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EDITORIAL

WHAT LESSONS WE LEARNT FROM JAPAN CRISIS

I respect Japan and admire their citizens not because of their electronics or automobiles, their *shinkansen* (bullet train) or highways, their airports or punctuality, not because of their recovery from the ravages of World War II to the second largest economy of the world (in 2010 China moved up to this position), but for their courage and pragmatism to accept nuclear power as a major energy source despite the devastation and havoc caused by the twin nuclear bomb attacks on Hiroshima and Nagasaki in 1945. Ironically, the effects of the bomb became a red herring to several countries, including India, to avoid anything labelled 'nuclear'. There is something intriguing about a people, the only deliberate victims of a nuclear explosion, to embrace the source of all malice and tame and use it for the economic prosperity of the country.

Earthquakes are not new to Japan— it has experienced several in the past and survived, and has evolved their building code to withstand tremors. The recent (March 11, 2011) earthquake measuring 9.0 on the Richter scale followed by a 20 feet tsunami which smouldered the reactors at the Fukushima Dai-ichi nuclear power station is however a completely different kind of situation, not faced by Japan before. There is no reason to suspect either the technological capabilities or the technical feat of Japan when one notices that not a single skyscraper has been ruined by earthquake in the last one hundred years. The current calamity has raised several doubts about the safety of nuclear reactors, but has also triggered a serious debate about the future of energy production without nuclear power. With increasing emphasis globally on the production of clean energy (without carbon dioxide emission), with our limited resources of fossil fuels and with our limited technological capabilities to produce energy by solar, wind or hydro-electric means, is it possible to meet our present and future needs without going nuclear? According to an estimate, if nuclear power was abandoned today and replaced by other existing technologies in proportion to their current usage, the world would emit an extra 2 billion tonnes of carbon dioxide every year. The question is whether we can afford this extra emission throwing aside environmental issues or shall we continue generating power from nuclear plants with added emphasis on safety regulations till we are capable of generating 'clean' energy from other source to meet our demands.

The current calamity has raised several doubts about the safety of nuclear reactors, but has also triggered a serious debate about the future of energy production without nuclear power. With increasing emphasis globally on the production of clean energy (without carbon dioxide emission), with our limited resources of fossil fuels and with our limited technological capabilities to produce energy by solar, wind or hydro-electric means, is it possible to meet our present and future needs without going nuclear?

This episode, like all accidents, is a lesson for scientists to understand that there is no room for complacency when expecting the unexpected, and gives the community a chance to introspect, analyse, understand and lead to new innovations. The earthquake has generated a huge volume of high-quality data which is an opportunity for seismologists and geophysicists to understand the mysteries of a mosaic of fault lines along the Pacific Rim. According to the National Institute of Geophysics and Volcanology in Italy, the earthquake released an amount of energy that is sufficient to shift the planet's axis by about 10 cm. The United States Geological Survey estimated the coastline shift of Japan's main island, Honshu, by eight feet. Readers will find articles in this issue of *Science and Culture* on the issues related to disaster and its management in the earthquake prone areas in the North-East of India, and the geological mosaic of the Pacific Rim to understand why earthquake and tsunami are so prevalent in Japan in particular. A method of predicting earthquake by observing changes in the electromagnetic field around the earth has been reported under "Notes and News".

A much-needed dialogue is required today between policy makers and a conscientious public to assess what needs to be done in the field of nuclear energy. Those who are in a mood to reject the nuclear energy option must enumerate carbon-free alternatives at this stage, while those who are bent in favour of nuclear energy need to convince others of the degree of safety in modern nuclear plants by explaining the inherent safety features in today's designs.

History reminds that accidents help us to rectify, to improve the system from its defect but not to discard it totally, to invent and innovate a better and alternate system before declaring it obsolete. And nuclear reactor technology is no exception. New reactors after Three Mile Island and Chernobyl accidents come equipped with passive safety systems that operate without human intervention reducing the risk of human error. Scientists are working now to devise safety systems in which reliable natural physical laws like gravity, convection, condensation etc. will take care of the emergencies even if the operators fled during the accident. AP1000 reactors under construction by Westinghouse are equipped with huge emergency water reservoir above the reactor vessel so that in case the reactor's cooling system fails, the valves holding the water will open and most reliable natural force of gravity will take care of the situation to pour the water down to cool the containment vessel. Immediately 'convection' another reliable natural force sets in to send the steam to go up to be cooled at the roof, condensed and came back as water again. The plan is to have an amount of water in the reservoir to last for three days, after which diesel-operated pumps set in to supply water from nearby water pool. Such advanced passive systems are now being incorporated in future reactors in China, India and in the US. In fact it is expected that the reactor with such passive systems will be 'go-live' in China in 2013. Researches are going on to invent radically new technology to have safer reactors. Ideal nuclear reactors needs to be, in the language of nuclear engineers, 'walk-away safe', which means that there will be no melt-down of the core, no fire in the spent-fuel rods and no emission of radioactivity even when there was power cut or other eventualities and the operators fled the site.

The safety features that we have talked about are all related to future nuclear plants. The relevant question is what could be done for the existing older reactors. These reactors require more careful vigil, to include modifications and changes (retrofitting) where possible and stricter regulatory norms in reissuing licences and shutdown in case of vulnerable reactors. It is time to negotiate the safety features of old reactors.

Reactor risk modelling is like financial risk modelling. In spite of historical data being available, it is difficult and often foolhardy to predict a rare event (such as a huge market fall) and its timing with accuracy. Sometimes even the wildest imagination fails to predict risk, as there are more things in heaven and earth than are dreamt of in our philosophy. New York's World Trade Centre had been built with steel frames to withstand the effect of a massive fire, but its architects could not have imagined the possibility of a full-blown deliberate impact of jetliners on the Twin Towers. Again, sometimes all possible events cannot be taken into account for practical reasons. I doubt current high-rise buildings are being constructed to survive an airplane assault, even though nuclear reactors currently under construction are being designed to withstand the

impact of a jetliner. Having said this, one needs to realize that no technology is hundred per cent safe and *absolute* technological security is a dangerous myth.

In democracies like India, people do not really know how to respond to a complicated and intricate subject like nuclear energy. The conventional wisdom on a controversial technology is usually framed by the politicians and the media, and the common reaction is to err on the side of status quo, thus rejecting new technology without assessing it properly. A case in point is the attempt to introduce computerisation about four decades ago. The bogeyman used to sway the public against computerisation was that it would lead to a loss of jobs, as computers and robots would replace human labour overnight. And while there may have been an initial reduction in manpower in the interest of operational efficiency, that courageous decision laid the foundation for India's ascent to global software prowess which has had the additional benefit of ushering in IT jobs, computer training centres and prosperity within the reach of the common man. In a similar manner, a much-needed dialogue is required today between policy makers and a conscientious public to assess what needs to be done in the field of nuclear energy. Those who are in a mood to reject the nuclear energy option must enumerate carbon-free alternatives at this stage, while those who are bent in favour of nuclear energy need to convince others of the degree of safety in modern nuclear plants by explaining the inherent safety features in today's designs.

In my opinion, Japan's tragedy has given us a chance to reassess our current safety measures and improve upon the safety standards of all nuclear activities. Locations of future nuclear reactors need to be assessed in terms of the seismic activities near the site. Further research needs to be undertaken to invent radically new technology to have safer reactors. If we assume that the risk factor of each reactor in any location is equal, then simple logic dictates that lesser the number of reactors lesser is the risk. Judgement in optimising the number of reactors and control of enthusiastic proliferation is also an important factor to be considered. Emphasis on research in production and commercialization of alternate green energy sources should be strengthened to obtain green energy at a competitive price and scale. The Indian government has taken major initiative, although late, in establishing Jawaharlal Nehru National Solar Mission in harnessing solar energy 'as a source of abundant energy to power our economy and to transform the lives of our people'. The target has been set to produce 20,000 MW of solar power by 2022. However, the Mission anticipates achieving grid parity by 2022 and parity with coal-based thermal power by 2030. Until that happens, it will be foolish to live as if nuclear energy has not been discovered lending credence to the adage "whoever invented the term 'fool-proof' underestimated the ingenuity of fools". ❐

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