

Workshop on the need for integral critical experiments with low-moderated MOX fuels (14-15 April 2004)

Introduction

Over the past several years, the NEA Working Party on Nuclear Criticality Safety (WPNCSS) has been discussing the need for additional integral benchmark experiments. An Expert Group on Experimental Needs was formed in 1997 to investigate international experimental needs. This Group has identified the MOX fuel manufacturing process, as an area in which there is a specific need for additional integral benchmark data. In November 2003, the WPNCSS issued a recommendation to the NEA Nuclear Science Committee (NSC) to promote the establishment of an international consortium that would perform the needed experiments. This recommendation was presented and discussed at the NSC bureau meeting in December 2003. The NSC bureau asked the NEA secretariat to organise a workshop where the needs can be further verified and proposals of experimental programmes presented and discussed. The main objective of the workshop was to address the following questions:

- (1) Is there a real need for additional MOX experiments?
- (2) Which proposal or combination of proposals seems to best fill the need?
- (3) What are the prospects for an International Co-operative Program?

Summary of the sessions

Forty-four participants from seven countries and two international organisations attended the workshop. The participants belong to the main industrial companies involved in MOX fuel manufacturing (Belgonucléaire, BNFL and COGEMA), to R&D organisations and to regulatory bodies. Seventeen presentations were given in three technical sessions and a panel discussion involving eight panellists concluded the workshop. The summary of the sessions is given below.

Session 1: MOX Fuel Fabrication - Design, Industrial Experience and associated Criticality-Safety issues

Five presentations were given. It was emphasised that the lack of experimental data on MOX fissile media does not impact the safety of existing plants. Indeed, safety margins were taken into account in the design of the plants and these margins are sufficient to compensate the lack of adequate data for the validation of current configurations. However, a reduction of margins would provide the operators of running MOX fuel fabrication facilities with flexibility in the process, especially in the preparation of the primary blend. Additional benchmarking may thus benefit application areas involving Pu and MOX powders by reducing the margins.

Session 2: Experimental Data Needs

Six presentations were made during this session. Sensitivity/uncertainty analysis techniques were extensively used. These techniques provide interesting insights into code, microscopic and integral data validation. However, the comparison of uncertainty data, available in major evaluated files, showed large differences. This impacts the calculations of the effect of nuclear data uncertainties on integral parameters.

Old versions of nuclear data libraries (e.g UKNDL, Hansen & Roach) lead to very conservative results. It was also demonstrated that high safety margins impact considerably MOX throughput and/or fault tolerance in some accident scenarios. Unfortunately, there isn't enough experimental data available to derive accurate determination of biases with recent evaluated data files. In fact, the only applicable experiments, performed at Hanford in the 70's, were shown to be of a limited reliability due to the lack of accurate experimental information. The results from some completed experimental programs (e.g. the ERASME/S experiments performed at CEA/Cadarache and some of the BFS configurations) may provide valuable (maybe limited) information if released.

A study from JAERI showed that mixing conditions in the MOX fabrication process need to be studied in more details (e.g. study of volume conservation when mixing the powder and additives and study of the effect of heterogeneous distributions of concentration).

Session 3: Proposed Programs and Presentation of Experimental Facilities

A wide range of experimental proposals was made including homogeneous and heterogeneous set-ups of low-moderated (tight pitches or voided) lattices. The possibility of using plutonium powder in a test zone or for oscillation measurements was also investigated. It was shown that the availability of fuel in the experimental facility impacts the cost of the programme. However, this also impacts the possibilities of experimental set-ups since the available fuel is not always representative of the needs.

Panel discussion: Prospects for International Co-operative Program

The following questions were debated:

1. Is there a real need for additional MOX experiments?
2. Which proposal or combination of proposals seems to best fill the need?
3. What are the prospects for an International Co-operative Program?

There was a consensus among the panellists that there was a lack of reliable data for better code validation and that additional experimental data would be beneficial. However, the variety of interests expressed by the panellists together with the lack of detailed information on the experimental proposals were the main reasons why a consensus on a single or a combination of experimental programmes could not be reached. Most panellists expressed their interest in setting-up an International Co-operative Program to perform the needed experiments. Indeed, this would allow an efficient cost sharing and thus optimising the resources.

Conclusion

The recommendations of the workshop can be summarised as follows:

- Investigate the possibility of releasing and evaluating unpublished experimental data (especially the ERASME/S and BFS-49 data).
- Define a framework and method for the selection and performance of new experimental program(s) of interest.
- Help disseminate and assess sensitivity/uncertainty methods.