CHAPTER- 5

India and Nuclear Power Safety Standards

This chapter is very significant from point of view of safe and planned realization of India’s dreams of expansion of nuclear power. As nuclear power generation is based on dual use technology and is fraught with many types of risks of varied nature. There are two significant aspects related with it, one is the international safeguard system under IAEA which had an important role first in imposing certain sanctions on India for more than three decades. When India conducted its peaceful nuclear explosion in 1974, it has to face sanctions of nuclear technology denial. Then when India exercised its nuclear option in 1998 under peculiar security environment and after facing stringent sanctions Indo-US civilian nuclear deal was signed in 2008 and got a waiver from the NSG. With these developments India became an equal partner in resuming international nuclear commerce. The second aspect is related with issues like nuclear safety and security, public concerns, environmental impact, nuclear waste management, radiation releases, emergency preparedness, and liability of nuclear power plants in India.

The nuclear accidents, The Three Mile Island 1979 in the US, Chernobyl 1986 in the erstwhile USSR and the recent Fukushima incident 2011 in Japan have revealed to the world, the dangers of nuclear energy, especially in the negligence of nuclear safety and security standards.\(^1\) Nuclear safety should be foremost priority of any state if it wishes to go for nuclear power expansion. In case of India when it is planning for massive expansion in the field of nuclear power. There should be appropriate structural and procedural modifications, so that regulatory bodies are in sync with international bodies mainly IAEA. Further the radiation leak in the Fukushima incident of 2011 in Japan has raised safety concerns with regard to expansion of nuclear power in India. This has compelled nuclear industry in India to make a revisit of crisis management plans. There are obvious questions like; how good are the safety procedures? How quick are the

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evacuation plans in case of any nuclear incident? On the positive side nuclear scientists and experts opine India’s nuclear plants have fool-proof safety profiles and they have been designed with worst case scenarios in mind.²

**Idea of Safeguards**

The idea for safeguards germinated with the 1945 joint declaration of United States (US), the United Kingdom (UK), and Canada for exchanging fundamental scientific literature about nuclear energy.³ The first resolution on atomic energy adopted by United Nations General Assembly 24 January 1946 established the United Nations Atomic Energy Commission “which shall make specific proposals: for control of atomic energy to the extent necessary to ensure its use only for peaceful purposes; for effective safeguards by way of inspection and other means to complying States against hazards of violations and evasions”.

The proposal caught the imagination of UN General Assembly and the world after a speech made by President Eisenhower on December 08, 1953(470th plenary meeting)⁴ and it is significant at that time that “such an agency would be set under the aegis of the United Nations”. Subsequently, The Prime Minister of India, speaking in the Indian Parliament on 10 May, 1954 also welcomed this new development regarding harnessing of atom for peaceful purposes⁵ said, “The President’s speech is worthy of our respect and careful attention. We welcome the entire approach of President Eisenhower in this matter. The use of Atomic energy for peaceful purposes is far more important for a country like India than it may be for other advanced countries.”

The proposal of peaceful uses of Atomic Energy was important, as it was to create great changes in the economic and political relations of the world. The benign atoms were to be sold as a panacea for all the intractable problems of the world now the atoms for peace were atoms for dollars. A multibillion dollar world nuclear market was opening up.

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⁴ *Statement by Krishna Menon in the UN general Assembly*, October 06, 1954.
⁵ *Statement by Krishna Menon in the First Committee of UN*, November 17, 1954.
In the 1950s the international community predominantly realized the prospect and potential of nuclear energy. The creation of International Atomic Energy Agency (IAEA) in 1957 helped in the institutionalization of idea of safeguarding atom. In this regard India being the only country in negotiating group from Asia and Africa, the delegates were deeply conscious of India’s responsibility to look after the interests of vast areas. The proposed composition of Board of Governors needed to be given adequate representation to various regions of the world.\(^6\)

The statute of IAEA was adopted unanimously on October 23, 1956 and its significance was far beyond the acceptance of the wording of the statute but also for the concern of the Government of India for the values India intended. Finally the statute came into force on July 29, 1957 headquartered at Vienna. India had accepted article XII on safeguards but also pointed out that in this regard much depended on the way they will be operated by the agency\(^7\).

**International Safeguard Regime**

The International Atomic Energy Agency was originally intended to be a kind of broker for controlled nuclear assistance and trade. Since 1957 the IAEA has—according to its mandate—ensured that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.\(^8\) These measures are also referred to as ‘traditional safeguards.’ Another set relates to the measures endorsed or encouraged by the IAEA Board of Governors since 1992 for strengthening the safeguards system.

The safeguards system comprises of an extensive set of technical measures by which the IAEA Secretariat independently verifies the correctness and the completeness of the declarations made by States about their nuclear material and activities.\(^9\) One set of measures relates to the nuclear material verification activities performed at facilities or other locations where States have declared the presence of nuclear material subject to

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\(^7\) Statement by Indian Representative Lall at Conference on the IAEA Statute, October 23, 1956, PP.74-75.

\(^8\) Article 2 of the statute of IAEA.

safeguards. As the world’s nuclear inspectorate, the IAEA performs an indispensable role in furthering nuclear non-proliferation.\textsuperscript{10}

Presently IAEA conducts four types of on-site inspections which are as under\textsuperscript{11}

- \textit{Ad hoc Inspections}: This is conducted to check the declared report of nuclear material.
- \textit{Routine Inspections}: The most common inspections conducted to a defined schedule. It may be unannounced and short-noticed.
- \textit{Special Inspections}: It is conducted in extraordinary circumstances when the IAEA feels that a country’s report on nuclear material is not adequate enough to fulfill the responsibilities of the safeguarding agreement.
- \textit{Safeguard Visits}: These are conducted on declared facilities to ascertain pertinent design data.

Safeguards are activities by which the IAEA can verify that a state is living up to its international commitments not to use nuclear programs for nuclear-weapons. The global Nuclear \textit{Non-Proliferation Treaty} (NPT) and other treaties against the spread of nuclear weapons entrust the IAEA as the nuclear inspectorate.\textsuperscript{12} Today, the IAEA safeguards for nuclear material and activities under agreements with more than 140 States.

The nuclear material verification activities are performed at facilities or other locations where States have declared the presence of nuclear material subject to safeguards were referred to as \textit{traditional safeguards}. Another set related to the measures endorsed and encouraged by the IAEA Board of Governors since 1992 for strengthening the safeguards system. These measures fall into two categories.\textsuperscript{13}

The first category comprises those measures to be implemented under the legal authority conferred by existing safeguards agreements. The second category comprises measures to be implemented under the complementary legal authority conferred by

\textsuperscript{10}\url{http://www.iaea.org/Publications/Factsheets/English/S1_Safeguards.pdf}, retrieved on, 18 August 2014
\textsuperscript{11} Fischer David “Nuclear Safeguards: the First Steps”, \textit{IAEA Bulletin 49/1}: 7, September, 2007
\textsuperscript{13} ibid
Additional Protocols concluded on the basis of the Model Additional Protocol. International Safeguards have chiefly come to mean an arrangement under which \textit{International Atomic Energy Agency} (IAEA) verify a pledge by a state that it will not use its nuclear activities to make a nuclear weapon with military intentions.

In 1998, the IAEA's Department of Safeguards embarked upon a program for the development and implementation of integrated safeguards. This term refers to the optimum combination of all safeguards measures available to the Agency, including those from the Additional Protocol, in order to achieve maximum effectiveness and efficiency within the available resources. The world nuclear community has made noteworthy progress in strengthening nuclear safety in 2012, as promoted by the IAEA Action Plan on Nuclear Safety (hereinafter referred to as the Action Plan).

\textbf{Safeguards, Non Proliferation Treaty \& India}

The State-level approach to safeguards implementation is based upon a continuous and comprehensive evaluation of all information. State must be able to optimize the collection, categorization and storage of that information. Building a nuclear security framework, which is suitable for today and sustainable for tomorrow, is a widely held priority of the international community.

The possibility that nuclear or other radioactive material could be used for malicious purposes is real. Here is a need for a collective commitment to the control and accountancy for, material, as well as to adequate levels of protection in order to prevent criminal or unauthorized access to the material or associated facilities.

In 2001, the Board of Governors tasked the IAEA with improving nuclear security worldwide. The report of IAEA has established a comprehensive nuclear security program; first the Nuclear Security Plan of 2002–2005 and the second plan in between 2006–2009. The comprehensive plans included developing internationally accepted nuclear security guidance, supporting international legal instruments, protecting material

\footnote{The IAEA Action Plan on Nuclear Safety was approved by the Board of Governors on 13 September 2011, and endorsed by the General Conference during its 55th regular session on 22 September 2011. This document is available at http://www.iaea.org/newscenter/focus/actionplan/reports/actionplanns130911.pdf.}
and facilities, securing transport and borders, detecting and interdicting illicit nuclear trafficking, strengthening human resource capacity and preparing response plans should a nuclear security event occur.

The IAEA has begun the implementation of its third Nuclear Security Plan, completed in 2013. This approach to nuclear security included an effective national nuclear security regime to be built on a number of factors: i.e. the implementation of relevant international legal instruments; IAEA guidance and standards; information protection; physical protection; material accounting and control; detection of and response to, trafficking in such material; national response plans and contingency measures.

Denis Flory Deputy Director General of the Department of Nuclear Safety and Security Foreword observed that since the 1970s, the IAEA has been hard at work providing assistance to States and supporting their national efforts to establish and improve nuclear security. There have been reports of illicit trafficking in the 1990s. For that the IAEA Security of Material Programme was created to reflect a more comprehensive approach by incorporating detection and response measures into the existing scope of work.

The risk that nuclear or other radioactive material could be used with malicious intent is regarded as a serious threat to international peace and security. Effective national systems for nuclear security are central to facilitating the peaceful use of nuclear energy and enhancing global efforts to combat nuclear terrorism. Today, nuclear security activities take place all over the world with even more intensive coordination and technical support than ever before. There is need for cooperation and support to evolve a ‘nuclear security culture’ that should transcend borders and provides a common basis for understanding and action at local, regional and global levels.

The nature of threat is global so the response must be global. There is a need to continue the work towards strengthened nuclear security measures at all levels and in all States. What all is needed is universal ratification and implementation of international legal instruments relating to nuclear security in general and the 2005 Amendment to the
Convention of the Physical Protection of Nuclear Material, the introduction of detection and nuclear forensics techniques supported by the scientific community, capacity building including education and training, and the promotion of research and development needs. Enhanced coordination and cooperation, the sharing of technical expertise and response preparedness for any location is also vital.

India did not join NPT, it was not under compulsions to embrace the safeguards arrangements structured for NPT member countries. Nuclear Non-Proliferation Treaty (NNPT) is an international treaty whose objective is to prevent the spread of nuclear weapons and weapons technology, to promote cooperation in the peaceful uses of nuclear energy, and to further the goal of achieving nuclear disarmament. Opened for signature in 1968, the Treaty entered into force in 1970.\(^{15}\) On 11 May 1995, the Treaty was extended indefinitely but India has always felt that this treaty in discriminatory and does not address India’s concerns.

Earlier India continued to stick to type 66 safeguards arrangement for its nuclear facilities as is the case with Pakistan and Israel the other two non NPT signatory countries.\(^{16}\) As the name suggests it was the second revised version of original document. This document was revised before the advent of NPT. Despite inadequacies in the document, some critics found, “In a few respects INFCIRC/66/ Rev.2 provides the basis for more extensive or effective safeguards than later model of NPT safeguards”\(^{17}\).

Now, India has evolved its approach towards safeguard system now. Earlier it considered the safeguard system as a spider’s web. Now it has accepted safeguards in some of its facilities. India has now been attaching great importance to safeguards activities, and quite active in IAEA meetings.\(^{18}\) The 18 July, 2005 joint statement issued by Prime Minister Manmohan Singh and the US president George Bush paid considerable attention to safeguard arrangement. India has embraced safeguards on 14 of its nuclear facilities.


India has now the same responsibilities, practices and can acquire the same benefits and advantages so as other leading countries like United States after voluntarily placing civilian nuclear facilities under IAEA. So far India has signed international safeguards with only one inspection agency—IAEA. The use of the phrase – other leading countries with advanced nuclear technology, such as the United States—gives an impression that for all practical purposes, India had been accepted as a nuclear weapon state, at least for nuclear commerce\textsuperscript{19}. But the later statements from US indicated that India has not been given full privilege. The Hyde Act and the on123 agreement used the term safeguards in perpetuity.

Among these growing fears and anxieties resulted in establishment of the International Energy Agency (IAEA) in 1957. Since then safeguards has been indispensable component of non-proliferation regime and has facilitated peaceful nuclear cooperation. This system of safeguard is authorized under Article III of the NPT. Under this model the State has to allow safeguards on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for exclusive purpose of verifying that such material accountancy to the combination accountancy, containment and surveillance\textsuperscript{20}.

**Safeguards and Indo-US Civil Nuclear Cooperation**

India had advocated very early the need for creating International safeguards against misuse of nuclear technology. These safeguards were demanded for all countries, whether in possession of nuclear technology/weapons or not. India’s first Prime Minister Pt. J.L. Nehru ascertained that the right of every nation should have access to nuclear technology for peaceful purposes. India signed the Moscow partial Test Ban Treaty in 1963 because it was designed to save mankind from the hazard of increased atmospheric radiation that always results for uncontrolled and open nuclear explosions conducted by nuclear states.

\textsuperscript{19} Ibid. p.93
\textsuperscript{20} International Atomic Energy Agency, *The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on Non-Proliferation of Nuclear Weapons*, INFCIR/153, June, 1972, P.1.
The system of safeguards is authorized under Articles III of the NPT. This model asks a state to allow safeguards on “all source or special fissionable material in all peaceful nuclear activities within a territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.” The IAEA is responsible for providing assurances to the international community that states are in compliance with their commitments to use nuclear material, equipment and technology for peaceful and non-explosive purposes. Through its safeguards system it deters the proliferation of nuclear weapons, by detecting early the misuse of nuclear material and technology. These strategic objectives apply to all States with a Comprehensive Safeguards Agreement in place, whether they implement an Additional Protocol or not.

The assumption underlying the traditional safeguards system is that every State with a civil nuclear program, by virtue of being able to divert nuclear material to non-peaceful uses, poses a potential proliferation threat. On that basis, therefore, safeguards measures have been applied to nuclear material and associated facilities without differentiation. Moreover, safeguards apply to all nuclear material and activities in a State, the agency’s primary activity has concentrated on verifying the correctness of that which the State has declared to the Agency.

To that end India created a criteria-based safeguards system. The proliferation risk is associated with the amount of declared nuclear material that a State possesses or the number and type of declared facilities. The major proliferation challenges have arisen in States with limited nuclear fuel cycle facilities. In the traditional safeguards system there was no real assessment of risk beyond the type and amount of declared nuclear material. It signifies the shift in the focus of safeguards implementation from mere accountancy to the combination of accountancy, containment and surveillance.

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Nuclear Security Framework

Nuclear security is the prevention, detection, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities. There are currently 30 countries that operate more than 435 nuclear power plants.25 Hundreds of thousands of high activity radioactive sources are in use in medicine and industry. The IAEA Annual Report 2013 stated that more than 172, 000 significant quantities of nuclear material were declared to the IAEA. With material and interest, there is risk that demands continuous attention. Security of nuclear material, in particular High Enriched Uranium (HEU) and plutonium, has always been a priority of the international community. Earlier it was assumed that radioactive material was self-protecting, in that the radioactivity itself would act as a deterrent and that the use of material in terrorist acts was beyond the scope of possibility for any one person but now this has also become a possibility.

The attacks of September 11, 2001 on World Trade Centre and the similar terrorist attack in Mumbai, November 26, 2008 redefined the context of nuclear security in terms of possible use of nuclear materials in conducting acts of terrorism. Radioactive material could potentially be a tool used for malicious purposes. This understanding dramatically accelerated work to improve nuclear security, which was recognized as being a vital but also very difficult task. In this new light, the need to secure vulnerable material, wherever used, stored, or transported, was urgent. Equally, a new framework for nuclear security had to be defined and established to ensure that the benefits from nuclear energy and nuclear applications would continue, but without the material and associated facilities being used with malicious intent. The IAEA assists States, upon request, in making their nuclear security programs robust, sustainable and effective. It ensures a global response to a global threat.

There is threat of theft of nuclear material being used in nuclear power generation as well as manufacture of nuclear weapons. It can be used for use in improvised explosive devices along with other radioactive material for use in Radiological Dispersal

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**Devices** (RDDs). Sabotage of nuclear installations or transport cannot be ruled out and poses the big risk. It goes to the extent that state should recognize *the threat of nuclear terrorism* and should take preventive measures in advance. In case of any complacency in understanding the problem, the terrorists will find and exploit the weakest link in any security system. Given the high number of possible targets and scenarios, nuclear security demands a comprehensive approach. Finding solution with help from the IAEA states; prevent people from gaining access to material and using it with malicious intent.

**Nuclear Safety Summit and Nuclear Power**

The Third Nuclear Security Summit was held in *The Hague*, at Netherlands, on March 24 and 25, 2014. The 2014 summit was attended by 58 world leaders, some 5,000 delegates and some 3,000 journalists. The representatives attending the summit included U.S. President Barack Obama and Chinese President Xi jingping.

The global nuclear security framework encompasses, inter alia, the binding and non-binding international legal instruments, the nuclear security guidance and standards developed and published by the IAEA in the Nuclear Security Series, and the mechanisms for their application and use. For the implementation of the framework, a State may establish a national nuclear security regime, which also recognizes the practical and institutional arrangements needed for its implementation. IAEA’s legal or regulatory assistance in the field of nuclear security is available to States upon request. This includes help to facilitate adherence to specific treaties and to establish national legislative and regulatory systems. A particular challenge in this area is that the legal framework is built on several international legal Instruments.

The sovereign rights of States in relation to their acceptance, or not, of international treaties may delay the establishment of a common, universal foundation for nuclear security. The IAEA has published an overview of, and information on, the legal instruments that are relevant for nuclear security and related obligations and responsibilities, both for States and for the IAEA.
The Nuclear Security Series of publications helps States to meet the requirements set out in international legal instruments. Sixteen publications, produced since 2006, provide practical guidance and standards for nuclear security at facilities, for transport or for areas outside of regulatory control.

The Recommendations on the Physical Protection of Nuclear Material and Nuclear Facilities have also been established as the 5th revision of INFCIRC/225(Information circular). The IAEA offers peer reviews and advisory services, missions and technical visits, to help States evaluate their nuclear security systems against the requirements and practices identified in the nuclear security framework, the legal instruments and the internationally accepted nuclear security guidance outlined in the Nuclear Security Series publications.

IAEA peer reviews and advisory missions are recognized as important tools in building confidence with the general public in a country and with its neighbors. The IAEA works towards having evaluation services that are useful and used regularly by all States. Making sure people have the right know-how. Developing human resources is essential to advancing a State’s nuclear security system.

The IAEA offers general training, specialized training and training of trainers in the areas of prevention, detection and response during 2002–2011 IAEA training reached over 10 200 persons in some 120 States Education and training is geared towards a varied audience ranging from nuclear regulators, facility operators, carriers, customs officers, police and border forces to instructors and research institutions.

Nuclear security involves protecting nuclear materials in order to guard against theft or diversion and preventing sabotage of nuclear facilities. It entails physical protection, the deployment of guards to confront on-site threats and to respond from off-site to emergencies, as well as the use of automated systems to prevent unauthorized persons from gaining access to nuclear materials.

The conference was aimed to improve international cooperation and more specifically to assess the objectives that were set at the previous summits in Washington, D.C. and Seoul had not been accomplished in the previous four years. The success can
be gained by reducing the amount of dangerous nuclear material in the world - especially Highly Enriched Uranium (HEU); and also improving the security of all nuclear material and radioactive sources; improving international cooperation.

India participated in Nuclear Security Summit process, but thus far the results of its engagement are mixed. The summits elicited commitments to stronger security measures but failed to convince New Delhi to increase transparency regarding its nuclear security practices.\textsuperscript{26} Till now the summits have not been able to break through India’s penchant for secrecy on what it considers to be matters of national security, so the country’s nuclear security arrangements remain somewhat opaque.

\textbf{India Specific Safeguard Agreement}

India decided to ratify the additional protocol to Indian specific safeguard agreement was a signal that the country will abide by its international obligations.\textsuperscript{27}

The Spokesperson in the External Affairs Ministry said, "\textit{Let me confirm to you that the government has decided to ratify the additional protocol to Indian specific safeguard agreement. We had signed this earlier, what we have decided is to take next step of ratification. This is a signal of our commitment to abide by our international obligations}". The commitment to ratify the agreement was given under Indo-US nuclear deal by the previous dispensation to grant greater ease to IAEA to monitor India’s civilian atomic program. The IAEA in March 2009 approved an additional protocol to India’s safeguards agreement consequent to a pact reached with the agency the previous year to place its civilian nuclear facilities under IAEA safeguards.

That agreement had paved the way for the 45-member \textbf{Nuclear Suppliers Group} (NSG) to grant India-specific waiver for it to have commercial relations with other countries in the civilian atomic field. The waiver was necessary as India, despite being a nuclear-armed state, is not a signatory to the NPT. The ratification is a signal by the Narendra Modi government to the world, particularly the US, that it is serious in continuing to implement the Indo-US nuclear deal.

\textsuperscript{26} Chari P.R. http://carnegieendowment.org/2014/03/18/india-s-role-in-hague-nuclear-security-summit
\textsuperscript{27} \textit{Press Trust of India}, June 23, 2014.
Nuclear Liability Regime

In the 1950s, when nuclear power was in its infancy, Western States acknowledged that the consequences of a nuclear accident would not stop at geographical borders. Because of the trans boundary effects of a nuclear accident, nuclear liability regimes were created under the auspices of the OECD and of the United Nations to compensate victims equitably.\(^{28}\)

Now a set of international conventions have emerged which are designed to provide compensation for damage arising from nuclear incidents. These conventions, which form an international nuclear liability regime, include: the Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960 (Paris Convention); the Convention Supplementary to the Paris Convention of 1963 *Brussels Supplementary Convention*,( BSC); and the Convention on Civil Liability for Nuclear Damage of 1963 (Vienna Convention). All these conventions have been amended by protocols.\(^{29}\) In particular, there is the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention of 21 September 1988, which bridges the gap between the Paris Convention and the Vienna Convention and extends the rights under the one Convention to victims in the territory of the other Convention.

There is also the *Convention on Supplementary Compensation* (CSC) for Nuclear Damage of 12 September 1997, which was developed as an umbrella for the other international liability conventions and to provide the basis for a global nuclear liability regime that could attract broad adherence from countries with and without nuclear power plants. Consequently, it is appropriate to ask whether more States should join the international nuclear liability regime. The answer to this question depends on an assessment of the pros and cons of adherence to the international nuclear liability regime.

\(^{28}\)http://www.wnti.co.uk/media/13831/8.pdf, World Nuclear Transport Institute(WNTI)

CONVENTION ON SUPPLEMENTARY COMPENSATION

On comparison of various provisions of CSC to that of the other international conventions, it can be found that it is beneficial for India to join CSC. The reasons for the same are given as under:

Firstly, CSC has enhanced the definition of ‘Nuclear Damage’ by explicitly identifying five additional categories of Damage relating to impairment of environment, preventive measures and economic loss that must be compensated (as provided in Article I of the CSC).

Secondly, CSC updates the principle of Exclusive Jurisdiction to cover not only nuclear incidents in the territory or territorial sea but also nuclear incidents in its EEZ (as provided in Article XIII of the CSC).

Thirdly, CSC assures availability of an adequate amount of compensation. It provides for a three tier of compensation as provided in Article III (1) of the CSC.

The enactment of long felt need for a civil nuclear liability law in India has come as a good instrument in the absence of an appropriate legal framework to establish liability and ensure swift compensation in the event of a nuclear accident. Furthermore, pursuant to the Indo-US nuclear cooperation agreement, India had supposedly avowed to adhere to the Convention on Supplementary Compensation (CSC) for Nuclear Damage that requires signatory states to legislate a compliant domestic liability law.\textsuperscript{30} CSC has been signed by India and is to ratify will require that domestic nuclear liability of the country should be consistent with the provisions laid down in the Annex of the CSC, which include the ‘Right to Recourse’

Civil Liability and India

India is learnt to have made it clear to United States that there will be no change in nuclear liability law, India tells US\textsuperscript{31} as it has serious reservations with this law.


\textsuperscript{31}The Tribune, New Delhi, August 5, 2014.
two countries would have to work with in ‘four corners’ of the Indian Civil Liability. The US and other nuclear partners of India like Russia and France have also objected to section 17(B) of the Act, saying it runs contrary to the International Convention on Supplementary Convention on Nuclear Damage. Thus, CSC requires domestic liability laws to confirm to a model text but the Indian text is tougher as it allows legal action against suppliers if any accident is caused by faulty or defective equipment.

**The Civil Liability for Nuclear Damage Bill, 2010:** This bill has elicited a multitude of responses from various sections of Indian public. There is need to put the bill in some perspective in relation to the India’s energy security in terms of nuclear power production. The protection that need to be afforded to the Indian public, the advancement of Indian nuclear industry in the global market, taking into account all the national and international factors. The need for a civil nuclear liability law has been long felt in the absence of an appropriate legal framework to establish liability and ensure swift compensation in the event of a nuclear accident. Furthermore, pursuant to the Indo-US nuclear cooperation agreement, India had supposedly avowed.\(^3^2\)

India's nuclear liability act, passed in 2010 evoked protests from US nuclear companies, as they wanted to start business in India. India's liability provisions, they believed, would impose too many liabilities on them as suppliers. But Indian lawmakers decided, in the background of the Bhopal case, that there was a need to hold foreign companies down to paying damages in case of a nuclear accident.

Nuclear energy will become vital for India’s energy security in the times to come. Some experts estimate that by 2050 India may have to depend largely on solar and nuclear energy to meet the growing needs. So a legal framework to facilitate development of nuclear energy in a safe and efficient manner is essential to meet this end.

Since its enactment in September 2010, India’s Civil Liability for Nuclear Damage Act (CLNDA) has been a subject of intense debate and controversy.\(^3^3\) The suppliers are concerned over the liability stipulated in the Act has supposedly deterred

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\(^3^2\) *Times of India*, New Delhi, June 22, 2011.

both international and domestic suppliers to supply reactors and components for upcoming nuclear power projects.

The impasse might derail the ambitious nuclear energy expansion plans to cater to this the government is working on various policy and legal options to resolve the issue at the earliest. India’s Prime Minister’s visit to US in October 2014 assured US administration to take corrective action.34

There is a set of international conventions which are designed to provide compensation for damage arising from nuclear incidents. These conventions, which form an international nuclear liability regime, include: the Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960 (Paris Convention); the Convention Supplementary to the Paris Convention of 1963 Brussels Supplementary Convention, and the Convention on Civil Liability for Nuclear Damage of 1963 (Vienna Convention).

All these conventions have been amended by protocols.35 Consequently, it is appropriate to ask whether more States should join the international nuclear liability regime. The answer to this question depends on an assessment of the pros and cons of adherence to the international nuclear liability regime.

Should nuclear power generation contribute substantial portion of the increasing demand for electric power in India? This question has been discussed in the introduction and first chapter of the thesis. Progressive efforts towards finding feasible solutions may hence entail some out-of-the-box thinking and exercising innovative policy options with a political resolve. Going by the current debate, it seems the supplier liability provisions have been unduly demonized without appreciating the government’s obligation of having to safeguard the public interest before expanding the country’s nuclear energy sector.

34 Kokodkar, Anil, ”Nuclear Power Investors Need Clarity on Liability,” The Economic Times, New Delhi, October 15, 2014.
Now, without clearing this impasse there won’t be any nuclear power plants in India and we cannot do without a liability bill. The NPPs will be in public sector and the public will bear the bill in any liability claim. It is felt that import of such reactors will contribute substantially to the increase in the share of nuclear power. In any case are these imports possible without a liability bill that confirms to the criteria set by international conventions.

American suppliers have for long been insisting on India’s early ratification of the CSC, which, they believe, would protect them from any liability since the US does not recognize Right to Recourse (RoR) by a CSC signatory country against its suppliers.36

Russia has promised to supply 12 reactors to India as has been declared by Russian President Vladimir Putin when he paid a visit for 15th bilateral Indo-Russia summit in December 2014. But the Russian suppliers have also been demanding an exemption from Indian law, based on the Intergovernmental Agreement (IGA) between India and Russia of December 5, 2008, which holds the operator fully responsible for any damage caused within and outside Indian Territory. Indian suppliers also have expressed reservations over the liability law and are reluctant to enter into contracts to supply components for the proposed Pressurized Heavy Water Reactor (PHWR) projects.

Nuclear machinery suppliers in India have also expressed reservations over the liability law and are reluctant to enter into contracts to supply components for the proposed Pressurized Heavy Water Reactor (PHWR) projects.

**Necessity and Impact of the Bill:** This is in-fact was one of the last steps needed to activate the Indo-U.S. Civilian Nuclear Agreement 2008, as the US nuclear reactor manufacturing companies require to know the provisions relating to the Liability of the parties, in case of a nuclear accident. The Bill, in the present form, is contained in 28 pages. It has 7 chapters constituted of 49 clauses and also ‘statement of objects and reasons’ and ‘notes on clauses’ following plus two memoranda.

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The government spokesperson had stated that various reputable international suppliers i.e. from France, Russia, U.S. etc, require India to enact a civil liability regime based on established international principle. So, in order to meet this requirement, it was necessary for India to enact a Nuclear Liability Act. India also has to become a signatory to a convention on nuclear liability so as to declare that it complies with the established international practice on the same. Even the Statement of Objects and Reasons of the Bill states that the Bill is meant to facilitate India’s entry into an international nuclear liability regime. It explicitly states that India intends to join the Convention on Supplementary Compensation for Nuclear Damage i.e. CSC, which was adopted in 1997.

The Indian Civil Liability for Nuclear Damage Act, 2010 is important step for India for its burgeoning nuclear power expansion program. India entered the nuclear arena very early and realized the potential of peaceful applications of nuclear energy and embarked on a well conceived plan to reap the benefits of this new science in the spheres of agriculture, medicine and energy.

The 1962 Atomic Energy Act under which Indian nuclear program has developed is silent on the subject of compensation to victims of nuclear accident. Now, till the passage of the Civil Liability for Nuclear Damage Bill in 2010, there was no regulatory mechanism or legislative provision in India for dealing with claims arising out of nuclear incident.

Although, the exercise has begun for the crafting of such a liability legislation in 2000, when the DAE assigned to the Board of Research in Nuclear Studies under Prof. S. Rajgopal of National Institute of Advanced Studies, Bangalore and V.B. Countinho, Professor at Government Law College, Bangalore to undertake a study on nuclear liability regime and related issues. The report was submitted in 2001 examined the international regimes in force and suggested that it was time for India to establish a

37 The Civil Liability for Nuclear Damage Act, 2010. The Bill was Introduced in the Parliament on May 7, 2010 and Passed by Lok Sabha on August 25, 2010, the Rajya Sabha on August 30, 2010 and received the President’s Assent on September 21, 2010.
domestic legal mechanism to provide compensation to victims of nuclear incident. Even the trans-boundary possibilities of nuclear accident were explored and Kudankalam Nuclear power Station was fit case for that.

It was evident only after the relaxation of the NSG guidelines, that foreign suppliers were keen to enter India for providing nuclear power reactors and nuclear fuel and enable Indian nuclear power program to expand. At this juncture the government felt that it was essential to provide liability protection to enable nuclear industry, both domestic and foreign, to participate in the planned expansion.

On the other hand the legislation became a necessity to become a legitimate member of international liability regime in the case of *Convention on Supplementary Compensation* (CSC).

Accordingly the bill that was introduced in the Parliament fully compliant with the requirements of the CSC and in particular the provisions of its Annexure and particularly Article 10 of the Annexure on the right to recourse, which stated clearly that, “National law may provide that the operator shall have the right to recourse only: (a) if this is expressly provided by the contract in writing; or (b) if the nuclear incident results from an act or omission done with intent to cause damage against the individual who had acted or omitted to act with such intent.”

Right to recourse in this case means the operator will be liable to first, compensate the victims, in case of nuclear accident, and after having compensated the victims in the line of its own liability, will have the right to sue the suppliers if there is enough proof of faulty/sub-standard supplies being the primary cause of accident. The Indian draft bill had an additional circumstance under which the Right to recourse could be exercised.

However, an examination of the nuclear liability laws in countries that are not party to either of the international conventions show that the India draft formulation of

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the operators ‘right of recourse’ was not unusual or unique i.e. South Korea has the similar condition.

Hence while Section 17(b) of the Indian draft bill may be contrary to the requirements of CSC and the international conventions, that may by its self is no bar against foreign suppliers supplying nuclear items to India. The ongoing stalemate could primarily be attributed to Section 17(b) of the CLNDA, which has a wider ambit than the two RoR clauses stipulated in Article 10 (Annex) of the CSC, namely:

(a) the RoR should be expressly provided for by a contract in writing, and

(b) if the nuclear incident results from an act (commission or omission) done with intent to cause damage.

The intricacy about CLNDA is that it specifies through Section 17(b) the possible conditional ties (act) leading to the incident as including even patent or latent defects in materials or equipment or sub-standard services. Though suppliers perceive it as an onerous provision, this additional provision, when read together with other clauses in Section 17, only comes as a natural sequence wherein it is elaborated that RoR could be invoked after establishing the nature of the supplier’s act, arising from his intent to cause damage.\(^{41}\)

Article 10 of the CSC specifies that the RoR can be applied only with two provisions: that it should be provided for in the contract and that intent to cause damage should be established. The emphasis on only could be seen as both an enabler as well as a limitation. The Convention requires signatory nations to formulate national legislations to provide for a liability framework, which should be consistent with it. Irrespective of whether the CSC provisions nations are expected to exercise due diligence in safeguarding their own public interests when formulating such legislations. The suppliers are apprehensive about potential legal challenges to the Act or Rules notification in Indian courts, especially since the Supreme Court has accepted a petition challenging the constitutional validity of CLNDA. Though it is unlikely that the Supreme Court will

\(^{41}\)Kumar, A. Vinod & Patil, Kapil, "Resolving India’s Nuclear Liability Impasse", *Defence Studies and Analyses*, December 06, 2014.
override a legislation passed by Parliament, the Court’s interpretation might be crucial on the Rules notification. 

In opinion of some legal experts Rule 24(2) is *ultra vires* for scaling down the liability limits and timeline and hence could be inconsistent with Section 6 of CLNDA.

**Liability Limits:** The maximum limit in case of current Nuclear Liability Act as *Special Drawing Rights* (SDR) 300 hundred million in rupees and the operator liability is different for each nuclear incident. According to Section 6(2) of the Nuclear Liability Act, the liability of an operator in respect of nuclear reactor having thermal power equal or above 10MW shall be rupees 1500crore, where as that of spent fuel reprocessing plants is Rs 300 crores.

Of the 28 countries that operate NPPs and have some liability laws; only in four countries is the maximum liability for a nuclear accident higher than the Indian limit of SDR 300 million. In 24 countries the maximum liability is less than or Equal to Indian maximum liability.

**Section 17(b) implication: Foreign and Domestic**

For politico-ideological reasons, sec 17(b) of the draft bill when passed by the Parliament was amended to read:“(b) the nuclear incident has resulted as a consequence of an act of supplier or his employee, which includes supply of equipment or material with patent or latent defects or sub-standard services;” omitting the qualifier, “the willful act or gross negligence.” This has some serious implications for the future development of India’s nuclear power program.

(i) **Foreign:** After NSG exemption was granted to India in September 2008, India entered into a number of bilateral agreements with the exception of jump starting of nuclear power program with the import of number of light water reactors. Various sites were allotted to Russia, France and USA for 26 light water reactors with a capacity of 30,000

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MWe and work was expected to start on early. Yet even after more than four years the import of any light water reactor – even for the two additional Russian reactors at Kudankulum where already two such reactors are ready to be commissioned.

The Primary reason for this has been Sec. 17 (b) of the Indian Act. All foreign vendors have expressed their unwillingness to supply reactors to India because of this provision. A case in point is the India France agreement for nuclear cooperation signed in2008. This agreement states that:

The parties agree that, for the purpose of compensating for damage caused by a nuclear incident involving material, nuclear material, equipment, facilities and technology referred to in Article IX, each party shall create a nuclear liability regime based upon established international principles (Article VIII (2) of India France Cooperation Agreement on development of peaceful uses of nuclear energy).

The French government had long insisted on such a liability regime before agreeing to supply nuclear items. This is the main reason why in-spite of India-France agreement on nuclear cooperation, the contract of Jaitapur NPP in India has not yet been concluded. China has put in place such a liability regime in March 1986, only to address the concern of foreign suppliers.

In a decision in respect of another dispute the International Court of Justice (ICJ, in its advisory opinion held that Court considers that signature constitutes a first step to participation in the convention. It is evident that without ratification, signature does not make the Signatory State a party to the Convention. Until this ratification is made, the objection of signatory State can be therefore it has no legal effect.

Therefore, the US would have no ground to either object to India’s liability act or appeal against it. However as soon as India deposits its ratification with the depository of

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CSC—namely the IAEA—it would also have to provide the depositary with a copy, of the provisions of its national law and copies of such provisions shall be circulated by the depositary to all other Contracting Parties. Hence once India ratifies to IAEA, the US can legally object to India’s liability law on the ground that it is not in conformity with the provisions of CSC.

Therefore, after India ratifies the CSC, the US objection of Indian Liability act would have legal force and at that point any dispute between India and the US will have to be settled as per the procedures of dispute settlement laid out in the CSC. Only a few countries have signed CSC, and it yet to come into force. It is unlikely that CSC would enter into force at anytime in near future in order to engage in international trade.

(ii) **Domestic:** The domestic implication of 17(b) are equally, if not more serious. So far Indian nuclear programme has been dependent on Indian nuclear suppliers for various equipment, component and systems for the indigenous PHWR (Pressurised Heavy Water Reactor) programme. India has already built 16 such reactors with varying capacities, with four more under construction and there are further expansion plans also.

All this have been possible because of an indigenous nuclear industry in the face of the international denial of technology to India in the past. One of the reason why Indian industry was willing to invest in such a manufacturing capability and capacity was lack of liability regime.

With the passage of Indian Civil Liability for Nuclear Damage Act, 2010, Indian suppliers too have become reluctant to supply equipment, components etc. for the planned indigenous nuclear plants and it seems very likely that indigenous PHWR program will too come to standstill because of Sec.17 (b) of the Liability Act, as NPCIL has been unable to conclude any fresh contract for supply of items for the planned power plants. Some remedial measures are needed so that Indian nuclear program comes out of the dead end where it has reached now.
Since its enactment in September 2010, India’s Civil Liability for Nuclear Damage Act (CLNDA) has been a subject of intense debate and controversy.\textsuperscript{46} This has deterred both international and domestic suppliers from entering into contracts to supply reactors and components for upcoming nuclear power projects. The resultant impasse might derail its ambitious nuclear energy expansion plans, as New Delhi has been considering various policy and legal options to resolve this issue. A target of installing 63 MW Gigawatts of nuclear capacity by 2032 has been reduced to 27.5 Gigawatts and none of the landmark deals envisaged has been struck.\textsuperscript{47} While the issue figured prominently during Prime Minister Narendra Modi’s October 2014 visit to the US, his promise about addressing various outstanding issues and the importance of nuclear energy for India’s energy security raised hopes of an early resolution of this impasse.\textsuperscript{48}

Though the Convention on Supplementary Compensation (CSC) and other conventions hold suppliers liable through the operator’s Right of Recourse (RoR), Section 17(b) of the CLNDA broadens the R-o-R conditions by stipulating that the operator shall have a right of recourse where the nuclear incident has resulted as a consequence of an act of a supplier or his employee, which includes supply of equipment or material with patent or latent defects or substandard services.\textsuperscript{49} A pragmatic and balanced implementation of civil nuclear liability is the basic prerequisite to ensure the success of India’s civilian nuclear energy program, it was stated at a round table discussion on ‘India’s Civil Nuclear Liability Law and Supplier’s Concerns’ on Thursday. The discussion was organized by the Institute for Defence Studies and Analyses (IDSA) and the Indian Pugwash Society. Prominent experts from the government, industry and civil society participated in the discussion.

Commenting on the standoff between the vendors and the government over the provisions of the Liability Act, the experts insisted that the objective of act should be that

\textsuperscript{46}Ministry of Law and Justice, “The Civil Liability for Nuclear Damage Act, 2010,” Government of India, September 21, 2010
\textsuperscript{47}Sen, Anupama and Gupta, Araghyaa Sen, Report on Operationalising India’s Nuclear Agreements: Issues and Solutions on Nuclear Liability, 2013.
\textsuperscript{48}Remarks by President Obama and Prime Minister Narendra Modi of India After Bilateral Meeting, The White House Office of the Press Secretary, September 30, 2014.
that the victim in case of a nuclear incident should be able to get prompt and adequate compensation. They agreed that the law has provisions to safeguards the interest of the victims.

The experts deliberated extensively on the various interpretations of the terms such as ‘vendors’, ‘contractors’ and ‘suppliers’ used for Indian industries in The Civil Liability for Nuclear Damage Act (CLNDA) 2010. The experts expressed optimism over formulating adequate insurance cover by the Indian insurance giants to address the liability to suppliers and operators arising out of the liability act. There is need to deliberate upon challenges and prospects for rigorous implementation of nuclear program through creation of mechanisms for technology absorption as well as to achieve greater degree of indigenization in nuclear reactor and component manufacturing.

There is need to find out some tangible solution or ‘corrective action’ to the satisfaction of all parties concerned since a review of the legislation seems improbable. The attempt to finesse the suppliers’ liability provisions through a rules notification has also not conclusively redressed prevailing concerns. 

Seeing the crux of the current debate, it seems the supplier liability provisions have been unduly demonised without appreciating the government’s obligation of having to safeguard the public interest before expanding the country’s nuclear energy sector. On the other side we see that Indian law provides a constructive template for civil nuclear liability that could emerge as a new best practice for the global nuclear industry.

Safety of Nuclear Power Plants and Public Concerns

Post Fukushima, the public confidence in India’s nuclear program has been shaken. It has led the Government of India to review the safety features of the Indian nuclear reactors. Though, the safety reviews carried by Atomic Energy Regulatory Board (AERB) concluded that India’s nuclear power plants are safe and wield sufficient safe margins to deal with extreme natural events as witnessed in Fukushima, Japan in 2011. Still the AERB functions under the aegis of DAE. That is the reason the public lack confidence in AERB’s safety review on the contrary Indian public and policymakers have

50 Department of Atomic Energy, Civil Liability for Nuclear Damage Act Rules, November 11, 2011.
traditionally been supportive of country’s nuclear program. So it is important that NPPs be constructed in accordance with the design and with required quality of materials, processes and workmanship.

In addition to that the wave of skepticism regarding nuclear energy in India has resulted in public protests. The public concerns relating to nuclear energy like environmental impact, effects of radiation release and nuclear waste management plans etc. need to be taken seriously and addressed properly through transparency. Periodic safety audit of various programs by independent regulator can help India realistically achieve the nuclear energy targets. The expansion of nuclear energy in India, currently, confronts various challenges in the form of opposition from the civil society groups.

**Nuclear Power Safety:** The Great East Japan Earth quake and Tsunami caused extraordinary damage to the Fukushima-Dai-ichi plant because of severe flooding, leading to large scale radiological flooding. While, the Fukushima accident reveals no fundamental flaw in nuclear technology, it did call for pertinent safety improvements from the lessons learned. The protection of public health and safety from radiological release has been, and continues to be, be primary factor of nuclear safety. After Fukushima, The Atomic Energy Regulatory Board (AERB) has undertaken exhaustive safety reviews; analysed important lessons; and has made recommendations for improving safety in Indian Nuclear power plants. The severe accident management infrastructure is extremely important.

The entire gamut of nuclear safety is directed to ensure that the workers, public and the environment are not exposed to any risk from the nuclear radiation. The radiation is measured by different Indian Environment Radiation monitoring Network (IERMON) stations. On an average, every individual receive 2400 micro sivert of radiation in a year from natural sources. One gets 50 Micro-Siverts (Sv). The maximum limit imposed on nuclear occupational worker is 20,000 Sv per year. The stress on nuclear safety is explicit from the importance safety gets in all phases of nuclear power development; siting, design, construction and operation.

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The effect of both natural and man-induced external events on the plant is assessed to ensure that they will not interact with the plant, in a way, in a way that could lead to unacceptable radiological consequences. Site related natural external; events from the design basis of the plant and include seismic activity, flooding and extreme meteorological events.

Map: Fukshama Japan


Safety of India’s Nuclear Power Plants: Nuclear Power Plant sites are so selected that sites with man-made events such as: air crashes, chemical explosions and toxic gas release, blasting and mining operations, drilling etc in the vicinity of the plant are excluded. The detailed criteria are given in the regulatory code of practice for site evaluation. The Site Evaluation Report (SER) also includes site characteristics affecting safety and interactions of NPP with its environment.
Data about meteorological conditions, frequency of occurrences and extreme meteorological conditions such as tornadoes, hurricanes or typhoons, cyclones and precipitation, distribution of wind velocity and direction, atmospheric diffusion and transport, cooling water requirements and sources, ground water movement, dispersion conditions are collected and used as an input for the design. A nuclear plant is designed to withstand the vibratory ground motion arising from earthquake motions. The Design Basis Ground Motion (DBGM), for this purpose, is evaluated for each sight.

**Design and Safety Principles of NPPs in India**

Defence- in-depth consists of well-defined principles that are incorporated in the design of nuclear power plant. This is done at various levels. At the first level components and systems are design pursuing conservative safety standards. The nuclear power plant is in conformity with international codes and standards. In the second level the design include the system to detect, intercept and control any diversions in normal operation. Such automatic protective feature is the fast automatic shutdown of the reactor, in the event of any event of selected plant parameters exceeding the pre-set limit. This feature provides a high degree of assurance that prompt shut down of the reactor will be achieved to curb plant disturbances. At the third level, additional safety features are provided to ensure that the consequence of accidents is mitigated. It is ensured that the continued cooling of fuel even under accident conditions and containing radioactivity are provided so that radioactivity is not released into the environment. The following safety systems are adopted:

- Emergency core cooling system.
- Containment system.

An added level of safety is provided by the containment building surrounding the reactor. It is leak-tight barrier around the reactor, designed to control the radioactivity into the environment even in the release of large release of radioactivity from the fuel. A salient feature of the design is the double containment principle.
Finally there is a fourth level, as a matter of policy in India, an exclusion area is maintained around the station, where no public habitation is allowed. Thus the **defence-in-death** approach provides for a conservative design with control and protective features to prevent the occurrence of an accident. In physical terms, there are series of barriers in a nuclear reactor between radioactive fission products in solid fuel matrix and the public. Thus defence-in-depth approach involves physical barriers between radioactivity and environment.

Over and above these provisions, there are procedures for managing any radiation emergencies and these are covered under **“Emergency Preparedness”** for the plant. The procedures relating to organization, responsibility and operations in the case of “plant” and site emergencies are prepared by the concerned plant, reviewed and approved by AERB. Periodic exercises are for all types of emergencies are conducted as per procedures at all power stations.

**Safety in Construction and Commissioning of NPPs**

The NPP is constructed in accordance with the design and required quality materials, processes and workmanship. The safety of **Nuclear Power Plants** (NPPs) in India is regulated by the **Atomic Energy Regulatory Board** (AERB). The IAEA **Operational Safety Review Team** (OSART) Mission for review of Rajasthan Atomic Power Station 3 and 4 took place from October 29 to November 14, 2012. The OSART Mission team reported a series of good practices and made recommendations and suggestions to further reinforce safety practices. The Indian Government has decided to declassify the report of the OSART mission.

The regulatory practices followed and the standards developed by AERB are in line with IAEA Safety Standards and international best practices. With over three decades of experience and established plan for augmentation of regulatory resources, AERB will be able to meet the future regulatory demands for reactors based on several different designs and technologies, and their associated fuel cycle facilities.
Securing Nuclear Facilities in India

Nuclear Security is the prevention and detection of and response to unauthorized removal, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear or radiological material or their associated facilities.\(^{52}\) The scale and scope of India’s civil nuclear program is unique for a developing country. India has twenty operating nuclear power plants, a range of fuel cycle facilities from mining of uranium and thorium to reprocessing plants and fast reactors, and a large, expert human resource in nuclear science and technology spread over a variety of research labs and institutions. Nuclear energy is slated to play an increasingly important role in India’s energy security and sustainable development plans.

In reply of a question in Lok Sabha on March 15, 2011 on “whether the atomic power plants in the country are under threats from various terrorist groups and outfits,” the Minister of State for Home Affairs, Mullappaly Ramachandran said, “In view of prevailing security scenario, the atomic power plants continue to remain targets of terrorist groups and outfits”.\(^{53}\) He assured that the centre security agencies review the security of atomic power plants periodically and make specific recommendation to enhance the security whatever required.\(^{54}\) This deliberation is, in fact, symptomatic of the dyadic nuclear security debate. Experts and critics feel NPPs are the top targets of terrorists as they could serve their purpose.\(^{55}\)

Security of Critical infrastructure has been a major global concern especially since 9/11. Critical infrastructure comprises systems and assets, whether physical or virtual, so vita to a state that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of these matters.\(^{56}\)

\(^{52}\)http://www.mea.gov.in/in-focus-article.htm?23091/Nuclear+Security+in+India, 18 March 2014
\(^{54}\) Ibid.
On April 27, 2011, the Department of Atomic Energy (DAE) and the Central Industrial Security Force (CISF) in a meeting, chaired by the CISF Director-General N.R. Das and attended by top officials of 14 atomic energy plants, reviewed the security of the major nuclear power plants in view of the constant threat to India’s sensitive installations.57

A serried of intelligence reports on different occasions has revealed that terrorists could target India’s nuclear infrastructure. According to a report, in 2001, smuggled uranium, confiscated from suspected terrorists in Balurghat, northern West Bengal, had been removed from the Jaduguda Uranium mines in Jharkhand, and was planned to be smuggled across the Bangladeshi border.58

**Public Concerns over Nuclear Power in India**

The public perception of the severity of risks associated with nuclear power are quite different from the actual risk posed by NPPs. Public opinion on nuclear energy differs considerably from the scientific evidence on safety and risk parameters of NPP’s. In the light of changing public perceptions of nuclear energy there is a need to assuage specific concerns expressed by common people. The viability of nuclear energy as a source of long term energy security depends on minimizing the various risks arising from nuclear installations and improving its wider public acceptance in the country. Some of such risks and concerns have been discussed below.

**Effects of High Level Radiation Exposure on Human Health**

Biological effects of very low level of radiation that prevail in the vicinity of NPPs are not discernible. The Biological effects of radiations by such low levels of radiations are generally viewed in the context of the Linear-No-Threshold (LNT) hypothesis. According to LNT hypothesis, there is no threshold below which radiations do not cause any damage and can be considered safe.

The small incremental rise in the background radiation from NPPs and other nuclear installations or in High Background Radiation Areas (HBRA) has often wrongly blamed for higher incidence of cancer, unbelievably high frequencies of malformations, were reported and blamed on radiation from uranium mines and tailings ponds in Jaduguda and NPP at Rawatbhata. The Department of Atomic Energy (DAE) took initiative in setting up first major Thermal Ecological Study (TES) in the country (TES Report, 2007)

Environment Impact Assessment (EIA)

An environmental clearance based on Comprehensive Environmental Impact Assessment process is mandatory requirement for NPPs and nuclear fuel cycle facilities in India. Environmental clearances are obtained as per various environmental legislations. These are granted by various central and state agencies. Important legislations essential for site evaluation are: Environment Protection Act, 1986 and rules there under, Coastal Regulation Zone Notification, 1991, Water (Prevention & Control of Pollution) Act, 1974, the Air(Prevention and Control of Pollution) Act 19741981, The Public Insurance Liability Act 1991 and its amendments, and Hazardous Wastes(management and handling) Rules 1989 and its amendments.

In 1986, the Indian Parliament enacted the Environmental (Protection) Act. Under the 1986 Environment Act, the Mo E&F promulgated a notification on January 27, 1994, whereby obtaining an environmental clearance (EC) for expansion and modernization of any activity or for setting up new projects in schedule 1 of the notification which includes NPPs and associated Fuel Cycle facilities, became a statutory requirement. This notification also introduced the requirement of comprehensive EIA for obtaining an environmental clearance for NPPs.

Environmental Impact on Nuclear Power Plants in India

Nuclear energy is an efficient, clean and powerful and clean technology that will last the energy needs of our planet, way beyond the fossil fuels. The radioactive products

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59 Gupta, Arvind, op.cit , P.126.
of the nuclear fission are contained in the reactor core and do not find the way into the environment. Unlike the fossil fuels, the nuclear power production does not involve release of ash, dust or green-house gases and do not cause environmental pollution in conventional sense. The possibilities that the NPPs can impact the environment is either by: (a) marginal increase in the background radiation levels around the nuclear power plants, or (b) release of large volume of heated water, used as coolant in reactor condensers, into the nearby water bodies. The nuclear power plants abide by strict laws and regulations dictated by the appropriate regulating authority agencies.

Wide ranging concerns have been expressed over the radiation and environmental impacts of India’s nuclear power program. At the various newly designated NPP sites, people lay fear that their lives and the surrounding environment will be adversely affected due to construction and operation of the nuclear reactors. The growing public debate in the country over various aspects of nuclear energy raises questions of environmental impact. The construction of nuclear power plants and their safe operation requires them to pass through various stages of approvals beginning from site approval, to environmental and nuclear safety related clearances, emergency planning requirements and finally decommissioning.

In India Atomic Energy Regulatory Board (AERB) stipulates the safe radiation limits to radiation workers and to the general public, while the Ministry of Environment and Forests (MoE&F) and the state bodies regulate the thermal discharge into water bodies. It is necessary to review the regulatory requirements for siting NPPs, to understand evolution of legal framework for environmental impact assessment and the regulations of nuclear installations in India.

The construction and operation of certain mega power plants has certain impact on terrestrial environment during the clearing of terrain for construction activities: loss of trees, frightened animals, noise dust and emissions of biocides etc. All mega power projects, the Nuclear Power Plants (NPPs) mainly generate various radioactive products which can pose a serious danger to environment and public.
The most serious concern relating to NPPs, however is the accidental release of radioactivity which can cause a serious disaster in the surrounding environment and for the population. Large scale radioactive exposures could pose serious health risks and socio-economic disruption and its mitigation requires committing vast financial resources for a prolonged period of time. Such futuristic eventualities require that safety related measures are properly implemented.

India has adequately framed *Environmental Impact Assessment Process* (EIAP). The technical complexities involved in the setting up and operation of NPPs require that utmost attention be given to the factors affecting the safety of public and environment. The regulation process begins in the initial stages of selecting a site for setting up a nuclear plant. In India the *Atomic Energy Regulatory Board* (AERB) was set up in 1983 to regulate the various stage of NPP construction and granting nuclear safety related approvals at each stage after detailed safety reviews.

The AERB’s consenting is based on several requirements specified in the AERB Safety Code “Regulation of Nuclear and Radiation Facilities” and associated safety guides. The major regulatory consents like siting approval start of construction, commission in and operation and eventual decommissioning are required.

Basic siting criteria lays down that that an exclusion zone is up to 1.5 Km around the installation is under the control of plant authorities. In addition to that AERB is required to meet the stipulated desirable population distribution characteristics such as:

a. Population density within 10 Km of site shall be less than 2/3 of the average population density of the state.
b. That there should no population centre with more than 10000 persons with in 10 Km of the plant;
c. That there should be no population centre of more than 1 lakh persons within 30 Km radius of the plant:

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60 AERB Safety Code, "Regulation of Nuclear and Radiation Facilities", No AERB/SC/G,

d. The total population in the sterilized area should be small, preferably less than 20000.\textsuperscript{62}

**Site Selection of NPPs in India**

The *site review* is the important stage in setting up the NPP. The initial site survey for the NPPs is carried out by *Nuclear Power Corporation of India* (NPCIL) based on primary information and data that satisfies the established criteria for site selection. When the pre-feasibility report is submitted by NPCIL, then AERB evaluates the site mainly from the safety point of view, assesses the possibility of engineering solutions to the site related problems, and ensures that NPP could be built and operated so that radiation levels are within the limits stipulated in the Code of Practice on Safety in Nuclear Power Plant Siting, AERB/SC/S.\textsuperscript{63}

To mitigate the accidents caused by a major seismic event, the sites falling in high seismic zones are rejected as per AERB’s rejection criteria. In the Indian context areas falling in Zone V are considered unsuitable for setting up NPPs.

**Environmental Clearance for NPPs**

An *Expert Appraisal Committee* (EAC) is set up within the MoEF for granting environmental clearances to the NPPs. The EAC is an important body which evaluates the environmental aspects of the project and grants environmental clearance report based on robustness of the EIA Report. The EIA even wields the veto power in the clearance process.

After that regulatory control of AERB starts from site selection to decommissioning of the project. Other regulatory authorities like MoEF, SPCB monitor the conditions set down in the clearance letter. The controls and regulations are aimed at radiation exposure controls and ensure safety to site personnel living around the plant.

\textsuperscript{62}Ibid, *Criteria for Regulation of Health and safety of NPP Personnel, the Public and the Environment*.

Environment Impact Monitoring (EIM) is an essential element of nuclear power plant operations in India. It is carried out by Department of Atomic Energy (DAE) in addition to various legal requirements and also to ensure compliance with regulatory guidelines. The Environmental Survey Laboratory (ESL) is established at each power plant at least two years before the commissioning of the plant. Its primary aim is to monitor radiation levels to ensure compliance with exposure limits set up for members of public by AERB.

At the ESLs three types of samples are collected. The first categories of samples are drinking water, air and locally produced dietary items. The second category of samples are weeds, sediment, soil, grass etc is ‘trend indicators’ for buildup of radio nuclides in the environment. The third category sample includes sensitive indicator organisms that accumulate specific radio nuclides to a great extent i.e. goat thyroid is used to detect low levels of fresh radioactive fallout of Iodine-131.

From the above analysis it seems that construction of NPPs in India is strictly adhered to the existing as well as statutory requirements stipulated by various agencies. The process of granting environmental clearances for NPPs in India has considerably evolved over the years and is on par with various international standards.

Nuclear Waste Management in India

The safe and effective management of radioactive waste has been given utmost importance since the very inception of nuclear industry in India and it covers the entire range of activities; right from handling, treatment conditioning, transport storage and disposal. Radioactive waste management is also associated with decontamination and decommissioning activities in view of the aging of nuclear power plants and other radio chemical facilities.

The objective of waste management in India is protection of man and environment. The necessary code and safety guidelines are provided by AERB in conformity with the principles of radiation protection as formulated by the International Commission for Radiation Protections (ICRP). Further India has followed a closed fuel
cycle strategy for development of nuclear energy. By adopting this ‘reprocessing to recycle’ approach, the nuclear resources can optimally be deployed for sustained energy production for a long time. Indian waste management facilities are co-located with waste generating facilities, i.e., the nuclear reactor, reprocessing plant and fuel fabrication facility.

**Radiation Release Risk and Mitigation**

The rise in the use of radiation and radioactivity for industrial, medical and power generation purposes is widely perceived to have enhanced the risk of radiation exposure for human beings. The radioactive releases from nuclear tests and reactor accidents have become a matter of serious concern for scientists, statesman and lay people alike.

In order to understand the biological effects of radiation; the general Assembly on December 3, 1955 unanimously adopted the US sponsored resolution 913(X), which established the United Nations Scientific Committee on Effects of atomic Radiation (UNCEAR) to collect and evaluate information on the levels and effect of ionizing radiation. UNSCEAR has published several reports on scientific observations and experiments relating to the effects of ionizing radiation on environment. The International Commission on Radiological Protection (ICRP) carries out studies on the Biological Effects of Ionizing radiation (BEIR) which belongs to US Academy of Sciences. The gamut of man-made uses and application of atomic radiation is vast it is relevant to study the radiation release from nuclear power plants and fuel cycle facilities in India. The safe operation of nuclear fuel cycle installations is essential for long term safety of the people and the environment in the surrounding areas.

A primary concern associated with nuclear power plant is the accidental as well as routine release of radioactive materials into the atmosphere, which could pose long term risk to environment and public health. A proper perspective of radiation releases from

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64 Gupta, Arvind, *op.cit*, P.138-140.
nuclear power plants can help assuage these concerns. So there is urgent need to find out and properly analyse various studies conducted by the ICRP and the UNSCEAR.

Radiation is widely present in the earth’s atmosphere. Scientifically radiation is classified mainly ionizing and non-ionizing radiation. Ionizing radiation is a central concern for scientists and health physicists because of its impact on public health and environment. Ionizing radiation is popularly termed as ‘doubled edged sword’ since it causes cancer and at the same time used for treating cancer. When human body is exposed to large dose of ionizing radiation it can damage tissues in the human body by damaging critical chemicals within the cells such as the DNA.

Extensive research studies have been conducted by various national as well as international agencies on the impact of radiation on human health. The radiation exposures are divided into – high and low level radiation dose. While, the health impact of high level radiation exposure have been well-established by scientific literature, the risk associated with low level radiation doses are still being debated and disputed by the scientists.66

**Measuring the Nuclear and Radiological Accidents:** The accidents or incidents which source the man-made radiation are classified on the basis of International Nuclear and Radiological Event Scale (INES) designed by the International Atomic Energy Agency. On this scale events are rated from Level 1 (anomaly) to level -7.(major accident) depending upon the level of radiological release and its impact. The upper level (4-7) rated as accidents and lower levels (1-3) are termed as incidents. Events with no safety significance are classified below scale at level 0 and are termed as “deviations”. In order to clearly communicate the safety significance to the public; a different phrase has to be attributed to each level of International Nuclear Event Scale (INES). These are (from level 1-level 7) and are described as: ‘anomaly’, ‘incident’, ‘serious incident’, ‘accident’, ‘accident with local consequences’, ‘accident with wider consequences’ ‘serious accident’, ‘major accident’.

In 1986 accident at the Chernobyl nuclear power plant and 2011 accident at the

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Fukushima Daiichi nuclear station are designated at level 7 on INES. These accidents were rated due to their wide spread impact on people and the environment.67

**Radiation Release from Operation of Nuclear Plants in India:** India’s nuclear program presently includes the full range of nuclear fuel cycle facilities. The primary objectives of safety aspects are, to protect the plant personnel, the population in surrounding area and the environment from radioactive contamination. To achieve this objective, the release from nuclear fuel cycle facilities is monitored on a routine basis. The available data shows that release from nuclear plants contribute little to the overall radiation dose received by the people all over the world.

The radiation release from India’s fuel cycle facilities have been stringently regulated and monitored as per the AERB guidelines. Measurement of and other pollutants has been an important objective of environmental radiation monitoring at all the nuclear fuel cycles facilities in India. Environment Survey Laboratories (ESLs) have been established at each nuclear site to constantly monitor radiation levels in and around these facilities.68 The radiation monitoring is carried out through vast collection of data on the size and distribution of the population, demographic and dietary patterns.

India currently operates 21 nuclear reactors which comprise: Two BWR supplies by GE; Two Canadian Built CNADU PHWRs; One Russian designed LWR; and 16 indigenously built PHWRs. In the last four decades of operation of NPPS, there has not been a single event at NPPs in India which had adverse radiological impact on environment and the population. During 2007-11, a total of 155 events have been reported to the Atomic Energy Regulatory Board by NPCIL. Of these, 142 were of Level-0 (i.e. no safety significance) as per the International Nuclear Event Scale (INES). The remaining 12 incidents were measured at Level-1 and one was of Level-2.69

In the history of nuclear power plants two major events of safety significance have occurred, the first one is the fire incident in the turbine building at Narora Atomic

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Power Station (1993, INES Scale Level-3) which resulted in a 17-hour long total station blackout and incident at Kakarpur Atomic Power Station caused by unintended power excursion (2004, INES Scale Level-2). Good thing was that both these events had no radiological impact on the workers, the public or the environment.\footnote{Chande, S.K.(2011), “Addressing Safety of Indian Nuclear Power Plants”, Atomic Energy Regulatory Board, URL://htppwww.aerb.gov.in/AERBPortal/paged/English/t/documents/SAFETYOFINDIASNPPs.pdf, accessed on January 13, 2014}

The AERB also requires that the ESLs should have the equipment and the facilities for detection/analysis of very low levels of radioactivity in the environmental samples. The study of one tear of Kakarpur Atomic Power Plan (KAPS) up to 30 Km distance was carried out by using Gamma Tracer, shows that the hourly average of gamma radiation in all routes varied from 56 to 112 nGyh with an average 77 nGyh. This data shows the negligible impact of operation of KAPS on the surrounding environment. Thus the environmental monitoring around the NPPs in India shows those radioactive releases into the environment as well as within limits prescribed by the Atomic energy Regulatory Board.

Epidemiological studies widely defined as the study of distribution of disease in populations and the factors that effect this distribution, conducted worldwide has shown in case of India, has shown that radiation exposures to workers at nuclear facilities and mines do not lead any adverse health impacts.

In January 1992, the Nuclear Power Corporation of India Limited commissioned the \textit{Tata Memorial Cancer Centre} (TMC) to analyze radiation impact on NPCIL employees and their families. These studies were carried out at six power stations at Tarapur, Maharashtra; Rawatbhata, Rajasthan; Kakarpur, Gujrat and Kaiga, Karnataka. One of the important results of these studies was that there was no increase in prevalence of malignancies in spouses and off springs of the employees as compared to workers.\footnote{Tata Memorial Centre, “Effect of Low-dose Ionizing Radiation Among the Employees at Tarapur DAE Centre: A Cross-Sectional Study”, \textit{The Epidemiological Studies Cell}, Mumbai: Tata Memorial Hospital, 1998, P.1-74.}

Thus, it can be said, that natural sources of radiation by far are the largest sources of radiation exposure to human population in India. Extensive monitoring of radiation
levels in and around the NPPs in India has shown no significant increase of environmental radioactivity due to operation of NPPs. The radiation monitoring surveys clearly shows that the doses received by the nuclear plant workers are significantly lower than the prescribed regulatory limits and pose no serious health risks to the workers and their families. The epidemiological studies have concluded that instance of cancer among nuclear plant workers are comparable with the national cancer average. Thus best practices have been adopt to eliminate health and environment related risks. Although, several civil society groups have expressed concerns over health impacts over operation of nuclear power plants in India.

Nuclear Emergency Preparedness in India: Operational safety has been the prime concern of the designers and operators of the nuclear power plants. All system and components in the NPPs are premised on ‘Defence-in-depth’ principle, where in multiple layers of safety systems: emergency plans are drawn up to deal with eventuality involving large-scale radioactive fallout. The off-site nuclear emergency management that comprises of various technical, administrative and regulatory arrangements has evolved over the years.

The nuclear power plant accident in Japan has revealed the need for further strengthening of emergency preparedness programs in all nuclear power producing countries. There is need to enhance interagency co-ordination and improved auxiliary infrastructure in the form of monitoring systems, transport arrangements, decommissioning facilities, etc. There is a greater need to work on comprehensive emergency plans and capabilities in India by Department of Atomic Energy (DAE) and the National Disaster Management Authority (NDMA) which would be crucial for the effective management and mitigation during off-site nuclear emergency.\textsuperscript{72}

An accident at nuclear power installation poses unique challenge in mitigating the subsequent consequences in the public domain. In case of nuclear accident, the population surrounding areas would fail to take measures to avoid exposure to high dosage of radiation. In that case remote sensing replaces the direct sensory observation as

\textsuperscript{72} The AERB safety guide discuss in detail various types of radiological emergencies.
the source of information about the evolving nuclear emergency at the nuclear power station.73

**Counter Strategy to Make Nuclear Power Safer**

India has been pursuing nuclear power for long time and has established a sound framework for its governance so as to address all issues related to safety, security and non-proliferation. The framework consists of legal instruments and policies. Legal framework arises from, national acts, and from international conventions, treaties and agreements to which India is a party.

**Legal Instruments:** The Atomic Energy Act of, 1962, is the main legislation for governance of nuclear issues in India. Under this act, the following rules have been framed:

- Atomic Energy (Control of Irradiation Food) Rules, 1996.

There are certain acts also which are as under:


Atomic Energy Regulatory Board has been functioning since November 15, 1983. To convert its, **de facto**, independence to, **de jure**, independence, Nuclear Safety

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Regulatory Authority (NSRA) Bill, 2011 has been introduced in the Parliament by an executive order (Gazette Notification No,25/2/83) under section 27 of the Atomic Energy Act (AEA) of 1962. Besides this several notifications have been issued under various acts.\(^{74}\)

India is party to several International conventions and treaties as follows:

- Agreement on the Privileges and immunities of IAEA.
- Convention and Physical Protection of Nuclear Material and its 2005 amendment.
- Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency.
- Convention on Nuclear Safety.
- Convention on Supplementary Compensation of Nuclear Damage has been signed in 2011 and awaiting ratification.

India participated in the Nuclear Security Summit 2014 and honours its obligations arising out of various UN Security Council Resolutions. Despite India being a signatory to NPT, India’s unique status has been addressed by international nuclear cooperation regime.

The relaxation in the civilian nuclear trade by Nuclear Supplier group (NSG) in September 2008, and the signing of Agreement between Government of India and the International Atomic Energy Agency (IAEA) for application of safeguards to Civilian Nuclear Facilities, India is now in a position to import Uranium and also set up nuclear reactors in technical cooperation with other countries. India can also contribute to the furthering of international nuclear renaissance.

Legal and Regulatory Framework for Emergency Preparedness in India: Till the time of Three Mile Incident (TMI) accident the radiological consequences of any accident that may occur were believed to affect only low population zones extending 2 to 3 miles from nuclear plant site. In 1977, the Nuclear Regulatory Commission (NRC) USA, \(^{74}\text{Rajaraman, R., (ed.), } India’s Nuclear Energy Programme: Future Plans, Prospects and Concerns, New Delhi: Academic Foundation, 2013, P.262.\)
published a Regulatory guide i.e10001 which specified more clearly the requirements of drafting emergency plans.\textsuperscript{75}

Chernobyl accident in 1986 highlighted for the first time the challenges of handling large-scale radioactive fallouts and its trans-boundary consequences. The regulatory interventions after ‘Chernobyl accident therefore, focused primarily on developing new safety codes for NPPs and decision support tools as a part of off-site emergency planning.

The nuclear emergency preparedness program in India has evolved over the years driving numerous lessons from TMI and Chernobyl accidents. The AERB published the first set of off-site emergency preparedness guidelines in October 1999, and subsequently revised them in March 2003. A comprehensive emergency preparedness plan is mandatory licensing requirements for operation of NPPs in India. The AERB has to ensure the development of emergency response plans by the nuclear operators in conformity with international practices so that any potential eventuality of undue radiological risks for the plant, personnel and the public is handled effectively.\textsuperscript{76}

The AERB has formulated various codes and safety guidelines which specify the necessary requirements, with respect to the emergency preparedness at the Indian NPPs. AERB Safety Code “Regulation of Nuclear and Radiation Facilities (AERB/SC/G, 2000).


\textsuperscript{76} Ibid
Indian Parliament passed the ‘Disaster Management Act’ in 2005. The Act provides for effective management for disasters including accident at NPPs in India.\textsuperscript{77} The National Disaster Management Authority (NDMA) was set up in 2006, with the Prime Minister of India as the chairperson and the State Disaster Authority (SDMA) at state levels, with chief ministers as chairpersons. The NDMA has published national guidelines on nuclear and radiological emergencies in 2009 which supplements the existing nuclear/radiological emergency management framework.\textsuperscript{78}

**Emergency Preparedness:** The AERB Safety Guidelines identify four types of emergencies depending on severity. These are as under:

- Plant emergency alert.
- Plant emergency.
- Site emergency.
- Off-site emergency.

NPCIL is primarily responsible for first three types of emergencies, while the off-site emergency, which assumes the highly unlikely possibility of large-scale accidental radioactive releases into public domain, is the responsibility of the district administration with the technical support and guidance received from DAE. In the operational history of NPPs in India, there has not been any off-site emergency causing adverse radiological impact on environment. In the unlikely event of off-site emergency NPCIL has to initiate the emergency measures. The AERB Safety Guide “Preparation of Off-site emergency Plans for Nuclear Installations” (AERB/SG/EP-2, 1999) specifies the criteria for declaring and terminating the off-site emergency.

Spread of radio activity in major nuclear accident could lead to high airborne activity and deposition of radioactive substances over large areas on the ground. In such a situation we depend on various parameters like source term, release height, meteorological conditions, topography around the site, etc. The radiological material so


\textsuperscript{78} National Dister Mangement Authority (2009), “Management of Radiological Emergency guidelines” ,February 2009. PP.1-132
released from the NPPs so disperse in the form of plume or cloud and the concentration of radioactivity decreases with distance from the site, being diluted and dispersed as it moves downside.\textsuperscript{79}

The general objective of implementing radiation countermeasures is to reduce health consequences; in particular, to avoid deterministic effects and to keep stochastic effects as low as possible. The AERB guidelines envisage various countermeasures like, sheltering, administering of potassium iodate tablets, evacuation and Controlling food and Water Supplies. The timely and appropriate implementation of the countermeasures during the off-site emergency can considerably reduce radiation doses to the public in vicinity of the nuclear installations.

The NDMA has accorded highest priority to the developing infrastructure in the form of equipment, facilities, services, etc. that are necessary to carry out emergency measures in the event of severe nuclear accident. The NDMA has also approached the state governments to prepare plans for developing local infrastructure in areas around NPPs.

In case of emergency preparedness in the NPPs it can well be said that there is a significant need for improving the public understanding about radiation-risks with regard to off-site emergency preparedness in India. This has become all the more important in the light of Fukushima Dai-ichi accident. With adequate emergency preparedness measures in place, the hazards of radiation exposure can be mitigated. The AERB has developed robust regulatory framework to declare and handle off-site emergencies at the NPPs. The nuclear authorities have put in place a diverse technological system to detect and handle radiological emergencies. The challenges involved in managing and mitigating the off-site emergencies thus can be addressed by sustained efforts and similarly public concerns can be addressed in a similar way.