

## **Methodology of probabilistic analysis for building structures of nuclear facilities**

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**Abstract:** Probabilistic analysis of building structures has not been generally incorporated in the PSA (probabilistic safety analysis) of nuclear facilities up to the time being. In some countries, such analysis was only performed for seismic actions in a simple manner. The PSA considers normally the systems and components related to the safety of nuclear facilities.

In order to introduce the structural failure into PSA it is necessary to assess the probability of structural failure. Depending on the action different structural failure modes can occur. Therefore it is necessary to take into consideration all possible failure modes for all possible actions and actions combinations. Then the corresponding probability of failure should be determined. This is a complicated engineering-mathematical task which can be solved with the help of methods developed and applied in conventional civil engineering.

The Eurocodes, among others EN 1990 “Basis of Structural Design”, have meanwhile been officially introduced. Although it bases on semi-probabilistic methods, the EN 1990 allows designing special construction works (e.g. nuclear installations, dams, bridges, etc.) based on probabilistic methods if the relevant authority give permission. On the other hand this code gives information for the management of structural reliability of construction works.

A methodology for implementing a probabilistic approach for design and assessment of NPP (nuclear power plant) structures has been developed. Particular aspects such as specific requirements on ultimate resistance and serviceability properties have been implicitly considered and addressed.

The nuclear structures (especially safety related ones) belong to a higher reliability class as the conventional ones. Therefore some design parameters of the Eurocode should be reassessed (e.g. partial safety factors). This is only possible by using probabilistic methods. Requirements on the achievement of a structural limit state are stronger because the nuclear structures belong to higher consequences class.

Some additional actions (e.g. tsunami, aircraft crash, explosion pressure wave) should be taken into account. Normally, they are not considered in the structural design. These actions may cause particular failure modes, e.g. perforation or scabbing. For some specific actions (e.g. aircraft impact) the failure modes are exemplary described.

The consequences of failure distinguish from the ones of nonnuclear structures (e.g. due to radiological release). This has to be taken into account by determination of target reliability. This possibility is provided in EN 1990.

The identified failure modes and its appropriate probability are introduced in the PSA event tree of NPP. Hence they are taken into account for following analysis of safety related structures and components.