framatome

Large scale 3D fire simulations

Performance of safety analyses relying on detailed modelling of large scale, complex geometry buildings

These safety analyses enable assessing the necessity to perform upgrade work inside the buildings in order to comply with new regulations related to fire protection of nuclear grade buildings.

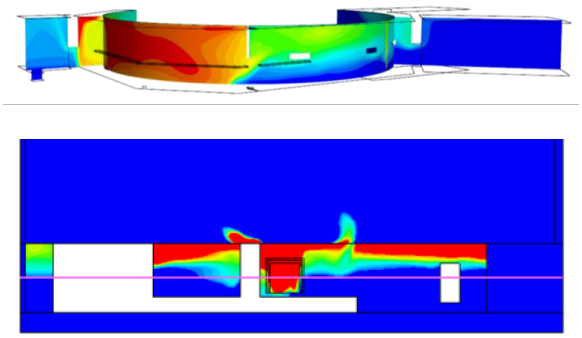
Challenge

Demonstration of fire resistance of existing nuclear buildings can be difficult when those buildings were designed using former safety referential.

In some cases, this requires that utility commits to perform maintenance or upgrade works which can be expansive both in terms of resources and of building availability.

In addition, building the safety justification file itself requires a significant amount of time and money, especially in a changing regulatory environment.

Finally, the Emergency Response Plan and the definition of fire response means are greatly improved by a detailed knowledge of the behavior of the installation during the fire scenario.



Location of high temperatures during a fire inside a reactor building

Solution

Performance of fire safety analyses including advanced 3D modelling :

- Enables to identify risks and envelope scenarios (in terms of thermal, mechanical aggressions etc.)
- Delivers a robust and licensable safety demonstration.
- Includes fine 3D models of buildings, which rely on robust solutions that enable to represent large scale buildings of complex geometry for which simplified approaches such as zone codes are unsuitable.
- Is grounded on Framatome's scientific software suite, including their validation files.
- Enables predicting the evolution of temperature and of velocity pattern of hot gases, without introducing in a best estimate way.
- Enables precise assessment of fire consequences on safety targets:
- Key equipment for asset protection
- Fire propagation risk
- Brings through innovative 3D approach large margins in safety justification files, enabling to limit the work to the strict minimum required for safety.

Customer benefits

Our experience feedback acquired in the field of complex physical phenomena enables us to guarantee :

- Less conservative results, closer to reality
- Less, more simple and smaller upgrade works to be performed inside the buildings
- Les operational constraints (less stringent fire protection rules)
- A better understanding a priori of fire behavior for a better crisis management when it comes to it

Your performance
is **our** everyday **commitment**

Technical information

Large scale fire simulations are based on fluid 3D flow computation techniques called « CFD » for Computational Fluid Dynamics. Framatome has developed a computation method (2MF3D) enabling to precisely simulate fires in any building.

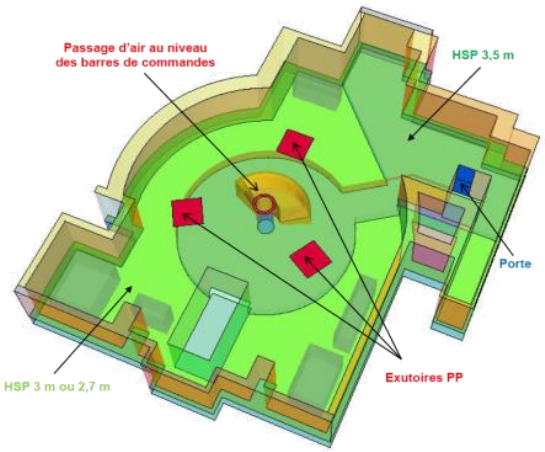
This method, based on standard and validated tools, enables quick performance of computations despite a high level of details in a large volume.

To achieve this, the geometry of the building is discretized in millions of elementary cells. Then, transient computations are performed on machines including hundreds of CPUs. Massive parallelization, together with Framatome know-how, enables to obtain a result quickly while relying on a high level of details, which is essential for an accurate result.

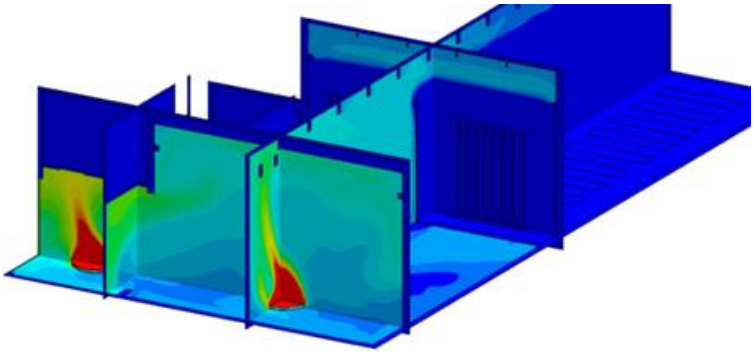
The fact that analyses are performed in 3D enables to limit and precisely localize the temperature peaks, which is not possible with legacy methods..

This computational approach has been successfully benchmarked with several scale 1 tests and has been approved by the French regulatory body (ASN) and its technical support (IRSN) in the frame of the instruction of several safety files.

The data required to perform the analysis are derived from the standard fire analysis : building geometry and accidental scenario.



3D reactor building modelling and associated results (location of high temperature zones)



Temperature field during a fire of a fuel assembly storage facility

Key figures

Framatome already justified **5 nuclear facilities** with respect to fire safety using this approach.

In all the cases, compared to legacy methods, the use of this new method enabled either to justify that **no upgrade work** was required, or to greatly limit the amount of work.

References

Framatome performed 3D computation based fire safety analysis for its own need as utility (CERCA plant) or as a support for its customers (CEA : reactor building of Phenix plant, EDF : fuel assembly storage facilities or SUPERPHENIX plant reactor building).

These files have been examined or are being examined by IRSN.

Contact: commercial_excellence_IB@framatome.com
www.framatome.com