Coordinated Research Project – Information Sheet

1. Title:

Spent Fuel Performance Assessment and Research (SPAR IV)

2. Summary:

Continued spent fuel storage and future transitions from one phase of the back-end of the nuclear fuel cycle to the next require that the operational experience and research results be reported and disseminated to the Member States for input to continued operations safety assessments and the licensing of new facilities. In this respect the SPAR CRP has supported this requirement through the reporting of on-going performance and research on the behaviour of power reactor spent fuel and materials in wet and dry storage.

In looking forward a number of SPAR participants identified that they would be continuing their research activities to bridge knowledge gaps on existing fuel behaviour, R&D to underpin new facilities and dry storage systems and in support fuel types being transitioned from a recycling strategy to direct disposal. A continuation of the project to report on these activities and to continue to collect and report fuel and system performance experiences, especially from the deployment of new technology, has been approved.

Research proposals are solicited from Member States related to one or more of the project specific research objectives; as given below.

3. Background Situation Analysis:

Since 1981 one mechanism used by the IAEA for collecting and reporting the behaviour of spent fuel and materials in wet and dry storage has been through the combined co-ordinated research projects of the behaviour of spent fuel assemblies in storage (BEFAST) and SPAR.

For zirconium and stainless steel clad light water reactor (LWR) spent fuels there is now >50 years wet storage and >30 years dry storage experience. Performance in storage remains excellent with no generic failure mechanism identified or experienced. In the case of stainless steel clad advanced gas reactor (AGR) spent fuels there is >30 years of wet storage experience. Storage performance is good provided the fuel is stored in the presence of a corrosion inhibitor. For Magnox spent fuel (magnesium alloy clad) there is >50 years' experience of handling and storage. The tendency is only to store for relatively short periods of time in wet storage, but the fuel will remain intact for longer periods provided optimum storage chemistry is maintained. It still remains important to report the findings from surveillance programmes to confirm the on-going integrity of spent fuel in storage for use in continued operations safety analysis.

In the last phase of the SPAR project considerable attention was paid to the properties which can be imparted into zirconium clad fuels as a result of drying fuel for either dry storage or dry transportation. This research looked at hydrogen behaviour and the impact on the fuel as a result of fuel or canister/cask drops. Further studies in this area are likely

as there are difficulties in establishing experiments under actual storage conditions. In the case of stainless steel clad gas reactor fuels development studies are in progress in support of long-term safety analysis to support pro-longed storage prior to direct disposal.

In terms of materials performance there is particular interest in the role of stress corrosion cracking of steels used in storage systems and a number of studies are on-going to improve the knowledge in this area. Other examples included the deployment of new structural materials, neutron absorbing materials and on-going seal performance.

As we look forward new storage facilities will be coming-on line and some countries are actively engaged in developing their own dry cask systems.

Whilst at-reactor (AR) wet storage still dominates, the amount of spent fuel that has been transferred to dry storage technologies has increased significantly over the last decade; for example in the United States of America around 28% of the total spent fuel inventory is now in dry storage. Given the delays in developing the endpoint to the fuel cycle and limited recycling capacity, both the quantity and the duration of spent fuel storage will continue to increase.

To maintain and update the knowledge base on spent fuel and materials performance in wet and dry storage it is proposed to continue SPAR into an IV phase.

4. Nuclear Component:

CRP will address spent nuclear fuel integrity during storage over long periods. The CRP results will provide the basis for maintaining all the options (current and future) of spent fuel management open. Containment of radioactive materials in spent fuel during storage period and during handling and transportation will enable safe final disposition of nuclear fuel irrespective of the chosen option.

5. Overall Objective:

To develop (continue the input to the existing) a technical knowledge base on the long-term behaviour of power reactor spent fuel and storage system materials through the evaluation of operating experience and research by participating Member States.

6. Specific Research Objective:

- To evaluate fuel and materials performance under wet and dry storage, and to assess the impact of interim storage on associated spent fuel management activities (for example spent fuel handling and transport);
- To develop the capability to assess the impact of potential deterioration mechanisms on fuel and spent fuel storage components;
- To collect and exchange relevant experience of spent fuel storage and the impact on associated spent fuel management activities in the participating countries;
- Surveillance and monitoring programmes of spent fuel storage facilities as one of the means to evaluate spent fuel performance during storage;
- To exploit areas of synergy among research projects of the participating Member States to gain agreed approaches to research and result analysis;
- To facilitate the transfer of knowledge by documenting the technical basis for spent fuel storage;
- To extrapolate predictions of spent fuel behaviour over long periods of time.

7. Expected Research Outputs:

The research outputs from the CRP will be published as a technical document with the same title at the end of the CRP cycle.

8. Expected Research Outcomes:

- A general reporting of research activities accessible to stakeholders of spent fuel storage facilities (e.g., for reference, performing analyses or supporting licensing and re-licensing of spent fuel storage facilities);
- Detailed peer review and reporting of key findings from participants research activities;
- Operating experience from wet and dry spent fuel storage;
- Updated assessment of spent fuel integrity during long term storage;
- Surveillance and monitoring results from wet and dry storage facilities;
- What's the exit strategy (re-word).

9. Planned Activities:

General Activities

- Review and assess results of the updated national plans of research on materials used in spent fuel storage;
- Review and update the results of the national research efforts on potential fuel materials deterioration over long-term storage of fuel;
- Update national experience on spent fuel storage as a continuing effort;
- Review and assess relevant results from surveillance programmes performed;
- Provide operating experience on spent fuel handling and its potential impact on spent fuel integrity; and
- Look to exploit synergy within the research programmes to gain agreement in techniques being used and the analysis of results to gain a common ground.

Specific Activities

For the following described activities, the international need and interest will be confirmed with representatives of potential participating Member States.

Wet storage

Zirconium based alloys

- R&D/management related to the storage of defective fuel or fuel debris.

AGR/Magnox fuel (subject to UK participation in the CRP)

- R&D underpinning AGR storage prior to direct disposal; and
- R&D on Magnox operating plan contingency options.

Pool construction materials/systems

- Review the behaviour of different pool structure materials (e.g., different stainless steels, neutron absorbing materials etc.) during extended operation periods; and
- R&D activities related to storage operations (for example pool water mixing).

Dry storage

Zirconium based alloys

- Detailed reporting and peer review of participants R&D;
- Techniques for confirming on-going spent fuel performance; and
- Perform a systematic review of potential fuel degradation mechanisms and assessment of their relevance for extended long-term storage and future spent fuel management activities;

AGR/Magnox fuel (subject to UK participation in the CRP)

- R&D in support of dry storage.

Construction materials used in dry storage systems

- Assess the long term behaviour of construction materials with time, impact of irradiation and external aggressive agents.

Management of damaged spent fuel

- Examine technical issues associated with storing damaged fuel

Transfer to the next phase of the back-end of the fuel cycle

- Examine technical issues associated with transferring intact and damaged spent fuel from one phase of the back-end of the fuel cycle to the next.

Proposals received so far (April 2016):

- Characterization of hydride content as a function of accumulate neutron flux and operating temperature Zr-4 with low tin content (Argentina-CNEA)
- Evaluation of storage system and used fuel during storage (France–AREVA - TN)
- Spent WWER-440 fuel performance under long-term storage conditions (Hungary–TS ENERCON)
- Evaluation of spent fuel integrity in dry storage and transportation (RoK-KAERI)
- WWER-440 wet storage facility structural materials performance in Jaslovske Bohunice (Slovakia-VJV)
- Spent fuel mechanical behaviour during long term storage and transportation (Spain-ENRESA)
- The development of database for the numerical estimation of temperatures inside storage casks (Ukraine– A. M. Pidgorny Institute….)
- Development of interim storage for spent AGR fuel (UK-SL)
- US Industry spent nuclear fuel management (R&D and operating experience) (USA-EPRI)

Expression of interest:

- EU (JRC-ITU), Germany (BAM), Japan (NRA), Switzerland (NAGRA), UK (NNL) and USA (DoE)