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Nuclear Energy Agency

NEA
NUCLEAR ENERGY AGENCY

International Perspective and FIDES Programme

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NRC Higher Burnup Workshop
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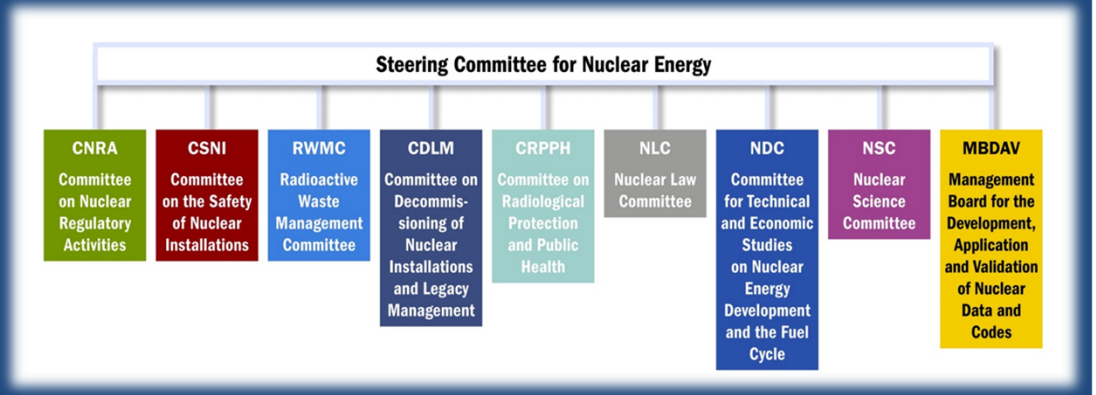
The NEA: 33 Countries Seeking Excellence in Nuclear Safety, Technology, and Policy

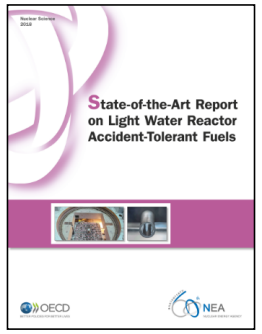
- 33 member countries and strategic partners
- The NEA is a framework for technical and policy cooperation in nuclear safety, stakeholder engagement, science, current and new and technology, economics, nuclear law, nuclear codes and data, waste management, decommissioning, legacy management, and radiation protection
- 8 standing committees and over 80 working parties and expert groups
- 23 international joint projects



Some NEA Studies and Data Supporting Higher Burnup

- Report **Very High Burn-ups in Light Water Reactors, 2006:**
  - Highlights R&D needs to support burn-ups in the range 60-100 GWd/t

- **State-of-the-Art Report on Light Water Reactor Accident-Tolerant Fuels, 2018:**
  - Delivered by the NSC Expert Group on Accident-tolerant Fuels for LWRs (EGATFL)
  - Provides overview of the state of the art for various ATF technologies



- **The International Criticality Safety Benchmark Evaluation Project (ICSBEP):**
  - Since 1995, yearly update and revision
  - About 5000 critical benchmark configurations, including many with uranium enrichments higher than the typical 5.0 w/o.

- **Database of measured isotopic compositions of spent nuclear fuels (SFCOMPO-2.0):**
  - 24,000 measured data from 44 reactors, representing 750 fuel samples

NEA Framework for Irradiation Experiments (FIDES)

FIDES is designed to **address the post-Halden situation** and provide continuity and sustainability in experimental support for fuels and materials testing by:

- performing high-priority experiments with key fuel and material test facilities in member countries;
- optimising value of experimental campaigns through cross-cutting activities:
  - data preservation and quality management;
  - professional development and educational activities;
  - state-of-the-art instrumentation, modelling and simulation;
- building a collective awareness of the needs and capabilities;
- identifying gaps that require investment in infrastructure;
- addressing practical issues, including nuclear fuel transport, waste management;
- enabling bilateral arrangements between trusted partners within the multinational Framework.


NEA Framework for Irradiation Experiments (FIDES)

Sustaining Multinational Nuclear Fuel and Materials Testing Capacities for Safety, Industry and Science

The FIDES framework will help regulators, their technical support organisations, research organisations and the industry to consolidate their needs and resources in order to create a dynamic for implementing Joint ExpErimental Programmes (JEEPs) in the key nuclear fuel and materials facilities around the world

The safe, reliable and efficient operation of nuclear power plants requires nuclear fuel and materials (F&M) technology to evolve and for their performances to be optimised. Achieving this requires solid experimental evidence, which can only be obtained from test facilities with the ability to perform neutron irradiation under representative steady state or transient conditions. F&M test facilities are essential for:

- validating safety margins, simulation tools, and demonstrating operational performances;
- assessing material behaviour in the context of the long-term operation programmes;
- developing advanced F&M.

However, the number of available test facilities around the world are in significant decline. In the past five years, several major research reactors that provided testing services for the nuclear community were shut down after over fifty years of service. These included the Halden reactor in Norway, the OSIRIS in France, the JMTR in Japan, the NRU in Canada, among others. Regulators and their technical support organisations, research organisations, and the industry all require F&M testing capacities on an ongoing basis. In particular, the availability of test facilities for loss-of-coolant accidents, reactivity-initiated accidents and power ramps, is crucial.

BR2 reactor of SCK•CEN (Copyright © SCK•CEN).

A new NEA joint undertaking: FIDES

In recent months the NEA has organised a series of workshops, bringing together participants from utilities, fuel vendors, regulatory bodies and their technical support organisations, research institutes, and experimentalists. The discussions have confirmed that a multinational framework is required to address current and future experimental needs. As a result, the international community is now coming together under the aegis of an NEA initiative to form a new multinational framework for in-pile fuels and material testing as a new NEA Joint research undertaking - the Framework for Irradiation Experiments (FIDES). This long-term endeavour has received strong support from NEA member countries.

FIDES objectives

- Identify and prioritise the needs of the nuclear energy community, including regulators and their technical support organisations, the industry and the research organisations;
- Identify and assure access to research facilities around the world in the most efficient way and facilitate high-priority experiments at those facilities;
- Define and implement a co-ordinated multilateral programme that meets short- and long-term experimental needs;
- Promote and sustain relevant state-of-the-art capacities: infrastructure, technology and skills;
- Establish the conditions necessary for conducting experiments on a bi-lateral contract basis.

By consolidating the needs and resources from the involved parties, FIDES will provide the framework for implementing its Joint ExpErimental Programmes (JEEPs) in a co-ordinated way.

FIDES concept and budget

Contributions to the FIDES budget will be commensurate with those provided for the NEA Halden Reactor Project (HRP). They will finance cross cutting-activities and partly fund JEEPs. FIDES activities will be overseen by the Governing Board (GB). Parties wishing to initiate a JEEP will constitute the core group for the experimental campaign and provide a substantial part of its funding, the rest being covered with FIDES fees. The core group will retain exclusive rights to guide the experimental programme. The FIDES GB will approve each

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FIDES Status

- **Dialog with vendors, utilities, safety regulators and R&D:**
  - NEA Workshop "Enhancing Experimental Support for Advancements in Nuclear Fuels and Materials", January 2018
  - NEA Workshop "Building Multinational Fuel and Materials Testing Capacities for Science, Safety and Industry", October 2018
  - NEA Workshop "Introduction to the Multinational NEA Framework for In-pile Fuel and Material Testing", March 2019
  - NEA Workshop "Preparing the kick-off of FIDES Joint Experimental Programmes", September 2019
  - FIDES Establishment Board meeting, June 2020
- **Support from NEA bodies:**
  - the NEA Committee on the Safety of Nuclear Installations Nuclear Science Committee (CSNI)
  - the NEA Nuclear Science Committee (NSC)
  - the NEA Steering Committee (Workshops statement presented and FIDES establishment supported)
- **Status:**
  - Participants: 26 organisations from 15 countries and the European Commission
  - Target budget ~ 15M€ (18M$)/3 years
  - Next Establishment Board meeting in September 2020
  - FIDES and JEEPs launch is scheduled for Q1 2021

FIDES Structure and Proposed Projects

Pursuant to Article 5 of the NEA Statute, the Framework will be established as an international joint undertaking under the auspices of the NEA with strong coordination by **the Committee of Nuclear Science (NSC) and Committee on the Safety of Nuclear Installations (CSNI)**

Framework for Irradiation Experiments (FIDES)

- Designed to provide a stable, sustainable, reliable platform for fuel and materials testing
- Encompasses **Joint Experimental Programmes** and the following **Cross-cutting Activities:**
  - **Data preservation and QA**
  - Training and education
  - State-of-the-art modelling & simulation and instrumentation for efficient design, performance and analysis of experimental campaigns

Joint Experimental Programmes (JEEPs)

- Enable in-pile experiments in Fuel & Material test reactors and PIE

P2M	LOCA MIR	INCA	HERA	LOCA	INSTEP		
Tests in BR2 & PIE in CEA. Proposed by CEA, SCK•CEN, EDF	tests in MIR.M1. Proposed by RIAR and ROSATOM	Cladding creep tests in LVR15. Proposed by CVR, UJV, VTT, CEA, Alvel	RIA tests with high burnup fuel in TREAT. Proposed by INL	tests in CABRI. Proposed by IRSN and CEA	RIA tests in NSRR. Proposed by JAEA	Tests for validation of 3D M&S. Proposed by INL	Potential new proposals for existing RR and RR under construction
Belgium France	Russia	Czech Republic	U.S.	France	Japan		

FIDES: Proposed Programme of Work for 2021-2023

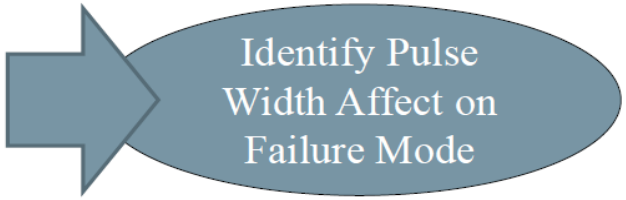
- **Programme for quantifying thermomechanical clad load mechanisms during LWR slow transient, or Power to Melt and Manoeuvrability (P2M), BR2 reactor, SCK.CEN, Belgium and PIE facility, CEA, France.**
- **In-pile Creep Studies of ATF Claddings (INCA), LVR-15 reactor and PIE facility, UJV Rez, Czech Republic.**
- **LOCA experiments with Gd-doped fuel (LOCA MIR), MIR.M1 reactor and PIE facility, RIAR, Russia:**
  - *Gd-doped fuel of 48,5 / 53 GWD/t (maximum for available Gd-doped fuel)*
- **High burnup Experiments in Reactivity Initiated Accident (HERA), TREAT reactor and PIE facility, INL, U.S.:**
  - *Fresh and high burnup fuels;*
  - *Two exposures (55-65) & (70-80) GWD/t;*
  - *Highly instrumented (temperature, pressure);*
  - *Several pulse widths;*
  - *INL is reaching out to CABRI (France), NSRR (Japan) and/or ACRR reactor at SNL in U.S. to test at narrower pulses (~5ms)*
- **Project on data preservation and data quality assurance.**

FIDES: Details of JEEP HERA*

INL Idaho National Laboratory

Proposed Testing Program

- 6 fresh fuel experiments with simulated high burnup features
  - Pre-hydrided cladding simulating waterside corrosion
  - Oversized pellets simulating pellet cladding gap closure
  - Two differential pressures simulating fission gas release
- 4 high burnup experiments
  - Two exposures (55-65) & (70-80)
  - Highly Instrumented (Temperature, Pressure)
- Make use of material already slated for shipment to INL from Byron reactor in IL
  - Material is being evaluated for use by DOE/EPRI's High burnup program
  - Material will be fully characterized using latest NDE/PIE techniques at INL hot cell
  - Synergistic mechanical testing on cladding
  - Synergistic furnace testing on fuel



Tentative Test Matrix

Test Number	Pulse Width (ms)	Reactor
HERA-Sim-1	600	TREAT
HERA-Sim-2	300	TREAT
HERA-Sim-3	100	TREAT
HERA-Sim-4	50	TREAT
HERA-Sim-5	30	ACRR/CABRI/NSRR
HERA-Sim-6	5	ACRR/CABRI/NSRR
Test Number	**Burnup (GWD/MTU)**	**Target Peak Radial Average Enthalpy (J/g)**
HERA-HBU-1	60	>600
HERA-HBU-2	60	<600
HERA-HBU-3	70	>600
HERA-HBU-4	70	<600

*From presentation at the FIDES Establishment Board meeting

Looking Ahead

- Resolution of scientific and technical issues associated with high burn-up requires a systematic approach and heavily relies on experimental evidence
- The NEA NSC projects on experimental data preservation and knowledge management
  - provide the well-established frameworks to deliver high-quality, internationally peer-reviewed experimental data
  - serve as the intrinsic backbone of contemporary modeling and simulation
- The NEA FIDES Framework and its JEEPs are designed to
  - establish new best practices and a paradigm shift in the experimental support for fuels, including high burn-up fuels
  - address the short- and long-term experimental needs for industry, safety and R&D in the post-Halden world