

## Significant Structural Design Features of Commercial-Sized Liquid-Metal Breeder-Reactor (LMFBR) Plants

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### SUMMARY

From a structural design point of view there are many significant differences between liquid-metal cooled fast-breeder reactor (LMFBR) plants and light water reactor (LWR) plants. This is particularly true of the area containing the nuclear steam supply system.

External loads involved in the design of an LMFBR plant -- such as tornadoes, wind, floods, seismic -- are, of course, quite similar to those used in LWR plants. What differs is the response of the LMFBR plant to some of these loads. For example under seismic conditions there are marked differences in the response of an LMFBR plant as compared to a LWR plant. This is due primarily to the use of thin-walled vessels and piping and also rather large diameter reactor vessels in an LMFBR plant.

Another major difference is the nature and consequences of design basis accident (DBA) loading conditions. DBA scenarios in a LWR plant create certain sets of loading conditions which usually result in the sudden release of high pressure energy. In most cases this results in rather high containment pressures (345-415 kPa) which are generally of relatively short duration, since the heat energy is transferred to engineered safeguards such as containment sprays, suppression pools, ice condensers, etc. DBA accident scenarios for LMFBR plants may result in the release of sodium into an air environment thus producing a sodium fire. This fire is self-extinguishing when the containment oxygen is consumed, and it produces much lower containment pressures (35-70 kPa) than the LWR DBA. The temperature to which the containment boundary is subjected is about the same as in a LWR plant. However, the DBA accident is of longer duration than the corresponding event in the LWR.

Under the DBA conditions LMFBR equipment cell structures in the containment may be subjected to higher temperatures than the containment boundary. This poses two structural problems; first the sodium must be isolated from the concrete to prevent chemical reactions. This can be accomplished with a carbon steel liner. Second, the effects of high temperatures on the structure which bounds the cells must be considered. Similar problems exist in the design of the steam generator building which must accommodate sodium-related accidents. Structural analysis of the effects of sodium-concrete reactions is complicated by uncertainties in rate and extent of penetration and actual damage to the structure. Considerable experimental work is underway to reduce these uncertainties.

A major design choice which must be made for an LMFBR plant is whether to use a loop or pool-type reactor system. A loop system employs individual components (usually located in individual shielded cells) connected with piping. The pool system is characterized by use of a very large primary coolant vessel (about 21 m diameter) which contains the entire primary heat transport system -- reactor, intermediate heat exchangers, and pumps. Each system provides challenging structural problems in design, analysis and construction.

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