

Validation of thermal hydraulic codes for fusion reactors safety (P3-J-206)

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A significant effort has been done worldwide on the validation of thermal hydraulic codes, which can be used for the safety assessment of fusion reactors. This work is an item of an implementing agreement under the umbrella of the International Energy Agency. The European part is supported by EFDA.

Several programmes related to transient analysis in water-cooled fusion reactors were run in order to assess the capabilities of the codes to treat the main physical phenomena governing the accidental sequences related to water/steam discharge into the vacuum vessel or the cryostat. The typical phenomena are namely the pressurization of a volume at low initial pressure, the critical flow, the flashing, the relief into an expansion volume, the condensation of vapor in a pressure suppression system, the formation of ice on a cryogenic structure, the heat transfer between walls and fluid in various thermodynamic conditions.

- A benchmark exercise has been done involving different types of codes, from homogeneous equilibrium to six equations non-equilibrium models. Several cases were defined, each one focusing on a particular phenomenon.
- The ICE (Ingress of Coolant Event) facility has been operated in Japan. It has simulated an in-vessel LOCA and the discharge of steam into a pressure suppression system.
- The EVITA (European Vacuum Impingement Test Apparatus) facility has been operated in France. It has simulated ingress of coolant into the cryostat, i.e. into a volume at low initial pressure containing surfaces at cryogenic temperature.

This paper gives the main lessons gained from these programs, in particular the possibilities for the improvement of the computer codes, extending their capabilities. For example, the water properties have been extended below the triple point. Ice formation models have been implemented. Work has also been done on condensation models.

The remaining needs for R&D are also highlighted.