Safety Corner

What is Earthquake (Seismic) Risk Assessment?

An explosion at the Fukushima Daiichi Nuclear power plant (NPP) in northeastern Japan following the devastating earthquake and tsunami on 11 March 2011 injured workers, destroyed exterior walls of reactor buildings, and led to release of radioactive materials into the atmosphere.

NPPs worldwide are designed so that earthquakes within the design criteria will not jeopardise safety. The assurance of earthquake safety can be conducted by a deterministic approach using regional or local earthquakes of the highest magnitude, which is represented by deterministic point values, to establish the maximum peak ground acceleration at NPP site, with safety factor, as the design criteria. Because the highest magnitude is either based on historical data or estimated from referenced sources, the deterministic approach has been known for inconsistencies amongst sources of information and with large uncertainties due to insufficient knowledge.

To account for the uncertainties due to insufficient knowledge, seismic probabilistic risk assessments (SPRA), which explicitly accounts for uncertainty by modelling inputs as probability distributions or curves, has been the central tool for proof of safety, more so in countries where the nuclear oversight agency has adopted risk-informed regulations.

A SPRA for NPPs consists of the following steps:

1. Seismicity– determination of how frequently ground motions of various sizes occur at the site;
2. Fragility – determination of the ability of various structures and equipment in the plant to survive earthquakes of various sizes;
3. Plant logic– determination of the effects of various structural and equipment failures on the behaviour of the plant;
4. Initial Assembly – combining the above three types of information into curves showing the likelihood of occurrence of various plant states as a result of an earthquake;
5. Final Assembly – further combination of these curves with the results of the containment model to obtain the likelihoods of various release categories, and these, in turn, with the site specific release consequences model to obtain the final seismic risk curve.

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