5-6 Verified Effectiveness of Pressurized Water Reactor Severe Accident Management
—Even When Break Is at the Worst Location in PWR Primary Coolant System—

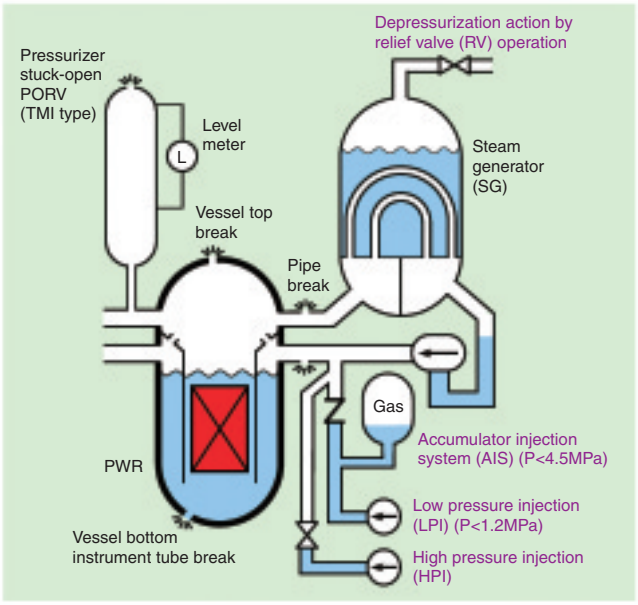

Fig.5-11 Simulated AM measures for various PWR/LOCAs
Various LOCA tests were conducted at LSTF, the world's largest plant simulator with the same height and 1/48 volume of a 3423 MWt PWR, to examine the effectiveness of accident management (AM) measures if there is severe loss of coolant. In case of HPI total failure, it is important for operators to depressurize the primary coolant system by opening SG relief valves (RVs) to activate the AIS and LPI system. The tests verified the effectiveness of this AM measure even in a LOCA caused by vessel bottom break which is the worst break location. A code analysis also confirmed the effectiveness.

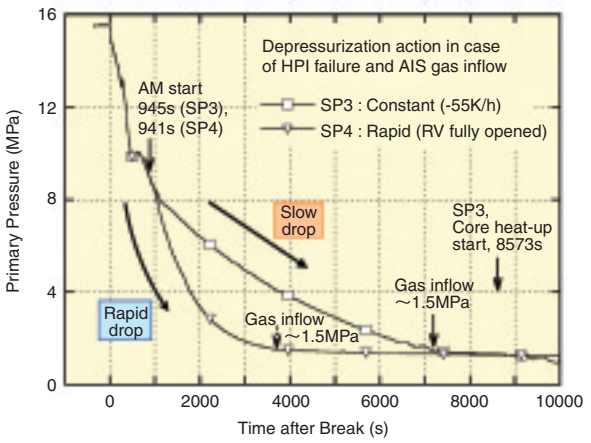

Fig.5-12 Core cooled by rapid-depressurization after bottom breakage with HPI failure and gas inflow

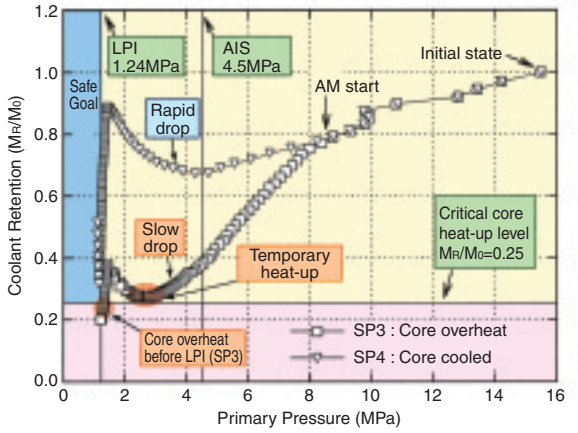

Fig.5-13 P-M map display useful for PWR/LOCA detection
This shows the difference in retained coolant in two tests of different AM actions (SP4 achieved the goal).

Pressurized water reactors (PWRs) are most common type of nuclear power plants in the world. The ROSA-V program has conducted small break loss-of-coolant accident (SBLOCA) tests with a break at various locations in the Large Scale Test Facility (LSTF) to study coolant behavior and to improve analysis code capability.

Following a study on effectiveness of accident management (AM) measures for SBLOCAs at the primary loops, we verified effectiveness of AM measures for SBLOCAs at the reactor vessel bottom caused by instrument tube nozzle failure (Fig.5-11). An indication of coolant leakage around two instrument tubes was newly found at the South Texas Project reactor in USA, and effectiveness of AM measures during a bottom break LOCA became one of priority issues of the OECD/NEA ROSA project initiated by JAEA in 2005.

We conducted two tests of vessel bottom break equivalent to a 0.2% cold leg break with total HPI failure and gas inflow from the AIS tanks taking different SG depressurization actions. Fig.5-12 compares their primary pressure transients and shows that the rapid depressurization in SP4 test achieved adequate core cooling irrespective of the gas inflow while a slow and constant cooling rate at -55 K/h in SP3 test resulted in core heat-up. A reason for these different core cooling results is clear in the Fig.5-13 chart showing dependence of coolant retention on primary pressure. In the SP4 test the conditions for LPI actuation were achieved maintaining coolant amount over the critical core heat-up level by the rapid depressurization, while coolant in the SP3 test decreased to the critical level, the larger coolant discharging due to higher pressure than in the SP4 test.

Reference

Suzuki, M. et al., Effects of Secondary Depressurization on Core Cooling in PWR Vessel Bottom Small Break LOCA Experiments with HPI Failure and Gas Inflow, Journal of Nuclear Science and Technology, vol.43, no.1, 2006, p.55-64.