7. CONCLUSIONS AND RECOMMENDATIONS

A large amount of work has already been performed in the framework of seismic analysis of fast reactor block components and piping. This work consisted of the development of advanced numerical techniques and wide-ranging experimental programmes, which covered all the items necessary for demonstrating seismic safety.

Although adequate methodologies to demonstrate fast reactor seismic safety exist, further improvements are necessary for the future reactors, in order to achieve a better knowledge of some physical phenomena, and thus to allow more realistic, less conservative, criteria and techniques to be adopted. The aim is a general improvement of the design, that may result not only in a decrease of plant costs, but also in a further increase in the overall reactor safety. In fact, the use of over-conservative criteria and methods, beside the cost consideration, could be detrimental for the performance in normal operation and often complicates the safety demonstration of design bases accidents which are more frequent than the earthquakes.

Further R & D work is necessary on fluid-structure interaction in general, sloshing and buckling phenomena, core behaviour and pump analysis. Studies should be done to understand how to exploit ductility margins in some components. Also the PRA methodology should be improved and applied in particular to the beyond design earthquake. Finally, on-site test techniques should be improved and applied.

The needs, problems and benefits, of new design solutions, that are capable of substantially reducing the earthquake effects, such as seismic isolation should be studied in depth.

The development and application of advanced seismic monitoring systems, capable of providing a detailed description of the reactor seismic behaviour in the time and frequency domains, is advisable.

Finally, it is noted that the adequate application of the improved methods and design solutions to the future fast reactors requires rationalization of the criteria used for defining seismic input (especially for the OBE) and the use of more reliable ground acceleration

data. In particular, a better knowledge of vertical acceleration component should be achieved, together with that of the long-period waves (these are of fundamental importance in the case of seismically isolated structures).

In conclusion, following recommendations are made: -

- The criteria for definition of seismic input should be rationalized;

- To improve the design criteria and methods further R & D work should be carried out, from both the numerical and the experimental points of view, on the following topics:

  . soil-structure interaction,
  . fluid-structure interaction,
  . sloshing phenomena,
  . buckling phenomena,
  . core seismic behaviour,
  . pump seismic behaviour,
  . strain criteria - ductility margins,
  . PRA methodology;

- On-site test techniques should be improved and applied to verify the actual dynamic behaviour of structures and components;

- The benefits, needs and problems of new design solutions (e.g. seismic isolation), which have a large potential to reduce the effects of earthquakes event on the reactor design should be studied;

- Advanced seismic monitoring systems which provide detailed information on the reactor excitation and response, should be adopted;

- The exchange of information and the existing international co-operation, mainly in the field of the R & D studies, should be enhanced.