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Nuclear power after Fukushima

Bhaskar Baladrishnan

The nuclear power industry will have to face the challenge of increased public concern by setting the highest possible standards of safety and security.

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The crisis at the Fukushima Nuclear Power complex in Japan, hit by the earthquake and tsunami, has sparked a renewed debate over the safety of nuclear power plants worldwide.

The Fukushima I complex has six Boiling Water Reactors (BWR) with a total power output of 4.5 GW. These are the second most common type of commercial reactors after the Pressurised Water Reactor (PWR).

The Fukushima II complex, located 11 km to the south, has four BWR reactors of 1100 MW each. These four reactors were successfully shut down in some 36 hours following the earthquake, despite the damage to cooling pumps in three of the units. India's nuclear establishment has been quick to underline that while the safety record of Indian plants is good, it would take into account the experience of Fukushima and reassess the safety situation. Of the 20 operating Indian reactors, only two at Tarapur are the BWR type, similar to those at Fukushima.

The 18 others are Pressurised Heavy Water Reactors (PWHR) of CANDU design, developed in Canada, said to be able to withstand high seismic stresses. Besides, India does not have the high level of seismic risks that Japan has.

Concern has been expressed over the relatively higher seismic risk at Jaitapur, Maharashtra, where NPCIL and AREVA are to set up a new mega nuclear power complex with PWR-type reactors.

The Fukushima I plant, fortunately, had only three reactors operating when the tsunami struck. These were the oldest reactors, commissioned during 1967-1970.

The three others had been shut down for maintenance. However, there was considerable quantity of spent fuel rods in the storage tank above Unit 4, which required cooling water to keep it from overheating.

Dangers ahead

There is growing concern that the failure to achieve a cold shut-down of the Units 1, 2 and 3 at Fukushima I may result in a core meltdown. Reports that radioactive Iodine and Cesium have been detected indicate that fuel rods inside the reactor may have been breached, allowing radioactive products to escape. Efforts are on to cool the reactors with sea water, but this is corrosive to the reactor structures.

The cooling water supply has been disrupted, exposing spent fuel to air. A fire broke out in the tank above Unit 4, probably due to hydrogen from overheated spent fuel rods. This could crack the shells, and could discharge radioactivity into the surroundings. The ultimate nightmare would be a zirconium fire, which would disperse large amounts of radioactivity. Reports of white smoke and calls for US army help, point in this direction.

Design Issues

The Fukushima accident raises several important issues of nuclear power plant operation and safety. First, the reactors must be able to do a cold shut-down in a scenario of zero off-site power and failure of main back-up power. Independent cooling systems must be incorporated. Containment structures should be designed to cope with hydrogen explosions.

The practice of storing spent fuel rods at or near the reactor buildings adds to risks, and safer and more secure storage sites must be found for this material. The storage of spent fuel in unsecured sites results in a serious security risk, as terrorists can target these facilities. Seismic risk factors need to be adequately taken into account while locating sites for reactors.The structures must be able to withstand seismic events an order of magnitude above what is considered likely. Emergency procedures to deal with the consequences of seismic events must be put in place, including measures to inform and safeguard the population.

Unfortunately, in these times, it is also necessary to make plans for dealing with seizure of the control room of a plant by terrorists. Nuclear reactor control systems need to be protected against cyber attacks as has recently happened in Iran with the Stuxnet worm. Fukushima has occurred on the verge of the 25th anniversary of the Chernobyl disaster. The nuclear industry would have to face the challenge of increased public concern, and measure

up to the highest possible standards of safety and security.

Revisiting the design of nuclear power plants, as well as operating procedures and safety arrangements, will go a long way to reassuring public opinion. Transparency and communication with the public is a key ingredient for success of this effort.

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