1 Background and Objectives of the Benchmark

Large sodium cooled fast reactors (LMFR) have the disadvantage of a reactivity increase in case of loss of coolant or sodium density reduction. Typical values for conventional large scale reactors with 1 m fissile height and 3 to 4 m fissile diameter are in the range of 5 to 6 $ when the whole sodium is lost from the fissile zones. Although large margins are available between the peak temperature and the boiling temperature of the sodium coolant, at least a limited amount of sodium boiling cannot be completely excluded. Mechanisms like local flow blockages, fission gas release or cover gas entrainment could cause local void effects with corresponding power transients. Moreover, the sodium void effect (SVE) in conventional LMFRs is a potential source of positive reactivity which may be large enough to drive an unprotected loss of flow accident into a core disruptive accident. Therefore, there is a strong incentive to reduce the SVE and this has motivated a lot of worldwide core optimization studies over the past twenty years.

One proposal has been made at the Snowbird Conference in 1990 [1] in which the upper axial blanket is replaced by a sodium plenum consisting of the sodium filled wrapper tubes. In this case the enhanced axial leakage causes a strong negative reactivity effect in case of voiding which compensates a large fraction of the positive SVE of the core region. The idea of placing a sodium plenum immediately above the core was already proposed thirty years ago [2] for an annular core.

This proposal was again taken up during the specialists' meeting on "Passive and Active Safety Features of LMFRs" [3] in Oarai, November 5-7, 1991. The participants agreed on a benchmark exercise under the auspices of the IWGFR, in which the SVE of the Russian zero void core and other core parameters should be evaluated. The Russian colleagues took over the task of preparing and distributing for comments a definition of the benchmark core.

The first draft of the benchmark specification was distributed by the end of 1991. Comments were collected by the IAEA and the second draft was the basis for a consultancy meeting held at the CEC in Brussels on June 15/16, 1992, where the final version of the specifications was agreed upon [4].

This benchmark is motivated by the specific physics characteristics of the core. Special design features allow for enhanced external leakage which can be accurately predicted only by making use of sophisticated methods. The negative reactivity effect due to the enhanced leakage is largely compensated by the positive spectral component; the resulting near-zero void worth is expected to be particularly hard to predict when making use of conventional methods.

It should be noted that this study only addresses the neutronic consequences of postulated voiding configurations; however, coupled thermalhydraulic/neutronic effects are also important, in particular, sodium boiling transient behaviour has to be assessed to determine the timing and location of local boiling.

The main aims of this benchmark exercise can be summarized as follows:

- to judge under static conditions on the physical feasibility of a near-zero SVE for the benchmark core
- to evaluate the degree of agreement between the different benchmark solutions
- to identify calculational difficulties.

Since it is well known that SVE improvements are usually achieved at the expense of disadvantages for other core performance or safety parameters, the benchmark exercise was extended beyond the frame given by the SVE to several important core design parameters.

This report is to be considered as a compilation of the results of the different contributors. These results were presented during a meeting in Vienna on November 23-25, 1992 [5].

Chapter 2 will first give a list of the participants and chapter 3 will describe the benchmark and the tasks to be performed. In chapter 4 a review of the different methods of calculations is given and the results for the SVE and the other core parameters are compiled in chapter 5.

A summary of the comparison is given in chapter 6, followed by a short discussion of possible items for a continuation of the benchmark.

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