



Fukushima: 15 Years Later – Driving Innovation in Nuclear Safety and Preparedness

*Risk, Resilience, and Reform: Safety
Research Shaped by Fukushima*

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60 years of joint experimental safety research projects (mainly focused on LWRs)

Non-member countries, industry and new-comers are welcome

400 years of cumulated experimental safety research

65 years of nuclear safety research

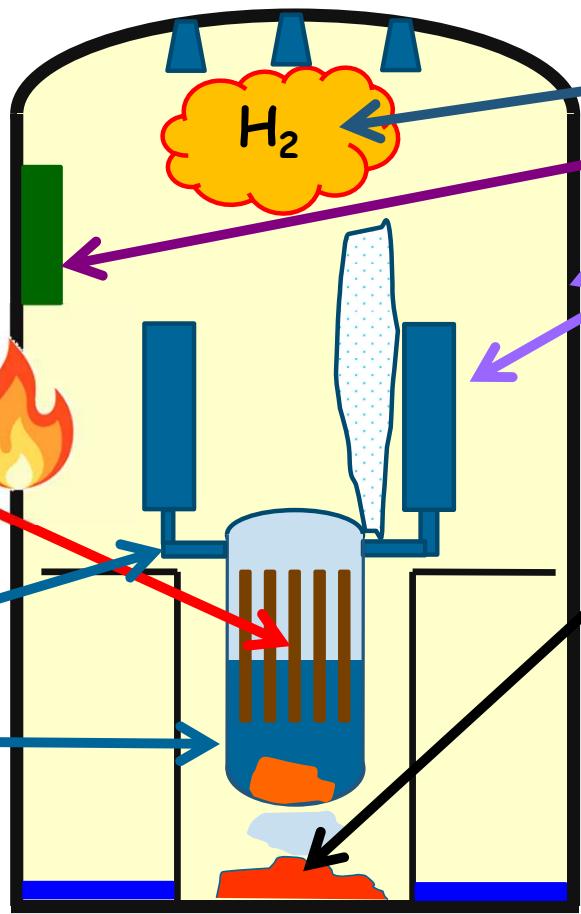
81 past and ongoing NEA JPs

60 completed projects

FIRE
Events & propagation

Fuel and cladding behaviour

RCS
Thermal-hydraulics
models and tools



Containment Issues

Gen IV reactors
HTR

SALMO, source term
Containment integrity

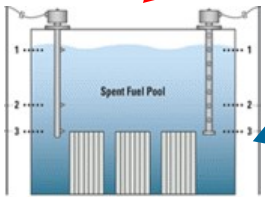
LTO component integrity harvesting

Post-Fuku. D. lessons learned

OE databases



Human and Orga. aspects

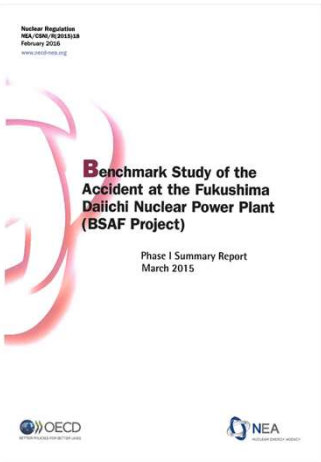


[NEA webpage](http://www.oecd-nea.org)

BSAF project: forging an internationally shared understanding of the accident

SAREF: defining safety research opportunities for supporting 1F decommissioning and safety enhancements

Phase I: 2012-2015



Significant progress achieved on scenarios in 3 damaged units

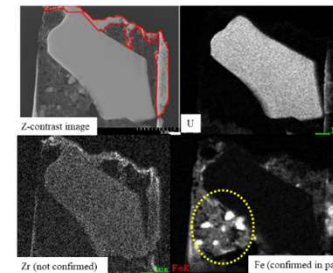
Potential in-vessel models enhancement identified for SA codes

Ex-vessel phases and related phenomena not well understood

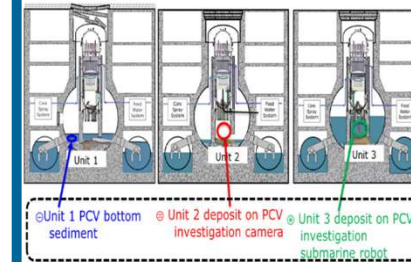


PreADES (2017-2021, 7 countries + EC)
Preparatory studies for fuel debris retrieval

- Debris characteristics
- Risks related to retrieval
- Potential analyses plans
- Future collaborations



FACE



Debris analysis and distribution
Figure source JAEA

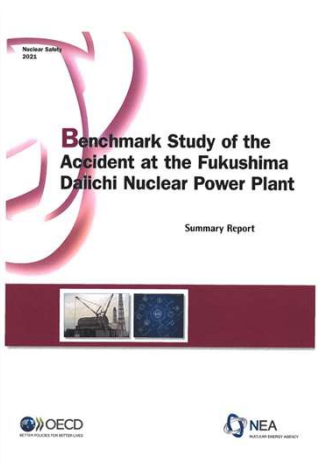
ARC-F (2019-2022, 12 countries)
Enhancing understanding of accident scenario and consequences, of plant damaged state

- Refinement of scenario (in and ex-vessel in U1-3, H₂ explosions)
- Refinement of FP transport and dispersion
- Capitalisation of data/information
- Future collaborations



Unit 3 investigations
Figure source NRA

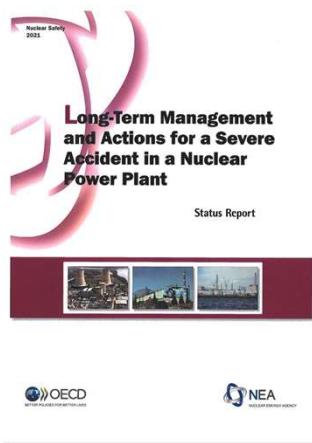
Phase II: 2016-2018



FP phenomena needs further investigations

BSAF triggered cooperative research initiatives (e.g. NEA projects)

LTMNPP: recommendations to enhance long term management of severe accidents



Recommendations covered:

- means to establish plant damage state
- expert systems for risk assessment and ranking
- phenomena affecting long term management (e.g. erosion, corrosion, leaching, dusting, etc.)
- maintaining cooling over long term
- fuel debris retrieval and disposal
- management of cooling waters and solid wastes
- knowledge capitalisation



Some of the above topics covered in post-1F NEA projects (PreADES, ARC-F, FACE, TCOFF)

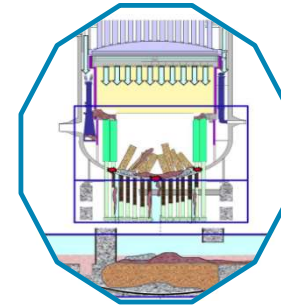
Specific CSNI/WGAMA workshops addressed:

- SAMMI2020: advanced measurement methods and instrumentation for enhancing SA in NPPs addressing emergency, stabilization and LT recovery
- RCCS2021: reactor core and containment cooling systems long term management and reliability

Note: waste, decommissioning and radioprotection addressed in relevant committees (RWMC, CDLM, CRPPH)

SA safety projects: focus on issues of relevance to Fukushima

Scheme of damaged unit at Fukushima Daiichi, Figure source: TEPCO



TCOFF (2017-2020)

Enhancement of thermodynamic databases for analysis of 1F accident, support to characterization of fuel debris and FP transport analyses



TCOFF-2 (2023-2026, 7 countries and EC)

Enhancement of thermodynamic databases for SA analysis, incl. for ATFs, fuel debris leaching studies

Started February 2023

FACE (2022-2026, 13 countries and EC)

Deepen understanding gained in ARC-F and PreADES to further support safety and decommissioning at 1F
New analyses on-going
Round-robin activity on-going



ARC-F (2019-2022, 12 countries)

FRAME Workshop

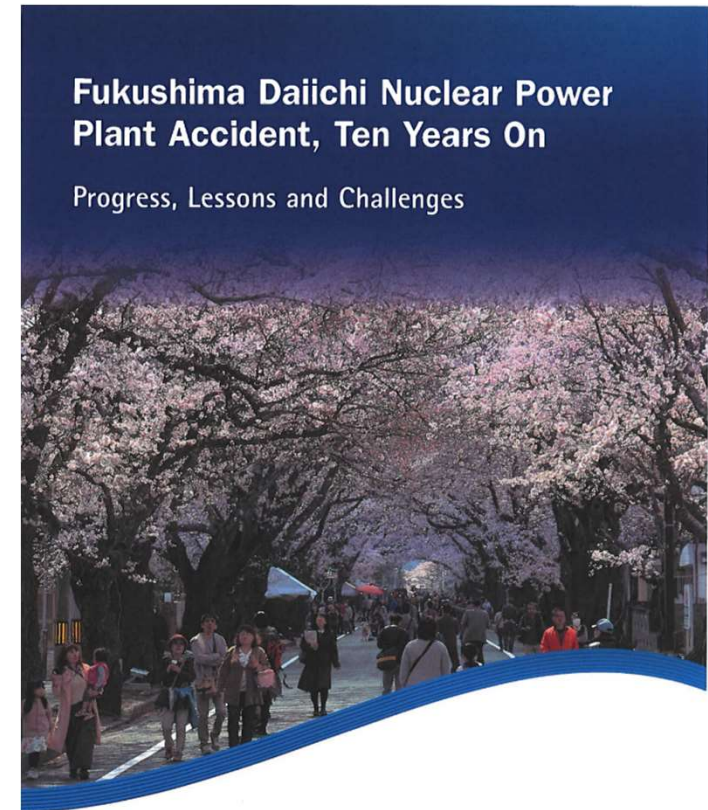


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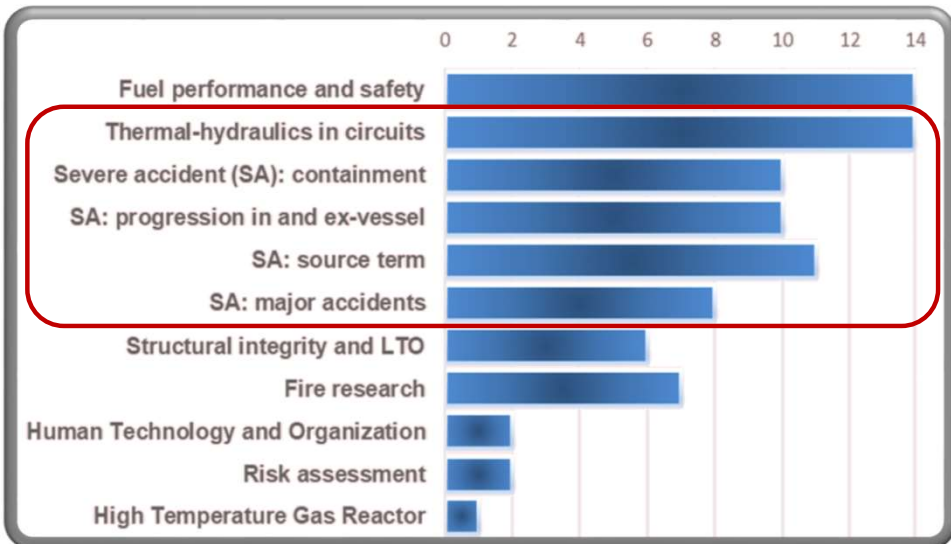
EPRI



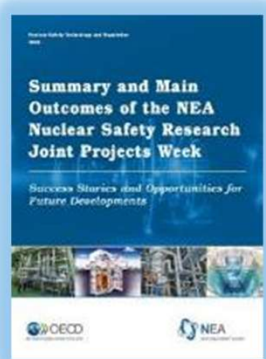
- **Large number of nuclear safety cooperative research activities conducted at NEA as a response to the 1F accident (projects and WGs activities)**
- **A variety of relevant research activities still on-going, e.g. in CSNI/WGAMA, IVMR, H₂ SOAR and BCAPFIS (boundary conditions for pool scrubbing)**
- **FACE, TCOFF-2, related projects and new investigations at the plant should open new research opportunities**
- **Knowledge management preservation of 1F data/information recognized as key by CSNI/SEGPD (senior expert group on key data sets preservation)**
- **NEA also leads joint research activities under RWMC, CDLM, CRPPH**



High-level nuclear safety research roadmap



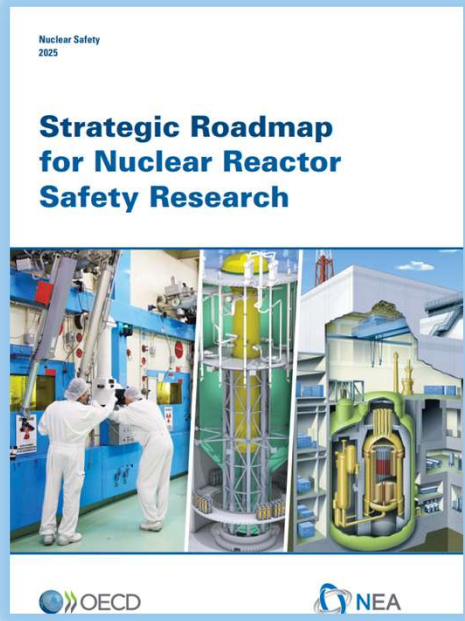
Balance to be reviewed considering long-term perspectives incorporating needs for innovative tools and technologies.



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Safety Research Roadmap - Strategic Pathways for Globally Aligned Research

Involving



Severe Accident - Future Framework & FACE Follow-up

- Roadmap priorities on SA: Ex-vessel, MCCI, H₂ behavior, Qualified source term, Facilities sustainment and code validation, 1F data preservation
- FACE:
 - Finalise unit-by-unit best estimate scenarios
 - Debris properties / leaching
 - Round-robin expansion
 - Provide curated datasets & benchmarks for decommissioning
- FACE Follow-up is essential to sustain Fukushima-related SA knowledge and capabilities



**Thank you for
your attention**

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