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**NUCLEAR ENERGY AGENCY
STEERING COMMITTEE FOR NUCLEAR ENERGY**

**WORKSHOP “INTRODUCTION TO THE MULTINATIONAL NEA
FRAMEWORK FOR IN-PILE FUEL AND MATERIAL TESTING”**

SUMMARY RECORD

**4-5 March 2019
NEA Headquarters BB1
92100 Boulogne-Billancourt, France**

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OECD/NEA**WORKSHOP “INTRODUCTION TO THE MULTINATIONAL NEA FRAMEWORK FOR IN-PILE FUEL AND MATERIAL TESTING”**

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46 Quai Alphonse Le Gallo, 92100 Boulogne-Billancourt, France

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SUMMARY RECORD**Welcome**

The NEA Director-General, **William D Magwood, IV**, opened the meeting and welcomed all participants (a list is given in *Appendix 1*), highlighting the importance of fuel and material (F&M) testing and the role of the NEA in facilitating multilateral work through its various joint undertakings. The two co-chairs, **Mirela Gavrilas** and **Rostislav Štaubr**, welcomed the participants with several high-level observations about the need for a new framework in the post-Halden situation and the opportunity for this new framework to better meet the needs of the international community.

Adoption of the Agenda

The proposed agenda was adopted (see *Appendix 2*). The workshop agenda consisted of three main sessions, starting with the proposal for a new multinational framework to facilitate, support and to interconnect in-pile testing research activities as a joint undertaking under the auspices of the NEA. In the second session, joint experimental programmes at various stages of development were proposed. In the third session, the participants provided general feedback, expressed their interest to be further involved in this initiative and agreed on a way forward and the next steps.

All the presentations given at the workshop can be found here:

<https://www.oecd-nea.org/download/science/workshops/neaframework/>

1. Session 1: Introduction to the New Multinational NEA Framework for In-Pile Fuel and Material Testing**1.1. Co-operation between NEA and IAEA on issues of transportation**

C. Xerri (IAEA), Director of the IAEA Division of Nuclear Fuel Cycle, Waste Technology and Research Reactors, described the IAEA International Centres based on Research Reactors (ICERRs) scheme that aims to assist IAEA Member States in gaining access to research reactors and ancillary facilities. He highlighted challenges with the transportation of nuclear materials, including ensuring compliance with SSR-6 regulations. The nature of this challenge requires a multinational solution that would be best addressed through a multinational forum.

NEA Deputy Director-General, **Daniel Iracane** emphasised the value of a large multinational testing framework as it will provide a platform for the coordination of important topics such as transport and waste management of experimental samples, and for engaging concerned governments, as necessary.

1.2. NEA Joint Projects: Best practices and lessons learnt

M. Beilmann (OECD-NEA) presented the lessons learnt from over 60 years of NEA Joint Projects, starting with the Halden Reactor Project in 1958. Participants were reminded of the operating practices and benefits of NEA Joint Projects, of which 16 are ongoing and 5 more are in preparation. Projects such as the CABRI International Project, Studsvik Cladding Integrity Project and NEST-HYMERES were used to demonstrate how these activities enable cost-sharing, provide flexibility depending on the needs of the participants, and integrate with other NEA Working Parties and the Data Bank to store and disseminate resulting data to members.

1.3. Framework's portrait: Goal, structure, cross-cutting activities and Joint Experimental Programmes

Tatiana Ivanova (OECD-NEA) gave an overview of the proposal of the multinational framework for in-pile fuel and material testing. The goals and the main activities of this framework were described in detail. The framework will cover fuel and material behaviour studies under irradiation using in-pile experiments in test reactors and post-irradiation examination facilities and will enable the establishment of joint experimental programmes. The Framework will aim to optimise the use of infrastructure and experimental capabilities, analyse and preserve experimental data and provide education and training opportunities. The governance structure and a process to deal with membership, submission and evaluation of joint experimental programmes were also detailed. This framework proposal will be finalised and reviewed during a follow-up meeting.

Daniel Iracane addressed several questions regarding the structure, membership and the added value of the framework. It was explained that this new Framework will be established through an Agreement binding the participating organisations. The Agreement will set up a Management Board who will manage the joint undertaking including its budget. The budget discussion will encompass the definition of the fees to be paid by the parties to the Agreement and the allocation of resources to the different activities and programmes.

Questions were also raised regarding the function of the joint projects, especially about the possibility for parties to engage more deeply in a given project. It was detailed that a party willing to engage more deeply in a given JEEP may consider to be part of the Core Group in order to have strategic benefits related to the definition and the implementation of the programme. This scheme has already been implemented in some NEA Joint Project.

1.4. Round table and discussion

The attendees expressed their general support for launching a new Multinational NEA Framework for In-pile Fuels and Material Testing. It was acknowledged that it addresses continuous needs, complements domestic research, and connects data users with facilities to offer greater value/cost from experiments. The Halden reactor, which has served as a major in-pile research facility for decades, is now permanently shut down, however there are multiple

facilities offering complementary capabilities. In the current situation there is a great need for an international framework which can provide a centralised 'brain' to co-ordinate needs and capabilities, connect experiments and data with state-of-the-art simulation and modern data management technologies, and provide a 'helicopter view' of international F&M testing for all participants. In order to realise the full potential of such a Framework, there was a mutual understanding that it must be supported by a full-time staff member of the NEA with additional support from the various NEA divisions.

It was agreed that the Framework offers other advantages, such as a platform to build the relationships and confidence required for strong bilateral engagements and ultimately the stability required for investment decisions necessary to ensure the availability of testing capacities in the future. It was noted that the Framework should be tailored to the needs of its potential members, offering the required flexibility to ensure greater value/cost from experiments while mitigating operational risk by pooling available resources of the participating organisations. It was evident from the discussions that various details about the interaction between the Framework and the research activities need to be clarified and defined before the Framework can be established. This process would involve numerous consultations with governments and organisations and will require some time before an official launch of the Framework is possible. In order not to lose the momentum and to ensure the availability of the necessary budget, the participants supported the initiation of the individual research activities as joint undertakings in parallel to the development of the Framework Agreement, subject to the condition that full funding of the activities can be achieved.

2. Proposals for Joint Experimental Programmes (JEEPs)

2.1. Quantifying thermomechanical clad load mechanisms and incipient fuel melting of a LWR fuel rod under power transients

G. Bignan & D.Parrat (CEA) A. Ambard (EDF) and B. Boer (SCK.CEN) presented the joint proposal by **SCK.CEN, CEA and EDF** Power to Melt and manoeuvrability (P2M) in which two integral in-pile tests are proposed to be performed in the BR2 reactor in Belgium, with the aim to reach incipient fuel melting after slow and specific power transients. Following a first calibration test of the experimental protocol with a low fuel melt fraction, a second test will increase the amount of melted fuel. The fabrication of the instrumented fuel rods and PIE will be done at the hot-cell laboratory at CEA, France (for destructive analysis) and at the hot-cell laboratory of SCK.CEN, Belgium (for non-destructive analysis). This proposal was already presented at the 4-5 October Workshop on “Building Multinational Fuel and Materials Testing Capacities for Science, Safety and Industry” held at the NEA premises in Boulogne-Billancourt. It was refined after the permanent shut down of the Halden reactor. It is foreseen that the final discussions will be held in early fall 2019 and that afterwards the activity will be officially launched. First irradiations are scheduled for late 2020.

2.2. Research into VVER fuel rods behaviour under LOCA conditions in the MIR.M1 reactor

A. Tuzov (RIAR) presented a proposal where two in-pile LOCA tests in the MIR.M1 reactor are conducted using VVER fuel with different average burnup. Both non-destructive and destructive analysis are proposed to be done on the fuel as well as the cladding materials, in order to extend the experimental database on fuel and materials behaviour in such scenarios. A second objective of the proposal is the provision of valuable data for code verification and validation purposes. RIAR informed the participants of the possibility of accepting foreign

fuel for testing in the MIR.M1 reactor and of increasing the availability of the reactor for international co-operation.

2.3. Experimental capability of Nuclear Safety Research Reactor (NSRR) and a JEEP proposal from JAEA

T. Sugiyama (JAEA) presented this recently developed proposal “INSTEP” (International NSRR Test Program for LWR fuels) which considers possible RIA tests on additive fuels in the newly restarted NSRR facility in Japan. These experiments would examine the failure limit and other behaviour in RIA events of additive LWR fuels and to compare it with the behaviour of conventional fuel types. It is planned to conduct this activity in a similar way to the ALPS (Advanced LWR fuel Performance and Safety) programme. Two experiments per year could be conducted in this proposed activity, after an initial preparation time of three years.

2.4. LOCA tests in CABRI water loop

L. Rigollet (IRSN) presented a proposal for possible utilisation of the CABRI reactor in France for LOCA tests in order to address knowledge gaps that were recently identified by the NEA Working Group on Fuel Safety. The experiments would be done in parallel to the ongoing NEA CABRI international project and would focus on fuel fragmentation and the relocation of fragments in the ballooned region of the fuel rod using the available hodoscope as an on-line measurement system.

2.5. Experiments in TREAT to support modelling and simulation

T. Ivanova (OECD-NEA) presented, on behalf of **S. Hayes (INL)**, a proposal for a Missing Pellet Surface (MPS) experiment using conventional LWR fuel to support 3D modelling and simulation. Prior to Halden Reactor shutdown, these experiments were proposed to be conducted in the Halden Reactor (IFA-800) in 2017. Their objective was to irradiate fuel rods with MPS defects and to measure large local cladding deformations after typical burnup times in order to validate 3D prediction of thermal and mechanical behaviour of the fuel with MPS.

2.6. Joint project proposal for in-pile creep studies of ATF claddings

M. Miklos (Centrum výzkumu Řež a.s.) presented a proposal considering the investigation of the long-term mechanical behaviour of ATF claddings and guide tube materials under irradiation in the LVR15 reactor in the Czech Republic. Results would be compared with the results from samples irradiated in LWRs. In parallel to the in-pile tests, detailed mechanical and microstructural studies will be carried out. The Melodie device, an innovative testing capacity developed collaboratively by CEA, France and VTT Finland, is planned to be used for the development of improved methods for in-pile creep studies, which could be transferred to the Jules Horowitz reactor after the proof of concept in this project. A kick-off meeting for this activity was preliminarily scheduled for the end of 2019.

2.7. Round table and discussion

The participants noted that these proposals were in varying stages of development but appreciated that new and promising proposals had been brought forward with limited development time. The capabilities offered for RIA tests at the JAEA NSRR, a modified LOCA loop within the CABRI reactor and in-pile cladding creep at the Czech LVR-15 raised interest for further, more detailed descriptions from multiple participants. The proposal brought by the Idaho National Laboratory, USA (presented by NEA) was well-received for its direct connection to advanced simulation methods and some participants requested additional focus toward nuclear safety issues. The participants noted that it would take time and more details to become sufficiently knowledgeable to support these proposals as JEEPs and welcomed future engagement as they are developed.

After each presentation, the proposals were generally discussed in terms of technical maturity, feasibility, budget, time schedule, attractiveness for different groups, as well as general boundary conditions for the performance of the experiments. It was appreciated that some proposals would grant access to impressive facilities and capabilities that were up to now not deeply embedded within international research activities. While comparing the different presentations it was also remarked that a clear description of the benefits for different organisations and stakeholders, e.g. industry, research organisations, TSOs and regulators, was extremely valuable for the understanding and promotion of the proposals.

3. Expression of needs and interest and further implementation steps

After reviewing the proposals presented in Session 2, the participants expressed their preliminary interest in these irradiation activities and provided feedback on the newly proposed Framework. The participants developed a comparison table to identify the strengths and weaknesses of the Framework against the existing Joint Project mechanism. The resulting table is provided in *Appendix 3*. Several strong arguments were presented for the establishment of such a Framework due to its ability to facilitate high-level co-ordination. The ability to offer more flexible funding options, where joint decisions to fund JEEPs offers cost and output (data) sharing, was also seen as extremely valuable.

Some participants expressed concern that the drafting and ratification of such a Framework Agreement may require a significant amount of time and effort, particularly due to the complex interface between JEEPs, their own management boards, and the Framework management. If there are significant delays it would result in discontinuities in both experimental activity and funding. It was agreed that the community should avoid discontinuities in F&M testing and maintain momentum with a prompt Framework Agreement that is developed in parallel to JEEPs based on the most mature proposals that were brought to the workshop.

The NEA was encouraged to engage in parallel on both fronts, i) develop agreements to connect interested parties in the current experimental proposals, and ii) draft the new Framework Agreement. As one part of this work, the NEA will also promote the outcomes of the series of workshops and the resulting activities at the meetings of the standing technical committees and the Steering Committee to familiarise governments with the value that such a Framework generates, and to co-ordinate the next steps in order to achieve the maximum political support for the long-term strategy. The Workshop Statement released after the workshop “Building Multinational Fuel and Materials Testing Capacities for Science, Safety and Industry”, held on October 4-5, 2018, was modified following the discussion that occurred during this workshop. It was presented at the NEA Steering Committee meeting in April 2019. The modified version can be found here: [[NEA/SEN\(2019\)3](#)]

The NEA agreed to organise technical meetings, tentatively scheduled for early autumn 2019, to discuss in more detail the proposals for the ‘Power to Melt and Manoeuvrability-P2M’ (2.1) and the LOCA (2.2) experimental programmes, proposed by SCK·CEN/CEA/EDF and RIAR, respectively. In these meetings the potentially interested organisations will be informed about the planned activities and the associated budget and will have the opportunity to provide their individual feedback on the exact definition. According to the discussions held at these meetings, and the expression of interest obtained from the different organisations, the following steps will be defined. The other proposals presented at this Workshop will be further developed and similar meetings will be held in parallel to the development of the new Framework Agreement. Another meeting will be organised after next fall to further explore the Framework Agreement. According to the request of some participants, all meetings will be held with the possibility for remote participation to limit the travel requirements for participants.

The NEA agreed to take these next steps in the development of the Framework and the JEEP proposals:

- The NEA will further explore the exact definition of a framework for in-pile fuels and materials testing and, in parallel, initiate the developments of Joint Project agreements for the mature individual irradiation activities.
- The NEA will present the current development process for setting up the new framework for in-pile fuels and materials testing to Governments and other stakeholders.
- The NEA will continue to engage in discussion with the Committee on the Safety of Nuclear Installations and the Nuclear Science Committee. This is a very effective way to create a common understanding, among the NEA Member Countries, regarding on one hand, on the design and content of the framework, and, on the other, the value of the proposed JEEPs.
- Organisations proposing a JEEP will further develop or refine the proposals (e.g. technical feasibility, schedule, budget etc.) for irradiation activities and will promote them in order to generate interest of potential participants.
- Dedicated expert meetings will be organised by the NEA as soon as the JEEP proposals are fully developed. For the furthest developed proposals, the first expert meetings are tentatively scheduled for early fall 2019.

APPENDIX 1. List of Participants

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APPENDIX 2. Meeting Agenda

Day 1, Monday, 4 March 2019
13:00-17:00

OPENING SESSION 13:00-13:30

- **William D. Magwood, IV**, Director-General, NEA
- **Mirela Gavrilas**, Director, Division of Safety Systems, Nuclear Regulatory Commission (NRC), US
- **Rostislav Štaubr**, Nuclear Fuel Manager, Fuel Cycle Strategy and Services Unit, ČEZ, Czech Republic

SESSION 1: INTRODUCTION TO THE NEW MULTINATIONAL NEA FRAMEWORK FOR IN-PILE FUEL AND MATERIAL TESTING 13:30-17:00

- *Co-operation between NEA and IAEA on issues of transportation and waste management*
Christophe Xerri, Director, Fuel Cycle and Waste Management, IAEA (via WebEx)
- *NEA Joint Projects: Best practices and lessons learnt*
Markus Beilmann, Division of Nuclear Safety Technology and Regulation, NEA
- *Framework's portrait: Goal, structure, cross-cutting activities and Joint Experimental Programmes*
Daniel Iracane, Deputy Director-General, NEA
Tatiana Ivanova, Head of Division of Nuclear Science, NEA
- *Q&A session*
- *Round table: Discussion of the NEA proposal on the Framework*
 - *Relevancy and practicality*
 - *Expression of interest*

COCKTAIL RECEPTION starting at 17:00, BB Espace Terrasse

Day 2, Tuesday, 5 March 2019
9:00-16:30

SESSION 2: PROPOSALS FOR JOINT EXPERIMENTAL PROGRAMMES
09:00-15:00

- *Introduction by co-chair*

Rostislav Štaubr, Nuclear Fuel Manager, Fuel Cycle Strategy and Services Unit, ČEZ, Czech Republic

- *Proposal by SCK-CEN, CEA and EDF: Quantifying thermomechanical clad load mechanisms and incipient fuel melting of a LWR fuel rod under power transients*

Gilles Bignan, User Facility Interface Manager, Commissariat à l'énergie atomique et aux énergies alternatives (CEA), France

- *Q&A session*
- *Round table: Value of the experiments for the community*

Coffee Break 10:30-11:00

- *Introduction by co-chair*

Mirela Gavrilas, Director, Division of Safety Systems, Nuclear Regulatory Commission (NRC), US

- *Proposal by RIAR: Research into VVER fuel rods behaviour under LOCA conditions in the MIR.M1 reactor*

Alexandre Tuzov, Director, Research Institute of Atomic Reactors (RIAR), Russia

- *Q&A session*
- *Round table: Value of the experiments for the community*

Lunch Break 12:30-13:30

- *Proposals for Joint Experimental Programmes under development:*

- *Experimental capability of Nuclear Safety Research Reactor (NSRR) and a Joint Experimental Programme proposal from JAEA*

Tomoyuki Sugiyama, Risk Analysis and Applications Research Division, Nuclear Safety Research Centre, Japan Atomic Energy Agency (JAEA), Japan

- *LOCA tests in CABRI water loop*

Laurence Rigollet, Deputy Head of the Department, Studies and Experimental Research Department, Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France

- *Experiments in TREAT to support modelling and simulation*

Steve Hayes, Leader in the Nuclear Fuels & Materials Division and a Fellow of the Nuclear Science & Technology Directorate, Idaho National Laboratory (INL), US. Presented by NEA.

- *Joint project proposal for In-pile creep studies of ATF claddings*

Marek Miklos, Business development manager, Centrum výzkumu Řež, Czech Republic

- *Q&A session*

Coffee Break 14:40-15:00

SESSION 3: EXPRESSION OF NEEDS AND INTEREST, IMPLEMENTATION STEPS 15:00-16:00

- *Round table: Building the Framework and its program of work*
 - *Expression of interest to the launch of the Framework*
 - *Expression of interest to the available proposals for Joint Experimental Programmes*
 - *Expression of needs for future experiments*
- *Wrap-up presentation: Proposed approach for establishing the Framework and possible next steps*

Daniel Iracane, Deputy Director-General, NEA

Tatiana Ivanova, Head of Division of Nuclear Science, NEA

CLOSING SESSION 16:00-16:30

- **Mirela Gavrilas**, Director, Division of Safety Systems, Nuclear Regulatory Commission (NRC), US
- **Rostislav Štaubr**, Nuclear Fuel Manager, Fuel Cycle Strategy and Services Unit, ČEZ, Czech Republic
- **William D. Magwood, IV**, Director-General, NEA

APPENDIX 3. Description and benefits of different management models for in-pile testing activities

Scenario A (modest FW + classic joint projects)	Scenario B (substantial framework + JEEPs)
FW provides only high-level coordination, e.g., summary of fuel/material testing activities across NEA	FW provides organizational and technical expertise, including <ul style="list-style-type: none"> • Maintains awareness of needs fuel/material testing needs + awareness of fuel/materials experimental capabilities • Identifies opportunities for cross cutting activities that support fuel/materials testing, e.g., computational, instrumentation • Retains cognizance of how other aspects of the fuel cycle affect fuel development • Retains cognizance of practical issues that impact fuel/material testing, e.g., transportation • Ensures data quality and preservation • Facilitates professional development/educational opportunities • Enables marketing • Ensures consistency • Facilitates political impact
Only project participants pay for/participate in projects	All FW members pay for a substantial portion of all projects
Only project participants get data	All members get all the data
Project defined primarily project participants	Project influenced significantly by FW members
Easier funding model—single tier	More complex funding model—double tier
Supports only facilities for which interest reaches the critical mass needed for a joint project	May support a broader set of facilities that are available for fuel/materials testing