Safety aspects of Indian nuclear power plants

The recent disaster at the Fukushima nuclear power plant in Japan following the devastating earthquake and tsunami has triggered widespread apprehension of a similar catastrophe in India. Even scientists are beginning to voice concern and are advising a review of our nuclear power policy. A panel discussion was held on 13 June 2011 in Mumbai to deliberate on the safety aspects of Indian nuclear power plants.

A. Kakodkar (former Chairman of the Atomic Energy Commission) mentioned that except for the reactors in the affected zone in Japan, all other reactors in its more than 50 nuclear power plants are either operational or under safe shutdown conditions. Even among the ~13 affected reactors, except for three units, the others are in reasonable shape. The reactors were apparently designed to withstand ~5.7 m of tsunami waves; but during this particular tsunami, waves were as high as 14 m or above.

In Fukushima, the first earthquake knocked-off power at the transmission tower. The reactor automatically shut down and the emergency cooling system started. But when the tsunami struck at that height, the emergency diesel system that supplies power in the absence of offside power also went down. Due to lack of power supply, the emergency core cooling system stopped functioning, thus leading to heating of the reactor core. A report was submitted to the International Atomic Energy Agency and a team was sent to the site to understand what happened.

Kakodkar averred that though the Fukushima incident has taken more than 13,000 lives with more than 14,000 missing, there have been no health-related consequences due to nuclear exposure. The permissible dose of radiation is near normal, except for some regions in Fukushima. He called attention to the beaches in Kerala, where people have been living for generations in locations where there has been nuclear exposure. Researchers at the Regional Cancer Centre in Thiruvananthapuram have concluded that there is no relation between cancer and natural radiation in background areas. However, it could be a risk factor for cancer.

Kakodkar pointed out that what happened in Fukushima may not happen in India, but lessons can be learnt and redundancies in the safety systems looked into. He said that India is a poor country but with a large economy; with a low per capita income but a large electricity system. We are the fifth largest electricity producers in the world (after China, the US, Japan and Russia), but our consumption is only ~650–700 kWh/capita, which is less than half the average consumption of the Non-Organisation for Economic Co-operation and Development (OECD) countries, suggesting that India is a less advanced country industrially.

How much energy does India need? The world average needed for desirable growth is ~4500–5000 kWh/capita. With the population of reaching 1.6 billion, the country would require 40% of the total energy that the world produces today. For producing 5000 kWh/capita, it is necessary to generate ~8000 total worldwide (TW) energy of electricity and for that, the Indian energy resources appear to be inadequate. Our coal, oil and uranium reserves will not last more than 11–12 years. Non-conventional energy sources such as hydroelectric power can supply only ~5% of the total energy requirement.

Solar and nuclear energy are the only large energy sources available to India. Kakodkar suggested recycling of CO_2 and converting it into artificial fluid hydrocarbons, facilitating the transfer of energy use from fossils to non-fossils, besides bringing down the CO_2 levels in the atmosphere. He also talked about the temporary import of light-water reactors and application of fast breeder technology to make India energy-independent in the future.

According to Kakodkar, nuclear energy is safe, but further improvements can help ensure this safety. India already has advanced heavy-water reactors in which radiation impact can be controlled even under dire circumstances.

Addressing the nuclear debate, P. Balaram (Indian Institute of Science (IISc), Bangalore) said that on the one side, there are scientists who are absolutely confident about the safety issues and about their abilities to project the power that would be delivered by nuclear reactors. On the other side, there is a worried civil society whose concerns need to be addressed.

The atomic nucleus is an enormously powerful entity, but one which is quite feared on account of the atomic bomb and the happenings in Hiroshima and Nagasaki. People have grown up hearing about threats such as nuclear war, nuclear annihilation and nuclear winters. The word 'nuclear' was removed from nuclear magnetic resonance imaging (NMRI) as it was acknowledged that a diagnostic method with the word 'nuclear' is unlikely to be acceptable to the public.

Looking at the historical origins of atomic energy research in India, Balaram said that it has been a monolithic and monopolistic entity, receiving legislative protection through the acts of 1948–1958 and 1962. The atomic energy establishment, then under Bhabha's vision, grew and under Jawaharlal Nehru's protection, grew in a particular direction. When a proposal was submitted by C. V. Raman and R. S. Krishnan in the 1940s to introduce nuclear physics in the physics department at IISc, it was not approved. Bhabha had already become the most influential man on these issues and nuclear physics became a prerogative of the Department of Atomic Energy. Expertise is located within a single organization, with very little technical proficiency among the academic community in the rest of the country. The department has developed competence in design, fabrication and maintenance of reactors.

Now, India has decided to import reactors on a large scale from France, Russia and the US. The sums of money involved in this venture are staggering and there is an enormous commercial interest. The question one can ask, as a society, is: are all these purchases made for the best possible reasons with the best possible safety parameters? Balaram opined that, with regard to nuclear expansion and projects, concerns about safety will be uppermost in the minds of everyone.

He quoted from a recent lecture by V. S. Ramamurthy, a nuclear physicist, at the National Institute of Advanced Studies in Bangalore: Safety issues of nuclear technology cannot be brushed off as insignificant or irrelevant. The past nuclear accidents such as the Three Mile Island accident in 1979, the Chernobyl accident in 1986 and the more recent Fukushima crisis, all these send out two unambiguous messages: no design is absolutely safe and human error can never be ruled out. Ramamurthy said

though the foreign reactors may have state-of-the-art designs, they come with limited operational experience and perhaps, there is a need for re-evaluation of the safety features before the green signal is given.

How are regulatory issues addressed in India? There is an Atomic Energy Regulatory Board, which is not truly an autonomous body as it comes under the Atomic Energy Commission. We need to have an independent regulatory authority, but where will the expertise to man this Board come from? For the Indo-US nuclear deal and the nuclear liability bill there have been legislative initiatives, but very little for the new regulatory act. The Government promises to grant autonomy, but this is a long process and people are concerned about safety issues.

Another problem, which Balaram pointed out, is that of weighing risks and benefits. He said that people have confidence in the power projections, but one needs to look at how many projections have been met. There are also difficulties in weighing technology options: solar or hydroelectric versus nuclear – how much of one, how much of the other? But what really worries people is the overriding commercial interest in selling technologies to India; today it will be nuclear reactors, tomorrow it will be something else.

Another concern is that of a missing generation of nuclear scientists and engineers in the Indian academic system. There is a need for experts outside the agencies who can contribute to an analysis of these problems. Balaram quoted a former foreign secretary S. Saran, who said that it will be easy for the mass media and anti-nuclear NGOs in India to play on public fears, to retard if not derail. The ambitious nuclear plans that were made possible by the Indo-US civil agreement in 2008 may be compelled to adopt more elaborate and expensive safety methods, to reassure a fearful population. But this would add to the cost of nuclear power. So there are issues of cost, risks and benefits as well as weighing all of these.

The overarching fear has been that of secrecy, a matter of concern for the past 50 years. Balaram stressed on the fact that as one is able to distinguish civilian and strategic applications of nuclear energy, a far greater openness on issues of nuclear power would help people move forward. One should not dismiss the concerns of the common man as foolish and irresponsible.

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IPCC and renewable energy

In May 2011, the Intergovernmental Panel on Climate Change (IPCC) presented its report on potential of renewable energy (RE) which emphasizes significant future role of RE in cutting greenhouse gas (GHG) emissions and powering sustainable development. A global team of technological experts and scientists reviewed over 160 scenarios on the potential of six RE technologies and compiled a report entitled 'Special Report on Renewable Energy Sources and Climate Change Mitigation' (SRREN) approved by member countries of IPCC. The present report is a short summary of approximately 1000-page comprehensive assessment done by 120 scientists for the IPCC Working Group III (WGIII)[1].

IPCC is the leading international body for the assessment of climate change, which was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to review and assess the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. The WGIII 'Mitigation of Climate Change' of IPCC assesses all relevant options for mitigating climate change through limiting or preventing GHG emissions and enhancing activities that remove them from the atmosphere. WGIII analyses the costs, benefits and risks of the different approaches to mitigation, considering also the available domestic instruments and policy measures as well as international arrangements.

According to this report, close to 80% of the world's energy supply could be met by renewable sources by the middle of this century if backed by the right public policies. The findings of the report also indicate that the rising growth of RE could lead to collective GHG savings equivalent to 220 to 560 Gigatonnes (Gt) of carbon dioxide between 2010 and 2050. A cut of around a third in GHG emissions from business-as-usual projections, could assist in keeping the concentration of GHGs at 450 ppm. This could contribute towards the goal of keeping the increase in global temperature below 2°C, as recognized in the Cancun Agreements of the United Nations Climate Convention.

The WGIII is co-chaired by Ottmar Edenhofer of the Potsdam Institute for Climate Impact Research, Germany; Ramon Pichs of the Centro de Investigaciones de la Economía Mundial, Cuba, and Youba Sokona of the Africa Climate Policy Center in Ethiopia.

When the report was presented R. K. Pachauri said, 'The IPCC brought together the most relevant and best available information to provide the world with this scientific assessment of the potential of renewable energy sources to mitigate climate change. The special report can serve as a sound knowledge basis for policymakers to take on this major challenge of the 21st century.'

Six RE sources recognized by 194 IPCC member nations are bioenergy, direct solar energy, geothermal energy, hydropower, ocean energy and wind energy. Scientists believe that of the around 300 GW of new electricity-generating capacity added globally between 2008 and 2009, 140 GW came from RE. Despite global financial challenges, the RE capacity grew in 2009, e.g. wind by over 30%, hydropower by 3%, grid-connected photovoltaics by over 50%, geothermal by 4% and solar water/heating by over 20%. The annual production of ethanol increased to 1.6 Exajoules (EJ)/76 billion litres (bl) and biodiesel by 0.6 EJ/17 bl by the end of 2009.