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Book Review

India's Nuclear Programme-Future Plans, Prospects and Concerns

R Rajaraman (Ed.), 2013, Indian National Science Academy, New Delhi pp. 1-278 (Price: Rs 995.00)
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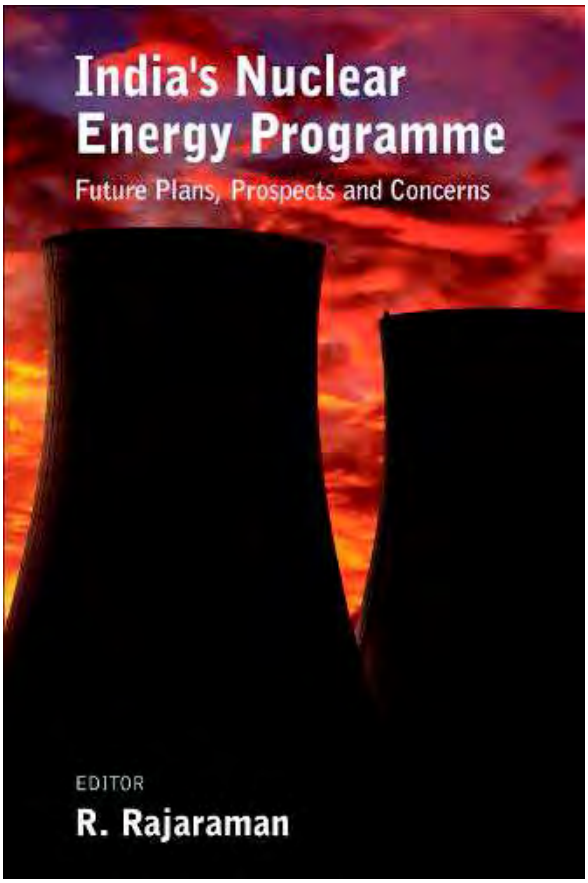
India's present electricity generation capacity is grossly in adequate to meet the needs of the industries as well as of the rural and urban households even for the current population. As a result, the country is witnessing routine load-shedding and a very large number of villages even do not have electricity connection. Moreover, if the country has to achieve a somewhat higher economic growth rate for the increasing population, the electricity generation capacity has to increase considerably in the coming years and for this we need to fully exploit all options that are available.The option of hydrocarbon based fuels, which has maximum share in the electricity generation, is known to have adverse effect on the climate and the international community is deeply concerned about it. Also, when the known resources of these fossil fuels get scarce in a not very distant future and the renewable sources alone are not able to fill the deficit, there may be no choice left except to fully exploit the nuclear energy option. In some developed countries, a large fraction of its electricity production is already from nuclear energy. Therefore a major goal of the Department of Atomic Energy (DAE) in India has been to carry out research and development in this field, to develop the required technologies to harness nuclear energy and to install nuclear power stations. While India is vigorously pursuing the nuclear energy programme, nuclear energy has always been a subject of much debate world-wide including India, particularly so post Fukushima accident. It is therefore quite appropriate that Indian National Science Academy organized a workshop on "Challenges in Nuclear Safety" during February 14-15, 2012, to give a platform to discuss and debate the view points of the proponents and also opponents on all aspects of the nuclear power programmes in India.The workshop covered almost



all topics relevant to nuclear power and some leading scientists of the DAE as well as experts and representatives of other organizations participated in it, gave talks and submitted written manuscripts on their respective topics. The present book titled "India's Nuclear Energy Programme-Future plans, Prospects and Concerns" edited by R. Rajaraman is essentially a collection of these workshop manuscripts on a range of topics related to nuclear energy with a preface by the editor giving a perspective of the nuclear power programme and the workshop.

The book has four sections namely (i) Overview, (ii) Reactor Safety and Radiological Concerns, (iii) Fuel Cycles and Technology and (iv) Legal and Regulatory issues. In the overview section, R. Chidambaram and S. Banerjee, the two former chairmen of the Atomic Energy Commission, who are renowned scientists in the field, have contributed the first two chapters titled "The Nuclear Energy Option and Nuclear Safety" and "Nuclear Power: Some Frequently Asked Questions", respectively. In the first chapter R. Chidambaram has outlined the programme of the DAE with respect to the development of nuclear power. He has pointed out that a direct relationship exists between human development index and per capita electricity consumption to emphasize the need for much additional production of energy from all available options and has discussed energy sources, the nuclear energy option and nuclear safety in Indian nuclear reactors. In the second chapter S. Banerjee has formulated several questions relating to the nuclear energy option, which are often raised in the media and in debates in the recent times and has provided answers to these. As mentioned in the overview chapters and in a later chapter by C. Ganguli, a special feature of India's nuclear power programme is that it is planned to have three stages to fully utilize not only uranium fuel but also large reserves of thorium in the country. For this, India has opted for a closed nuclear fuel cycle,which means that the spent fuel is also utilized by reprocessing it chemically to recover plutonium to fuel the fast breeder reactors to be set up in the second stage. The fast reactors can be designed to also convert thorium by neutron absorption into the fissile isotope U-233 for the third stage comprising of thorium-U-233 fueled reactors.

Paramount importance has to be given to the radiation safety aspect in the design and operation of nuclear power plants and other processes such as uranium mining and reprocessing of the spent fuel and this aspect is covered in the section on "Reactor Safety and Radiological Concerns". In the chapter on "Nuclear Reactor Safety" S. A. Bhardwaj brings out that the multilevel defence in-depth approach is taken to provide a strong network of features which make the possibility of an accident ending up in the release of radioactivity in public domain an extremely rare event. Nevertheless, radiation safety to the workers and public at large has been a subject of much debate as reflected in the chapter by S.D. Gadekar and S. Gadekar on "Observations Regarding Health Impacts of Some Indian Nuclear Installations on Surrounding Populations-Studies of Rawatbhata Nuclear Power Plants and Jaduguda Uranium Mines". These two authors argue in this chapter that the statistical analysis of the data from their survey indicates a connection of the diseases of the population surrounding nuclear facilities to radiation effects. On the other hand, in the chapter on "Environmental Impact on Aquatic Ecosystems, Biodiversity, Agriculture and Human Health in the Vicinity of Operating Nuclear Power Plants" S.K. Apte presents relevant data in the vicinity of operating nuclear power plants and make the point that there is no basis to associate the negligible radiations from nuclear power plants with any detrimental effects on humans.The biological effects of radiation are generally considered on the Linear-No-Threshold (LNT) hypothesis which assumes that radiations, no matter how small, can cause corresponding biological effect. But this hypothesis has been debated, as it does not take into account the ability of cells to repair damage caused by low levels of radiation. P.C. Kesvan concludes that LNT hypothesis is incorrect in his very detailed review paper in the chapter on the subject of "Low Dose Radiation Health Hazards-Radiological Mechanisms versus Theoretical Predictions based on Linear, Non-Threshold Model". In short, the articles of S.K. Apte and P.C. Kesvan argue that there is no reason for the public to have any apprehensions with regard to radiation safety issues in nuclear power generation.

In the section on "Fuel Cycles and Technology" Baldev Raj, P. Chellapandi & S.C. Chetal present a detailed account in the chapter on the "Science and Technology of Sodium Cooled Fast Spectrum Reactors and Closed Fuel Cycles in Three Stage Programme". This chapter makes the point that going for the fast spectrum reactors and closed fuel cycle is an inevitable option for providing energy security in India. It describes the science and technology of the fast spectrum reactors with a focus on the

programmes in the country since the inception starting with 40 MWt fast breeder test reactor to the construction of 500 MWe prototype fast breeder reactor. The chapter contains valuable data giving world scenario of fast reactors and fast fuel reprocessing plants and has a detailed coverage of the complex technologies involved, which should be of much interest to the experts in the field. The chapter on "An update of Uranium Fuel Cycle and the Challenges-India's Access to International Uranium and Fuel Cycle Market" by C. Ganguli also provides a very detailed and comprehensive technical coverage of the subject. It explains the three stage indigenous nuclear power programme in India and gives a wealth of data on the aspects of nuclear power related to nuclear fuels and spent fuel reprocessing. The chapter has rich technical contents and its summary and concluding remarks cover various aspects of India's nuclear power programme. Another chapter in this section is on "History and current status of Reprocessing and Plutonium Breeder Programme World-wide" by Frank von Hippel, a nuclear physicist and a professor of Public and International affairs at Princiton University, USA. This chapter is aimed to give the global scenario on the subject of spent fuel reprocessing and fast reactor programme covering current policies relating to spent fuel reprocessing in various countries. It puts forward an alternative viewpoint not favoring closed fuel cycle and reprocessing for plutonium production. The main argument is that several countries, notably, France, Japan and the United Kingdom launched large scale processing plants for commercialization of breeder reactors which finally did not materialize. It expresses the view that now that India has access to global uranium market, it can reassess the economic justification of the closed fuel cycle and fast reactor programme. But this suggestion will also imply giving away the three stage programme and utilization of thorium for nuclear energy generation, which is an important part of DAE's long range plan of harnessing nuclear energy.

The last section of the book is devoted to legal and regulatory issues. In the chapter on "National Framework for Governance of Nuclear Power" R.B. Grover gives outlines of the Atomic Energy Act 1962, agreements with respect to the International Atomic Energy Agency, Indo-US Joint statement of 2005, relaxation of the guidelines of civil nuclear commerce by Nuclear Suppliers Group in September 2008, and agreements for nuclear cooperation with different countries. In the chapter on "Nuclear safety-the New Regulatory framework" R. Ramachandran discusses the importance of the regulatory functions and the current arrangement which vests the responsibility of regulatory functions with the Atomic Energy Regulatory Board (AERB), a wing of the DAE itself. It brings out that in view of the need to make a completely independent regulatory body the government has already tabled in the Lok Sabha the Nuclear Safety Regulatory Authority (NSRA) bill to replace AERB with NSRA.

In conclusion, the book is a valuable addition to the literature on India's nuclear energy programme.

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