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Nuclear Safety and Regulation in India: The Way Forward

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Introduction

On 27 March 2015, the Integrated Regulatory Review Service (IRRS) submitted a draft report to India's Atomic Energy Regulatory Board (AERB) reviewing the country's legal and regulatory regime for safety of Nuclear Power Plants (NPPs) and safety practices and policies at plants across the country. A peer review service of the International Atomic Energy Agency (IAEA), the IRRS conducts its reviews against globally accepted IAEA safety standards. The Indian Government had invited the IAEA to conduct the review, which included interviews and discussions with regulatory staff, site visits and inspections over a period of 12 days.

The IRRS draft mission report, the final version of which is expected by the government in three months, found India to be strongly committed to nuclear-energy safety. The team leader, Ramzi Jammal, Executive Vice-President and Chief Regulatory Operations Officer at the Canadian Nuclear Safety Commission said: "India's Atomic Energy Regulatory Board is an experienced, knowledgeable and dedicated regulatory body for the protection of the public and the environment. It continues to enhance its regulatory programme to face the current and future challenges in regulating nuclear safety, such as reinforcing the safety of existing nuclear facilities, monitoring ageing and decommissioning, as well as providing oversight of the construction, commissioning and operation of new nuclear power plants".¹

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At the same time, however, the report noted the lack of institutional independence of India's civil nuclear regulator, the AERB. The report urged: "The Government should embed the AERB's regulatory independence in law, separated from other entities having responsibilities or interests that could unduly influence its decision-making".² The draft report also recommended that India's AERB should "Promulgate a national policy and strategy for safety, and a radioactive waste management strategy as a statement of the Government's intent".³ Other recommendations to the AERB of the IRRS draft report were the following:

- Consider increasing the frequency of routine on-site inspections at NPPs to allow for additional independent verification and more effective regulatory oversight;⁴ and
- Develop and implement its own internal emergency arrangements, including detailed procedures to fulfil its emergency response role.⁵

In a statement, the AERB said it had accepted the review team's suggestions and recommendations "as an opportunity to enhance the regulatory framework" and had already started work on a detailed action plan to address them.⁶

This paper will examine some of the recommendations made by the IRRS and offer an analysis of the context in which India's nuclear regulatory structure has developed since the inception of its civil nuclear programme. It will also deal with the issue of waste management in India and conclude with some policy recommendations for India's civil nuclear safety and waste strategy.

Nuclear Regulation in India: Current Criticisms

Regulation is an important component of the safety climate in any given system. In the case of nuclear power, regulation helps in standardising complex safety measures and also maintains an oversight to foresee any discernible design or operational defects in the NPPs. For this reason, the regulatory system is recommended to be kept independent of the operators and the promoters of nuclear power, so as to avoid a conflict of interest and enable shutdown of NPPs should they be in breach of safety standards. Indeed, a basic starting block for nuclear power regulation as recommended by the IAEA is that the safety regulator must be independent of both industry and government to enable autonomous decision-making based purely on safety principles and devoid of commercial or political interference.⁷

While most countries follow this maxim, in India, the regulator has been at best only functionally autonomous, and not institutionally: this has raised serious doubts about its efficacy to enforce complex safety measures and penalties in case of non-implementation of safety recommendations.

In India, the overarching legislation for nuclear power activities is the Atomic Energy Act, 1962, which is complemented by other laws and regulations on narrower thematic issues. The administration of the Act is entrusted to the Department of Atomic Energy (DAE). The AERB is answerable to the Atomic Energy Commission (AEC), whose Chairman is also the Secretary, DAE.

The Managing Director of the Nuclear Power Corporation of India Limited (NPCIL), the operators of NPPs in India, is also a member of the AEC. Thus, the regulatory structure can be construed as inherently subservient, with the regulator having to answer to both the promoters and operators of nuclear power in the country.⁸ Former AERB Chairman, Dr. Gopalakrishnan has gone on record to say that “95% of the members of the AERB's evaluation committees are scientists and engineers on the payrolls of the DAE”.⁹

The Comptroller and Auditor General (CAG) of India had previously weighed in on the activities of the AERB. In 2012, a report submitted by the CAG to Parliament concluded that “the legal status of AERB continued to be that of an authority subordinate to the Central Government, with powers delegated to it by the latter”¹⁰ and that the AERB “did not have the authority for framing or revising the rules relating to nuclear and radiation safety”.¹¹

Furthermore, the report highlighted that despite an order issued by government in 1983, the AERB has still not developed an overarching nuclear and radiation safety policy for India.¹² Various non-governmental experts have also on many occasions questioned the AERB's ability to take stringent actions against nuclear operators. The 2012 CAG report stated that the DAE and NPCIL have not complied with 375 of the 3,200 recommendations made by the AERB.¹³

Regulation plays an important role at all the stages that are critical for setting up the nuclear power stations—starting from nuclear plant siting, construction, commissioning and operation. Given AERB's crucial responsibilities, its non-autonomous structure has created serious doubts about its capabilities.

Explaining India's Unique Nuclear Trajectory

Understanding the role the AERB has so far played in India's nuclear programme requires a nuanced approach. While India's proposed plans for a massive expansion of its civilian nuclear energy sector—and consequently for a greater contribution of nuclear power to its energy needs—merit an independent regulator going forward, criticisms of the historic role and function of the AERB tend to overlook the peculiarities of India's nuclear programme. Applying international standards of independent safety regulation to India's programme right at the outset would have been an exercise in failure.

The end-goal during the inception phase of India's nuclear program was not necessarily the existence of an independent regulator, but that of an excellent nuclear safety climate. The understanding of how that end-goal can be best achieved may differ depending on assessments of the environment, attitudes of key actors, established working practices, norms, beliefs, among others. India's safety culture at the inception of its nuclear program could easily be found wanting when examined with the wrong lenses.

Theoretical perspectives on safety back this claim. As Nick Pidgeon writes in his landmark paper on safety culture, “what we think of as 'appropriate' for safety under one circumstance may not look so good to somebody else, or in other contexts”.¹⁴ Additionally, the ability to reactively alter the prevailing socio-organisational arrangements as unforeseen hazards arise may well be a desirable facet of a safety culture.¹⁵ By giving little to no leeway for organisational specific variations and circumstances which account for significant cleavage in safety practices across safety-critical organisations, and by failing to explore subtle variations in how the safety agenda is driven in different situations, a significant amount of learning is lost and reliable organisations can be deemed otherwise.

The unique nature of India's nuclear programme quite simply merited a unique approach to nuclear safety regulation. Some of the features that necessitated such an approach are discussed below:

Its indigenous nature: India's civilian nuclear programme received minimal foreign assistance following its Peaceful Nuclear Explosion (PNE) in 1974 and subsequent development of nuclear weapons. The need for self-reliance and a lack of widespread domain knowledge resulted in a pooling of resources and adoption of unique approaches to safety issues, not conditioned by international standards and approaches to safety. While this is changing—the CAG report suggests that the DAE is adopting international safety standards—there is still some way to go before we would be able to recognise universal values of safety culture widely prevalent in the Indian context.

Its modest capability to date: Criticisms of India's nuclear establishment have largely focused on how it has continually failed to deliver on its promised targets of installed capacity (with a current installed capacity of just under 6 GW) and have questioned how it manages to justify its annual budget.¹⁶

However, these criticisms are counter-intuitive to the criticisms of regulation. Organisational theory would suggest that India's atomic establishment would seek to expand the scale of India's nuclear program including the civil component, in order to protect its interests and increase its influence. In fact this has been a frequent criticism of the DAE and its inflated targets for India's nuclear capacity which have repeatedly not been met. If India's regulatory body suffered from undue pressure,

India's nuclear capacity would surely have increased at a quicker rate, freed from ensuring the highest standards of safety which would have been relegated to a secondary issue at best. Some of these criticisms for example have been made against China's nuclear programme which is now expanding rapidly.¹⁷

Its close links and intermeshing with the strategic programme: In its early stages, there was a significant amount of clustering in India's atomic programme both in terms of intellectual capital as well as resources. The need of the hour was close cooperation, coordination and most importantly, high levels of secrecy. The regular overlapping between the weapons and civilian establishments meant the presence of an independent regulator would have complicated this arrangement. However, subsequent to the Indo-US nuclear deal of 2008, India's civilian nuclear assets have been separated from its military counterparts and placed under IAEA safeguards, thus freeing the way for an independent regulator to now function unimpeded.

Last but not least, the glue that binds some of these arguments together is the post-colonial mindset that was unquestionably present amongst India's early nuclear policy-makers. A desire to develop indigenous expertise, fiercely protect domestically developed technology from foreign oversight of the same, and maximise domestic resources for a joint effort that contributes to nation-building, all meant that India's nuclear safety culture evolved in its own geographical and intellectual vacuum. Further, the historical overlap between India's strategic and civilian programme meant that any international oversight was a non-possibility. Distrust of international oversight processes which are largely seen as directed by the West continues to be rampant in developing countries, who view such measures as an infringement on national sovereignty.¹⁸

While at no point one could reasonably suggest that the above characteristics are desirable for a civilian nuclear programme, they are however representative of the Indian civilian nuclear power story as it has developed so far. Given the same, one can understand the circumstances within which AERB has had to fulfil its requirements, performing a delicate balancing act between multiple centres of gravity. Judging by the IRRS assessment of the AERB's capabilities and functioning, it is safe to say that the AERB continued to develop excellent safety standards despite its lack of institutional independence.

The IRRS draft report notes several impressive aspects of India's nuclear safety climate, including a well-developed educational and training system for its nuclear programme; a strong research and development infrastructure that provides support to regulatory activities; and a continuous effort to evolve its regulatory framework and processes.¹⁹

Waste Management Strategy in India

The need for a radioactive waste management strategy is also urgent as recommended by the IRRS report. India currently undertakes disposal and treatment of radioactive wastes in line with international standards and the IAEA practices wherein nuclear waste is classified into Low Level Waste (LLW), Intermediate Level Waste (ILW), and High Level Waste (HLW), depending on the level of radioactivity present. Reprocessing and Waste Management plants are currently being operated by the Bhabha Atomic Research Centre (BARC).

The low and intermediate level nuclear waste containing radioactive substances with short half-life and lower levels of radioactivity are generated at NPPs and are processed on-site. The spent fuel which contains long lived radioisotopes is stored for a long period to reduce the level of radioactivity before reprocessing at reprocessing plants to enable extraction of reusable fissile material. HLW generated from the reprocessing plant is vitrified into a glassy form, contained in multiple barrier containers and stored for an interim period of three to four decades in engineered vaults with necessary surveillance facilities.²⁰

After cooling down in these storage facilities, waste containers will be stored for long term in deep geological repositories.²¹ As we are nearing the end of three to four decades of storage time for HLW from India's first nuclear reactors, the DAE has begun the process of site identification for an underground waste repository. In 2012, the DAE announced that it will set up an underground laboratory in one of its uranium mines to study rock formations for potential selection as a site for final waste disposal.²²

Nuclear Safety Regulatory Authority Bill

Nuclear power generation in India is likely to increase significantly over the next three to four decades with a possible 10- to 15-fold increase over current levels by 2050. In recognition of the AERB's growing domain expertise, capacity and oversight responsibilities, the DAE drafted the 'Nuclear Safety Regulatory Authority Bill' (NSRA 2011) which was introduced in the Lok Sabha by the United Progressive Alliance (UPA) government in 2011.

The Bill seeks to replace the AERB with the NSRA and calls for the establishment of a Council of Nuclear Safety (CNS) which will be under the stewardship of the Prime Minister. The CNS will be tasked with overseeing and reviewing the country's policies relating to nuclear safety.²³ The bill was not taken up for debate in Parliament and subsequently lapsed. Following a change of government in 2014, the bill now needs to be re-introduced in the Lok Sabha.

Even as the NSRA Bill is an improvement, it has also faced criticisms. For starters, the proposed legislation fails to clearly outline the independence of the regulator. Moreover, the Chairman of the AEC who is also the Secretary of the DAE will sit on the CNS. The CNS will appoint the search committee which, in turn, appoints both the Chairperson of the NSRA as well as other members of the NSRA. Thus, the Secretary of the DAE, the organisation which controls NPCIL, i.e. the operators of NPPs in the country—is involved in regulatory oversight and review of safety policy.

This is potentially an area of conflict of interest. Secondly, the Chairperson of the NSRA would also sit on the committee that selects the remaining members of the NSRA (of which there will be two full-time and up to four part-time members). This can compromise independent judgments because each member of the NSRA is required to independently evaluate each case. Last but not least, as per the Bill, members of the NSRA can be removed by an order of the central government, which once again raises concerns regarding the independence and freedom from governmental authority bestowed upon the NSRA.²⁵

The Public Accounts Committee (PAC) of Parliament produced a report in 2013 on the functioning of the AERB in which it stated that the “DAE should seriously re-examine the provisions of the (NSRA) Bill and take necessary steps urgently so as to ensure that the nuclear regulator becomes an independent and credible body at par with similar regulators in other Countries”.²⁶ Furthermore, the Parliamentary Standing Committee on Science and Technology, Environmental and Forests in their 221st report on the Nuclear Safety Regulatory Authority Bill, 2011 found that the Bill though meeting values of competence, stringency and transparency, was found wanting on the count of independence. The Standing Committee recommended several modifications to the DAE in order to ensure that the envisaged regulator is more independent and autonomous.²⁷

What Lies Ahead

It is unknown how many of the recommendations of the Parliamentary Standing Committee will be finally incorporated by the DAE when the Bill is reintroduced in Parliament. It is certainly true that the NSRA Bill proposes a structure that is a considerable improvement from the status-quo. The AERB was set up by governmental order whereas the NSRA would be established by Parliamentary Authority and will report to Parliament rather than the AEC. Nevertheless, considerable scope remains for strengthening the independence of a new nuclear safety regulator in India.

It is hoped that the IRRS report will act as a reminder of the urgent need for India to have an independent nuclear regulator as it seeks to significantly expand the capacity of civil nuclear power generation. This was also admitted by the Chairman of the AERB, Mr S.S. Bajaj who received the IRRS draft report when he said, “The Board is functionally independent from the Department of

Atomic energy (DAE) as well as from the influence of licensees, but there's scope for strengthening that independence by enacting an Act”.²⁸

The new government should encourage the DAE to adopt some of the proposed amendments to the NSRA Bill by the Standing Committee and the PAC reports, in particular: regarding the composition of the CNS, so as to not include the Secretary of the DAE; the composition of the search committee for remaining members of the NSRA to not include the Chairperson; and bringing procedures for removal of members of the NSRA in line with the practices of other regulatory bodies in India.

With regards to waste disposal strategies, while India operates a closed-fuel cycle which significantly reduces the amount of HLW required to be disposed of, nevertheless it will soon need to finalise its plans for deep level geological disposal. Across the world various countries are taking steps in this regard, with respect to site-selection and design of geological waste repositories. To date there has been no practical need for final HLW repositories, as surface storage for 40-50 years is first required so that heat and radioactivity can decay to levels which facilitate handling and storage.

However with first stage nuclear reactors around the world and in India soon approaching the end of their life cycle, finalising plans for final disposal of HLW is essential. A concomitant long-term strategy document on the treatment and disposal of radioactive waste would further strengthen India's capabilities and vision for its nuclear programme as well as improve public perception of nuclear power by tackling some of their key concerns. Furthermore, such a strategy document will help set the foundations for India's waste disposal and processing plans over the next few decades, as it significantly ramps up nuclear power generation.

Lastly, in order for the country to ensure continuing high standards of safety across the increasing number of NPPs in its territories, it is necessary to develop indigenous technical safety knowledge on the operation of nuclear power technology.

While the availability of skilled engineers and scientists for nuclear science research and operation of nuclear power plants is a universal challenge, it is particularly acute for India. A DAE projection exercise in 2006 estimated that the replacement of retiring personnel and increased manpower requirements for India's civil nuclear programme would mandate the training and requirement of about 700 scientists and engineers every year in R&D units and about 650 engineers every year in Public Sector and Industrial Units.²⁹

The PAC report on the AERB also noted the fact that capacity building is vital for effective regulatory practices, stating in their report: “Needless to say, the huge manpower shortage has left a

large gap in the regulating and monitoring regime. Taking note of the fact that capacity building is crucial for effective monitoring, the Committee hardly need to emphasize that the AERB need to augment their manpower requirement at various levels through appropriate recruitment and training policies based on periodic cadre review”.³⁰

Nuclear technology is cross-disciplinary, highly technical, and its education and knowledge development need to take into account concerns around safety, security and secrecy. The required infrastructure and resources are thus enormous. The initial human resource for India's nuclear programme was developed in-house by the DAE but five universities in India now offer post-graduate courses in nuclear engineering to go with the Homi Bhabha National Institute (HBNI) which was set up the DAE in 2004. Going forward, the increasing demand for manpower will only be met if the DAE continues to support universities offering nuclear energy related courses and helps more universities in India gear up to fulfil this need. One of the problems with any scale-up of nuclear education in the country is the lack of suitable faculty.

However, the IAEA has been initiating web-based education programs to address this difficulty worldwide. In Asia, the IAEA has set up the Asian Network for Education in Nuclear Technology (ANENT) to coordinate nuclear education. Leveraging such networks will be crucial if the DAE is to successfully stimulate nuclear knowledge development in the country.

The Indian government has also established the Global Centre for Nuclear Energy Partnership (GCNEP). The Centre is under construction presently but has already initiated off-campus training programmes and workshops. GCNEP will house five schools to conduct research: School of Advanced Nuclear Energy System Studies; School of Nuclear Security Studies; School on Radiological Safety; School of Nuclear Material Characterization Studies and School for Studies on Applications of Radioisotopes and Radiation Technologies. The Centre will be available for research projects of both Indian and visiting international scientists; training of Indian and international participants; hosting of international seminars; and development and conduct of courses in conjunction with the IAEA and interested countries.

Conclusion

This paper has sought to highlight the unique context in which India's nuclear programme and its regulatory structure has evolved. The conditions merited an unconventional approach to creating a strong nuclear safety climate where the focus was on a capabilities-based and not principle-based framework to address issues of nuclear safety and regulation. More than fifty years after India's first nuclear reactor attained criticality, the country once again stands on the cusp of a transformational opportunity. With international nuclear markets now open to India after the Nuclear Suppliers Group (NSG) India specific waiver in 2008, the country now has the opportunity to follow through on its ambitious plans for nuclear power generation.

While the regulatory structure and associated safety climate that unfolded with India's limited civilian nuclear programme has served it well for the past few decades and warrants its own contextual appreciation—which this paper has sought to illustrate - nevertheless, it is important that India integrates a principle-based approach to nuclear safety going forward. This will help in both laying strong foundations for a scale up of its civilian nuclear capacity and also in demonstrating to international nuclear suppliers that the country is adopting and practicing best practices of nuclear safety.

For this to happen, one of the first necessary steps is the reintroduction of a modified NSRA bill in the Lok Sabha which must be passed expeditiously. Secondly, India must take on board the recommendations made by the IRRS to develop a strategy document outlining the approach to treatment and disposal of radioactive waste as well as move forward on the selection of a final geological repository for HLW.

To conclude, India has the potential to not only substantially increase its civil nuclear capacity, thereby making important strides to address its energy shortfall, but it also has an opportunity to develop itself into a world leader in nuclear technology over the coming decades. This could create a pathway for India to become an exporter of nuclear technology at some point in the future, a position that would have many positive geopolitical ramifications for the country. For this to happen, the country's nuclear establishment must pivot away from a strategy of nuanced, inward-looking safety culture to a more global and principled approach.

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