Summary of Results of the DISCO-C Experiments

Several stages take place during the blowdown process at the breach in the lower head: single-phase liquid flow, two-phase flow after the blowthrough and single-phase gas flow, choked and subsonic. The time duration of all these periods depends on the failure mode, the initial pressure and the amount of liquid.

Dispersed melt enters the compartments in two different flow structures:

1. Liquid rivulets or drops resulting from the fragmentation of the liquid film are driven up the cavity walls into the compartments. These drops have larger diameters and lower velocities.

2. Drops are entrained by the gas due to the shearing force existing between gas and liquid film in the annular gap. These drops are carried out of the reactor pit and along the main coolant lines into the compartments by the gas. They have higher velocities and smaller diameters. Large holes and high pressures lead to a spray [4].

With **holes at the base of the bottom head,** the most important parameters governing the dispersion of melt are the hole size and the burst pressure. Practically no liquid remains in the RPV. Dispersal rates higher 50% can be observed even at pressures below 1 MPa with both liquids, water and metal. An almost constant amount of liquid is found at the RPV support, if the liquid reaches this position. The dispersed fractions are lower with metal than with water, but still high. The results concerning the dispersed fractions could be correlated by the Kutateladze number $Ku = \rho_G u_G^2 / (\rho_L g \sigma)^{1/2}$, with u_G, the maximum gas velocity in the annular space around the RPV, for all hole sizes, both driving gases, nitrogen and helium, and both liquids, water and Bi-alloy, with $f_d = 0.4 \log_{10}(Ku) \leq 0.76$. The Kutateladze number represents the conditions to levitate droplets against gravity. No sharp threshold velocity or pressure could be found, below which no dispersion occurred. From the similarity correlations we can deduce that the results from the liquid metal tests represent the lower bound for the dispersed melt fractions in the reactor case. Thus, if the ejected melt fraction has to be less than 10%, the pressure at failure must not be higher than approximately 0.5 MPa and the hole diameter not bigger than 0.5 m, unless the cavity is specially designed for trapping the melt. This statement pertains to large melt masses and failures in the lower part of the bottom head.

With lateral breaches the liquid height in the lower head relative to the upper and lower edge of the breach is an additional parameter for the dispersion process. In most cases not all the liquid is discharged out of the RPV. Shifting the break from the central position towards the side of the lower head leads to a smaller dispersion of liquid, even if the dispersed fraction is related only to the liquid mass that has been ejected out of the RPV. The main effect is probably the circumferential component of the velocity in the cavity. If the initial liquid level is above the upper edge, the blowdown starts with the single-phase liquid discharge, driven by the pressure difference between vessel and cavity, as for central holes. However, the gas blowthrough occurs earlier than with central holes. In the subsequent stage the liquid is carried out of the lower head by entrainment. The gas velocity, the density ratio of gas and liquid, the surface area of the liquid pool, and the duration of the blowdown govern this entrainment process. Therefore, the entrained liquid fraction can be higher with a small breach than with a large one, because the blowdown time is longer while the maximum velocity may be the same. Also the fraction of melt dispersed out of the reactor pit may be larger with smaller lateral breaches than with very large ones as with dropping of the whole lower head.