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An Intensity-based Comparison of Seismic Hazard Assessment Methods for Critical Infrastructures on the Example of a Nuclear Power Plant

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For potentially hazardous installations like nuclear power plants, a robust seismic design is essential to avoid inacceptable consequences to the environment. A reliable, site-specific hazard assessment provides the basis for a robust design. Different seismic hazard assessment methods (SHA) are or were in use to provide the seismic design basis for operating nuclear power plants. A systematic comparison of different seismic hazard assessment methods was performed on the example of a site-specific hazard assessment of NPP Goesgen. The comparison included the following approaches:
• French SHA (historical deterministic approach)
• German SHA (historical probabilistic approach)
• US performance-based approach (PSHA, SSHAC level 4)
• Swiss interpretation of the SSHAC level 4 approach (hybrid deterministic-probabilistic approach).
It is shown that a technically meaningful comparison of SHA methods can only be performed in terms of macro seismic intensity (here in EMS-98 or MSK-64 scale) because intensity contains the needed information on the physical impact of earthquakes. The use of engineering parameters for a comparison leads to questionable results, because the robustness of the seismic design then depends on the level of sophistication of the engineering design methods (e.g. performance-based non-linear design methods versus force-based linear elastic design methods). The paper demonstrates that the SHA methods used in Europe (French, German and Swiss approach) leads to similar hazard estimates and therefore to a similar seismic design basis for nuclear power plants despite difference in the resulting design spectra as long as an adequate link to the engineering design methods is maintained. The performance-based approach as used in the U.S.A leads to a rather optimistic hazard assessment that does not even reproduce the historically observed seismicity in Switzerland.