Main results of the bundle test QUENCH-10 on air ingress

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The main objectives of QUENCH-10 test are following: an intensive oxidation of the bundle before the air ingress (around 600 micrometers of oxide scale at the upper end of the heated zone), the rapid bottom flooding of the bundle by water (~50 g/s) and the examination of oxidation and nitride formation of Zircaloy during air ingress. Four new special instrumentation features were used during this experiment: controlled synthetic air input, aerosol measurement, helium-filled rods and pressure control for annulus shroud/cooling jacket. The time scheme includes the following phases: facility stabilization, transient, pre-oxidation by steam, cool-down, air ingress and quench. Presentation comments a large amount of experimental results: bundle temperature evolutions at various locations and elevations in the bundle focusing on the air ingress phase, axial temperature profiles at the end of the pre-oxidation phase and at the quench initiation (maximum temperature at 950 mm and 850 mm, respectively) , the distribution of the oxide layer thickness on the withdrawn two corner rods (before air ingress and flooding), the evolution versus time of the water injection and steam generation (the maximum water level reaches 1.3 m), the hydrogen release (total of 53 g), the mass spectrometer measurement of N_2 and O_2 after air ingress and their balance between the injected and consumed amounts. The post-test analysis of powder collected on off-gas pipe bottom as well as some post test views of the degraded bundle focusing on nitride formation and various oxide scales (dense and porous) are discussed.

No melt relocation in the bundle was observed: the long term oxidation during the pre-oxidation phase (steam exposure) leads to negligible melt formation during the temperature escalation and the quench phase.

The dense and porous oxide layers were observed: the dense oxide was formed during the pre-oxidation whereas the porous one was due to the re-conversion of nitride into oxide and void (indeed nitride phase was found at the interface between these both oxide layers).

The MELCOR code reproduces fairly well experimental results before the air ingress phase (that means during the pre-oxidation phase) but fails simulating the air-ingress phase - some improvements are necessary on the modeling of oxidation by air ingress.