Seismic safety of nuclear power plants against inland crustal earthquakes and the "science vs. engineering problem"

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The seismic safety of nuclear power plants (NPPs) against inland crustal earthquakes has been a big problem in Japan since a nuclear reactor developed in the United Kingdom, an aseismic country, was introduced as the first commercial reactor in the 1950s (e.g., Ishibashi, 2015). However, even now, this problem has not been settled at all. In this presentation, first I review various problems of seismic safety of NPPs related to inland crustal earthquakes referring to the ongoing safety regulation. Then, I discuss the so-called "science vs. engineering problem" concerning NPPs' seismic safety.

The fundamental problem in the seismic safety of NPPs against inland crustal earthquakes is that the largest earthquakes which could affect each NPP severely by strong ground motion, or surface fault dislocation, or coseismic crustal deformation, or ground failures, or large tsunami, cannot be predicted precisely because of the intrinsic nature of earthquakes. Active faults don't indicate seismic fault planes of future earthquakes, and distribution of SMGAs (Strong Motion Generation Areas), stress drop values nor slip amounts on SMGAs cannot be known beforehand. Thickness of earthquake generation layers in the upper crust around each NPP is also obscure, though very important. In addition, prediction of occurrence and strong motion of slightly deep earthquakes in special tectonic environments such as the 2018 Hokkaido earthquake (M_J 6.7, H37km, maximum observed PGA 1796 Gal) is extremely difficult.

These essential difficulties bring underestimation of DBEGM (Design Basis Earthquake Ground Motion) or tsunami, and missing of possible crustal movement, which have actually occurred in several NPPs. Successive large aftershocks which may cause severe effects to a NPP damaged by the main shock is also a serious problem, but is not taken into account in NPPs' earthquake countermeasures. Next NPP accident in Japan may be brought about by this kind of phenomena.

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