7.6.3 Loss-of-Coolant Accident: LMFBRs

Studies of postulated loss of coolant accidents in LMFBRs necessarily begin with the two basic differences between LMFBRs and LWRs. The first and most obvious is that the coolant in the LMFBR (attention here will be confined to sodium coolant) is contained at low pressure and at a temperature well below its boiling temperature. Consequently a primary coolant loop depressurization does not lead to the kind of rapid vaporization that occurs during the initial phase of a LOCA in a LWR. However, the second major difference is that in most LMFBR designs overheating of the coolant in the core that leads to boiling and increased void fraction then produces an increase in the reactivity and therefore increase in the heat generated. Accident analyses and safety systems necessarily take into account these major differences in the reactor designs.

Specifically, boiling and loss of sodium in the core of an LMFBR would cause changes in the reactivity as follows. The sodium would no longer slow down the neutrons and hence there would be proportionately more fast neutrons. The neutron absorption by the sodium would be absent but this is a lesser effect than the increase in the number of fast neutrons. The net effect is an increase in the reactivity of the reactor giving it a *positive void coefficient* (see section 7.1.2) though, to some extent, this potential increase is reduced by the increase in the flux of neutrons out of the reactor at its *edges*. In most designs this is not sufficient to overcome the positive void coefficient of the bulk of the reactor and the resulting reactivity increase would therefore result in an increase in the core heat production. This is in contrast to the LWR response and means that a LOCA in an LMFBR could have more serious consequences and could more readily result in a core meltdown. This is the reason for a focus on the *hypothetical core disassembly accident* discussed below. It is, however, valuable to point out that there have been efforts to redesign an LMFBR core in order to achieve a negative as opposed to positive void coefficient. One way this could be done would be to change the geometry of the core and the blanket so that the negative effect of an increased leakage of neutrons as a result of the voidage more than negates the positive void effect in the bulk of the core (Wilson 1977).

The most likely scenario for a LOCA in an LMFBR is considered to be a blockage in one of the core coolant channels that leads to overheating in that channel, to boiling and to increased void fraction in the core coolant. With a positive void coefficient this might lead to escalating temperatures and to possible melting of the cladding of the fuel rods. While this series of events could be avoided by prompt reactor shutdown, nevertheless the consequences of such a cladding melt have been exhaustively analyzed in order to understand the events that might follow. The conceivable scenarios are termed *hypothetical core disassembly accidents (HCDA)* and, within that context, it is possible that a *vapor explosion* or a *fuel coolant interaction (FCI)* event might occur. These phenomena will be discussed in the sections that follow.