

Report from breakout session and discussion on safety issues

OECD/NEA Workshop on Accident Tolerant Fuels of LWRs
10 -12 December, 2012
NEA Headquarters, Issy-les-Moulineaux

What is ATF?

- ▶ From a safety point of view, the prime objective should be to avoid, or at least to limit, the release of radioactive materials to the environment
 - ▶ To limit releases, severe accident (core melting) situations must be avoided
 - ▶ The core geometry must remain coolable
 - ▶ This requirement is one of the Design Basis Accidents
- ▶ Thus DBA appears to be a good framework for assessing the performance of ATFs

What is ATF?

- ▶ There was a consensus that Station BlackOut is a good “Reference Accident” to evaluate the merits of the proposed new designs
- ▶ 3 figures of merit appear to be of primary interest
 - ▶ The “grace time”
 - ▶ The amount of combustible gases produced
 - ▶ The radioactive release
- ▶ Those 3 values are not independent and they may be seen as 3 ways of measuring the improvements arising from ATFs

What goal to pursue?

- ▶ The notion of “grace time” is not straightforward. It was suggested to be compared to the time needed to switch from normal operation procedures to accident management
- ▶ The “grace time” should be counted in hours, or even days (realistic?). A “grace time” of some minutes was considered to be pointless and not worth the effort

DBA / beyond DBA

- ▶ The improvement resulting from ATF for DBA must not lead to a worse situation than the present one if, despite all the efforts, core melting cannot be avoided
- ▶ It is thus important to measure the oxidation rate and to characterize the materials interaction above 1200° C

ATF is part of a system

- ▶ The question of ATF must be viewed globally as a system
 - ▶ Fuel elements (pellets, cladding)
 - ▶ Channel box
 - ▶ Control rods
 - ▶ Supporting structures

Normal operation and AOO

- ▶ Normal operation should not be forgotten
 - ▶ The safety must be at least as good as today
 - ▶ It might be needed to revisit the criteria if the design of ATFs is significantly different than the present one
- ▶ Apart from DBA, there is a number of criteria to be verified: e.g. dimensional stability, corrosion resistance, DNB, FGR, IASCC, PCMI, SCC-PCI, ...
- ▶ Ensuring a high quality level of manufacturing is also an important requirement

Testing priorities

- ▶ Corrosion under in-service conditions, including a representative primary water chemical composition
 - ▶ Oxidation, hydriding, CRUD deposition, ...
- ▶ Oxidation experiments at $T > 1200^{\circ} \text{ C}$
- ▶ Degradation test under steam environment
 - ▶ Material interactions may be more complex than just what thermodynamic equilibrium predicts

Simulation tools

- ▶ Simulation tools will be required in order to evaluate the merits of ATF proposals
 - ▶ Adequate modeling
 - ▶ Validation
 - ▶ Uncertainty analysis
- ▶ It takes time to fulfill these requirements and it requires experimental support

Very innovative concepts

- ▶ It was stressed that in case of a change in reactor operation or the use of fuel with characteristics very different from the current LWR fuel (e.g. enrichment), the safety issues would need to be revisited
- ▶ This was clearly out of the scope of our discussion

Final words

- ▶ The development of fuel with improved properties is a component of the more general framework of defence-in-depth
- ▶ Besides, there are other actions developed
 - ▶ ECCS reliability
 - ▶ Emergency preparedness
 - ▶ ...
- ▶ Cost matters