Analysis of hydrogen combustion hazards for ITER subsystems in case of loss-of-vacuum accidents

Thomas JORDAN

The fully mechanistic and self-consistent analysis procedure for reactive flows developed and validated at the Forschungszentrum Karlsruhe is explained. With the help of this simulation toolset the risks from hydrogen and dust combustions in the relevant ITER accident scenarios are quantified and possible mitigation measures may be introduced, which help to limit these risks to acceptable levels. For example, the analyses of loss of vacuum (LOVA) scenarios are presented for main ITER components: vacuum vessel and three further modules, namely the cryo pump, the heating neutral beam (HNB) and the diagnostic neutral beam (DNB).

The combustible hydrogen air mixtures can develop in all of these sub-modules during LOVA scenarios. However, fast burning regimes with relatively high pressure effects develop only in slow air ingress events which are characterised by a pressure rise rates of 1.5 mbar per second.

Only for the first 20 s detonation hazards with peak pressures beyond the static design pressure are observed. Later only deflagrations may develop. Applying these loads in structural analyses the following conclusions are drawn. The analysed vessel and sub-modules seem to be well designed and the selected scenarios do not pose a threat to the structural integrity of the cryo pump, the HNB, and the DNB. Therefore a release of radioactive inventory can be practically excluded.