovative designs aging management</strong></td>
<td>• Create a research frame for collaborative research on harvested material (including metal, concrete, polymer material)</td>
</tr>
<tr>
<td>• Existing frame (FIDES II) for material irradiation testing and pilot project (SMILE) for research on material harvested in plants</td>
<td>• <strong>Involving all stakeholders</strong> in collaborative research on LTO</td>
<td>• WGIAGE to provide directions on research priorities to support LTO’s licensing</td>
</tr>
<tr>
<td>• Innovations in NDE</td>
<td></td>
<td>• Engage further FIDES II in material irradiation testing (ongoing)</td>
</tr>
</tbody>
</table>
**EGSMR How to advance the safety demonstration of SMRs?**

**Challenges & Opportunities**
- Define areas of common interest for research on SMR safety to close the knowledge safety gaps.
- Co-ordinate/seek synergy with IAEA, GIF, EC-Euratom to optimise efforts.
- Establish close links with regulators, as the focus on near-term deployment of SMR needs strong scientific support for licensing.
- Support international harmonisation in safety assessment and licensing of SMRs.

**Type of Reactors**

<table>
<thead>
<tr>
<th>Reactor Type</th>
<th>LWR</th>
<th>HTGR</th>
<th>SFR</th>
<th>MSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of responses per design type</td>
<td>25</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

- **First priority**
- **Interesting, but not as prioritised**

**Advanced Designs**

- **PIRTs**
  - Define the knowledge gaps

- **Opportunities**
  - NEA Safety Research Joint Projects
  - Produce quickly experts opinion papers on the key safety issues for SMRs
  - Define the knowledge gaps
  - Update CCVM
  - Support validation and verification of computer codes

**Fuel, Materials, Accident Analyses, Simulation Codes**
Main Conclusions

• NEA operates an exclusive and unique framework and data bank for supporting important international safety projects with proven benefits for the nuclear community

• LTO and deployment of SMR impose the need to accelerate innovations for safety assessment through experimental programmes and advanced simulation and modelling

• NEA should reinforce its efforts to ensure accumulated data in the past could be classified and utilised appropriately for future nuclear safety assessment

• NEA should further facilitate and enhance interactions between Joint Projects and Committee on the Safety of Nuclear Installations (CSNI) Working Groups to ensure maximum benefits for nuclear safety globally

• Joint projects and CSNI Working Groups reports should be complementary, to the extent possible, in solving key priority safety issues
Proposed actions to be discussed

**Establish a safety research board**
- With members from CSNI and CNRA, EC, IAEA, GIF to advise on CSNI research programme

**Organize an R&D framework model**
- Reinforce the link CSNI / WGs / JPs
- End-user WG for projects
- Address topics under a single mandate and technical community (e.g. FIDES-II)

**PIRTs and databases for innovative designs**
- Review existing databases for innovative designs

**Engaging with policy making bodies**
- Seek financial support for safety research
Thank you for your attention!

Vesselina RANGUELOVA
Deputy Head of Nuclear Safety Technology and Regulation Division
OECD Nuclear Energy Agency
Vesselina.RANGUELOVA@oecd-nea.org
SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research

Better Addressing the Challenge of Joint Projects Data Preservation and Dissemination

Dr Didier JACQUEMAIN
Senior Nuclear Safety Specialist
Division of Nuclear Safety Technology and Regulation, OECD Nuclear Energy Agency (NEA)
**Dr Didier JACQUEMAIN** is a Senior nuclear safety specialist at the NEA since January 2020. He is a technical advisor for the working groups active under the Committee on the Safety of Nuclear Installations (CSNI) and a technical co-ordinator for the NEA joint nuclear safety research projects. Before joining NEA, he worked for 27 years at the French Institut de Radioprotection et de Sûreté Nucléaire (IRSN) in the nuclear safety research area and was mostly involved in research programmes on fuel safety, severe accidents and ageing with an active contribution to international research projects in nuclear safety. He received a PhD in physical chemistry from the Weizmann Institute of Science (Israel) in 1992 and graduated from the École Supérieure de Chimie Industrielle de Lyon in 1988. His book on Nuclear Power Reactor Core Melt Accidents was published in 2015.
Better Addressing the Challenge of Joint Safety Research Projects

Data Preservation and Dissemination

Didier JACQUEMAIN
NEA, Nuclear Safety Division

Alice DUFRESNES
Michelle BALES
NEA, Division of Nuclear Science and Education
NEA objectives

I. Collecting, preserving and disseminating all joint safety research projects data through the NEA Data Bank (NEA DB)  
   *Co-ordinate with CSNI, NSC and MBDAV activities*

II. Enhancing the collection, preservation and dissemination of data of completed projects  
   *Prioritise efforts on key datasets*

III. Optimise data management for ongoing and future projects  
   *Engage actions for data management early in joint projects development*
I - Preserving and disseminating projects data by NEA DB

**NEA DB** is an International Centre of Excellence for a **SAFE and DURABLE REPOSITORY** of projects Data Packages (DPs)

At the **END OF PROJECTS**, reports and data are grouped by the operating agent in data packages (DPs) that are generally collected by the NEA DB for preservation and dissemination.

DPs are **ARCHIVED** and **DISSEMINATED** for the benefit of the nuclear safety community.

- DPs may be distributed, after a non-disclosure period, to individuals with a professional affiliation in NEA member countries upon request.
- Non-disclosure period and distribution rules are agreed with members.
- Distribution is upon request for a specified use and to a single user.

Most generally used in:
- Data and codes assessment activities (e.g. ISPs, benchmarks)
- Training and educational activities for the next generation of experts

Available DPs can be requested at [https://www.oecd-nea.org/tools/ie/list](https://www.oecd-nea.org/tools/ie/list)
I - Preserving and disseminating projects data by NEA DB

- Close to 50 NEA safety projects completed by 2023 and about 20 more expected to be completed by 2025 (excluding events database projects)
- NEA DB also distributes integral experiments data, databases (e.g. IFPE), benchmarks results (most related to projects)

**Participation in joint safety research projects**

**Cumulated number of safety related projects**

Including events database projects

Excluding events database projects
Specific efforts have been undertaken for harmonising data preservation approaches (e.g. DPs content and format) where this clearly appears beneficial for end users, i.e. in the fuel performance and safety and in the thermal-hydraulic areas.
I - Preserving and disseminating projects data by NEA DB

- Legacy database is wide and will be significantly widened in the coming years
- Not all completed projects have delivered DPs, notably when project members have not agreed on DPs content and distribution at the project time; retrieval more challenging with time; proprietary and export control issues may cause additional challenges
- DPs have not all been reviewed and exercised to the same level (e.g. through benchmarks) and data completeness and quality assurance (QA) are less known for less exercised data
- Older DPs have not necessarily been prepared with currently expected completeness and QA standards, notably for advanced codes applications

- Legacy database mostly developed for current large reactors designs
- Technical bases considered in safety analysis of advanced and new concepts (e.g. iPWR SMRs)
- Efforts needed to develop the value of the legacy database for future safety applications (e.g. SMRs)
II – Enhancing data management for completed projects

- NEA engaged in efforts to **COLLECT KEY DATABASES FOR NUCLEAR SAFETY**, despite proprietary and export control issues (e.g. Halden F&M database), with NEA DB providing preservation and distribution schemes addressing project members’ needs and constraints.

- NEA **ENCOURAGES DATA REVIEW ACTIVITIES** to exercise legacy data (international standard problems or benchmarks) within projects or under NEA WGs.
NEA will collect and manage from 2024 the Halden reactor project (HRP 1958-now) legacy database

- Significant HRP effort to archive all reports and data in an organised database completed in 2021
- HRP members agreed on legacy database transfer to NEA early 2024
- Distribution: HRP members and working with IFE on having a list of pre-approved countries for export (all NEA members)
- New activity will start in 2023 under CSNI Working Group on Fuel Safety (WGFS) to review completeness of some key HRP datasets
- Some data sets already included in NEA IFPE database, notably datasets exercised in NEA and IAEA benchmarks

- Will be a major resource for fuel performance and safety analyses
- Experience in data preservation and review will serve future data preservation efforts in the field, e.g. data from FIDES JEEPS
II – Enhancing data management for completed projects

CSNI Senior Expert Group on Preservation of key experimental Datasets (SEGPD) works on providing recommendations on priorities after reviewing existing preservation efforts.

1. Have a safe, organised, central repository for all DPs (collect missing key datasets)
2. Provide end users with status and completeness and QA
3. Provide end users with intelligent search tools
4. Advanced developments to be carefully considered per technical area

High cost/benefit ratio
II – Enhancing data management for completed projects

Provide end users with **status of completeness and QA of archived data**:

- organise first a simple **screening** on qualitative criteria related to **availability of information and data** for end users
- foster efforts for **exercising key datasets** where end users see interest and benefits for safety
- **collect** more systematically and synthetise **feedback from end users** (e.g. through benchmarks and NEA DB distribution)

**Identify key datasets at risk**: organise detailed reviews with NEA members in various safety technical areas to identify key legacy datasets at risk and of value for future application (e.g. for advanced claddings and fuels, SMRs)
Activity to **harmonise methods for data archiving** in the **thermal-hydraulic** technical area in CSNI Working Group on the Analysis and Management of Accidents (THEMPO) started in 2022

- establish guidance for ensuring data completeness and QA and specify database features for preservation addressing at best end users’ needs

Activity with similar objectives in CSNI Working Group on Fuel Safety for a **RIA database** started in 2022

**Final objective:** databases for assessing performance and safety of current and more advanced designs, e.g. advanced cladding and fuel behaviour, passive systems
Second NEA Framework for Irradiation Experiments (FIDES-II): data preservation and QA project

Will establish QA standards and guidelines at the FIDES level for implementation at the level of its Joint Experimental Programmes (JEEPs) and for the benefit of all FIDES members.
III – Optimise data management for ongoing and future projects

SEGPD works on providing recommendations

**SYSTEMATIC COLLECTION BY NEA DB OF PROJECTS DPS**, with early setting of preservation and distribution schemes, in agreement with project members

**ENGAGING PROJECTS** to ensure DPs are designed to answer end users’ needs, are complete and their QA level known

- NEA to establish high-level guidance on DPs content and to foster anticipated discussions on DPs in projects
- Project members to enter early in discussions on DPs content
- Systematise benchmark activities in projects with operating agents to include in proposals resources needed for co-ordination
- Project members to engage resources to contribute to exercising data during a project
- Make benchmark information/reports available in future distribution
**Conclusion**

**CO-OPERATION** in data preservation is vital to maximise the benefits of joint safety research projects.

**COLLECTING, DEVELOPING AND DISSEMINATING** outcomes from joint projects, all contribute to increase the value of projects for nuclear safety.

NEA members should consider that activities for preservation of data, completeness of data, QA of data have to be included in projects efforts for a **DURABLE USE OF DATA IN THE FUTURE**; the large database established for current designs is a basis for assessing safety of new designs.

Courtesy Framatome and USNRC
Thank you for your attention!

JACQUEMAIN Didier
Senior Nuclear Safety Specialist
OECD Nuclear Energy Agency
Didier.Jacquemain@oecd-nea.org
Session 5

Future Needs for International Co-operation in Nuclear Safety Research

Break

14:36 – 14:46 CET
Brief summary of the key outcomes of the workshop sessions
Main outcomes of sessions 1-4, tentative recommendations

Didier JACQUEMAIN
NEA, Nuclear Safety Division

Prepared with:
Moderators, panellists and speakers of sessions
Session 1: nuclear safety research joint projects, benefits and challenges for the future

Establish an international strategic research plan (high-level roadmap) with main knowledge gaps identification and key research platforms to maintain, incl. for advanced reactor and fuel concepts

- Co-ordinate with regulators, industry and other international organisations
- Work in parallel on safety harmonisation for advanced concepts

Increase industry’s involvement

- Promote joint projects to industry (interest to work on TRLs and LRLs at the same time), include industry needs as far as feasible, convince industry of the interest to provide advanced material, promote joint projects on innovation
- Enlarge expertise on advanced concepts in CSNI WGs (experts from industry)

Organise projects around platforms in key safety technical areas

Enlarge networking, establish mechanisms for funding maintenance of key research infrastructure and to alleviate risks for operating agents

Enhance education activities in joint projects

Promote education tasks in projects, guest scientists at facilities
Session 2: nuclear safety research joint projects for safety in designs, learnings and perspectives

Establish global research roadmaps in fuel performance/safety and TH areas to support design & licensing of advanced reactors and fuel concepts
- Identify gaps and key research platforms to maintain on LT (incl. transient reactors)
- Co-ordinate between relevant NEA WGs on prioritisation (e.g. organise common PIRTs)

Increase industry involvement, including smaller companies, newcomers (cf. slide 2)

Enhance integrated approaches in safety research in fuel and TH areas
- In the fuel safety area, FIDES-II established, interactions with JPs for out-of-pile testing (SCIP, QUENCH-ATF) could be enhanced
- In the TH area, an integrated project approach would be beneficial (establishing a research platform, addressing scaling, collaborative activities on modeling & simulation and data preservation, encouraging joint workshops between different JPs)

Promote activities in relevant WGs for the durable preservation of JPs data
- Engage actions for identification of key datasets for future applications in relevant WGs, promote ISPs and benchmark activities
- Engage projects in data preservation activities (as in FIDES-II), e.g. in the TH area

Launch a pilot activity to assess the benefits of AI or Machine Learning technologies in the TH area (Intelligent search and interrogation of existing databases for gaps identification)
- Co-ordinate between relevant activities under CSNI and NSC
Session 3: nuclear safety research joint projects for safety in operation, learnings and perspectives

Review further research opportunities/capacities in fire, LTO (incl. harvesting), HTO areas

Identify research needs and opportunities for safety in operation for new technologies

Enhance co-ordination and sharing of experience between projects

In the LTO area, with growing opportunities in harvesting activities, structure an integrated approach for research and seek involvement of utilities

Secure joint projects data preservation and dissemination for the long term

Promote capacity building objectives in joint projects

- Disseminate data for education purposes, increase universities involvement, assess how to integrate education activities in database projects, organise final seminars/summer schools for largest projects, plan venue of guest scientists at facilities

- Launch actions for dissemination to non NEA member countries with nuclear programs under development
Session 4: nuclear safety research joint projects for safety in accidental situations, learnings and perspectives

Establish global research roadmaps in the SA area to support development of projects responding to priority safety assessment needs for existing and advanced reactors (incl. SMRs)

*Use expertise amassed through WGAMA activities (e.g. PIRT, SOARs, CCVM...) to derive actionable proposals*

Promote more integrated approaches in main areas, e.g. TH including passive safety systems, hydrogen risk management, source term, in-core and ex-core cooling etc.

*Increase collaboration between JPs in a given technical area, sustain better key experimental platforms, foster joint benchmarking activities*

Review the achievement for safety applications (e.g. calculation tools/methods) to identify needed way forward

*Further discuss safety applications (use of results to enhance accident management for different designs, representativeness/scaling/remaining gaps/uncertainties)*

Promote optimised use, updating and transfer of the knowledge base for safety assessment/accident progression evaluation

*Develop, use and manage TH database (based on THEMPO recommendations), promote ISPs, benchmarks, knowledge transfer to younger researchers (THICKET)*

Launch activities to assess the benefits of using AI and Machine Learning advanced techniques for more effective approach to accident analyses

*e.g. addressing large accident scenarios variability, detailed uncertainties evaluations*
Key generic recommendations

- Prioritise (globally and per main safety technical areas) to support development of projects proposals responding to priority needs
- Promote more integrated approach of safety research, around sets of experimental platforms, in main safety technical areas
- Secure projects results QA, preservation and dissemination
- Implement mechanisms for expertise building in projects
Thank you for your attention!

JACQUEMAIN Didier
Senior Nuclear Safety Specialist
OECD Nuclear Energy Agency
Didier.Jacquemain@oecd-nea.org
What mechanisms to establish priorities for future international co-operation in nuclear safety research? Which frameworks to address future safety research?
Ms Aline DES CLOIZEAUX
Director, Division of Nuclear Power, Department of Nuclear Energy, International Atomic Energy Agency (IAEA)
Ms Aline DES CLOIZEAUX is Director, Division of Nuclear Power, in the Department of Nuclear Energy of the International Atomic Energy Agency. Before joining the Agency, Ms des Cloizeaux worked as Director, Civil Nuclear and Equipment Business Line at Naval Group, Programme Director at Framatome, Large Investment Projects SVP at Orano, and held various positions at Areva and Cegelec, in Paris, France. She is Vice-President of the IAEA Chapter of Women in Nuclear. Ms des Cloizeaux holds a Master’s degree in Science and Engineering Technology from the École Polytechnique, a Master’s degree in Civil Engineering Technology from the École Nationale des Ponts et Chaussées and an MBA from the Collège des Ingénieurs.
Mr Roger GARBIL

Head of the Fission Section, Euratom Research Unit, Directorate General for Research and Innovation, European Commission
Mr Roger GARBIL is Head of the Fission Section of the Euratom Research Unit of the Directorate General for Research and Innovation, at the European Commission in Brussels, Belgium. Graduating in 1995 as a Nuclear Physicist from the University of Saint-Etienne, France, he has worked in nuclear fusion and fission research for over 25 years. He is a promoter of Euratom research and training activities and innovation, cross-cutting infrastructures, education, training, mobility and international co-operation through the IAEA, GIF and NEA.
Mr Jess GEHIN
Associate Laboratory Director, Nuclear Science and Technology, Idaho National Laboratory (INL), United States
Mr Jess GEHIN became Associate Laboratory Director for the Idaho National Laboratory (INL) Nuclear Science & Technology (NS&T) Directorate in March 2021 after serving as chief scientist for the directorate since 2018. Over his 28-year career, he has built national strategies and priorities for nuclear energy, led complex projects and organisations, and developed strong relationships with senior leaders within the INL, Department of Energy and federal sponsors, as well as other laboratories, companies, and universities. In support of the DOE Office of Nuclear Energy, he served as the national technical director for the DOE Micro-reactor Programme. He expanded NS&T’s strategic direction and helped develop and establish key projects to build advanced reactors at INL, such as the Department of Defense’s demonstration micro-reactor Project Pele, and the Micro-Reactor Applications Research Validation and Evaluation (MARVEL) Project. Previously, he held research and leadership positions at Oak Ridge National Laboratory (ORNL) in nuclear reactor core physics, reactor core and system technologies, reactor modelling and simulation, and fuel cycle reactor applications. While at ORNL, he served as Director of the Consortium for Advanced Simulation of Light Water Reactors. He earned a Bachelor’s degree in nuclear engineering from Kansas State University, and master’s and doctoral degrees from the Massachusetts Institute of Technology. His was an associate professor at the University of Tennessee, is a Fellow of the American Nuclear Society, and has authored or co-authored more than 120 peer-reviewed journal and conference articles, technical reports, and conference summaries.
Panel SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research

Dr Jean-Christophe NIEL
Chair of the OECD NEA Committee on the Safety of Nuclear Installations (CSNI), Director-General, Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France
Dr Jean-Christophe NIEL is Director General of the French Institute of Radiation Protection and Nuclear Safety (IRSN). Over 30 years Dr Jean-Christophe NIEL has gained a long experience in the control of nuclear safety and in radiological protection through various positions, at the Institut de Radioprotection et de Sûreté Nucléaire (IRSN), French technical safety organisation and at Autorité de sûreté nucléaire (ASN), the French nuclear safety authority. He was Director General of ASN for almost 10 years. The President of the French Republic appointed Jean-Christophe Niel as the head of IRSN in April 2016. He was reappointed in April 2021 for a further five years. Dr Niel currently chairs the NEA Committee on the Safety of Nuclear Installations (CSNI). He has recently been appointed member of the International Nuclear Safety Group (INSAG) by the Director General of IAEA, Raphael Grossi.
Thank you for your participation!

Questions, feedback and suggestions - link available in the registration confirmation email

Event public page: Nuclear Energy Agency (NEA) - NEA Nuclear Safety Research Joint Projects Week: Success Stories and Opportunities for Future Developments (oecd-nea.org)