Simulation of PARAMETER SF4 experiment with MAAP4.07

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In a nuclear power plant, a severe accident is an unlikely event that may lead to core damage

and fission products release in the environment. In the situation of a reactor pressure vessel (RPV) failure, a potential danger is an air ingress. Air is a highly oxidizing environment that can potentially lead to an enhanced fission product release, that is why it is important to model correctly the kinetic of cladding oxidation by air. PARAMETER SF4 test is designed to study the air ingress issue in severe accident. It was used to validate air oxidation models available in MAAP4.07 that have been implemented according to literature.

The Zircaloy steam oxidation law used for PARAMETER SF4 modelling is Cathcart and Urbanic, as recommended by the scientific community. The zircaloy air oxidation law is called NUREG. It was taken from the “*Review of the technical issues of air ingression during severe reactor accidents*”. In this report, Powers established three correlations for different temperature regimes. For this modelling, the bundle is composed of four channels : the central rod for the first channel, 6 rods for the second one, 12 rods for the third one and 12 peripheral rods for the last channel.

For the validation of MAAP4.07 against PARAMETER SF4, the pre-oxidation phase under steam atmosphere is considered to check approximately rod temperature and hydrogen production. The initial conditions before air ingress are thus well estimated.

During air ingress, the hot point seems to have moved in a lower part of the bundle, in comparison with the steam phase. This is maybe due to an early melting of the bundle and its relocation in a lower part. Thermocouples failure during this air phase renders a precise analysis difficult. This hot point relocation is not reproduced with MAAP4.07, in which the hot point is still at about 1150 mm height. Furthermore, for the post-breakaway regime, no acceleration in the temperature escalation in the overall bundle is modelled, which is due to the use of parabolic laws. Oxygen starvation is predicted 200 s earlier in the modelling than in the experience, which is a quite good approximation.

These different results underline the need for improvements, especially in the modelling of breakaway and post-breakaway regime.