

Analysis of protection against external hazards ; examples of flooding and climatic hazards

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External hazards originate from outside the plant:

- not possible to act on their causes (e.g. weather)
- external hazards must not constitute a large part of the risk related to the plant.



IRSN (French Technical Support Organization) analyses the protection of nuclear power plants against external hazards.

1 - Characterization of the hazards

Depending on the depth of the analysis, IRSN assesses: the definition of the hazard, the methods for its determination, its determination for each site.

Definition of the hazards includes: identification of phenomena to be taken into account, definition of the parameters that maximize the challenge to plant safety, identification of potential combinations of phenomena or hazards.

For determination of the hazards IRSN evaluates for example:

- statistical methods for calculation of extreme values for water and air T°, sea level, river flow;
- hydrological modelling to estimate extreme water level.

The depth of the analysis must be commensurate with the consequences for safety of the considered hazard. The definition of the appropriate depth is based on expertise in safety analysis and experience feedback

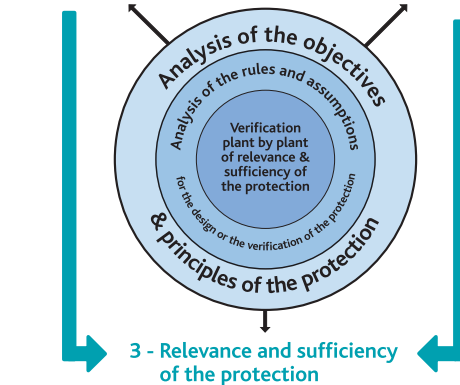
1 - Characterisation of the hazards

2 - Vulnerabilities of the plants

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External hazards may challenge plant safety by different means: unavailability of equipment, unavailability of the heat sink, loss of off-site power sources, isolation of the plant site.

IRSN makes sure that all the effects on the plant are considered including credible secondary effects and combinations with other events in order to ensure that the general safety objectives can be met.



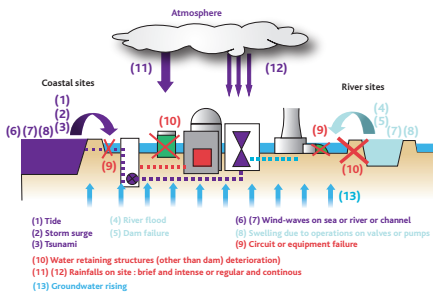
3 - Relevance and sufficiency of the protection

Functions and components required to bring the plant in a safe shutdown state and to prevent and limit radioactive releases must not be inadmissibly affected.

Protective measures against external hazards may be: protection devices and structures, operating measures, maintenance and monitoring measures, emergency procedures.

IRSN analyses that protective measures provides sufficient margins with regard to the vulnerabilities of the plant:

- analysis of civil works and structures for different load cases induced by external hazards,
- thermal calculation to estimate sufficiency of heat exchangers or air conditioning devices for extreme water and air temperature.



Identified sources of flooding

Protective measures are regularly inspected by French Safety Authority with the technical support of IRSN.

Accomplishments

Very low temperatures
(After winter 1985 and 1987)

- analysis of the protection approach from its objectives up to its application,
- evaluation of new low T°,
- assessment of additional protective measures (insulation, heating devices, warning system).

High temperatures
(After summer 2003)

- assessment of the objectives and methodology of protection against high T°,
- reassessment of water and air T° taking into account climatic changes,
- analysis of scenarios and assumptions for thermal calculations,
- ➔ some modifications already implemented (e.g. modification of heat exchangers).

Flooding
(After "Le Blayais" partial flooding in 1999)

- analysis of the new methodology defined by EDF,
- extended analysis of flood phenomena,
- deeper investigations on sites vulnerabilities,
- reassessment of maximum design flood levels,
- systematic review of all protections measures,
- ➔ many modifications and improvements at all sites,
- ➔ revision of the French Safety Rule to integrate recent work.

Participation of experts from IRSN to international works in the fields of hydrology, hydraulics or meteorology,

- ➔ preparation of an IAEA safety guide for the characterization of flood hazards and meteorological events.