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USE OF RPV THERMOCOUPLES FOR ACCIDENT MANAGEMENT

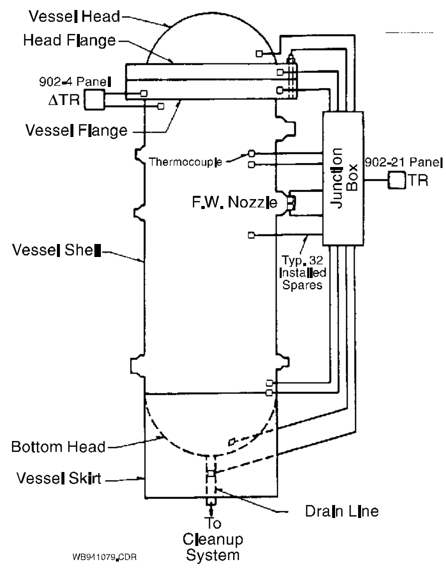

Figure 1

In assessing accident management (A.M.) strategies for severe (i.e., core damage) accidents, attention should first be directed towards existing reactor coolant system instrumentation, and the information it provides. All available instrumentation should be reviewed to assess their applicability to severe accidents and to identify the types of information they can provide regarding accident progression. Instrumentation not normally considered vital to the reactor coolant system may provide useful data.

Thermocouples typically provided on the outer surface of a BWR reactor pressure vessel (RPV) are a case in point. These thermocouples, as shown in Figure 1, are positioned on the vessel head and flange, along the RPV wall including the feedwater nozzle, and on the vessel lower head. The thermocouples normally provide data on the various vessel sections to control the rate of vessel cooling or heating during shutdown or startup. These thermocouples are used to ensure that the stresses between RPV sections are maintained within allowable limits. The use of these instruments is not required for Design Basis Accidents, primarily because reactor vessel water level instrumentation would directly indicate whether the core is uncovered. However, during the progression of an event with inadequate ECCS injection, water level will eventually drop below the narrow range monitors, at which point the core water level can still be determined through the wide range monitors.

The RPV thermocouples can supplement water level measurements by providing insight into the core configuration. To this end, a station blackout (SBO), a small LOCA, and a large LOCA were investigated using the advanced severe accident code MAAP 4.0. The upper head, upper vessel wall, lower vessel wall, and lower head were modeled using a 5 x 5 node structure. The outer node was used to represent the response expected by the RPV thermocouple. For both the small LOCA and SBO a linear increase in surface temperature was observed between the times of core uncovery and core relocation. This temperature rise was felt by both the upper head and upper vessel wall, as illustrated in Figure 2 for the upper head temperature.

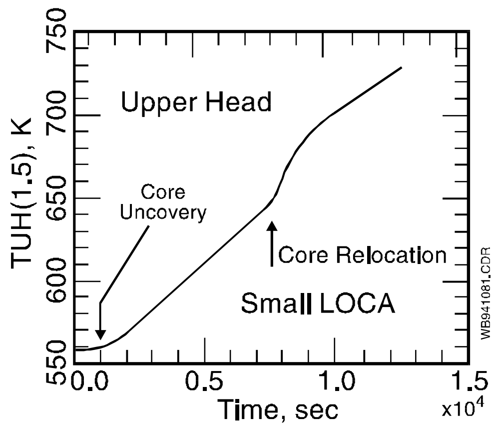

Figure 2

The magnitude of the temperature rise is not so important as is the trend. During a severe accident, loss of the narrow range level monitors coupled with a linear increase in the upper vessel head and wall temperatures would provide indication of the extent of core melt progression.

Unlike the small LOCA and SBO, results for the large LOCA indicated that the melt progression was too rapid to result in RPV heatup significant enough to demonstrate a trend for the thermocouples to track.

The thermocouples in the lower vessel wall and head can play a valuable role in monitoring the integrity of the lower head following core relocation. For example, an increased wall heatup rate is evident following core relocation. The RPV temperature history provides insight on the potential success of A.M. strategies such as external cooling of the RPV. Although the temperature could eventually exceed the capability of the thermocouples, this maximum value is expected to be high enough to allow an accurate conclusion regarding lower head integrity.

FAI has performed detailed studies of RPV instruments relative to their A.M. applications. We welcome the opportunity to discuss these results with you further.

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