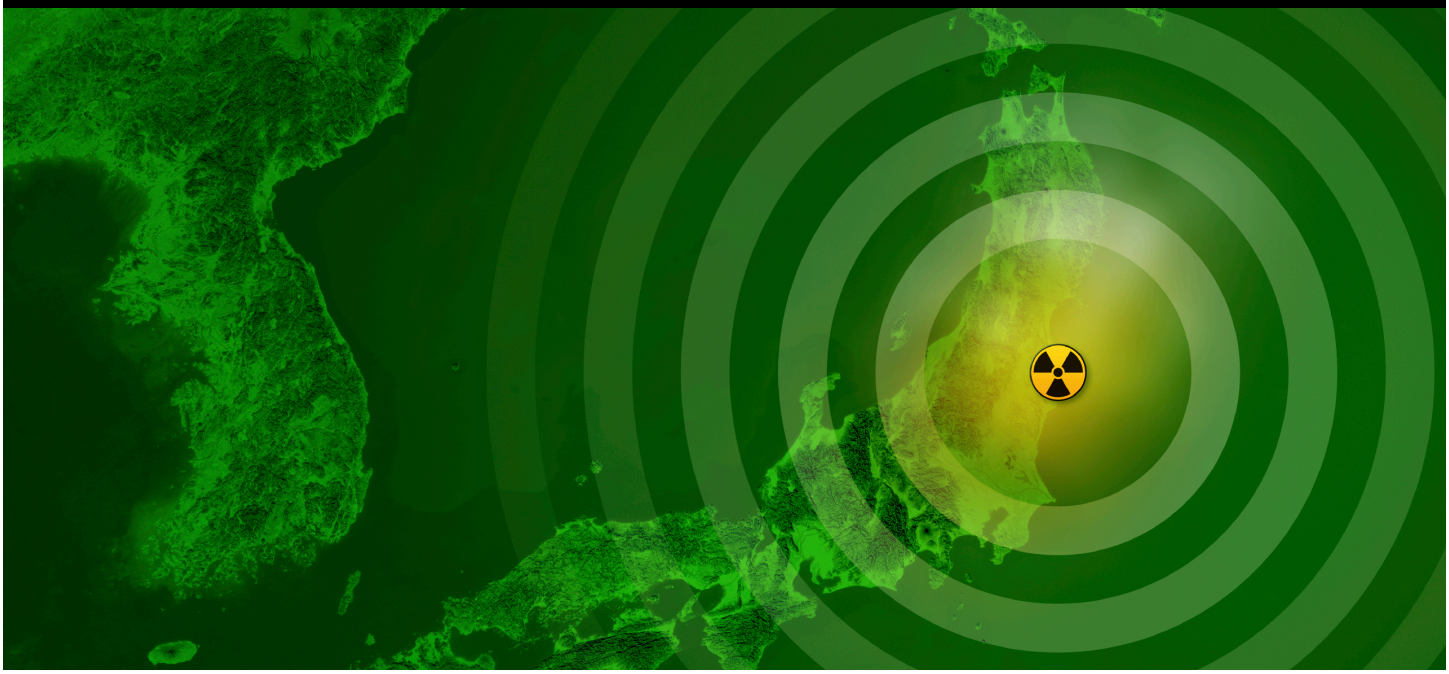

Protection of Nuclear Installations from Disasters

BY BASANT KUMAR MOHANTY, Ph.D, and NOSHIR SOONAWALA, Ph.D

The 9.0-magnitude Tohoku earthquake on March 11, 2011 off the eastern coast of Japan, and the subsequent tsunami, caused more than 14,600 deaths, about 5,300 injuries, and more than 11,000 people went missing in the affected area. The disaster was compounded by severe damage to Units 1, 2, and 3 of the Fukushima Daiichi Nuclear Power Plant and the resulting radiation leaks. The World Bank estimates that the damage due to the 2011 Tohoku earthquake and tsunami could be between US$122 billion and $235 billion. The Japanese government's official figure puts the damage at $309 billion, making it the most expensive natural disaster on record. Japan is facing one of its toughest times in the 65 years since the end of World War II.

So, it is time to think about ways to reduce the impact of future natural disasters on nuclear installations. All national nuclear regulatory agencies, as well as the International Atomic Energy Agency (IAEA), have produced voluminous safety standard guidelines and regulations for the siting of nuclear power plants, and no doubt, the Fukushima Daiichi plant was built in accordance with such guidelines. All the same, the disaster happened. It is evident that this plant withstood the earthquake quite well: immediately after the earthquake, structures seemed to be intact and there was no breach of the reactor cores. The principal causes of the catastrophe were the events triggered by the tsunami such as the loss of offsite power and the flooding of the standby generators. The accident-analysis scenarios for seismicity used for the design of the plant were obviously adequate, but not those for the tsunami. Tsunamis have at least cursorily been recognized as a natural hazard even in the earliest safety guidelines. Notably, a Nuclear Regulatory Commission document published in 1976 (NSIC-118) makes a passing reference to "...waters associated with hurricanes and/or tsunamis..." but obviously safety analyses for tsunamis have not been as thorough as for earthquakes.

The IAEA and national regulatory agencies should revise their safety analyses for tsunamis and ensure that existing nuclear power plants, as well as those in the planning stage, are able to withstand tsunamis of the magnitude that have occurred in the last decade. Revised safety guidelines should consider siting new power plants well away from the shoreline at suitable elevations. Seawater that is required for cooling, can be pumped to reactors sited at a distance from the shore. Very strong barrier walls should be built between the coastline and the existing nuclear installations. The walls should be built of materials able to withstand the force of future tsunamis and should be designed to reduce the strength and impact of any tsunami. The walls should be backed up by deep trenches to reduce the destructive strength of the sea waves following a tsunami. Finally, a few layers of concrete structures, one to two feet in size, should be built between the sea and nuclear installations and around the installations to reduce the destructive strength of tsunami waves. Plants where this is not possible should be shut down.

The nuclear industry is making a major push for expansion into regions of Asia prone to tsunamis. For example, a mammoth power station of up to 9,000 megawatt capacity is planned for Jaitapur on the Maharashtra coast in India. This plant will likely be built by a French company. The rapid expansion of nuclear power into developing economies of the world raises two questions regarding credible safety analyses for natural events: first is there sufficient historic seismic and meteorological data available for these sites; and secondly, do the European and North American manufacturers have sufficient knowledge of the natural conditions prevalent in Asia, and have these site-specific conditions been included in their safety-related design procedures.

Even the best safety features built into a nuclear power plant would fail miserably if the operators ignore the safety procedures -- a safety culture has to be well established at every level in an organization, from the executive down to the humblest worker. The immediate cause of the other major disaster in the history of nuclear power, the Chernobyl accident of 1986, was the shutting down of major safety systems of the reactor by operators who thought that was a way to meet a tight deadline for resumption of power to the grid following a planned outage. Many countries with nuclear power ambitions have a culture in society at large that encourages flouting of rules, and they suffer from entrenched corruption. Such a culture, if it ever seeps into the nuclear industry, would be an invitation for disaster. Nuclear is unforgiving -- all safety rules have to be followed all the time. No exceptions.

Many see the replacement of nuclear power with benign sources of energy such as wind, solar, tidal and so on as the ultimate guarantee against disasters like Fukushima and Chernobyl. However, that may not be realistic because in almost every industrialized country, nuclear has established itself as a reliable base-load electricity supplier, and developing economies are hungry for additional power. Major disasters at nuclear power plants can be avoided with better and updated accident scenario analyses for tsunamis and other natural events, and revised mandatory regulations. Costs of these revisions and the retrofitting of existing nuclear power plants though considerable, would still be orders of magnitude less than the cost of an avoidable future accident, a cost that developing economies in particular can ill afford.

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