FRONTLINE
Volume 30 - Issue 07 :: Apr. 06-19, 2013
INDIA'S NATIONAL MAGAZINE
from the publishers of THE HINDU

BOOKS

Nuclear questions

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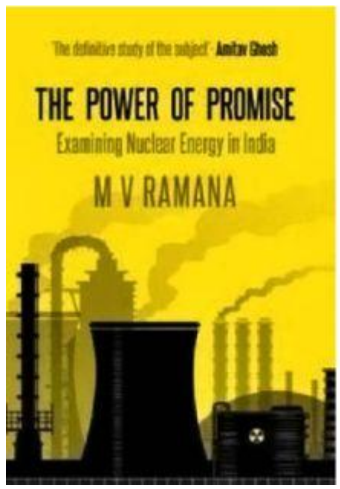
The book brings out the lack-lustre progress of India on the nuclear power front.



The Power of Promise:
Examining Nuclear Energy in India
By M.V. Ramana
Penguin India
Pages: 366
Price: Rs.699

Before reading the book under review, I had drawn certain conclusions about nuclear energy and weapons. On specific contemporary issues, I was curious to find out whether the book would change my perceptions.

There are three main arguments in M.V. Ramana's *The Power of Promise*: the Department of Atomic Energy (DAE) should not engage in an ambitious expansion of the nuclear programme by projecting a generation capacity of 40 gigawatt of nuclear power by 2020; it should give up the fast-breeder reactor (FBR) programme since it is not economical and since the India-United States deal has enabled access to uranium; and that FBRs are inherently unsafe.

The opening pages of the book include appreciation of Ramana's arguments by several people, among them author Amitav Ghosh. Ghosh in his blog (see http://amitavghosh.com/blog/?p=4857) says "the most disturbing sections" of Ramana's book "are those that relate to safety. Ramana describes two incidents that came fearsomely close to disaster". Ghosh refers incorrectly to the first incident as the "Narora event at Rajasthan" (Narora is in Uttar Pradesh) and the second one, a near mishap at the Kakrapar reactor in Gujarat in 1994. Ghosh concurs with Ramana's assessment that the Kakrapar event, when water began entering the turbine building following torrential rains, would have resulted in offsite emergency and evacuations. Fortunately, the plant was not operating. Since these were perceptions, I turned straight to the book and made my own assessment from other sources of "what really happened". There was another query by Ghosh to Ramana, who I knew as a particle physicist, about the book *Storms of My Grandchildren: The Truth About Coming Climate Catastrophe and Our Last Chance to Save Humanity* by James Edward Hansen, environmental scientist and activist, who argues in favour of FBRs. Ramana's response in the blog post was: "… I argue against relying on nuclear power, especially fast-breeder reactors, in India, not on ideological or moral lines, but based on an evaluation of the costs and the benefits. (I hope that comes through in my writing.)" Sadly, this does not come through in the book. *The Power of Promise* is well written and will be useful for those with some scientific background. Ramana makes a sincere effort to explain the technical details. While doing so his ideological and moral objections become evident in several places.

Ramana appears to have a low opinion of Indian scientists and engineers, particularly those who have decided to "stay back and slog". In his attempt to demonise Homi Bhabha, he almost suggests that his family and political connections were linked to his success. This simply ignores Bhabha's contributions on Bhabha scattering, or his cascade theory of cosmic ray showers.

In the same vein, Ramana suggests that the mathematician D.D. Kosambi's service in the Tata Institute of Fundamental Research (TIFR) was terminated because he supported solar energy, whereas it is reasonably documented that his removal was due to internal issues relating to the Math School of the TIFR after his publication on the Riemann Hypothesis in the *Journal of Indian Society of Agricultural Statistics.*

Ramana attempts to downplay self-reliant development of nuclear energy, particularly in developing reprocessing and plutonium extraction technology. He goes on to say that scientists such as Homi Sethna, as the Chairman of the Atomic Energy Commission, and N. Srinivasan, as the first Director of the Indira Gandhi Centre for Atomic Research, Kalpakkam, were only window-dressing imported plants. What is his evidence? First of all, these scientists were those sent to the United States for training by Bhabha. But, of course, several young scientists went for training, and that by itself did not reduce their value. Secondly, he quotes one Robert Kupp, a "nuclear engineer" of Vitro International, as saying that he visited Trombay thrice to help in the plutonium programme. A cursory look at Kupp's book shows that his expertise was in enrichment using gaseous diffusion. Before 1974, Indian scientists regularly had interactions with several foreign scientists, but it is hard to believe that in this highly advanced and competitive area of technology they would have readily parted with expertise.

Ramana is being unfair to people who played a significant role in India's nuclear programme. After the Pokhran nuclear test in 1974, when Canada withdrew from the Rajasthan project, the same group of scientists continued to work independently and completed the project and went on to redefine the Canadian design. The completion required overcoming several obstacles, including the initial shortage of heavy water.

Going back to the Narora incident of 1993, was it a "fearsome disaster in the making"? People who have details tell me a different story, which is as follows. After the turbine tripped, the reactor shut itself down in exactly 38 seconds. As an additional precaution, boron was added to maintain the reactor in sub-critical state. The steam discharge valves were opened to cool the reactor. When the steam was lost, water was pumped to extract the heat. These actions took 30 minutes. The reactor was shut down and kept in a cooled state for 17 hours. No doubt, these were accomplished by well-trained plant workers and engineers.

This event, the highest on the International Nuclear and Radiological Event Scale (INES) in India, is ranked Level 3. (Local plant operators, the Atomic Energy Regulatory Board (AERB) and the International Atomic Energy Agency (IAEA) are involved in assigning the INES scale.)

Level 3 means an incident (not an accident) within a plant with no offsite impact. What about

Kakrapar? The reactor had been shut down a few months before the rains in 1994. Had it been in operation, the rising water level would have called for swift action to shut down the reactor in good time. There would have been no need for offsite emergency as there were arrangements to cool the reactor, and there would have been no radioactive release. In fact, there was an unintended power level at the Kakrapar plant during operation in 2004, but the reactor shut itself down before reaching full power, as designed. At Level 2, this was the second highest incident in India. These levels are like the readings on the Richter Scale, the severity growing exponentially and incidents classified as accidents only from Level 4. When the tsunami struck Kalpakkam, near Chennai, in 2004, routine action was taken to shut down the Madras Atomic Power Station's reactors. It is possible to speculate that a Fukushima-like incident would have happened. But the fact is that it did not happen. According to S.K. Chande, former Vice-Chairman of the AERB, there were 156 events in India in the past five years of which 140 were of Level 0 (no safety significance) and 16 of Level 1 (signifying an anomaly). This does not mean that AERB or DAE personnel can become complacent and reduce the level of preparedness.

K.V. SRINIVASAN

The safety vessel, one of the major nuclear reactor components, being lowered into the reactor vault at the Indira Gandhi Centre for Atomic Research, Kalpakkam. A file picture.

In his scholarly analysis, Ramana correctly points out that the DAE never delivered on its earlier promise of 10 GW by 2000, or of 20 GW by 2010. In fact, even by 2010, it could only install 2.5 GW, which is only 25 per cent of the first stage of the programme. It has a running fast-breeder test reactor and is building a prototype FBR (PFBR) of 500 mega watt at Kalpakkam. Given such a backlog, it is preposterous to make a projection of 40 GW by 2020.

While Ramana brings out the lack-lustre progress on the nuclear power front, he ignores the international isolation India faced after 1974. Despite the conflict between the energy and weapons lobbies and the difficulties faced in developing sophisticated technologies for the reactors, the energy lobby has been fully committed to its goal. With dedication and in the spirit of scientific adventure, it has evolved an advanced design of the pressurised heavy water reactor (PHWR), overcome the obstacle of heavy water shortage, and developed the PFBR design. With the end of the isolation, standardisation of the PHWR design and construction of the PFBR, one can expect a better realisation of the goals.

Ramana's suggestion to abandon the "three-stage nuclear programme" has several problems and is not substantiated. Energy security and abundance of thorium still form the basis for the FBRs, which provide an appropriate link for the second stage. His suggestion to rely on uranium from outside is not credible.

Ramana rightly believes that former AEC Chairman Anil Kakodkar's projection of 40 GW by 2020 through imported pressurised water reactors (PWR) to be overzealous. Probably this was done to enhance the political support base for the India–U.S. deal at that crucial stage. It was opposed by many former DAE scientists too. But, the 40 per cent larger capacity of the PWRs can ease the requirement of new sites.

Ramana prescribes scaling down of the projections for the FBRs because they are more expensive. Justifiably, he feels the lack of sufficient operating experience warrants more work. His estimate of the FBR cost as 50-75 per cent higher than that of PWRs or PHWRs is also in line with the projections by some former DAE officials (CSTEP study 2012; Bharadwaj, et al). These estimates do include the cost of plutonium. A contrary view is that these estimates cannot be taken as final since the PFBR is the first of its kind, designed and constructed indigenously. Standardisation can reduce the cost and the construction time.

Ramana cites the breeding ratio of 1.04 as inadequate to justify FBRs. On the contrary, the main aim of the PFBR is to gain experience in design, construction and operation. Improvements in breeding are possible and should follow naturally.

Fast-breeder reactors have been in existence since the 1950s. Two of them suffered fuel melting, with little environmental release, and later resumed operation. Some countries have now given up their FBRs because they have access to plentiful uranium. Russia, China and India still have active programmes. FBRs are not more dangerous than other reactors as Ramana tries to argue. They have inherent safety since coolant sodium remains a liquid up to 1,000 °Celsius with no pressure increase. It is true that sodium burns in the air and reacts with water, but reactor design can effectively isolate it from both. The real challenge is not in the reactor operation, but in the handling of the fuel during fabrication and reprocessing. Current initial steps are based on the experience gained so far. Ramana's word of caution about the need for additional experience before undertaking a rapid expansion of FBRs deserves attention.

Reckless importing of reactors to satisfy the backdoor understandings involved in the India–U.S. deal will lead to trouble. But, as Ramana himself points out elegantly, a rapid expansion is also not practically possible. There is not enough capacity now for obtaining plutonium for the breeders. Also, the matter of public approval for new sites requires patience. The DAE has not ventured into this area.

Ramana has not examined another major obstacle, that of securing adequate well-trained manpower for the programme, which is important. Our educational system is not geared for this and the DAE does not have a training programme to match the requirements of their projections. Going ahead without enough preparation in this respect will have its own repercussions.

Ramana also questions the DAE for keeping the PFBR outside safeguards, the suspicion being that it could be a route for "laundering plutonium for bomb". It is a theoretical possibility reflecting the views of some U.S. groups and will remain so until evidence appears. The DAE's logic stems from the guideline of allowing international inspection only in those structures that come through outside collaborations. But democratic movements should be built against any diversion of plutonium for bombs.

The most important thing to consider is that any gap in the supply of electricity will most likely be filled by coal, leading to an increase in carbon dioxide emissions posing a greater threat of global warming. Many environmentalists anticipate that even countries that have given up nuclear energy will have to revisit it in the light of climate change issues. Ramana pays very little attention to this complex question and even strangely ridicules the environmentalists as a “depressed lot” (see Ghosh’s blog).

Going back to the question I posed in the beginning, the answer is mixed. I still support Kudankulam I and II; Jaitapur is too expensive and could better be scrapped. Negotiate the price for Kudankulam III to VI, and do not dilute liability clauses. The PFBR can continue to lay the foundation for operating experience in the second stage cornerstone activity of the nuclear programme.

The major concern thrown up in the book is that importing reactors as a quid pro quo to help to come out of nuclear isolation can lead to enhanced cost and that there is a possibility of suppliers going back on their promise.

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