

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

9-13 January 2023

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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

 **NEA**
NUCLEAR ENERGY AGENCY

ABOUT US | TOPICS | NEWS AND RESOURCES | LEARNING AND TOOLS

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.

Session 1: Nuclear Safety Research Joint Projects: Benefits and Challenges for the Future
Questions for session 1

Session 2: Joint Projects for Safety in Design, Learnings and Perspectives
Questions for session 2

Session 3: Joint Projects for Safety in Operation, Learnings and Perspectives
Questions for session 3

Session 4: Joint Projects for Safety in Accidental Situations, Learnings and Perspectives
Questions for session 4

Session 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 safety research joint projects

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

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.

If you already know the NEA joint projects framework, could you please tell us what suggestions you have for future revisions, and in case you are not familiar with the NEA joint projects framework, please share with us potential mechanisms and frameworks that could be used in the future to address nuclear safety research. *

Professional information

First Name *

LAST NAME *

ORGANISATION *

COUNTRY *

Professional e-mail address *

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

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.

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



Dr Toyoshi FUKETA

Advisor, Nuclear Regulation Authority (NRA), Japan

SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research



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 ASTEM 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

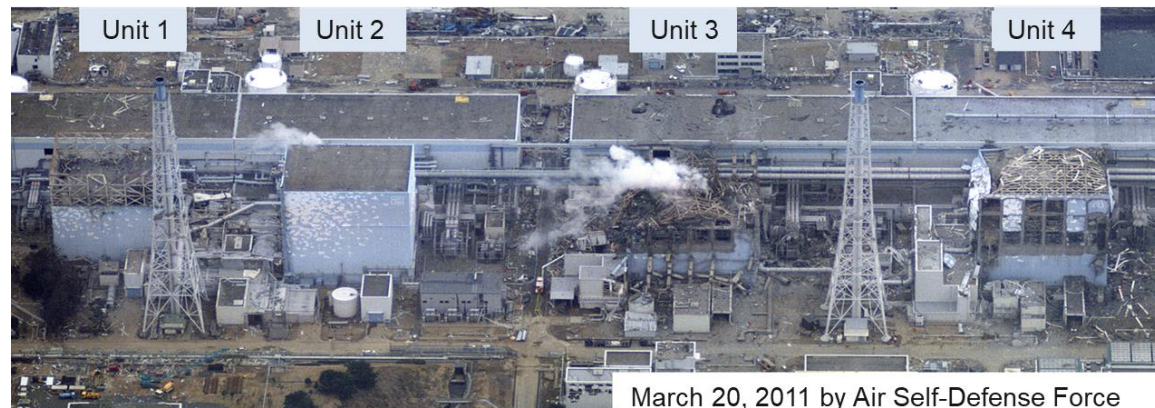
F-1 accident investigation

- ✓ NRA's second-phase investigation
- ✓ FACE project

Opportunity for Future Research

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

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 (**F**ukushima Daiichi Nuclear Power Station **A**ccident Information **C**ollection and **E**valuation) 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



- ✓ 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.

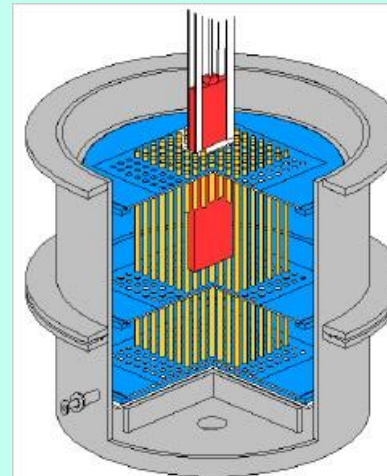
For examples;

- ✓ 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.



CIGMA to simulate ex-vessel phenomena at severe accident



STACY, Critical assembly with thermal neutron spectrum



- ✓ 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 secondees 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



Nuclear Innovation-2050: An NEA Initiative to Foster Innovations in the Nuclear Sector



Dr Fiona RAYMENT, OBE FREng

Chief Science and Technology Officer, National Nuclear Laboratory (NNL), United Kingdom

SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research



Dr Fiona RAYMENT OBE, FEng. 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.

Nuclear Innovation 2050

Fiona Rayment

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

www.oecd-nea.org/ndd/ni2050/



Nuclear Innovation 2050 (NI2050)

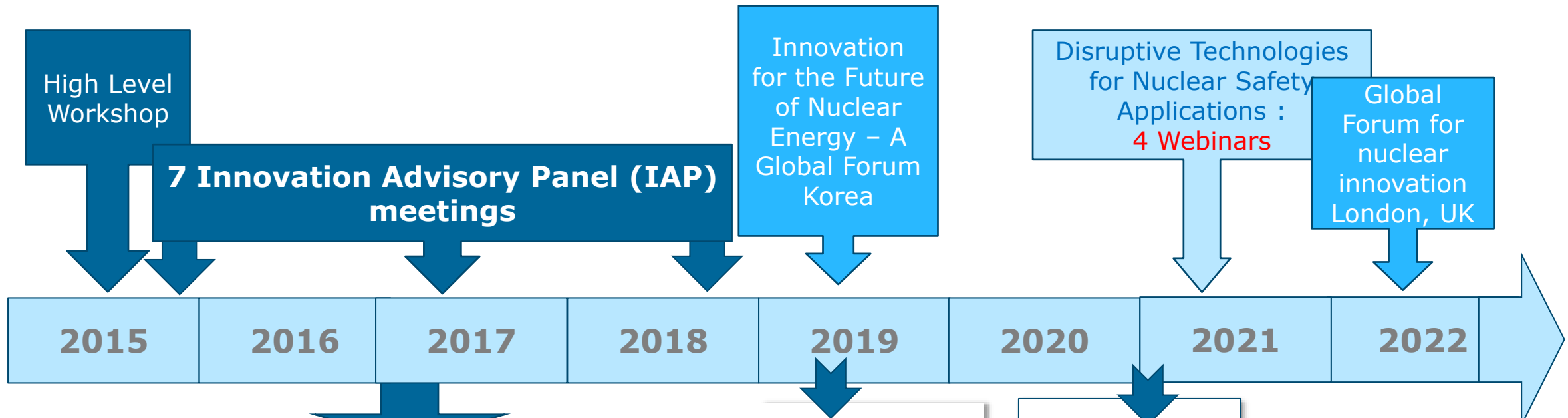
NI2050 is a broad NEA initiative aimed at accelerating market deployment of nuclear innovations in support of global emissions reduction targets for 2050.



To achieve such broader strategic objectives, NI2050:

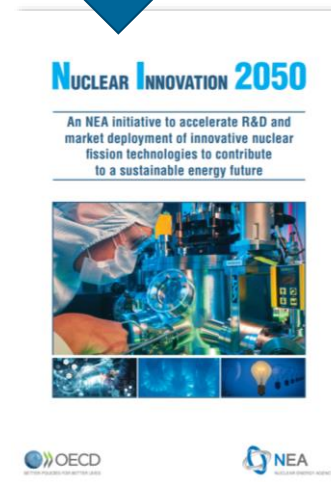
- ❑ Applied an innovation lens Agency-wide with input from an Innovation Advisory Panel
- ❑ Fostered deeper collaboration along the supply chain with input from an Innovation Advisory Panel
- ❑ With a dual focus on technology readiness and regulatory readiness

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*



Innovation Advisory Panel (IAP) Members during Phase I and II

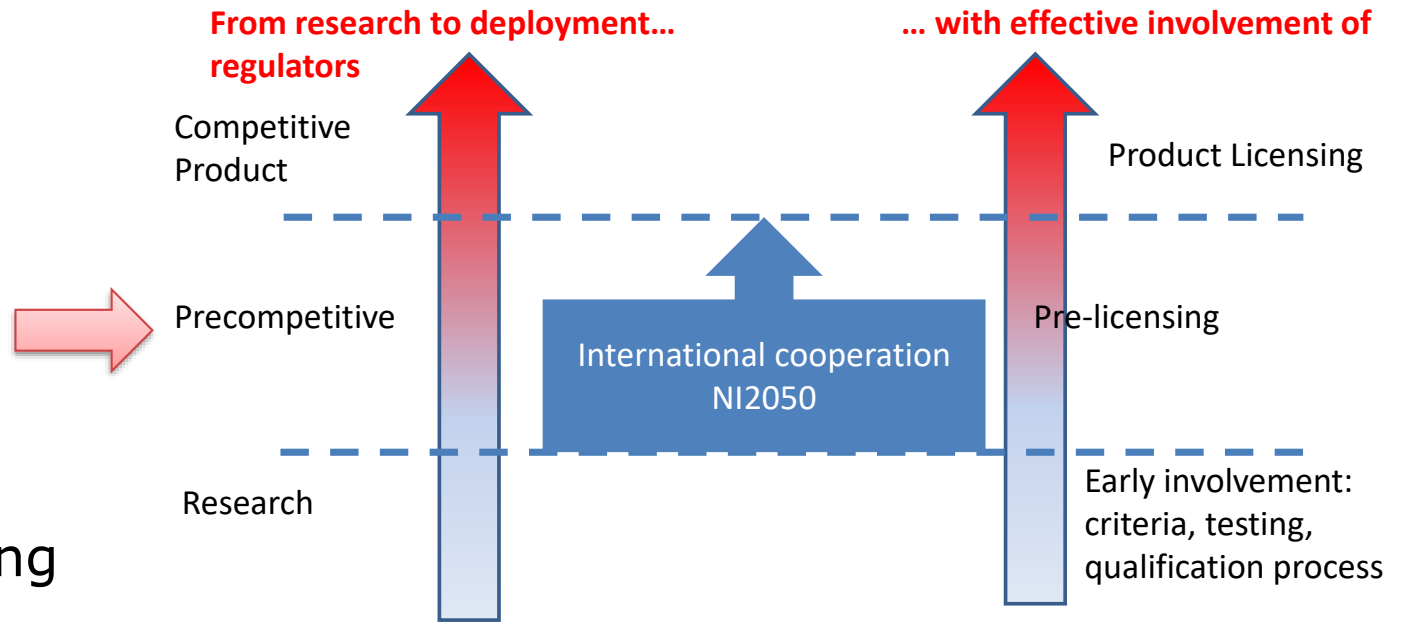
Innovation Advisory Panel Members	
Idaho National Laboratory (INL)	World Nuclear Association (WNA)
Central Research Institute of Electric Power Industry (CRIEPI)	Commissariat à l'Énergie Atomique et aux énergies alternatives (CEA)
National Nuclear Laboratory (UK NNL)	International Atomic Energy Agency (IAEA)
Electricité de France (EDF)	Institute for Radiological Protection and Nuclear Safety (IRSN)
Canadian Nuclear Laboratories (CNL)	Belgian Nuclear Research Centre (SCK.CEN)
Oak Ridge National Laboratory (ORNL)	Rosatom
Korea Atomic Energy Research Institute (KAERI)	The European Commission
Nuclear Decommissioning Authority (UK NDA)	Center for Energy, Environmental and Technological Research (CIEMAT – Spain)
US Department of Energy (US DoE)	Poland National Centre for Nuclear Research (NCBJ)
Nuclear Energy Agency (NEA) (*)	Fortum Power and Heat Oy – Finland

(*) All relevant NEA standing technical committee chairs and heads of division were part of the dialogue.

NI 2050 final report conclusions

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

NI2050: from Phase I & II to phase III

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

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**

Phase I & II



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,...

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,...
 - **Review specific documents on Innovation:** PoW- Gap analysis, Nuclear Innovation ecosystem vs outside, Issues faced by Industry & Government role, Talent pipeline, TRL-LRL: Demonstration-qualification-simulation,...

The Global Forum for Nuclear Innovation (GFNI)

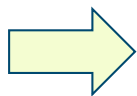


- **GFNI is a joint effort** between:  **EDF**  **EPRI**  **IAEA** International Atomic Energy Agency  **NATIONAL NUCLEAR LABORATORY**  **NEA** Nuclear Energy Agency
- The initiative is hosted at the NEA under the **umbrella of NI2050**.
- The objective is to bring together likeminded people all over 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:



Korea Atomic Energy
Research Institute



NEA
NUCLEAR ENERGY AGENCY



한국원자력학회
KOREAN NUCLEAR SOCIETY

**NEA Nuclear
Innovation 2050**

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.



**Spring 2021
teaser webinars**

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

**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)

SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research



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

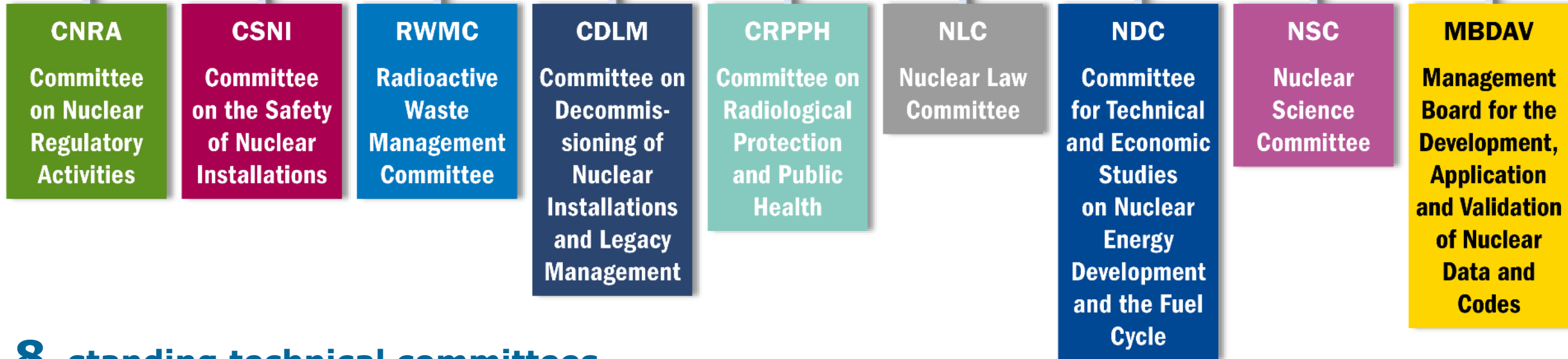
January 13, 2023



NEA committees (as of 1 January 2023)



Steering Committee for Nuclear Energy



8 standing technical committees

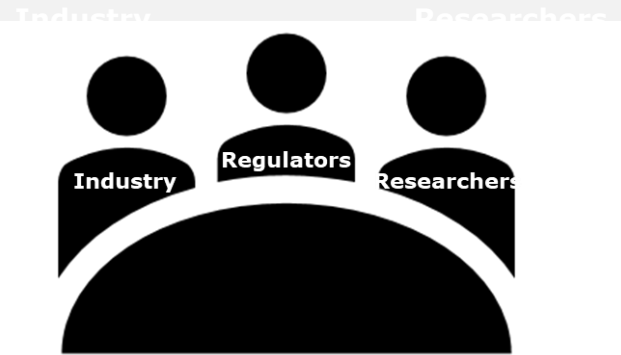
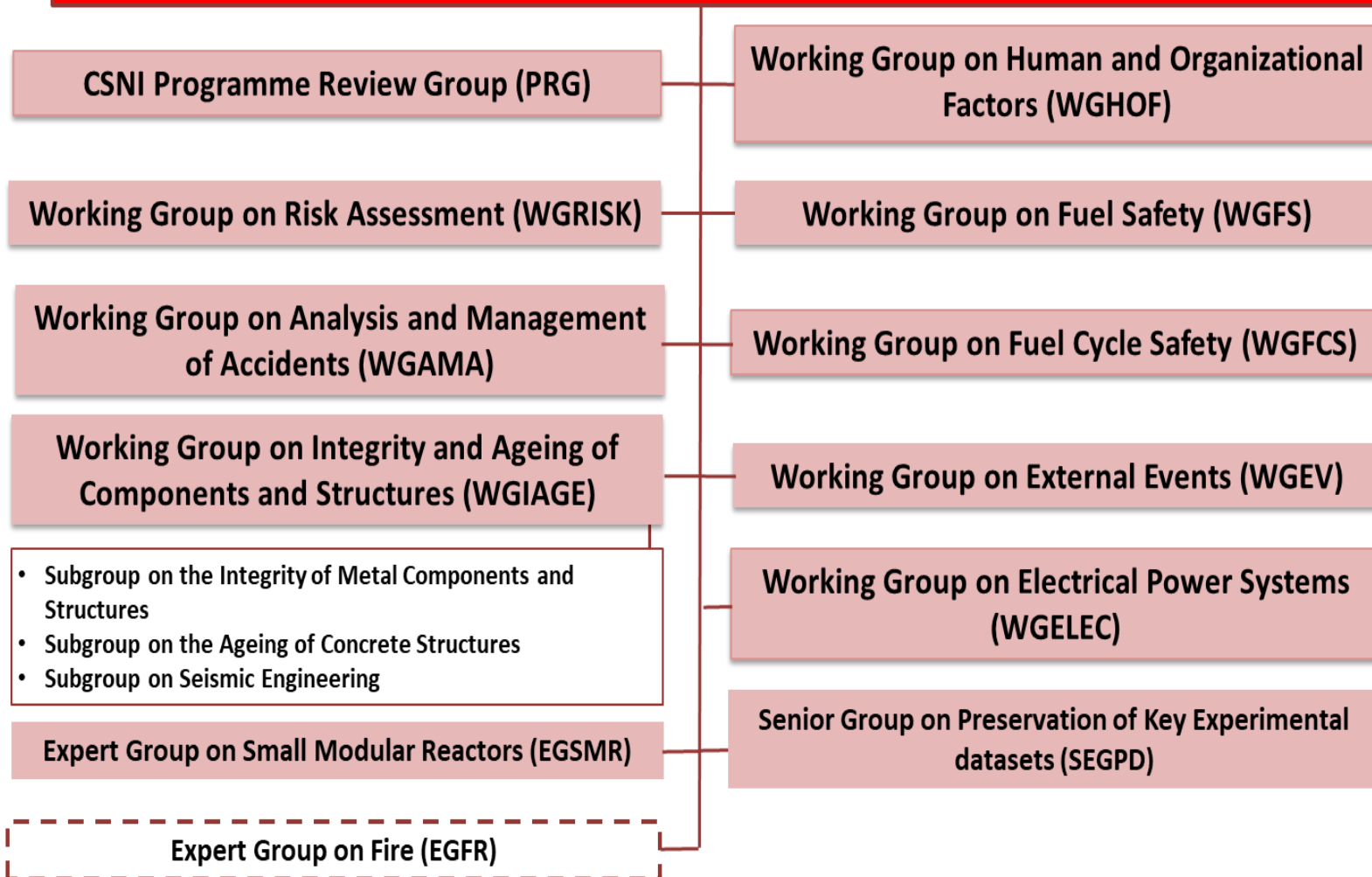
1 management board

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

Committee on the Safety of Nuclear Installations (CSNI)



- 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

Working and Expert Groups Support Safety Research Prioritisation

PIRTs

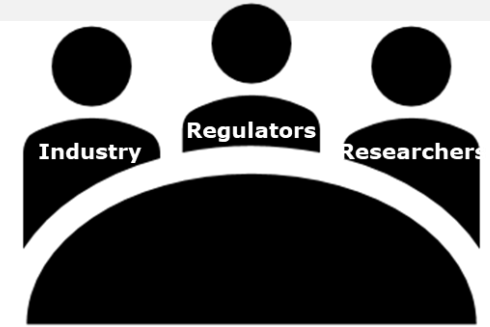
SOARs

ISPs, benchmarks

**Technical opinions papers,
status reports**

Joint projects summaries

Workshop summaries



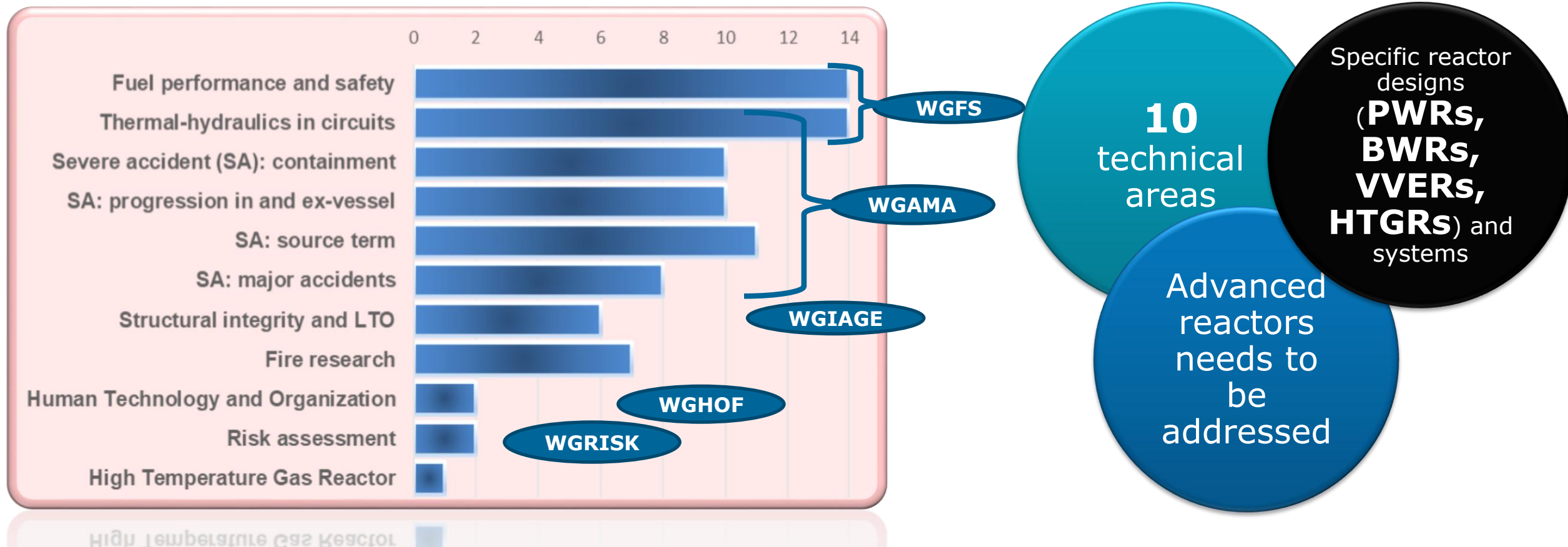
Recommendations on safety research, on infrastructures, on data preservation in safety technical areas addressed by committees



**Expert groups
SMRs
Fire research
SESAR/SEGPD, ...**

Distribution of joint projects related to the different CSNI WGs activities

Number of completed and ongoing projects per technical area



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

Future Safety Research Prioritisation (1/2)

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**

Future Safety Research Prioritisation (2/2)

Possible ways forward

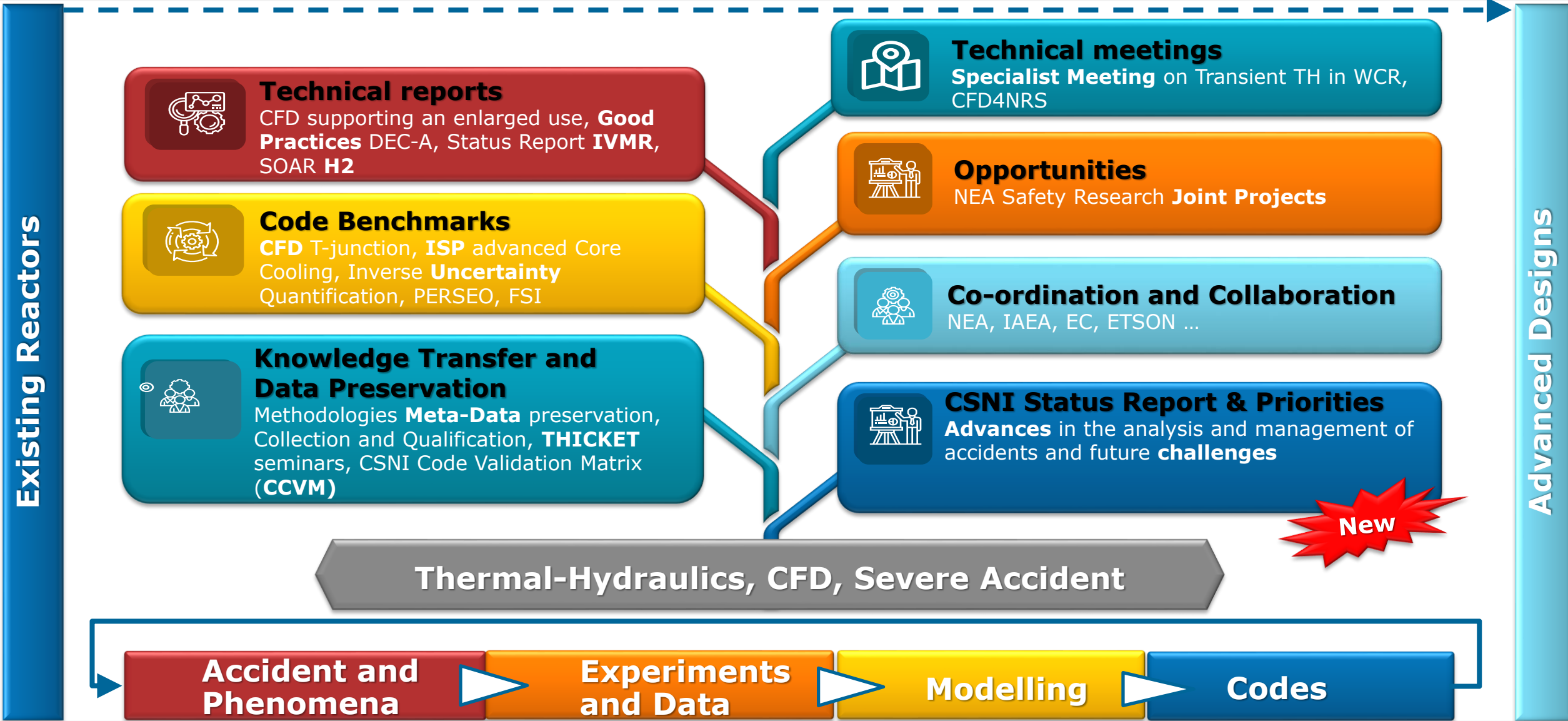
Stakeholders

- 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)



WGAMA: Advancing the understanding of accident phenomenology and enhance accident management(2)

Opportunities	Challenges	Possible ways forward
<ul style="list-style-type: none"> • Amassed expertise in TH, CFD, SA with large knowledge base, needs for existing reactors identified • Advanced simulation and modelling under development • Innovation in SA management (e.g. new systems and response) • New questions for accident analyses for advanced designs, fuels and materials • Lessons from Fukushima-Daiichi accident analyses 	<ul style="list-style-type: none"> • Extend WG expertise to new needs • Secure resources: <ul style="list-style-type: none"> ○ to maintain / adapt / develop key research capabilities for future needs in TH, CFD and SA ○ to review/revise knowledge base for future applications • Prioritising research efforts with the right balance between existing and advanced designs 	<ul style="list-style-type: none"> • Expand scope/applications to advanced reactors • PIRTs for advanced reactors, fuels and materials (including SMRs) • CCVM review/update of databases for advanced designs • Status reports and research priorities in TH, CFD, SA • Support projects to secure needed resources and addressing priority needs

WGFS: Advancing the understanding of fuel and clad behaviour in accidents and methods, tools for fuel safety analysis

Opportunities

- Large international research efforts to establish **technology readiness** of ATFs
- **Amassed expertise** for safety of conventional fuels and clads with large **knowledge base**, needs for ATFs, HBU/HALEU and doped fuels safety identified
- **Advanced simulation** and modelling under development
- **Established frames** for irradiation testing (FIDES II) and other projects (QUENCH-ATF, SCIP)

Challenges

- Extend **WG expertise** to new materials (e.g. TRISO)
- **Secure resources** to maintain key research capabilities for future needs, in particular research reactors for irradiation tests
- **Prioritising** research efforts to support establishing licensing readiness for ATFs with near-term deployment
- **Data preservation** and **dissemination** with export control/proprietary issues

Possible ways forward

- **Invite experts** in advanced materials to join WGFS
- WGFS to provide directions on **research** priorities in relation with FIDES II
- **Accelerate testing** in established projects on ATFs with near-term deployment
- **Continue ongoing actions on data preservation** (Halden F&M legacy data, FIDES II data preservation project)

WGIAGE: Advancing understanding of ageing mechanisms and ageing management of SCC

Opportunities

- **LTO of operating plants** (60 years or above) planned in a number of countries
- **Harvesting opportunities** from decommissioning plants increasing in many countries
- Existing frame (FIDES II) for material **irradiation testing** and pilot project (SMILE) for **research on material harvested in plants**
- **Innovations** in NDE

Challenges

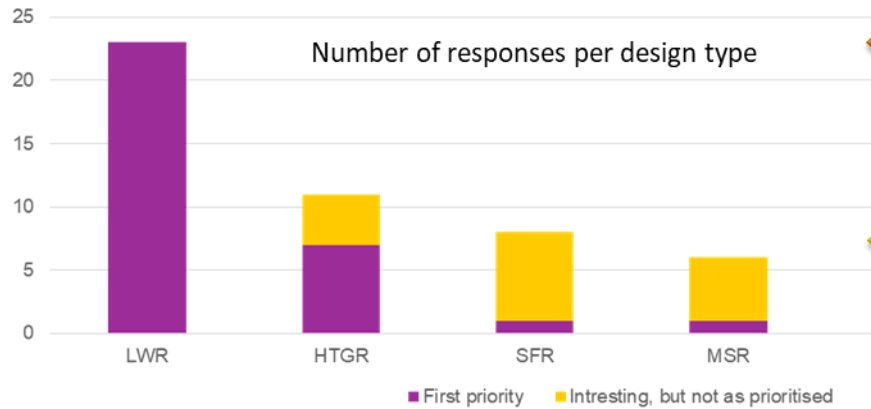
- **Different interests** related to different structures, components, materials and history of operating conditions
- Extend **WG expertise** to new materials and innovative designs aging management
- **Involving all stakeholders** in collaborative research on LTO

Possible ways forward

- **Engage further industry** in collaborative research on LTO, Advanced Manufacturing Technology, new materials and innovation in NDE
- **Create a research frame for collaborative research on harvested material** (including metal, concrete, polymer material)
- WGIAGE to provide directions on **research priorities** to support **LTO's licensing**
- Engage further FIDES II in **material irradiation testing** (ongoing)

EGSMR How to advance the safety demonstration of SMRs?

Type of Reactors



PIRTs
Define the knowledge gaps

Opportunities
NEA Safety Research **Joint Projects**

Update CCVM
Support validation and verification of computer codes

CSNI Topical opinion papers
Produce quickly experts opinion papers on the key safety issues for SMRs



Fuel, Materials, Accident Analyses, Simulation Codes

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

Advanced Designs

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**

Organize an
**R&D
framework
model**

PIRTs and
databases
for
innovative
designs

Engaging
with
**policy
making
bodies**

- With members from CSNI and CNRA, EC, IAEA, GIF to advise on CSNI research programme

- Reinforce the link CSNI / WGs / JPs
- End-user WG for projects
- Address topics under a single mandate and technical community (e.g. FIDES-II)

- Review existing databases for innovative designs

- Seek financial support for safety research



Thank you for
your attention!

Vesselina RANGUELOVA

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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)

SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research



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:

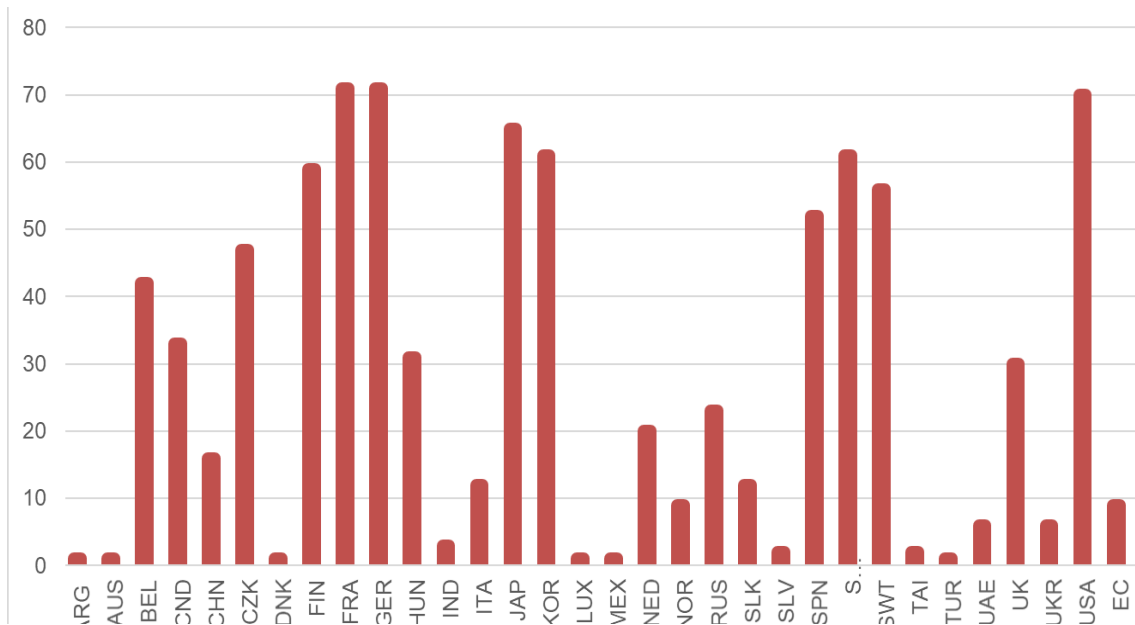
- data and codes assessment activities (e.g. ISPs, benchmarks)
- training and educational activities for the next generation of experts

Available DPs can be requested at <https://www.oecd-nea.org/tools/ie/list>

I - Preserving and disseminating projects data by NEA DB

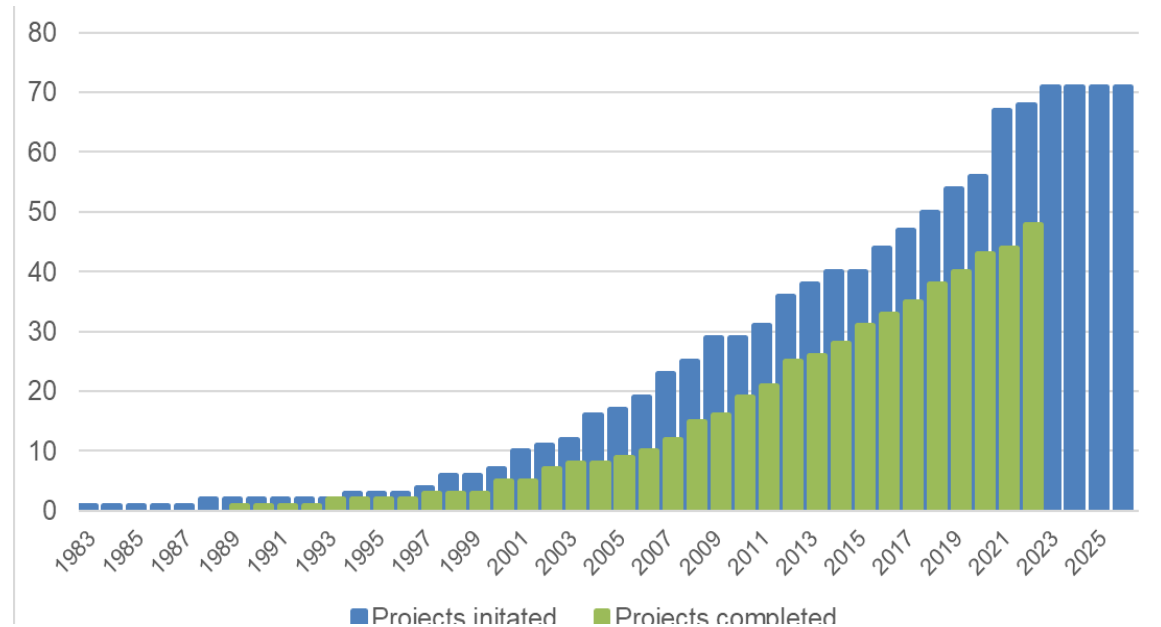
- Close to 50 NEA safety projects completed by 2023 and about 20 more expected to be completed by 2025 (excluding events database projects)
- NEA DB also distributes integral experiments data, databases (e.g. IFPE), benchmarks results (most related to projects)

Participation in joint safety research projects



Including events database projects

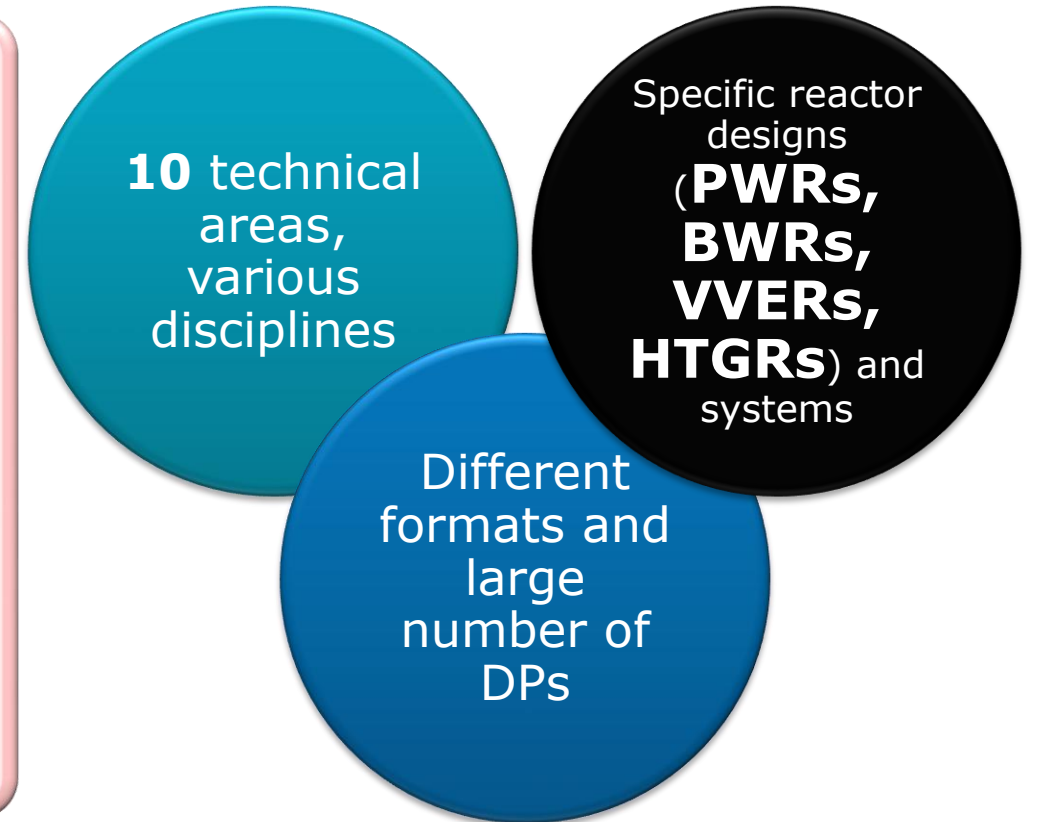
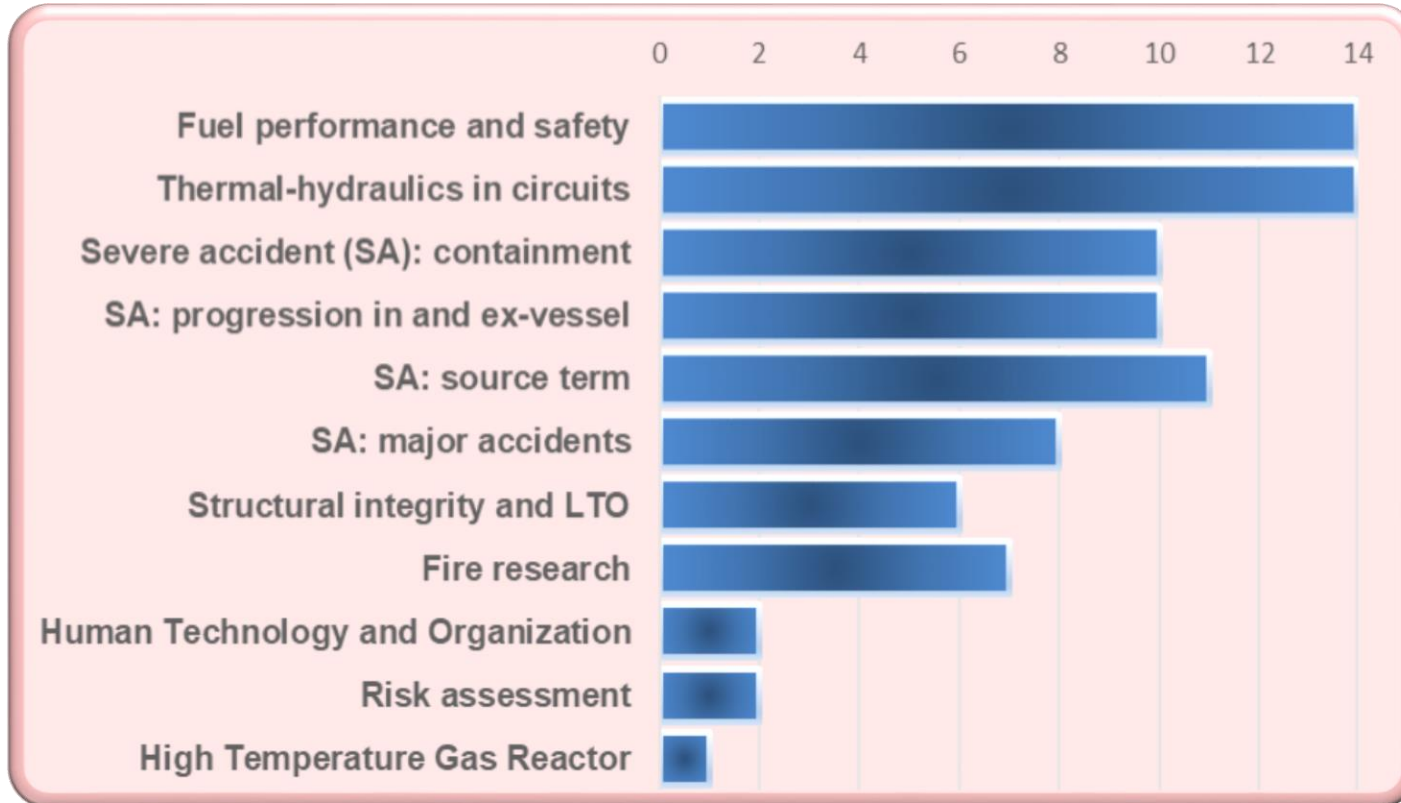
Cumulated number of safety related projects



Excluding events database projects

I - Preserving and disseminating projects data by NEA DB

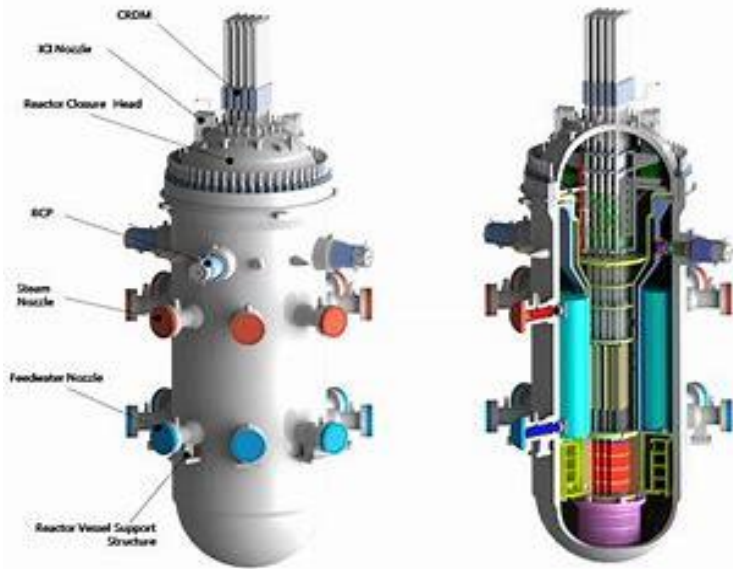
Number of projects per technical area



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

SMART concept



Courtesy KAERI

- 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

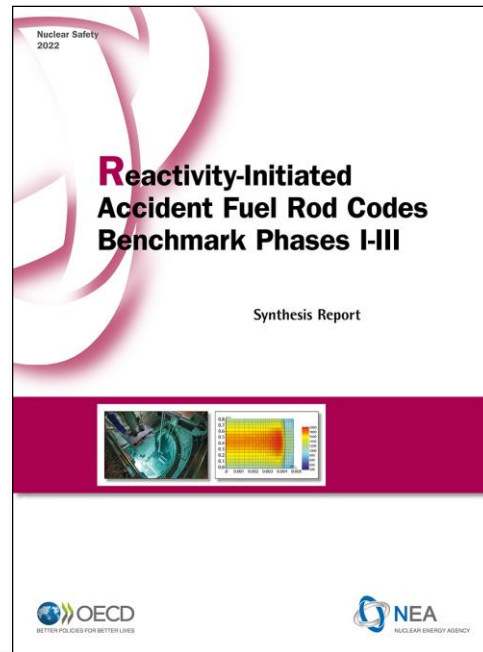
- NEA engaged in efforts to **COLLECT KEY DATABASES FOR NUCLEAR SAFETY**, despite proprietary and export control issues (e.g. Halden F&M database), with NEA DB providing preservation and distribution schemes addressing project members' needs and constraints
- NEA **ENCOURAGES DATA REVIEW ACTIVITIES** to exercise legacy data (international standard problems or benchmarks) within projects or under NEA WGs



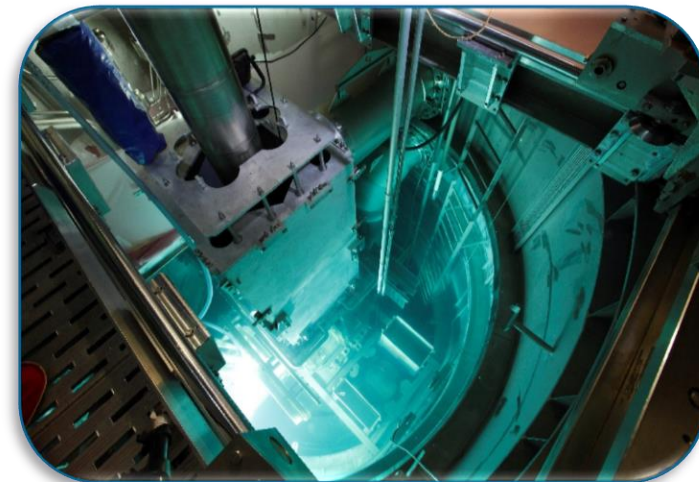
ATLAS Facility



Courtesy KAERI



CABRI reactor



Courtesy IRSN

II – Enhancing data management for completed projects

Halden reactor



Courtesy IFE

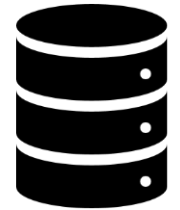
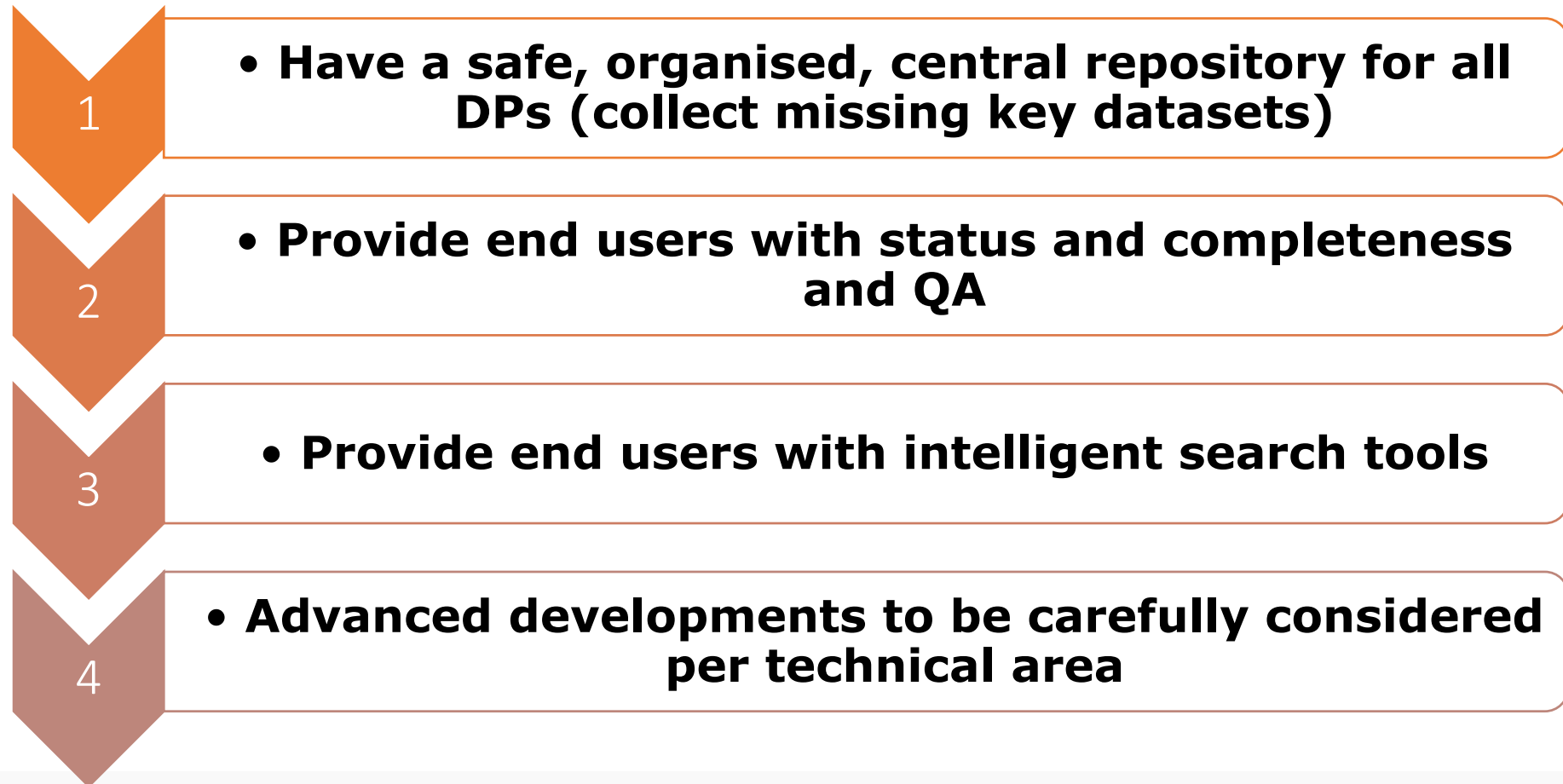
NEA will collect and manage from 2024 the Halden reactor project (HRP 1958-now) legacy database

- 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



**High
cost/benefit
ratio**

II – Enhancing data management for completed projects

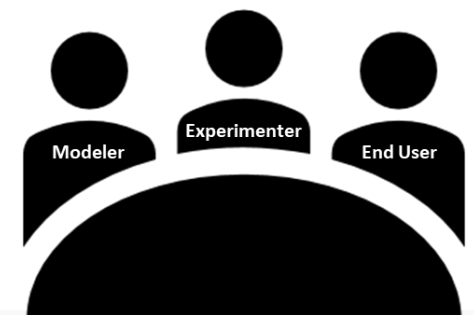
Provide end users with **status of completeness and QA** of archived data:

- ✓ 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 synthesise **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)

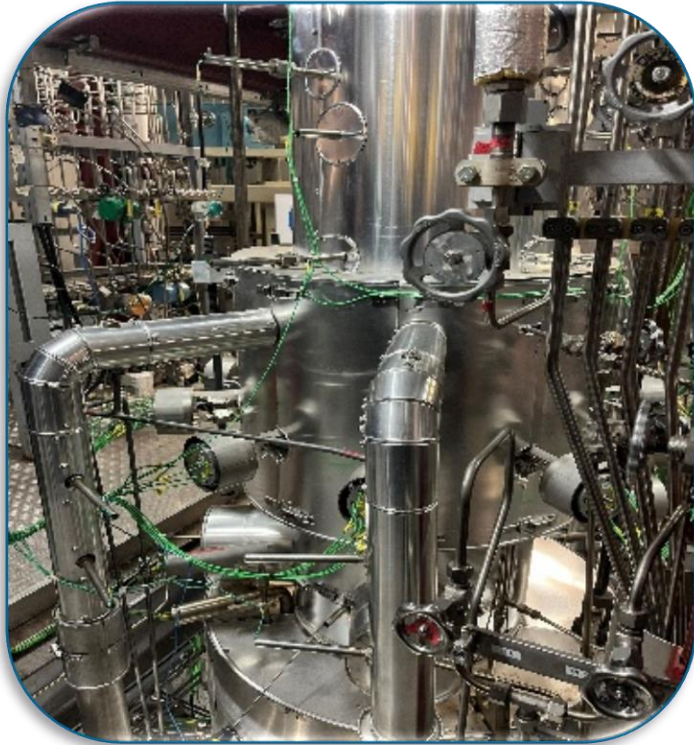


**Committees
working groups**



III – Optimise data management for ongoing and future projects

PKL Facility



Courtesy Framatome

- 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

III – Optimise data management for ongoing and future projects

Second NEA Framework for Irradiation Experiments (FIDES-II): data preservation and QA project

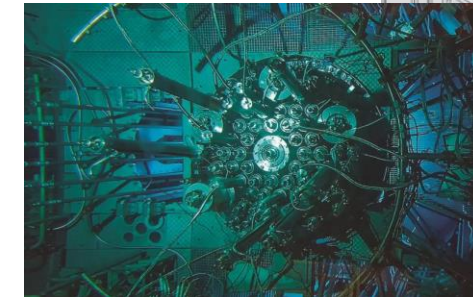
Will establish **QA standards and guidelines** at the FIDES level for **implementation** at the level of its Joint Experimental Programmes (JEEPs) and for the **benefit** of all FIDES members



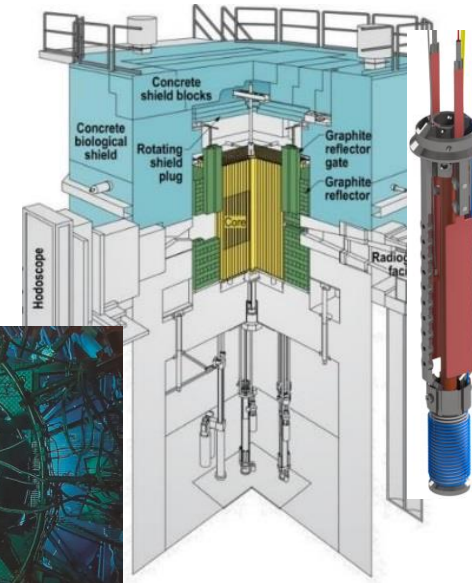
High Burnup Experiments in Reactivity initiated Accident Conditions (HERA)

INCA
In-pile Creep Studies of ATF claddings

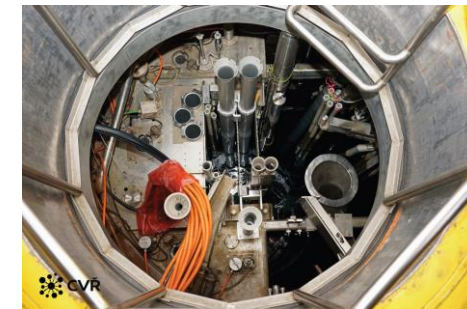
P2M



LVR-15 Reactor
Figure source: SCK•CEN



HERA in pile-testing
Figure source: INL



LVR-15 Reactor
Figure source: CVR

III – Optimise data management for ongoing and future projects

SEGPLD works on providing recommendations

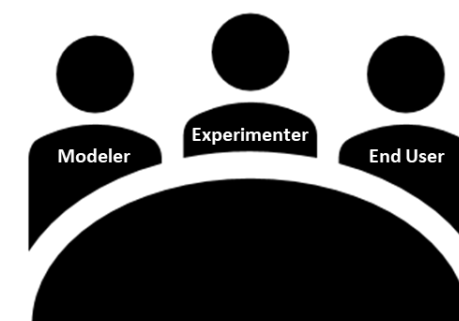
SYSTEMATIC COLLECTION BY NEA DB OF PROJECTS DPS, with early setting of preservation and distribution schemes, in agreement with project members

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



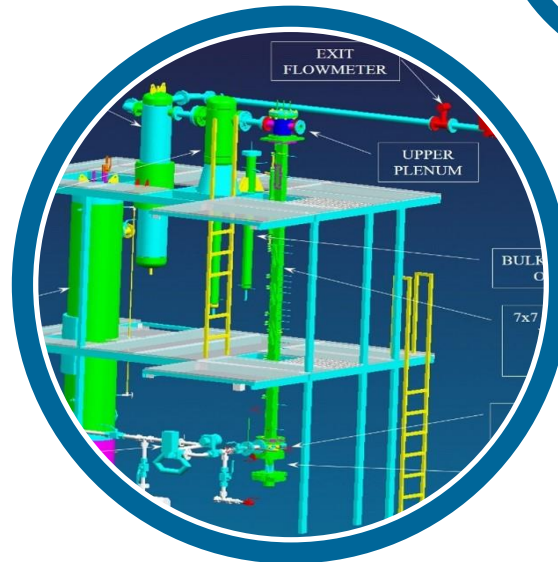
Projects



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!

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Session 5

Future Needs for International Co-operation in Nuclear Safety Research

Break

14:36 – 14:46 CET



Dr Didier JACQUEMAIN

Senior Nuclear Safety Specialist

Division of Nuclear Safety Technology and Regulation, OECD
Nuclear Energy Agency (NEA)

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

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Panel SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research

What mechanisms to establish priorities for future international co-operation in nuclear safety research? Which frameworks to address future safety research?



**Dr Toyoshi
FUKETA**

Advisor, Nuclear
Regulation
Authority (NRA),
Japan



**Dr Fiona RAYMENT,
OBE FREng**

Chief Science and
Technology Officer,
National Nuclear
Laboratory (NNL),
United Kingdom



Mr Jess GEHIN

Associate Laboratory
Director, Nuclear
Science and
Technology, Idaho
National Laboratory
(INL), United States



**Ms Aline DES
CLOIZEAUX**

Director, Division of
Nuclear Power,
Department of Nuclear
Energy, International
Atomic Energy Agency
(IAEA)



Mr Roger GARBIL

Head of the Fission
Section, Euratom
Research Unit,
Directorate General
for Research and
Innovation,
European
Commission



**Dr Jean-
Christophe NIEL**

Chair of the
OECD NEA
Committee on the
Safety of Nuclear
Installations
(CSNI)



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.

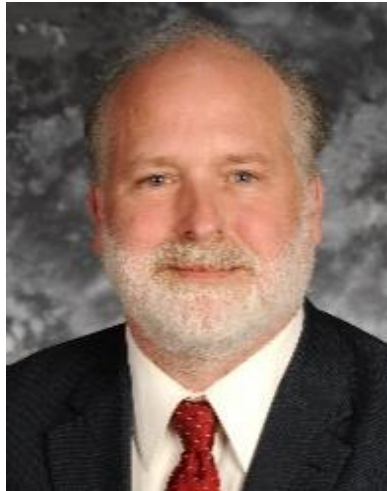


Mr Roger GARBIL

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

Panel SESSION 5: Future Needs for International Co-operation in Nuclear Safety Research



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. He 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.



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.

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

9-13 January 2023

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 \(oecd-nea.org\)](#)