Post Fukushima

The most powerful earthquake ever recorded in Japan was not a singular event. A significantly damaging earthquake followed by a tsunami and then a nuclear accident, what happened thereafter was *catastrophic.*

At 2:46 pm on Friday March 11, 2011, an earthquake of magnitude 9.0 hit the coast of Japan leading to high damage of life and property. However, situation worsened further when the earthquake was followed by a large tsunami. The quake itself was of a rare kind lasting for about three minutes and the height of the tsunami was 15 meters at the shore. These two back-to-back natural calamities were enough to frighten the entire world but then the unthinkable happened. The power supply and cooling system of three Fukushima Daiichi reactors failed leading to a nuclear accident.

A total of eleven reactors at four nuclear power plants were operating at that time and all of them were immediately shut down (an automatic shut down process) as a response to the earthquake. However a plain shut down of the reactors is not enough because even if the reactor is not operating, there is a great amount of accumulated heat (called *decay heat)* inside the containment that must be removed. Most power plants have pumps and cooling systems that can remove heat efficiently even under conditions of complete power failure.

Situated about 180 kilometers from the epicenter, the Fukushima Daiichi reactors had proved their ability to withstand a magnitude 9.0 earthquake but failed when hit by the 15 meter high tsunami. The entire site that was 10 meters above sea level with seawater pumps 4 meter above sea level was flooded. This disabled the back-up generators on site that were being used to operate the heat exchangers for removing the decay heat from within the reactors. The units hence failed to maintain proper reactor cooling and water circulation. The tsunami also drowned the diesel generators, switchgear and batteries, all of which were located in the basements of the turbine buildings. There was a complete station blackout. Failure to remove heat led the reactors to accumulate excess heat and eventually develop a hydrogen bomb-like situation.

Around 3:30pm on March 12, there was a hydrogen explosion in the unit 1 reactor building. The explosion blew off the roof and the released hydrogen, coming in contact with air, caught fire. The explosion was followed by fuel melting. Though most of the fuel remained contained within the building, some gases escaped and contributed to the radioactive releases. These events led the authorities to declare a nuclear emergency and start evacuation. The evacuation zone was initially set at 2 km around the plant on March 11 and by the next day, the Japanese Government had extended this to 20 km.

Engineers and operators worked tirelessly to retrieve the cooling systems. A new treatment plant was setup that used recycled water to cool the reactors. Two weeks after the disaster, all three reactors were stable with water addition. Suitable steps were taken to prevent any further radioactive releases to the environment and even after six years, the area is being continuously monitored. 31 fire-fighting workers lost their lives while trying to combat the fire resulting from the explosion.

There have however been no harmful effects from radiation on local people and no instance of any harmful dose levels was found. Confirmed reports of absolutely no deaths from short-term radiation exposure following the nuclear accident were released. The high death figures often quoted are actually casualties of the earthquake and the tsunami and not the nuclear accident itself. However a total of

100,000 people needed to be evacuated and the Government has still not been able to get them back. Maintaining the evacuation has been a great challenge for the Japanese Government that is still skeptical about re-establishing people around the affected area. Official figures indicate about 1000 people have died in the evacuation process.

Immediately after the tsunami disaster on Fukushima reactors, Japan shut down all the 48 reactors and was contemplating a permanent moratorium for nuclear power. The Fukushima Daiichi reactors were designed in the 1960s. These designs took into account all the earthquake and tsunami considerations as were scientifically available at that time. Design specifications however change with time and need to be modified. Information released by the World Nuclear Association (www.world-nuclear.org) revealed that scientific information regarding the likelihood of a massive earthquake followed by a tsunami of about 15.7 meters was available as early as about 18 years before this disaster. There were ongoing discussions amongst the plant operators and the Nuclear & Industrial Safety Agency (NISA) which is the Japanese regulatory board to make significant design changes but no actions were being taken. Modifications such as moving the backup generators at a greater height above the sea level, sealing the lower part of the buildings, and having some back-up for seawater pumps were absolutely necessary given the clear warnings. But NISA allowed the Fukushima reactors to run without any of these changes and that eventually led to the disaster.

After a thorough check, Japan admitted to a lapse on its part in maintaining proper design requirements in the Fukushima reactors. The entire world is now convinced that the nuclear accident at Fukushima was a result of faulty design and not incorporating improvements despite warnings. A proper action by the plant operators and NISA could have averted the disaster. Independent studies indicated that by February 2014, the residents in areas 20 to 30 km from the plant and others from 50 km northwest received radiation doses from the contaminated ground similar to that they would have received just from the country's natural background levels. Following this realization, Japan is beginning to restart its reactors and there are plans under way to build some more with the latest design specifications and better regulation. *[As published by Simon Tomlinson in dailymail.co.uk on 26 February, 2014.]*

A shocking news was revealed to the world in 2012 when Germany suddenly declared its decision to permanently shut down and decommission all the nuclear power plants in the country. All the existing reactors that are operating at present would not be extended beyond their lifetime. They claimed to meet all their energy demands by wind and solar power. This claim was rather baffling and was not well received by the rest of the world. Contradictory to their claim, Germany started buying electricity from the European grid most of which is supplied by France and as of 2017, France is deriving 75% of its electricity via the nuclear route.

On the brighter side, as of 2014, many countries with existing nuclear power programs like Argentina, Armenia, Brazil, Bulgaria, Canada, China, Czech Republic, France, India, Pakistan, Romania, Russia, Slovakia, South Korea, South Africa, Ukraine, UK and USA have plans to build new power reactors beyond those now already under construction.

There are also considerable new entries in the Nuclear power sector:

1) The United Arab Emirates has awarded a $20.4 billion contract to a South Korean consortium to build four 1400 Megawatt-electric (MWe) reactors by 2020. The first ones are already under construction.

2) Vietnam has committed plans for initiating into the nuclear power programme by construction of reactors at two sites (2000 MWe each) to be operating by 2020. In addition to the established International Atomic Energy Agency (IAEA) laws, Vietnam is also developing its own legal and regulatory body to govern the nuclear infrastructure.

3) Dhaka – Russia and Bangladesh suffer acute shortages of electricity generation. To combat this, they have signed an agreement to install the country's first nuclear power plant at Rooppur, Pabna. Plans to construct two reactors, each with a capacity of 1,000 MW are underway.

4) Jordan has committed plans for its first reactor to be operating by 2020. Development of legal and regulatory infrastructure has already started.

5) Turkey has signed contracts for four 1,200 MWe Russian Nuclear reactors.

6) Kazakhstan, in a joint-venture with Russia is planning to develop small and medium-sized reactors, starting with a 300 MWe Russian design.

With time, most countries are realizing the need for nuclear power and are responding positively to it. The potential of nuclear power is already clear. A strong and strict regulatory board to ensure plant safety and operation with the latest design specifications and a qualified workforce is what is needed to avoid any further nuclear accidents and enable smooth and clean electricity generation.