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The Effects of Earthquakes on Nuclear Power Plants

[1] Evaluation of corrosion behaviors for reactor pressure vessels/primary containment vessels in Fukushima Daiichi units 1–3 nuclear power plant

Kaneko, Tetsuji, Norihiko Tanaka, Tetsushi Yamaoka, Hiroshi Masaki, Yuuki Masuda, Masaru Iwanami, Shinichi Ishioka, Kazumi Fujii, Yasuyuki Goto, Koichi Saito, Yutaka Yokoyama, Ryuji Umehara, Katsuhiko Kumagai, and Yuichi Fukaya. "Evaluation of Corrosion Behaviors for Reactor Pressure Vessels/primary Containment Vessels in Fukushima Daiichi Units 1–3 Nuclear Power Plant." Journal of Nuclear Science and Technology 52, no. 6 (2015): 773-83. Database: Compendex on Engineering Village

[2] Seismic Damage Indicating Parameters at Nuclear Power Plants Affected by the 2011 Tohoku-Oki Earthquake and Plant Shutdown Criteria

Grant, Fred F, Yuchuan Tang, Greg S Hardy, and Robert Kassawara. "Seismic Damage Indicating Parameters at Nuclear Power Plants Affected by the 2011 Tohoku-Oki Earthquake and Plant Shutdown Criteria." Earthquake Spectra 33, no. 1 (2017): 109-21. Database: Compendex on Engineering Village

[3] Earthquake response spectra for seismic design of nuclear power plants in the UK

Bommer, Julian J, Myrto Papaspiliou, and Warren Price. "Earthquake Response Spectra for Seismic Design of Nuclear Power Plants in the UK." Nuclear Engineering and Design 241, no. 3 (2011): 968-77. Database: Compendex on Engineering Village

[4] Seismic Hazard Assessment for Nuclear Power Plant Sites in the UK: Challenges and Possibilities

Bommer, Julian. "Seismic Hazard Assessment for Nuclear Power Plant Sites in the UK: Challenges and Possibilities." Nuclear Future 6, no. 3 (2010): 164-70. Database: Compendex on Engineering Village

Earthquakes are one potential hazard to the design of a nuclear power plant (NPP), as seismic activity can damage equipment and critical safety-related structures. With this in mind, new NPP's have been designed to resist the effects of earthquake loadings [1, 4]. The effects of earthquakes on nuclear power plants include corrosion and nuclear contamination based on

emergency countermeasures. Additionally, in the aspect of structural analysis, the effects produce inconsistencies in seismic damage analysis that affect seismic design. [1,2,3]

The Fukushima Dai-ichi nuclear disaster in March 11, 2011 is one of the most devastating nuclear accidents in history, with the Fukushima disaster cleanup yet ongoing. Unlike the nuclear accident in Chernobyl in 1986, which was due to human error, the Fukushima Dai-ichi accident was due to the nearby 9.0 magnitude Tohoku-Oki underwater earthquake, which caused a station blackout and.cooling function decline, in turn causing a nuclear meltdown. [1,2] In the event of an earthquake emergency, crew in a NPP (nuclear power plant) have little time to react. As a countermeasure to the Fukushima Dai-ichi NPP, seawater was injected to cool the core down, yet the reactor pressure vessel (RPV) and primary containment vessel (PCV) is not designed to intake seawater. In effect, this caused corrosion to the RPV and PCV that a scientific study shows to hold their structural integrity for 15 years after the accident. [1]

The four Fukushima Dai-ichi NPP's damaged from the Tohoku earthquake additionally affected seismic damage indicating parameters of NPP's. [1,2] The Fukushima Dai-ichi NPP's experienced earthquakes that greatly exceeded the Cumulative Average Velocity (CAV_{STD}) thresholds developed by the Electric Power Research Institute, yet safety-related structures, systems, or components remained functional, prompting a study to suggest that CAV_{STD} is too conservative and needs to be revised. [2] Similarly, the seismic design of NPP's in the United Kingdom are based on standard spectral shapes devised in the 1981 via predicted peak ground

acceleration values from a single ground motion prediction (GMP) equation produced by Principia Mechanica Ltd. Given that there are advancements in GMP and a clearer understanding of tectonics, the NPP's of today easily surpass these dated technical values and the spectral shape itself, suffering from epistemic uncertainty, is undynamic and outdated. However, the uncertainty of even the most appropriate formulated model or technical value raises the need for expert judgement as well as refined seismic hazard assessment. [3, 4]

Earthquakes introduce an aspect of structural analysis in NPP's that directly affect design processes and the reliance of unprecedented countermeasures, elements that are beyond post-earthquake damage analysis. Efforts to keep up with the state-of-the-art in seismic design and state-of-the-practice in seismic hazard analysis are arduous. It introduces a great trouble to nuclear energy especially after the controversy of Fukushima Dai-ichi.