

Methodology for the Analysis of Consequences of Pipe Rupture

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The design of nuclear power plants takes into account protection against consequences of high energy piping rupture. They can be an unacceptable deformation of components of the reactor coolant system or the collapse or the rupture of other safety pipings or supports and the collapse of containment.

If the consequences of free whipping are unacceptable, prevention against pipe rupture is obtained by placing pipe restraints to limit pipe movements. In all the cases, consequences on components, supports and structures must be quantified. For this purpose, a methodology has been developed which take into account the blowdown characteristics, the pipe whip behaviour, and the impact on different targets-restraints, supports, walls, containment, ... -including energy dissipation by local deformation during crushing.

This methodology is based on the two following points :

- An extensive experimental work which includes pipe whip tests and determination of static and dynamic crushing properties for different piping components and configuration.
- Computer codes which simulate the non-linear materials and geometrical dynamic behaviour of piping during whipping and during crushing on a target. Those computer codes are qualified in different configurations by the experiments which were successfully numerically simulated.

Test results and codes capabilities allow us to take into account in a more realistic way the pipe whip behaviour including the modelisation of pipe crush either by a simplified model or by a refined analytical model depending on configuration.

Examples of application on actual plants are presented. They show, particularly, that taking into account local crushing of the impacting pipe component can decrease the applied load on restraint or on adjacent structures, and in some cases they can lead to the suppression of unnecessary restraints.