Japanese Nuclear Power and Wrath of Nature

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Japan, perched on the so-called Pacific "Ring of Fire," is one of the most seismically unstable countries. In the 20th Century, about 158,280 persons died there in nine major earthquakes, with Richter magnitude 6 and above. The Japanese had that in mind when building 55 nuclear reactors for 17 nuclear power plants, which supply the country with 34.5% of its electricity. They made them sturdy enough not to release any dangerous radioactivity outside the plant limits, even due to the worst earthquakes. The quake of March 11, 2011, of magnitude 9.0, the greatest in the Japan history, proved that the plants operated almost as expected. No dangerous radioactivity was reported to escape from the destroyed Fukushima nuclear power plants into the environment outside the plants' limits, and nobody was seriously harmed by radiation among the public.

However, even though the power plants evidently withstood the 9.0 magnitude earthquake, they appeared to be sensitive to the enormous tsunami, with the waves up to 7 meters high, which flooded their emergency diesel power generators, intended to provide back-up power for the pumps that cooled the reactor core. This was evidently an effect of the poor original design of the 40-year-old power plant, as the generators were located just behind a sea wall on low-lying coastal ground. The tsunami overwhelmed the 6-meter high barrier. The result was an overheating of the cores of the reactors. Like Chernobyl 25 years ago, Fukushima now brings important lessons for the only 56-years-old nuclear power.

In the heavily affected prefectures of Miyagi, Fukushima, and Ibaraki, there are 11 nuclear power reactors. Those which operated during the earthquake were automatically shut down when tremors started, and the crews started standard procedures of cooling the "residual heat," i.e., pumping the water to the pressure vessels of the reactors. However, after an hour, the emergency power generators at Fukushima Daiichi plant were destroyed by the tsunami; the high pressure emergency cooling was lost, and before the mobile generators were supplied, the temperature of the core in the Unit 1 reactor increased to a level where the zirconium cladding of the fuel rods reacted with water, producing hydrogen gas. When the gas was released from the pressure vessel on 12 March, outside the primary containment, a hydrogen explosion occurred in the reactor building, outside the primary containment vessel, which remained intact. This technically aggravated situation injured several persons, but did not cause a large release of radioactivity to the environment. Cesium-137 and iodine-131 levels increased initially after the explosion, but these levels have been observed to lessen a few hours later.

On 14 March, this was repeated with an explosion at the Unit 3 reactor at the Fukushima Daiichi plant. The reactor building was destroyed, but again, the primary containment vessel remained intact and kept inside the radioactivity released from reactor fuel. And on 15th March at 6 a.m. local time, a third hydrogen explosion occurred inside the plant's Unit 2 reactor. Pressure readings indicated that the reactor's containment vessel may have been damaged.

In addition to these three hydrogen explosions in four days, radiation has also spread into the atmosphere from the spent fuel pond at the Unit 4 reactor at this plant. A dose of up to 400 mSv per hour has been reported from a single location between reactor 3 and 4; later this dropped to 11.9 mSv per hour, and after six hours, to 0.6 mSv. The fire was probably caused by a hydrogen explosion. As a precaution, the workers have been evacuated from the vicinity of this reactor. The fire was extinguished early on 15th March, and according to a spokesman for the Prime Minister, the fuel in the pond did not cause the fire.

All four reactors in the Fukushima Daini nuclear plant have now achieved cold shutdown, where coolant water is at less than 100°C, with full operation of the cooling system. Water levels are now stable in all four reactors and offsite power is available.

Precautionary Measures

Several precautionary measures were taken by the authorities. More important among them were evacuation of about 200,000 residents of ten towns near the affected nuclear plants, and distribution of 230,000 units of stable iodine to evacuation centers from the area around the Fukushima Daiichi and Fukushima Daini nuclear power plants. The iodine has not been yet administered to residents, as this measure is not necessary.

The situation at the Fukushima nuclear plants is still unpredictable. However, one may imagine what would happen in the (rather improbable) case of a total reactor meltdown of all Fukushima Daiichi and Fukushima Daini power plants. We know what happened after a partial reactor meltdown in 1979 Three Mile Island event and a full meltdown in the 1986 Chernobyl catastrophe. In Japan, the result would be probably similar as in the Three Mile Island power plant accident, where the reactor was protected by a thick concrete containment which efficiently retained fission products: There was almost no emission of radionuclides into the atmosphere, except innocuous radioactive noble gases, and practically zero radiation exposure of population.

There is a zero possibility of repeating in Japan the scenario from the Chernobyl nuclear power plant. The Chernobyl plant, an engineering pathology, was not

fitted with a containment vessel, and for ten days the radioactivity was freely escaping from the melted reactor, roasting in the burning graphite used for its construction. But even if by a magic miracle the containments of the Japanese plants perished completely in the quake or tsunami, the residents around them would not be harmed by radiation.

This is what we learned from the Chernobyl disaster, in which not a single person died among the affected populations of Ukraine, Belarus, and Russia, as according to a recent report of United Nations Scientific Committee on the Effects of Atomic Radiation, a body most authoritative in radiation matters (UNSCEAR 2011), the radiation doses from Chernobyl fallout (of about 1 mSv per year) were below the natural radiation, too small to produce any effect. Even after ten times higher doses, the result would be the same.

UNSCEAR. 2011. Sources and Effects of Ionizing Radiation. Vol. II. Annex D Health effects due to radiation from the Chernobyl accident, pp. 1-173. United Nations.

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