History of design basis earthquake ground motion for nuclear power plants in Japan

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I would review a history of design basis earthquake ground motion (“the design ground motion” hereafter) for nuclear power plants in Japan. The first official guidelines of design ground motion established in 1978, when a number of nuclear power plants had already been constructed or in operation. The plants were designed in 1960s without the earthquake risk evaluation based on the plate tectonics theory.
In the 1978 guidelines, the design ground motion S1 expected by strongest possible nearby earthquakes and the design ground motion S2 expected by unrealistically strong earthquake with consideration of earthquakes in the last 50,000 years. The facilities of class A should be in an elastic deformation by the S1 motion and those of class As should maintain its safety. Updates of the 1978 guidelines had not been initiated until we experienced the devastating Kobe earthquake in 1995. The guidelines were updated in 2006. While a basic policy of the 2006 guidelines was not much different from the 1978 guidelines, the design ground motion is unified to Ss from S1 and S2 in the 1978 guidelines. An earthquake fault model was introduced to evaluate ground motion. Estimation period of fault activity was elongated from 50,000 to 130,000 years. Surprisingly a tsunami risk was introduced for the first time in the 2006 guidelines in spite that the tsunami disaster had occurred frequently by great thrust earthquakes in Japan. The power companies had a duty to examine whether existing plants fit to the 2006 guidelines and to reinforce when necessary. The 2011 Tohoku giant earthquake led to the severe accident of the Fukushima Daiichi power plant, for which the power companies stated “totally unexpected”. The accident strongly indicated that further and severer update was required. In 2013, new guidelines were defined. Although the government and power companies emphasize that the new guideline is severer in the world, there are still debates whether the new guidelines are reasonably severe for the nuclear power plants in Japan, where earthquake activity is extremely high in the world.

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