NEA Perspectives and Activities Supporting Advanced Fuel Technologies

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Technical Session Accident Tolerant Fuel Readiness
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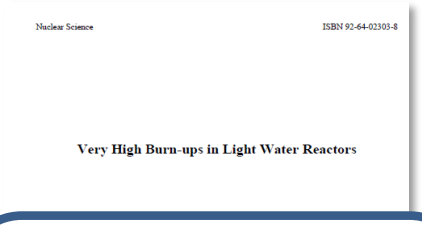
Some NEA Data, Studies and Perspectives

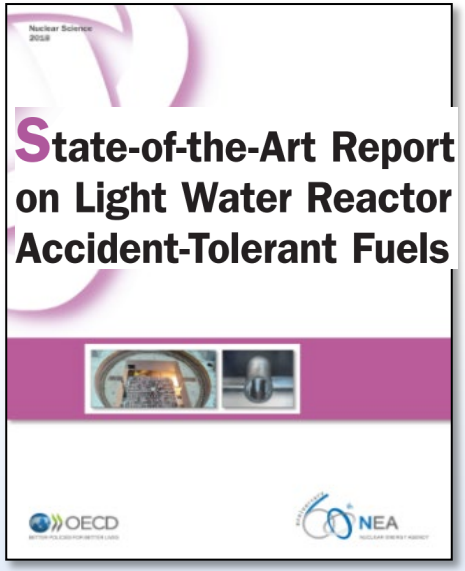
ICSBEP Over 5000 critical benchmark configurations – yearly updated

Configurations with uranium enrichments higher than 5.0 w/o

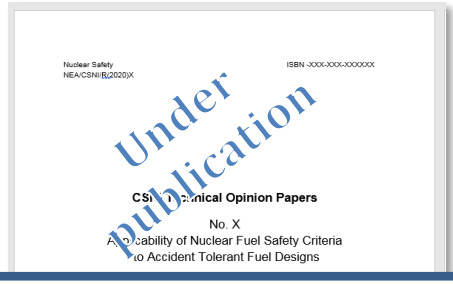


2006 - NEA No. 6224- *Very High Burn-ups in Light Water Reactors*

R&D needs to support burn-ups in the range 60-100 GWd/t



2018 - NEA No. 6224
overview of SOA for various ATF technologies



2022- NEA No. 7615 - *Technical Opinion Paper Applicability of Nuclear Fuel Safety Criteria to ATFs*

- Applicability of existing fuel design performance requirements to ATF designs
- New phenomena or mechanisms -> need for performance metrics and design requirements
- Data gaps - opportunities for international collaborative research

- CSNI/WGFS-NSC workshop on fuel modelling is support of performance and safety, 2017, covered modeling gaps for ATF
  -> identify further areas where advanced techniques for fuel modelling could be used to address safety issues.
- WGFS status report on fuel safety implication of extended enrichment -> to be issued in 2022

Emphasizing opportunities for Collaborative Research

Opportunities for Collaborative Research Research Needs	Data Gaps: Coated Zirconium Cladding	FeCrAl Cladding	SiC Cladding	Doped UO_2 Pellets	U_3Si_2 Pellets
Commercial Reactors					
LTA long-term irradiation	✓	✓	✓		✓
Pool-side examination of commercial LTA (e.g., growth, distortion, profilometry, corrosion)	✓	✓	✓		✓
Irradiation-assisted creep and growth measurements	✓	✓			
Hot-Cell Facilities					
Examination and microscopy (e.g., hydrogen, grain size, rim)	✓	✓	✓		✓
Mechanical testing (e.g., YS, uniform elongation, fatigue)	✓	✓	✓		
FGR measurements (rod puncture)					✓
Fuel pellet melting analysis					✓
Chemical assay of depleted fuel pellets					✓
Electron Probe Microanalysis (EPMA) of depleted fuel pellets					✓
Integral LOCA testing (e.g., ballooning, embrittlement, FFRD)	✓	✓	✓	✓	✓
Research Test Reactors					
Long-term irradiation	✓	✓	✓		✓
On-line FGR measurements and mass spectrometer gas analysis					✓
On-line fuel temperature measurements			✓	✓	✓
Irradiation-assisted creep and growth measurements	✓	✓			
Power ramp testing	✓	✓	✓	✓	✓
RIA prompt pulse testing (e.g., cladding failure, melt, rod fracture, FFRD, FCI)	✓	✓	✓	✓	✓
Integral LOCA testing (e.g., ballooning, embrittlement, FFRD)	✓	✓	✓	✓	✓

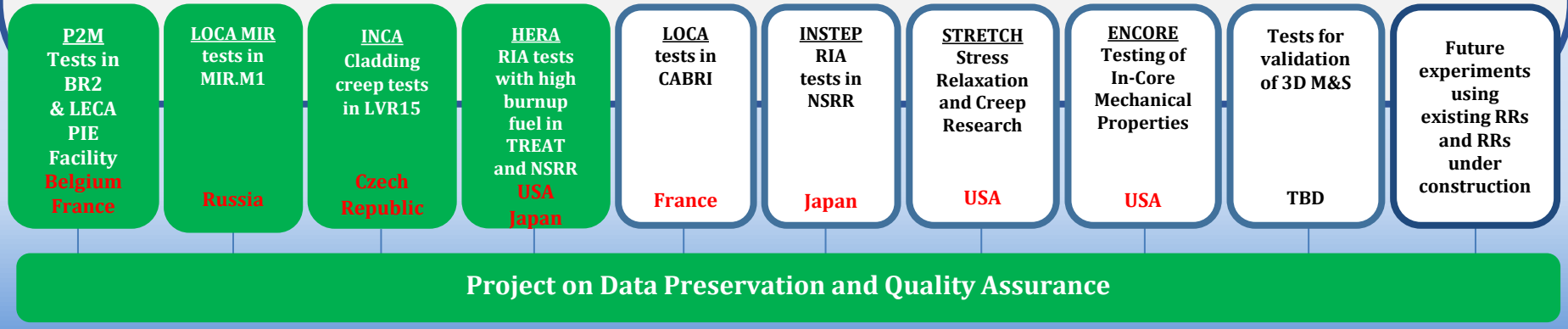
Enhancing Testing Capabilities: NEA Framework for Irradiation Experiments (FIDES)

- **A stable, sustainable, reliable platform for fuel (including ATF) and materials testing using nuclear research reactors around NEA member countries (addresses post-Halden situation)**
- Generates experimental results and expertise for shared costs
- Launched in March 2021
- Participants: 27 organisations from 12 NEA countries and the EC
- **PoW 2021-2024 includes 4 JEEPs and Project on Data Preservation**

Tests with ATFs in 2021-2024

- JEEP INCA: In-pile Creep Studies of ATF Claddings at LVR-15 reactor and hot cells, ÚJV Řež, Czech Republic
- JEEP HERA: High Burnup Experiments in Reactivity Initiated Accident at TREAT reactor and hot cells, INL, USA and NSRR, Japan

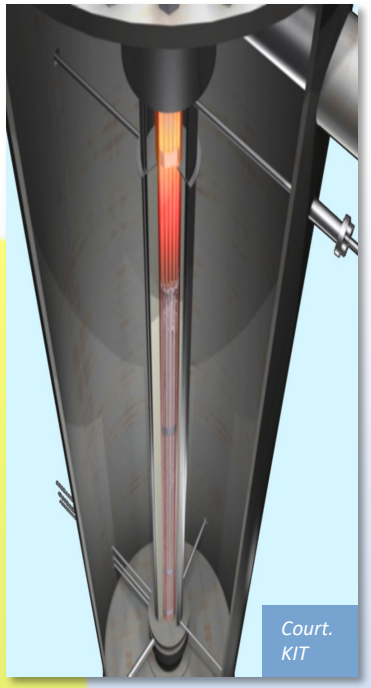
Joint Experimental Programmes (JEEPs)



New Experiments: QUENCH-ATF Joint Project

A new joint project to investigate ATF claddings for enhanced performance and safety:

- Three large-scale bundle tests with ATF cladding materials:
- Performed at the QUENCH facility (KIT, Germany) *scheduled for closure in ~2024*
- Simulating design-basis and severe accident scenarios
- Supporting separate-effects tests
- Numerical simulation exercise: blind post-test benchmark
- Complementary tests performed by IRSN
- Participants: 19 organisations from 8 NEA countries
- Time frame: 2021-2024 (4 years)


Court. KIT

Test Matrix

QUENCH-ATF #1
- Cr coated Zr
- Bundle with 24 heated rods
- Extended LOCA conditions

QUENCH-ATF #2
- Cr coated Zr
- Severe accident conditions

QUENCH-ATF #3
- Cr coated Zr or SiC
- Scenario depending on material and results of previous tests

Looking Ahead

NEA will assist its members with promoting international collaboration to support advanced fuel technologies by:

- Ensuring information exchanges between relevant international initiatives in the field
- Updating research priorities for ATF development, integrating, as far as feasible, state-of-the-art knowledge from R&D and implementation plans in NEA member countries
- Enhancing testing capabilities and developing FIDES as a framework for fuel testing in key research reactors
- Coupling experimentation with advanced modeling and simulation
- Preserving key experimental data and competencies