19.5 Source Term Sensitivity Studies

19.5.1 Core Melt Progression and Hydrogen Generation

Analysis was performed using MAAP to determine the effects of additional hydrogen generation due to oxidation of zirconium (Subsection 19E.2.6.1).

The core melt progression used in MAAP assumes that corium blockages in the channels are formed as the channels melt. This prevents steam from flowing past the fuel in the later stages of the core melt progression. This starves the upper region of steam and thus limits the metal water reaction. Further, MAAP assumes that no metal water reaction can occur once the corium reaches the eutectic temperature of the fuel. For these reasons, MAAP predicts less metal water reaction and, consequently, less hydrogen generation than do other models.

In order to investigate the response of the ABWR to an increase in the amount of hydrogen generated, four sensitivity studies were performed: two with vessel failure at low pressure and two with vessel failure at high pressure. In all four studies, MAAP was run with both the blockage and eutectic cutoff models disabled.

For the low pressure melt sequences, the rate of zirconium oxidation increased from 6.3% of the active cladding to 15.8%. The increase in the metal-water reaction caused the time of vessel failure in both cases to decrease from 1.8 hours to 1.1 hours. For the dominant case with the Firewater System operating, the rupture disk opens at 30.6 hours as compared to 31.1 hours for the base case. The time of rupture disk opening decreased from 20.2 hours to 16.7 hours for the case with passive flooder operation. The change in the magnitude of fission product release for both cases was negligible.

In both high pressure melt sequences, the fraction of active zirconium oxidized increased from 5.1% to 35.9%. The increased hydrogen generation reduced the time to rupture disk opening from 25.0 to 19.7 hours for the high pressure case with passive flooder actuation and RHR spray. The change in fission product release for the case was negligible.

For the less likely case with passive flooder activation only, this resulted in an 11 hour decrease in the elapsed time (from 18.1 to 7.1 hours) to the onset of fission product leakage from the drywell. Additionally, the magnitude of the CsI release fraction at 72 hours increased from 8.7% to 12.5%.

19.5.2 Not Used

19.5.3 Alternate Definition of Containment Failure

In this PRA, containment failure has been interpreted to mean failure of the containment function. For calculational convenience, this has been taken to be doses greater than 0.25 Sv at 0.8 km (0.5 mile). It has been shown that the ABWR can meet the goal of 0.1 conditional containment failure probability (CCFP) using this definition (Subsection 19.6.8.3).

The NRC staff has proposed an alternate definition of containment failure, one independent of source term:

> “Containment failure occurs when its integrity as a pressure boundary can no longer be controlled.”

This definition recognizes the containment function by permitting normal leakage as well as acknowledging credit for suppression pool scrubbing in conjunction with a “last resort” controlled release path, while properly accounting for postulated gross structural failure.

Based on this pressure integrity definition, a new conditional containment failure probability, designated CCFP-PI, can be found. The ABWR meets the containment performance goal regardless of the definition of containment failure.