IRSN developed the DRACCAR computer software in support of the safety analysis of pressurised water reactors (PWR). This software simulates loss-of-coolant accidents (LOCA) such as the loss of coolant in the reactor core or in a spent fuel storage tank. During the course of such an accident, the coolant vaporises and the fuel rods dry out, which leads to an increase in their temperature, to cladding swelling and failure. This swelling could be responsible for major blockage in part of the core and thus can prevent the back-up systems from cooling the core.

Objectives

The 3D multi-rod software is designed to model a fuel assembly so as to assess rod cooling and the blockage rate caused by deformed rods, by taking into account mechanical and thermal interactions between rods. The software can:
- Provide a consistent interpretation of the entire experimental database for a « single-rod » configuration or a « rod-bundle » configuration with either real or simulator fuel;
- Transpose onto a reactor scale the phenomena involved, using validated models in experimental data, in order to determine what kind of research still needs to be conducted;
- Carry out safety studies.

Models

The models developed for this software cover:
- Heat transfers by conduction, convection and radiation;
- Oxidation of cladding and Zircaloy guide tubes, as well as hydriding which can change mechanical properties;
- Thermomechanical behaviour of cladding (deformation and failure), including bowing;
- Thermal-hydraulics on the scale of an assembly (to couple with appropriate software), including a reflood model;
- Fuel relocation and release of fission gases.

Validation and future developments

A first version - DRACCAR V1 - was delivered in March 2008 and validated on the basis of available experimental data (EDGAR, PHEBUS LOCA, PERICLES, REBEKA, HALDEN, etc.). A second version (V2) will be available some time in 2012 and will be coupled to the numerical simulation platforms PLEIADES and NEPTUNE developed in partnership with the CEA, EDF and IRSN.

Scientific community and collaborations

This tool is developed in partnership with EDF and is integrated since 2009 into a European platform of the 7th FP. It will benefit from a high-level scientific environment thanks to various collaborative agreements with research organisations such as the CNRS Laboratoire d’Energétique et de Mécanique Théorique et Appliquée (Nancy), and the Institut de Mécanique des Fluides (Toulouse) for the local-scale development of models which will be integrated into the next version of the software (V2).