EURAD: SFC WP
Spent Fuel Characterisation and Evolution Until Disposal

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Task 1 - S/T coordination, State-of-the-art and training material

Task objectives:
- To provide efficient management and administration of the work package, to identify potential problems at an early stage and provide timely and effective solutions.
- Developing/updating State-of-the-art, performing WP-specific gap analysis.
- Developing training materials as an input to KM.
- Collecting data from tasks 2-4.
- Collecting experience from the project to guide efforts in a possible future 2nd wave of the programme.

Subtask 1.1 – S/T coordination
- WP operational management and performance monitoring
- WP information and communication management

Subtask 1.2 – State-of-the-art and Gap analysis
- Current state-of-the-art: The current state-of-the-art of nuclear fuel characterisation and evolution of its properties will be summarized in a state-of-the-art report.
- Updated state-of-the-art: At the end of the project, the report describing state-of-the-art will be complemented with text on how state-of-the-art has been improved by contributions from the project.

Subtask 1.3 – Training materials
- Training material, in the form of e.g. lecture materials, containing state-of-the-art of nuclear fuel modelling, characterisation and evolution of nuclear fuel until disposal, is to be developed during the project in close link with KM Training/Mobility WP.

Task 2 - Fuel properties characterisation and related uncertainty analysis

The main objective is to produce experimentally verified procedures to estimate reliable source terms of spent nuclear fuel (SNF), including realistic uncertainties. The main source terms of interest are gamma-ray and neutron emission rate spectra, decay heat and inventory of specific nuclides, i.e. activation products (e.g. ⁴⁰Ca and ³⁶Cl), long lived fission products (FP), fissile nuclides (²³⁵U, ²³⁹Pu) and minor actinides (²⁴¹Am, ²⁴²,²⁴⁴Cm). The inventory of fissile nuclides is needed for reactivity calculations to prevent criticality and emission rate spectra, decay heat and inventory of specific nuclides, i.e. activation products (e.g. ⁴⁰Ca and ³⁶Cl), long lived fission products (FP), fissile nuclides (²³⁵U, ²³⁹Pu) and minor actinides (²⁴¹Am, ²⁴²,²⁴⁴Cm). The inventory of fissile nuclides is needed for reactivity calculations to prevent criticality and

Subtask 2.1 – Theoretical study of SNF source terms
Subtask 2.2 – Develop, improve and demonstrate NDA methods/systems for SNF characterisation
Subtask 2.3 – Determine the inventory of activation and fission products in cladding material
Subtask 2.4 – Define and verify procedures to determine the source terms of SNF assemblies with realistic confidence limits

Task 3 - Behaviour of nuclear fuel and cladding after discharge

The aim of the work is to understand and describe numerically the behaviour of spent nuclear fuel (SNF), irradiated cladding, fuel/cladding chemical interaction (FCCI) and ageing effect under conditions of extended interim storage, transportation and emplacement in a final disposal system. These objectives will be achieved by involving experimental works and modelling studies.

Subtask 3.1 – Thermo-mechanical-chemical properties of SNF rods and cladding
- Thermo-mechanical-chemical properties of unirradiated and irradiated samples of spent nuclear fuel rod segments and cladding (BAM leading institution with contributions of CIEMAT, JRC-KA, MTA-EK, NAGRA, UPM, VTT).

Subtask 3.2 – Behaviour of SNF pellets under interim storage conditions
- Influence of oxygen and fission products on microstructure of UO₂ fuel and He within the UO₂ matrix (HZDR leading institution with contributions of CIEMAT, CNRS-CEMHTI and CNRS-ICSM).

Subtask 3.3 – Pellet-cladding interaction under conditions of extended storage, transport and handling of SNF rods
- Chemical and structural / crystallographic properties of simulated fuel pellets and irradiated fuel pellets at the cladding/fuel interface (KIT leading institution with contributions of CIEMAT and PSI).

Task 4 - Accident scenario and consequence analysis

The main goal of this work package is to study SNF behaviour under accident conditions which may lead to a potential loss of confinement during storage, transport and pre-disposal activities. As a result, the task will be fed by the empirical formulations in conjunction with mathematical numerical models produced in task 2 and task 3 and building up synergetic activities, to the development of concepts for the mitigation of the consequences.

Subtask 4.1 – Accident scenario for fuel under dry interim storage conditions.
The subtask aims to provide a synthetic analysis of identified potential but credible accident scenarios related to the transport and long-term dry interim storage of SNF.

a) Accident conditions during transport, two main specific objectives are planned by establishment of a comprehensive methodology for assessing the postulated scenarios, based on analytical tools with 3D capabilities and development of an engineering methodology capable of assessing the scenarios with considerably less computational cost and without losing accuracy.

b) Regarding accident conditions in interim storage, two specific tasks are to be tackled by development of a vault model adapted to a lumped parameter code and establishing a methodology for determination of the potential source term.

Subtask 4.2 – Consequence analysis of accident scenarios.
Experimental investigations and analytical studies from previous tasks are considered to assess accident scenarios with loss of cladding integrity. The experience gained from investigating the real consequences of beyond design basis accident at Chernobyl NPP would also support the assessment of simulation models for radiation release and environmental impact.