

Advances in the Analysis of Fast Reactor Core and Coolant Circuit Structures

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1. INTRODUCTION

For the 10th SMIRT Conference, it has been decided to make general reviews of the accomplishments throughout the conferences. The aim of this paper is to make such a review in the field of fast reactor core and coolant circuit structures, which is now fully treated in division E. That was not true in the past : at the earliest conferences up to the 5th, the division E dealt with accidental studies among which the hypothetical core disruptive accident was the most important. So, to cover the subject from the first SMIRT to now, it has been necessary to search into all the past division in order to recover the studies fitting into the scope of the present division E. This has allowed a table showing the number of presented papers on the various topics at the SMIRT conferences to be set up (table I).

Then, some significant topics have been studied in detail, highlighting the main accomplishments, but trying also to point out the shortcomings and the work still to be done, in view of the present state of art.

2. HISTORY OF THE SUBJECT

The present division E is concerned with all the mechanical and thermal problems applied to fast breeders reactors. The corresponding topics may be summarized as follows :

- Accidental studies : typically, HCDA (Hypothetical Core Disruptive Accident) and sodium-water reactions in steam generators.
- Core mechanics : core overall mechanical behaviour, core support and boundary structures design and analysis.
- Thermal and thermomechanical analysis.
- Seismic analysis of core, vessels, piping and components.
- Vibrational studies.
- Buckling studies.

- Design concepts, methods and rules.

In the past SMIRT conferences, those topics were dispersed in various divisions. So, a correct history of the subject can only be obtained by a careful review of the papers presented in divisions other than division E of each SMIRT.

1st SMIRT (1971) Berlin

The existing division E was entitled "Shock and Vibrations Analysis of Reactor Components". The subdivision E2 was specially devoted to Fast Reactor Excursion and Containment Behaviour (7 papers) and a paper on the vibrations of Fast Reactor Internals, applied to the Phenix Reactor, appeared in E 4.

Division F, Structural Analysis of Core Support and Coolant Circuit Structures, dealt with some core mechanical studies and Division K, Seismic Response Analysis of Nuclear Power Plant Systems contained one paper on the aseismic design of JOYO, the Japan Experimental Fast Reactor.

2nd SMIRT (1973) Berlin

Division E, with the same title, was more orientated towards the Fast Reactor core accident studies, in the subdivisions E1, E2, E3, with 19 papers.

Division F saw also an increase of papers on fast breeders structural analysis problems ; core structures (6 p.) pipework (2p.) nozzle (1 p.), heat exchangers (3p.). The inelastic analysis of LMFBR vessels was presented in two papers of division G.

No seismic study in the scope of the present division E was presented.

3rd SMIRT (1975) London

Division E was given a new title : "Fast Reactor Accident Analysis", and it expanded to 34 papers, treating the problem of the HCDA in the fuel subassemblies as well as for the primary containment, and beginning to handle the dynamic structural loads produced by large sodium water reactions.

The division F entitled : "Structural Analysis of Reactor Core and Coolant Circuit Structures" contained many studies applied to fast reactors : internal structure vibrations (6 p.), piping analysis (5p.) and heat exchanger design (3 p.).

Two fast reactor vessel analyses were presented in division G, and two seismic analyses in division K. The core mechanical studies were treated in division D with three papers of interest for us.

4th SMIRT (1977) San Francisco

Division E was still in extension with the same scope (48 papers) among which more importance was given to large sodium water reactions (8 p.).