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Japan's nuclear regulation standards against natural hazards after Fukushima

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Japan has established Nuclear Regulation Authority (NRA) in 2012 after the Fukushima Daiichi (F1) accident that was principally caused by the 14 m-high tsunami induced by the M9.0 earthquake on 11 Mar. 2011. NRA accepted the Integrated Regulatory Review Service (IRRS) of International Atomic Energy Agency (IAEA) in Jan. 2016, which identified "good practices" such as "independent and transparent regulation" and "prompt and effective incorporation of lessons from the F1 accident in the areas of natural hazards, severe accident management, emergency preparedness and safety upgrades of existing facilities" (Press release of IAEA on 21 Jan. 2016, Tokyo).

As a geologist and commissioner of NRA, here I explain essentials of our new nuclear regulation standards against natural hazards, which mostly follow those defined by IAEA [1] but include some more stringent standards to fit the very active geological environment of Japan.

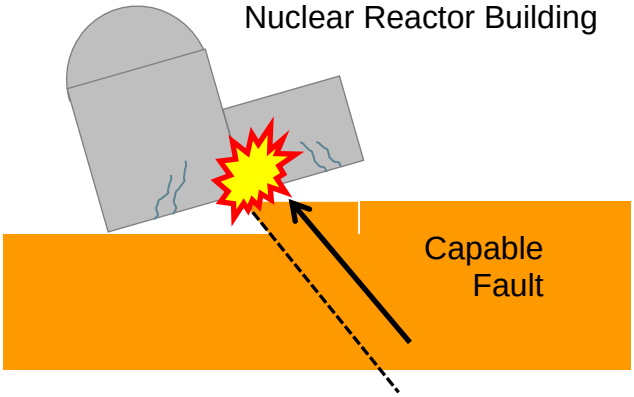

Figure 1: Risk of loss of safety function of a nuclear reactor by the activated capable fault

Important nuclear facilities must be placed on the ground without outcrop of capable faults, whose activities since the Late Pleistocene (120,000 to 130,000 years ago) cannot be denied (Fig. 1). The geological relationships of the fault with covering beds and cutting dikes (or mineral veins) are robust evidence for their evaluation, but we stand on the safety side if such relationships are not available.

Design basis seismic ground motions are defined on the basis of historical and pre-historical earthquakes and capable faults in the nearby areas as well as selected typical earthquakes of appropriate size. We require three-dimensional acoustic survey to depict detailed underground structure of the site to check if any amplifier is present or not. The engineering basement (Vs>0.7 km/s) is an assumed underground horizon where the design basis seismic ground motion is defined, and its depth ranges from ~0 to ~350 m among Japanese nuclear sites. The seismic basement (Vs>3 km/s) approximates upper limit of the seismic foci in the crust, and its depth ranges from ~0 to ~6 km.

NRA also requests to define the design basis tsunami that exceeds the largest in the historical records and to consider tsunamis caused not only by earthquakes but also by volcanic activity and landslides.

Volcanoes are also risky in Japan. Volcanoes within 160 km distance should be evaluated for eruption histories, geothermal activities, lavas, pyroclastic flows and ash fall. If the site is placed near an active

caldera volcano, the company should conduct seismic and geodetic monitoring of the caldera. This is the case for the Sendai Nuclear Power Plant in Kyushu that restarted in 2015 under NRA regulation.

The goal of NRA is to protect human life and environment, and NRA aims at independent scientific and technical decisions, field-based effective regulation, transparent and informed processes, professional moral and ability, and immediate and organized action at crisis.

Reference:

[1] IAEA Safety Standards Series No. NS-R-3 (2003) and No. SSG-9 (2010).