Assessment of Core Status of TEPCO's Fukushima Daiichi Nuclear Power Plants (64) Validation of SAMPSON/DCA creep model against OLHF experiments

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During a severe accident, temperature profile on the lower head is very important in determination of failure time. For this reason a new model is implemented in SAMPSON code to take in account of temperature profile in time-to-failure calculation. New model failure time prediction is around 20% more accurate than the previous model and also can predict deformation of the vessel during the accident.

Keywords: SAMPSON, Severe Accident Code, Lower Head Failure, Creep Models

1. **Introduction:** In the Debris Cooling Analysis (DCA) module of the severe accident code SAMPSON, the existing lower head failure model is based on constant mechanical stresses on the thickness, Larson-Miller parameter and damage function for creep evaluation. This model does not take into account the temperature profile in the stress distribution, which is a very important effect, because the outer surface that is colder than the inner surface, can increase total resistance of the lower head. To evaluate contribution of temperature profile, a new model was implemented in SAMPSON, based on non-uniform thermomechanical stress distribution on the lower head thickness and on failure-by deformation criteria and validated against the OLHF experiments.

2. **Results:** In the simulation an increasing temperature of 12K/min is imposed on the inner surface of the lower head and on the outer surface is imposed a natural convection plus a radiative heat exchange with the environment at 300 K. In the experiment, at failure time, the inner temperature of the lower head was 1440 and 1724K with a ΔT of 220K and 500K, while the inner temperature was 1503 and 1775K with a ΔT of 310K and 490K respectively for OLHF-1 and OLHF-2. Calculated time-to-failure with the default model is respectively 12 minutes earlier for OLHF-1 and 29 minutes earlier for OLHF-2 compared to the experimental values, while the newly implemented model calculates the time-to-failure with around 20% more accuracy. Moreover the model is able to calculate deformation of the vessel that can be useful in analysis of penetration ejection. Differences with the experimental deformation of the lower head bottom are around 1-2 cm for both the simulation.

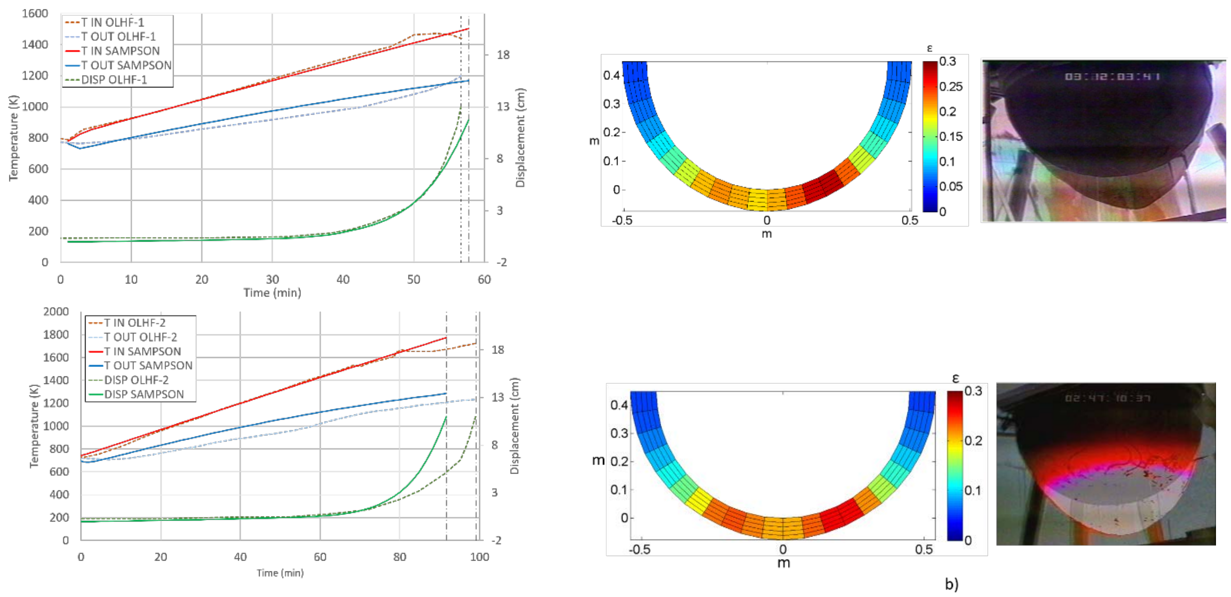

Figure 1 comparison of lower head deformation and temperature with experimental data up) OLHF-1 down) OLHF-2

3. **Conclusions:** Comparison of the two models show that in the analysis of thermomechanical resistance of lower head vessels is very important to take in account thermal gradients present on the vessel wall, especially when creep become the dominant effect in the deformation and failure time at low pressure. Calculated time-to failure and lower head deformation show a good agreement with test data and analysis capability of the model are confirmed.

References

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