Progress of IRSN R&D on ITER safety assessment

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Abstract:

The French "Institut de Radioprotection et de Sûreté Nucléaire" (IRSN), in support to the French "Autorité de Sûreté Nucléaire" (ASN), is now analysing the safety of ITER on the basis of ITER Fusion facility safety file. The operator delivered this file to the ASN as part of its request for a creation decree, legally necessary before building works can begin on the site. The IRSN first task in following ITER throughout its lifetime is to study the safety approach adopted by the operator and the associated issues.

A multi-year R&D program has been set up in 2007 to support this safety assessment process. Its main objectives are to identify the key parameters for mastering some major risks involving complex phenomena and to perform some verifications with methods independent from the operator's ones. Priority has been given to three technical issues: simulation of accident scenarios, risk of gas/dust mixtures explosion, and tritium behaviour. For the two first fields, this work takes the maximal benefit of the very large experience accumulated by IRSN on safety of fission reactors since many years, as well from the knowledge as for the methods, tools and simulation codes.

For the first issue on simulation of accident sequences, the ASTEC system code, developed by IRSN (jointly with its German counterpart, the GRS) for severe accidents in Pressurised Water Reactors and now considered as the European reference code, is being adapted to the ITER conditions, in a first stage for accidents caused by water or air ingress into the vacuum vessel (VV) where most of its physical models are already applicable. The following model developments have been performed: oxidation of VV first wall materials by steam or air, and transport and oxidation of dust particles. The validation results on the ITER-specific ICE and LOVA Japanese experiments on respectively water and air ingress events have shown a good agreement on thermal-hydraulic aspects. Other model improvements are planned in the next years, as feedback from the conclusions of the technical issues below.

The second issue concerns the risk of explosion of gas/dust mixtures in the ITER main volumes (VV but also the neighbouring volumes), due to concentrations of hydrogen and carbon monoxide produced by wall materials oxidation and to the dust resuspension and transport. The first results of the corresponding R&D programme on experiments and simulation codes are described in another IRSN paper presented at the SOFT conference (A.Bentaib et al.).

The third issue concerns the behaviour of tritium released from the pressure suppression system compartment or from any other building. The objective is to evaluate the efficiency of the diverse processes foreseen for detritiation, either in the VV or in the other rooms, in relation with the ventilation systems. In a first stage, analyses using thermo-chemical tools have been performed on tritium speciation during transport in the gas phase of cooling circuits and during trapping in the liquid sumps in the neighbouring volumes or buildings. In a second stage, experiments will be defined in IRSN existing facilities to evaluate the most influent factors on detritiation (humidity, oxidation, etc...).

After the analysis of the ITER safety file, this R&D global programme could be reoriented in accordance with the safety issues.

Keywords: ITER, safety, ASTEC, scenarios, dust, hydrogen, tritium