ORIENT- NM

Organisation of the European Research Community on Nuclear Materials

A Coordination and Support Action in Preparation of a Co-Funded European Partnership on Nuclear Materials

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Work Package 4 – Interaction with other bodies, initiatives and stake-holders, including infrastructures

Deliverable D4.8: Revised protocol of European Joint Programme interaction with international organizations

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List of abbreviations

AC	Associated Country
ARIS	Advanced Reactors Information System
CEP	Co-funded European Partnership
CRP	Coordinated Research Project
CSI	Chief Scientific Investigator
EC	European Commission
EJP	European Joint Programme
ENEN	European Nuclear Education Network
ENS	European Nuclear Society
EU	European Union
FIDES-II	Second Framework for Irradiation Experiments
FORATOM	The Voice of the European Nuclear Industry
FR	Fast Reactors
GCR	Gas-Cooled Reactors
GFR	Gas-Cooled Fast Reactor
GIF	Generation IV International Forum
HTR	High Temperature Reactor
IAEA	International Atomic Energy Agency
ICTP	International Centre for Theoretical Physics
IG	Innovation Group
LFR	Lead-cooled Fast Reactor
LTO	Long-Term Operation
MS	Member State
MSCFP	Marie Sklodowska-Curie Fellowship Programme
MSR	Molten-Salt Reactor
NEST	Nuclear Education, Skills and Technology
NFCMS	Nuclear Fuel Cycle and Materials Section
NKS	Nordic Kärnsäkerhet / Nordic Nuclear Safety
NPES	Nuclear Power and Engineering Section
NPTDS	Nuclear Power Technology Development Section
OECD/NEA	Organisation for the Economic Cooperation and Development / Nuclear Energy Agency
pSSC	Provisional System Steering Committee
R&D	Research and Development
SAB	Scientific Advisory Board
SCWR	SuperCritical Water-cooled Reactor
SFR	Sodium-cooled Fast Reactor
SMILE	Studsvik Materials Integrity Life Extension
SMR	Small and Medium Size Modular Reactors
SSC	System Steering Committee
VHTR	Very High Temperature Reactor
Vgbe	international association of companies from the electricity and heat supply industry in Germany
WNA	World Nuclear Association

WGIAGE	Working Group on Integrity and Ageing of Components and Structures
WPFM	Working Party on Material Science Issues in Nuclear Fuels and Structural Materials
WPFC	Working Party on Scientific Issues of Advanced Fuel Cycles

Summary

This document, revision of the deliverable D4.1 of ORIENT-NM, describes how the future co-funded European partnership on nuclear materials may establish relations of collaboration with a number of international organisations and European associations, with mutual benefit. Contacts have been taken with: IAEA, NEA/OECD, GIF, ENEN and FORATOM. While legal agreements are unlikely or even impossible, several ways of cooperation have been identified.

1. Introduction

The goal of this deliverable is to identify possible protocols of interaction of a Co-funded European Partnership (CEP) on nuclear materials with international organisations and associations, with mutual benefit and with a view to optimising the use of resources and minimising the potential duplication of initiatives and activities. The present document revises and extends the first draft, provided in the deliverable D4.1 of ORIENT-NM.

Several European and international organisations were contacted, through appropriate channels, in order to organise an exchange of information in the form of a web meeting, namely:

- IAEA (International Atomic Energy Agency): Widely known as the world's "Atoms for Peace and Development" organisation within the United Nations family, the IAEA is the international centre for cooperation in the nuclear field. The Agency works with its Member States and multiple partners worldwide to promote the safe, secure and peaceful use of nuclear technologies.

- OECD/NEA (Organisation for the Economic Cooperation and Development / Nuclear Energy Agency): NEA is an intergovernmental agency that facilitates co-operation among countries with advanced nuclear technology infrastructures, operating within the framework of the Organisation for Economic Co-operation and Development (OECD). The objective of the Agency is to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally sound and economical use of nuclear energy for peaceful purposes.

- GIF (Generation IV International Forum): The GIF is an intergovernmental co-operation framework based on a signed charter that enables international collaboration in research and development of the next generation of nuclear energy systems. It is organised in different groups, dealing e.g. with policy and technical progress revision, as well as in committees and boards, each dedicated to the various reactors systems and relevant issues.

- ENEN (European Nuclear Education Network): ENEN is an international non-profit organisation, the main purpose of which is the preservation and the further development of expertise in the nuclear fields by higher education and training in Europe; this objective is realized through the co-operation between universities, research organisations, regulatory bodies, the industry and any other organisations involved in the application of nuclear science and ionising radiation.

- FORATOM - The Voice of the European Nuclear Industry: FORATOM is the Brussels-based trade association for the nuclear energy industry in Europe. It acts as the voice of the European nuclear industry in energy policy discussions with EU

Institutions and other key stakeholders. Its membership is made up of 15 national nuclear associations representing nearly 3,000 firms.

Other organisations were also contacted, namely WNA[1], ENS[2], NKS[3] and vgbe[4]. WNA replied declining interest, while no answer was received by the others. With all other organisations, in addition to the online meeting that was organised on 25th June 2021, several contacts were taken on different occasions, by email or through (video)calls.[5] This document summarises the outcome of the discussion concerning ways of interacting between the mentioned organisations and the future CEP on nuclear materials. All organisations mentioned here were informed about the content of this document and in some cases actively participated to its preparation, so it is considered that the content of this deliverable is consensual.

2. Possible protocols of interaction

IAEA

A formal legal agreement with an EU consortium of organisations is not feasible, however IAEA can likely sit in a stake-holder group or advisory board of projects and initiatives. In the specific case of the CEP on nuclear materials, a seat for the IAEA could be foreseen in the General Assembly as observer. Intellectual property rights should be clarified in terms of possibility of disclosing project results. In principle, the members of all governance bodies of the CEP are expected to sign a non-disclosure declaration. At the same time, since the policy of the EC is towards open access and open data, the diffusion of results should not be a major issue.

[1] WNA (World Nuclear Association) is the international organization that represents the global nuclear industry: its mission is to promote a wider understanding of nuclear energy among key international influencers by producing authoritative information, developing common industry positions, and contributing to the energy debate.
[2] ENS (European Nuclear Society) is a Learned Society that brings nuclear societies and professionals in Europe together, allowing them to exchange knowledge and experience about nuclear science and technology. ENS promotes the development of nuclear science and technology and the understanding of peaceful nuclear applications.
[3] NKS (Nordic Kärnsäkerhet / Nordic Nuclear Safety) is a funding organisation in the Nordic countries: Denmark, Finland, Iceland, Norway and Sweden. The owners and main financiers of NKS are a number of central authorities, safety organisations and one ministry, and it is supported by industry. It has two programs, one on reactor safety, including materials, and one on radiology.
[4] vgbe energy is an international association of companies from the electricity and heat supply industry. The association is based in Essen/Germany. One topic vgbe deals with is nuclear energy. In this area, vgbe provides the communication platform for questions concerning technology, operation and safety of nuclear power plants, both in the operating phases and in the phase of dismantling and decommissioning. The focus is on short-term and practice-oriented issues as well as long-term, strategically oriented topics.
[5] However, neither ENEN, nor FORATOM replied to the request of contact in the course of the update of this document, which is interpreted as implicit agreement.

Three main channels of interaction have been identified between the future CEP and the IAEA, subject to the IAEA's established mechanisms, rules, and regulations:

1) Coordinated research projects (CRPs). These bring together research institutes in both developing and developed IAEA Member States to collaborate on research topics of common interest. Research Contracts and Research Agreements are awarded by the IAEA to institutes in Member States for their completion of research work under these CRPs. Each established CRP typically consists of a network of 10 to 15 research institutes that work in coordination for three to five years to acquire and disseminate new knowledge. Research takes place at participating institutes that have been selected and awarded Research Contracts or cost-free Research Agreements. For each Research Contract or Agreement, one institute staff member is designated as the Chief Scientific Investigator (CSI) responsible for the progress of the research work. The IAEA acts as the coordinating and sponsoring body, with an IAEA technical staff member assigned to lead each CRP as Project Officer. CRP results are eventually available, free of charge, to scientists, engineers and other users from all IAEA Member States.
   Several ongoing CRPs address topics that are potentially of interest for the partnership (see Annex I). The participation in them of CEP beneficiaries and affiliated entities can be a way to create synergy and interaction with future CEP projects. The CRP would then benefit from the research funded by the CEP and the CEP would benefit from inclusion of non-EU countries to contribute to the research topic.
   In the longer term, partnership's projects may be the motivation for the launch of parallel, or complementary, IAEA CRPs, on subjects of common interest. Since the IAEA procedure to launch CRPs is relatively long, however, this common interest should be better identified in the early phase of the CEP, in order to take benefit of this possibility.

2) Joint organisation of workshops and training courses. This may happen either in the form of IAEA support for grants to students for the participation in such workshops and training courses, or by jointly organising them, e.g. in collaboration with the ICTP (International Centre for Theoretical Physics in Trieste), which is governed by UNESCO, IAEA and the Republic of Italy.

3) IAEA Marie Sklodowska-Curie Fellowship Programme (MSCFP). The MSCFP aims to help increase the number of women in the nuclear field, supporting an inclusive workforce of both men and women who contribute to and drive global scientific and technological innovation. The Programme provides highly motivated female students with scholarships for Master's programmes and an opportunity to pursue an internship facilitated by the IAEA. Selected students receive a scholarship for Master's programmes in nuclear related studies at accredited universities. They are also provided with an opportunity to pursue an internship facilitated by the IAEA for up to 12 months. Scholarships are awarded annually to 100 plus students depending on the availability of funds. Consideration is given to field of study, and

geographic and linguistic diversity. While applications are made by individuals irrespective of the CEP on nuclear materials, young researchers involved in the CEP will be encouraged to consider this opportunity.

The IAEA Sections with specific interest and potential benefit to be collaborating with the future CEP on nuclear materials are listed in what follows:

Nuclear Power and Engineering Section (NPES) – Long-term operation (LTO).

The NPES cooperates with Member States with operating and expanding nuclear power programmes. It provides a wide range of services, such as expert missions, training courses, technical meetings, workshops and guidance documents. In support of safe, secure and sustainable nuclear power operations, NPES disseminates good practices and helps share experiences to improve operational performance, technical infrastructure, management systems, human resource development and stakeholder involvement. In this framework, it is conceivable that any type of advance in terms of materials behaviour monitoring and prediction achieved within the partnership will be of interest for the NPES, while collaboration in the organisation of training courses, technical meetings and workshops in connection with materials aspects seems to be a good ground for mutually beneficial interaction.

Nuclear Power Technology Development Section (NPTDS) - Advanced water reactors including small and medium size modular reactors (SMR), gas-cooled and high temperature reactors (GCR/HTR), fast reactors (FR), nuclear fusion, and also non-electric applications of nuclear power.

The NPTDS fosters information exchange and collaborative R&D on nuclear technology development and innovations. It manages six international Technical Working Groups and, on average, 12 CRPs every year with institutions and stakeholders in MS, covering different technical aspects of advanced reactors and non-electric applications, as well as nuclear fusion technology for energy production. The NPTDS provides technical documents, databases, toolkits and portals on development and deployment of evolutionary and innovative nuclear power plants and their applications. It develops, maintains and updates the Advanced Reactors Information System (ARIS) and trains embarking countries in reactor technology assessment for near term deployment. Human resource capacity building in embarking and expanding countries is supported through training courses and workshops and includes a suite of basic-principle nuclear reactor simulators for education and training of engineers and researchers in MS. Here, therefore, the possibility of collaboration through CRPs having materials in the focus exists, as well as collaboration in the organisation of training courses and workshops.

Nuclear Fuel Cycle and Materials Section (NFCMS) – Fuel performance and safety, new fuels and fuel cycles for innovative reactors

To contribute to the sustainable development of nuclear power, the NFCMS supports interested Member States via Sub-Programmes that are dedicated to: (1) Develop adequate infrastructures for uranium (and thorium) resources exploration and production; (2) Improve nuclear fuel performance during nuclear power reactors operation; (3) Manage safely the spent fuel generated by their NPPs, through long-term storage, reprocessing and recycling; (4) Develop new nuclear fuel concepts and technologies as well as nuclear fuel cycles for innovative nuclear reactors (including SMRs). The scope of (2) and (4) has clearly significant overlap with the objectives of the partnership, especially considering that important issues addressed in NFCMS are: raw materials for nuclear reactor fuel; power reactor fuel technology (fabrication and in-reactor behaviour, as well as advanced nuclear fuel cycle technologies, such as ATFs).

OECD/NEA

The interaction between the CEP stemming from ORIENT-NM and the NEA would be beneficial to both organisations and, in general, to efforts devoted to nuclear materials related research. In terms of outreach, the NEA is a key partner that would allow bridging the work done within the European Union with similar undertakings worldwide. In particular, when standard methods and approaches are to be developed, cooperation with the NEA would allow broadening the community of practices. Furthermore, improving the efficiency of any research strategy implies avoiding duplication of efforts within the same country or continent. This requires surveying ongoing initiatives, analysing their contents and objectives, exploring areas for potential cooperation among countries and organisations by identifying sufficiently significant overlaps of objectives that would justify joining efforts and removing hurdles to cooperation. The NEA is well placed to contribute to coordinate and optimise research efforts through its member states.

Considering the above, it is worth designing an interaction scheme allowing cooperation between the CEP on nuclear materials and the NEA. The simplest way of progressing along these lines would be to liaise with appropriate NEA representatives and to suggest nominating an observer from the future CEP in NEA working parties and expert groups relevant to material science research. These observers may also, but do not have to, be delegates of specific EU countries that are involved in the CEP on nuclear materials. What matters is that these individuals are explicitly recognised as representing CEP. Vice versa, NEA is expected to either appoint an observer in the governing body of the CEP (General Assembly) or contribute a member to one of the advisory bodies of the CEP (Scientific Advisory Board, SAB, and Innovation Group, IG) of the CEP, or both. This will ensure direct communications and sharing of information between NEA and the CEP on nuclear materials. Below is a list of the NEA standing

technical committees (and underlying activities) and joint projects that would be important to consider for interaction.

Nuclear Science Committee:

- Working Party on Material Science Issues in Nuclear Fuels and Structural Materials (WPFM), and the two Expert Groups: Expert Group on Fuels Materials (EGFM) and Expert Group on Structural Materials (EGSM).
  Contact: Alice DUFRESNE, alice.dufresne@oecd-nea.org
- Working Party on Scientific Issues of Advanced Fuel Cycles (WPFC), Expert Group on Reactor Coolants/Components Technology.
  https://www.oecd-nea.org/jcms/pl_22458/wpfc-expert-group-on-reactor-coolants/components-technology-egcocot
  Contact: Gabriele GRASSI, gabriele.grassi@oecd-nea.org

Committee for the Safety of Nuclear Installation:

- Working Group on Integrity and Ageing of Components and Structures (WGIAGE).
  https://www.oecd-nea.org/jcms/pl_25598/working-group-on-integrity-and-ageing-of-components-and-structures-wgiage
  Contact: Keiko CHITOSE, keiko.chitose@oecd-nea.org

NEA Joint Projects:

NEA also coordinates international R&D joint projects. Not all the NEA member states contribute to these projects, whose membership changes from a project to another and results are generally only accessible to contributing countries during an embargo period which is specific to each project. The European Union participates to some of these efforts through the JRC and, when it is not the case, information exchanges could be organised between the projects' management boards and CEP representatives. In the latter case, the NEA could help organising such exchanges while complying with potential confidentiality constraints. Below is a list of Joint Projects that could be relevant to the nuclear materials CEP activities.

Projects that ended or are about to end:

- Thermodynamic of Advanced Fuels – International Database (TAF-ID-3), Phase 3.
  EC-JRC Karlsruhe is a member of the project.
  oe.cd/taf-id
  Contact: Alice DUFRESNE, alice.dufresne@oecd-nea.org

- Thermodynamic Characterisation of Fuel Debris and Fission Products Based on Scenario Analysis of Severe Accident Progression (TCOFF-2), Phase 2.
  EC-JRC Karlsruhe is a member of the project.oe.cd/tcoff
  Contact: Alice DUFRESNE, alice.dufresne@oecd-nea.org

On-going projects that will overlap with the CEP:

- Studsvik Materials Integrity Life Extension (SMILE)
  https://www.oecd-nea.org/jcms/pl_53316/new-joint-project-studsvik-material-integrity-life-extension-smile
  Contact: Didier JACQUEMAIN, didier.jacquemain@oecd-nea.org

- Second Framework for Irradiation Experiments (FIDES-II): Promote international fuels and materials irradiation campaigns
  https://www.oecd-nea.org/jcms/pl_70867/second-framework-for-irradiation-experiments-fides-ii
  Contacts: Michelle BALES, michelle.bales@oecd-nea.org; Markus BEILMANN markus.beilmann@oecd-nea.org; fides@oecd-nea.org

- Nuclear Education, Skills and Technology (NEST) framework.
  https://www.oecd-nea.org/jcms/pl_21786/nuclear-education-skills-and-technology-nest-framework
  Contact: Antonella Di Trapani, antonella.ditrapani@oecd-nea.org

The last two frameworks are of special importance, the first one as a framework for irradiation campaigns (to be analysed in task 4.5.3, deliverable D1.4), the second one because of its potential connection with the education and training activities planned in task 3.5 (deliverables D3.6, D3.11). In particular, FIDES-II could be interested in using the capacities developed in the CEP for non-irradiation experiments, and the CEP in using the irradiation tests possibilities offered within FIDES-II: it would thus be relevant to seek and identify synergies for potential data exchanges. In addition, the CEP could also benefit from the experimental protocols developed in FIDES-II.

GIF

The GIF has established System Steering Committees (SCCs) to implement the research and development (R&D) for each Generation IV Reactor Concept, with participation from GIF Members interested in contributing to collaborative R&D. Each SSC plans and integrates R&D projects contributing to the development of a system. The participants in SSCs and projects sign agreements that govern intellectual property rights and other matters in order to work co-operatively on the concepts.

Four System Arrangements have been signed (GFR, SCWR, SFR and VHTR) while for the last two systems, LFR and MSR, Memoranda of Understanding have

been signed to allow for collaboration until System Arrangements have been put in place. In these last cases a provisional SCC (pSCC) is established.

The collaboration between the CEP stemming from ORIENT-NM and the GIF may take place through the SCCs and pSCCs.

Chair and Co-Chair of each SCCs and pSCCs may participate, upon invitation, in technical meetings with the CEP, favouring mutual alignment and reinforcing synergies among the R&D program that are being implemented under the umbrella of the CEP and the GIF, respectively. (p)SCCs EURATOM representatives will act as contact points with the CEP, proposing jointly organised dedicated meetings, workshops and seminars, to enable the CEP contribution to each GIF initiative and vice versa.

VHTR Materials (Chair)	POUCHON, Manuel, PSI
SFR SSC (Co-Chair)	SERRE, Frédéric, CEA
SCWR SSC (Co-Chair)	SÁEZ MADERUELO, Alberto, CIEMAT
MSR SCC (Chair)	KREPEL, Jiri, PSI
LFR pSCC (Co-Chair)	TARANTINO, Mariano, ENEA
GFR PMB (Chair)	HÓZER, Zoltán, MTA

ENEN

ENEN can provide the link with universities and students. Materials are a good and important subject as they are the base for innovation. Joint summer schools that target nuclear materials subjects can be considered. ENEN is also launching a new mobility programme, ENEN++, certainly of interest for the CEP. Plans for education & training, as well as mobility, activities within the partnership are elaborated in task 3.5 of ORIENT-NM. Therefore, more details on possible interactions with ENEN will be given as part of that task (deliverables D3.6, D3.11).

FORATOM (now Nuclear Europe[6])

Key topics for FORATOM are: security of energy supply, competitiveness, economics of nuclear, nuclear safety, nuclear liability, radioactive waste, decommissioning, nuclear transport, environment, new projects, R&D, energy mix, non-proliferation, public opinion, EURATOM treaty, emergency preparedness.
The main activities of FORATOM are:

- to provide information and expertise on the role of nuclear energy; by producing position papers, newsfeeds, responses to public consultations, analyses of public opinion;

[6] https://www.nuclearеurope.eu/

- to organize regular networking events like dinner debates, workshops, one-on-one meetings, press briefings and visits to nuclear facilities.

In this context, the interaction with the future European partnership on nuclear materials can be envisaged to pivot around two axes:

- FORATOM can act as a springboard and amplifier towards its members and beyond for any communication action undertaken by the partnership, be it in the form of newsletters, factsheets, or flyers;
- In the framework of its networking events, especially R&D&I-oriented workshops, FORATOM can periodically provide the occasion for the partnership to inform about its activities, ambitions and results, and possibly obtain feedback in terms of industrial needs that may be taken into account in the drafting of the forward programme of the partnership.

Annex I – Active, approved and planned IAEA CRPs of possible interest for the future CEP on nuclear materials

This list may be not exhaustive. Contact with the person in charge may be taken via the IAEA website: https://www.iaea.org/projects/coordinated-research-projects. In this same website information on past and closed projects is available. It is possible that the status of some of the projects mentioned here will have changed by the start of the partnership, so this list should be considered only indicative.

Accelerator Simulation and Theoretical Modelling of Radiation Effects - SMoRE-II - active, started 2016

Description

To develop structural materials for advanced reactor concepts and life extension of existing reactors will require a new paradigm for irradiation testing of candidate materials. This new paradigm is accelerator-based ion irradiation. Establishment of its efficacy will be accomplished through the use of standardized testing, to establish confidence in ion irradiation results between various laboratories, and to verify agreement between neutron and ion irradiated property-controlling microstructures. A Round Robin to fabricate and distribute selected materials for ion irradiation and post-irradiation examination will be a focus of this CRP. It is through this mechanism that (i) the degree of interlaboratory variation will be quantified and (ii) a direct comparison of ion beam to reactor irradiations will be made. The results from this CRP should lead to recommendations for best practices in the use of ion beam research for the emulation of in-reactor damage to materials. Several important questions regarding the behaviour of selected structural materials under irradiation will also be addressed by the CRP participants, which may include understanding the dose-rate effect of accelerator irradiations, understanding the primary damage state of different irradiation conditions, and investigation of microstructure changes during the incubation period (e.g. of void swelling). In comparing ion and neutron irradiated property-controlling microstructures, the following may be addressed: determination of analysis procedures and criteria for comparing ion irradiation to neutron irradiation, conducting ion irradiation of previously neutron-irradiated materials, conducting very high dose/high-temperature ion irradiations for future reactor applications, comparing ion and neutron irradiation within a steady state microstructure.

Objectives

Development of best practices for conducting ion irradiations for the design of new materials for existing and future reactors

Specific objectives

Improved knowledge of the nature of radiation damage in candidate structural materials for reactors on the basis of ion irradiation and modelling of its effects

Intercomparison of the results of different ion irradiations conducted across the CRP and the development of recommendation on improved best practices.

Quantification of the degree of agreement between microstructures generated by ion and neutron irradiation.

Fuel Materials for Fast Reactors – active, started 2019

Description

The main purpose of a new Coordinated Research Project (CRP) is to support the fuel and cladding materials performance assessments for the sodium-cooled fast reactor technology, in accordance with the Gen-IV requirements, through enhancing the fuel performance codes. Methodologies to achieve this goal are to collect irradiation test data and build a dataset that shall be shared among the IAEA Member States (MSs) and to extend the validation basis of fuel performance phenomena.
The CRP will bring together specialists from IAEA MSs with active sodium-cooled fast reactor programmes to share their national efforts. A key topic of this new CRP is to expand the IFPE database, currently dedicated to thermal reactors, to include fast reactors (FRs). To achieve this, new datasets on prototypic commercial irradiations as well as experiments performed in research reactors will be collected from participants. Simultaneously, some experiments from these datasets will be chosen for international benchmarking exercises for FR fuel performance codes used by MSs.
Correspondingly, two focus areas for this CRP are 1) collecting irradiation test data on fuel materials, including oxide (UO2/MOX) and metallic (U/U-Pu based alloys) fuels and steel-based claddings (austenitic, ferritic-martensitic, ODS steels etc.) and 2) performing benchmarking exercises. The approach could be starting with an open literature survey on selected topics.
The subsequently approach is to reinforce/supplement the datasets with additional irradiation test data from MSs participating in this CRP. A completed dataset, as a minimum, from one fuel pin irradiation test should follow. It is the participant's responsibilities to ensure test data will be provided in English. A template used/recommended by the OECD NEA is considered as the basis for a "complete" dataset. An overview document is recommended, as the first step, to ensure a common irradiation dataset could then be identified and agreed.
This CRP will have several benchmarking exercises, based on selected data, with clear objectives that focus on the driver fuel. Participants could subsequently express their interests (topics) of their choices.

Objectives

Effective dissemination of knowledge and expertise on sodium fast reactor fuel behaviour under irradiation conditions, by facilitating the collaboration among MSs.

Specific objectives

To bring together experts to enhance the international collaboration and save efforts by optimizing the use of data from limited number of facilities for joint benefits.

To promote sharing of data from fast neutron irradiation experiments on fuel pins and associated post-irradiation examination.

To perform simulations of these datasets, using various fuel performance codes.

To compare, analyse and share simulation results among participants, including recommendations on fuel performance codes enhancement and identification of gaps in irradiation data.

Testing and Simulation for Advanced Technology and Accident Tolerant Fuels (ATF-TS) - active, started 2020

Description

The proposed CRP will support interested IAEA Member States in their efforts to design and develop Accident Tolerant and Advanced Technology Fuels (ATF) for light water reactors (LWRs) to enhance the safety and sustainability of nuclear power. The design, fabrication and in-pile behaviour of currently operated and innovative nuclear fuels and materials to enable a reliable and safe operation of nuclear power plants is a recurrent priority of IAEA's sub-programme "Nuclear Power Reactor Fuel Engineering". Development and validation of computer codes for fuel design and in-pile behaviour analysis under normal and off-normal conditions (including Design Extension Conditions, DEC) are possible only if high-quality experimental data are made available. That is why international cooperation in this area is highly desirable, and in particular among IAEA Member States interested in enhancing their computer code capabilities to predict nuclear fuel behaviour under Design Basis (DB) and Design Extension (DE) Conditions.
The CRP will bring together specialists from IAEA MSs with active ATF R&D programmes to share their national efforts and to contribute in any of the following objectives of the CRP:
Round Robin tests on different ATF cladding concepts (e.g. coated Zr cladding, FeCrAl, SiC);

Bundle tests under DB/DEC with ATF materials (e.g. with coated Zry-4 rods under SA and/or LOCA conditions);
Collection of irradiation tests data;
Code benchmarking against existing data, relevant for advanced fuel and cladding concepts from other experimental Programmes, as well as new tests data obtained during the CRP;
LOCA evaluation methodology development for NPP applications including uncertainty and sensitivities studies.

Objectives

To support Member States to understand and address factors affecting the design, fabrication and in-pile behaviour of currently operating and innovative nuclear fuels and materials for power reactors, to increase technology readiness for candidate ATF materials.

Specific objectives

To perform experimental tests including single rod and bundle tests on ATFs' performance under normal, DB and DE conditions

To benchmark fuel codes against new test data either obtained during the CRP or from existing data relevant to advanced fuel and cladding concepts from Member States' experimental Programmes.

To develop LOCA evaluation methodology for ATF performance with a view for NPP applications.

Towards the Standardization of Small Specimen Test Techniques for Fusion Applications - Phase II – active, started 2022

Description

Fission neutrons for materials testing have been available for decades in hundreds of experimental reactors worldwide; an extensive database for irradiated materials is available. Unfortunately, experimental Fusion reactors for materials testing do not exist. Testing facilities with a 14 MeV neutron source for irradiating candidate materials under Fusion-reactor conditions and offering control of the temperature of the irradiated material have been subject of development for four decades, but now have become an urgent need and crucial feature in world Fusion roadmaps. The available volumes for testing will be inherently reduced; in the design of IFMIF (International Fusion Materials Irradiation Facility) or its simplified versions the Japanese A-FNS or the European IFMIF/DONES, a maximum of 500 cm3 will allow the irradiation of structural

materials at the needed dpa values. The optimization of the limited testing space makes the use of small specimens a stringent necessity.
The limited testing volume with needed neutron fluxes in accelerator driven Fusion relevant neutron sources drove the development of small specimens for fusion applications. The first review of the state-of-the-art dates from 1983. The development has continued in a steady manner in various laboratories worldwide yielding similar results, but without a standard procedure. Since 1983, more than 10 specific Symposia have taken place, mainly organized by ASTM, but no harmonization of small specimens test techniques has yet ever been accomplished.
The nuclear industry, and in particular Fusion, has detected that the lack of common practice and standards in Small Specimen Test Techniques (SSTT) is preventing them to be able to compare and to use data in a rigorous manner. Standards reduce the risk of rejection of data gathered by validation and QA procedures of Nuclear Code Frameworks, prevents from likely repetition of tests and, therefore, accelerates material development and qualification cycles.

This CRP is a continuation of the effort started already in the previous CRP F1.30.17 on “Towards the Standardization of Small Specimen Test Techniques for Fusion Applications”. In this second phase of the project focus shall be on the applicability of guidelines and methodologies drafted so far under high temperature (HT) conditions and suited for hot cell (HC) environment as well as closing some gaps in the output of CRP F1.30.17

Objectives

The overall objective of this research proposal is to provide the bases for the standardization of SSTT specimens making them available for their use in Fusion material irradiation facilities. This includes:

(a) to provide a set of guidelines for SSTT based on common agreed best practices on main test techniques (tensile, creep, low cycle fatigue, fracture toughness, fatigue crack growth) valid for reference structural Fusion materials (RAFM steels);
(b) to establish supporting experimental activities and
(c) to elaborate datasets and elements needed for a full standardization of the SSTT by an international authority like ASTM or ISO.
This effort started already in the previous CRP F1.30.17 on “Towards the Standardization of Small Specimen Test Techniques for Fusion Applications” and this new CRP would be the second phase of it.

Both, the development of guidelines and the accompanying experimental programme shall be building on the CRP F1.30.17 and complementary focus on high temperature application and remote capabilities as required in hot-cell experiments.

It shall be noted, that the standardization through an international body itself is not an objective of this CRP

Specific objectives

Continuation of the supporting experimental program (“Intercomparison exercise from different labs”) for the respective test methods. The focus shall be on the applicability of guidelines and methodologies drafted so far under high temperature (HT) conditions and suited for hot cell (HC) environment as well as closing some gaps in the output of CRP F1.30.17 that are specific for the respective test methods addressed.

To establish reference guidelines for tensile tests using small specimens for RAFM steels. A focus will be given on achieving a firm basis of test results at elevated temperatures. Formulation of guidelines shall follow criteria and practice from well-established standards like ASTM or ISO.

To establish reference guidelines for creep tests using small specimens for RAFM steels. A focus will be given on consolidating the test results to analyse the consistency of the data to be obtained for the test matrix defined in CRP_SSTT-I. Formulation of guidelines shall follow criteria and practice from well-established standards like ASTM or ISO.

To establish reference guidelines for low cycle fatigue tests using small specimens for RAFM steels. A focus will be given on testing small specimens at diameters, which will allow to recommend a minimum diameter. Formulation of guidelines shall follow criteria and practice from well-established standards like ASTM or ISO.

To establish reference guidelines for fracture toughness tests using small specimens for RAFM steels. A focus will be given addressing technical gaps/challenges. Formulation of guidelines shall follow criteria and practice from well-established standards like ASTM or ISO.

To establish reference guidelines for fatigue crack growth tests using small specimens for RAFM steels. A focus will be given on achieving a firm basis of test results at elevated temperatures. Formulation of guidelines shall follow criteria and practice from well-established standards like ASTM or ISO.

To establish guidelines for the use of SSTT taking into account the need of integrating these elements or data gathered from SSTT into nuclear code frameworks.

Standardization of Subsized Specimens for Post-Irradiation Examination and Advanced Characterization of Fuel and Structural Materials for Small Modular Reactor and Advanced Reactor Applications – approved, to start

Description

The proposed Coordinated Research Project (CRP) will support interested IAEA Member States in their efforts to support new or advanced fuel developments for use in innovative reactors. Post-irradiation examination (PIE) has remained a vital component in the understanding, development, qualification and continued surveillance of irradiated reactor fuels and related structural materials. Considering that it usually takes a long period to generate PIE data and more work is still required to develop the PIE data for new or advanced fuel types for innovative reactors, multi-laboratory collaboration has been proposed as an effective means of developing such PIE data for new or advanced fuel developments and thus obtaining adequate fuel/fuel assembly qualification information to support the safe operation of specific new or advanced fuel types. Under this CRP, a multi-laboratory round-robin PIE plan will be developed and executed to assess the feasibility of expanding PIE capabilities of an individual laboratory that may suffer equipment availability issues, resource issues, etc., through the application of multi-laboratory collaboration, to support advanced characterization of advanced/next-generation fuels and structural materials for innovative reactors. Effective multi-laboratory collaboration strategies can be realized through efficient and standardized sample preparation and testing, packaging and radioactive material shipping/transport mechanisms from one laboratory to another.

Objectives

To support Member States by demonstrating that collaborative efforts for advanced characterization of innovative fuel types can be performed and the required fuel performance parameters for a given fuel type or material can be properly assessed, sample preparation guidelines are well defined and similar across laboratories, and irradiated sample transport is viable.

Specific objectives

To develop a ‘PIE roadmap’ (for a given fuel and/or structural material type such as TRISO, SiC, graphite, new or existing alloys) that incorporates advanced characterization techniques and harmonizes manufacture, preparation, testing, and characterization methods across collaborating laboratories.

To execute the round-robin PIE exercise for a given fuel and/or structural material type that includes both non-destructive examination (NDE) and destructive examination (DE).

To demonstrate and look for efficiencies associated with transport of small /sub-sized samples to and from collaborating laboratories.

Planned

Advanced methodologies for in-situ analysis with ion beam accelerators and synchrotron radiation

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