IDSA Task Force Report

Development of Nuclear Energy Sector in India

Institute for Defence Studies and Analyses, New Delhi.

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First Published: November 2010

Price : ₹ 200/-

Published by : Institute for Defence Studies and Analyses
No.1, Development Enclave, Rao Tula Ram Marg,
Delhi Cantt., New Delhi - 110 010
Tel. (91-11) 2671-7983
Fax.(91-11) 2615 4191
E-mail: idsa@vsnl.com
Website: http://www.idsa.in

Printed at : A.M. Offsetters
A-57, Sector-10, Noida-201 301 (U.P.)
Tel.: 91-120-4320403
Mob.: 09810888667
E-mail : amoffsetters@gmail.com

Contents

INTRODUCTION

The atom today generates less than three percent of India's electricity needs. But the country has an impressive plan for the future. By 2022, the total generation of nuclear energy is expected to increase eight times catering to around 10 percent of India's electricity needs. And by 2052, the energy generated from atom would have increased 70 fold contributing nearly 26 percent of India's total electricity requirements. Therefore, the reliance on nuclear energy to satisfy the power needs of the world's second fastest growing economy (among major countries), is poised to record quantum progress.

The vision for the development of nuclear energy in India is not new. It dates back to pre-independence days. The nation had embarked on the development of large-scale infrastructure for nuclear power generation and building scientific-technological base for it. The process of the development of nuclear energy was, however, not smooth. It had to overcome enormous difficulties to reach the present stage. The obstacles it had to face were primarily due to the technology denial regimes adopted by various nations that either had the expertise or had harnessed nuclear energy.

Nevertheless, through a determined effort, India successfully overcame the denial regimes. It did so adhering strictly to non-proliferation principles and this stood in stark relief to the clandestine transfer of technology by some nations. The impeccable non-proliferation track record received international acknowledgement and its most notable recognition came in the form of the decision of the Nuclear Supplier Group in 2008 to lift the prohibition on member nations to deal in nuclear commerce with India.

The inclusion of India into the global nuclear energy order has, however, made it further necessary for the country to make structural and procedural modifications in its nuclear regulatory framework by bringing them in conformity with international norms and practices. What makes it important for the nation to make the changes in its regulatory frame work is that among the various energy sources, nuclear has the highest potential and maximum risks and no universally acceptable method of disposal of nuclear waste has been found.

The nuclear accidents in Chernobyl and the Three Mile Island in the US had revealed to the world the dangers involved in using the atom to generate energy. It aggravated the fear that if nuclear energy is not generated adhering to the highest standards of safety, the consequences could be cataclysmic. These accidents had even led many countries to either withdraw the plans for the construction of new rectors or decommission the operating reactors. But all that appears to be changing and the use of atom to generate electricity is making a strong comeback even in Germany which had planned the closure of existing plants.

Nations one after another seem to be veering to the conclusion that they cannot continue to rely primarily on fossil fuel for energy. According to the Department of Nuclear Energy of the IAEA which makes two projections, one low and the other high, the world could see a significant shift in reliance to nuclear energy. Its studies reveal that the total production of electricity could vary from 447 GW(e) in 2030 (low projection) to 691 GW(e) in 2030 (high projection). Accordingly, by 2030, the increase in electricity production could be 25 percent or 93 percent respectively. Further, by this time, the number of countries generating nuclear energy could increase from the present 30 to 50.

The disastrous effect on climate that the use of fossil fuels and beget, their exhaustible nature and the absence of any other viable alternative that could satisfy the fast growing energy needs of the world striving to achieve economic growth have propelled the reversal of the policy of abandoning nuclear energy as the focus of the future. India too has taken a similar decision. But before it embarks on increasing its reliance of atom for energy, it would be imperative for both the operators and regulators to create a culture of management and follow standard practices that do not permit any form of deviation from the highest levels of safety.

The evolution of the development of nuclear energy has standardized certain obligations that operators and regulators are enjoined to perform. While operators have been entrusted with the responsibility of ensuring the highest safety standards, the regulators ensure that they are followed without any deviations and undertake their obligations. In order for the operator to perform this role, it must have the requisite engineering, financial, and management capability to built, manage and operate following the highest safety standards.

Throughout the world, the operators and regulators function under a global nuclear safety regime. The regime is a collective international enterprise that sets safety parameters for all the operators and regulators, monitoring the progress and safety measures in place, and building competence among them. The adoption of higher safety standards by individual countries will not only enhance the credibility of the global regime but will also help in assuaging the fear of the civilian population to the establishment of nuclear plants. Thus the global regime requires individual countries currently using or contemplating nuclear power to ensure that primacy is placed on the adoption of safety measures. Technical assistance is provided by various international organizations like IAEA, NEA and WANO for the upgradation of safety standards.

But the decisions of each nation-state largely determine the extent and scope of international engagement. Though the international engagement is an important factor, the responsibility for ensuring safety ultimately lies with individual countries. As nations zealously guard their sovereignty, the creation of an overarching international regulator with the power to interfere in the operation of plants is individual countries is unlikely. The populace of nations, particularly those who are inhabitants in areas close to nuclear plants would prefer governments with the authority to accept regulatory and safety measures reflecting their sensitivities and fears in contrast to an international regulator which could seem distant and out of depth with local sentiments.

Besides safety which primarily aims at avoiding all major and minor accidents, security issues of nuclear materials are also matters of huge concern to the international community. This aspect is today gaining equal, if not more attention as it is feared that terror groups could try to either destroy such plants to release radioactive material to steal nuclear material to be used later. Therefore, along with safety measures designed to prevent accidents, there is an equally important need to adopt security measures drawing on and pooling the technological resources available.

The need for such international cooperation is only bound to increase with the prospects of commissioning of new nuclear power plants and fuel cycle facilities becoming brighter. The international security related practices in the form of intelligence sharing and threat assessment are still in the embryonic stage. There are, however, difficulties in evolving such a cooperative architecture. Even where measures have been developed by certain nations, sharing becomes difficult due to the confidentiality protecting such information and technology that may be safeguarded by Intellectual Property Rights etc.

In view of the some of the challenges outlined above, India would have to modify its regulatory structure and norms to make the generation of nuclear energy safe and viable as it moves seriously towards relying more on the atom. The objective of this taskforce has been to study the existing national and international frameworks, regulations and norms and make recommendations to strengthen the former. The study therefore covers the following areas:

- the prospects for nuclear energy development in India and the possible trajectory India's civilian nuclear energy programme could take
- a survey of the best international practices relating to safety, security, liability management and ENR transfer operations and suitable recommendations there for
- the existing legal and institutional structures in India and the need to build a nuclear regime in the country that would be more responsive and accountable to the concerns and needs of the public
- the need for Indian government to enact a nuclear liability act to make it a partner in the international nuclear regime.
- recommendations

It is hoped that this task force would generate further discussions on the subject of the development of nuclear energy in India and the possible steps that it would have to take to make the generation of the power from atom safe and secure.

28th August 2010

KEY TRENDS IN GLOBAL NUCLEAR POWER INDUSTRY

Introduction

Affordable and uninterrupted energy supply is critical to attain development goals. But the disparity in access to energy supply across the world is a major concern among countries. Lack of access to adequate energy supply translates into economic deprivation and an upsurge in poverty levels, both at the individual as well as national levels. It is important to understand the disparity in global energy access as a first step towards resolving the economic and social deprivation of humankind.

Roughly 1.6 billion people live without access to electricity and about 2.4 billion rely on conventional biomass for energy supply. It is also important to note that globally, majority of the people without access to electricity live in developing countries. According to the International Energy Agency (IEA), non-OECD countries account for about 90 per cent of the increase in global demand between 2007 and 2030, driven largely by China and India. Can nuclear power bring about a feasible solution to the energy crisis in the world today?

The impact of the Chernobyl accident which happened in 1986 on the global nuclear industry was catastrophic. In its aftermath, many countries made changes in their legislations to phase out the existing nuclear power generating facilities. Many non-nuclear power countries decided not to develop nuclear power. This resulted in the nuclear industry being viewed with suspicion and fear by people across the world.

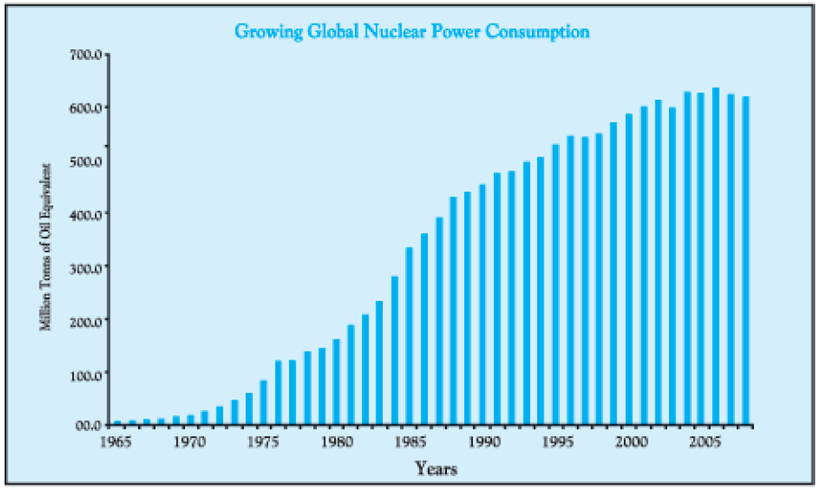
However, today global nuclear industry is growing at a faster pace with many of the existing nuclear power countries planning more operable reactors and also with the emergence of new countries planning to build nuclear power as a long-term alternative. Countries such as Germany, Italy and UK have already made clear plans to further develop their nuclear power industry. Despite apprehensions that prevailed earlier regarding phase out, nuclear energy continues to play a key role in UK's energy mix. The country is also planning to build 4 Evolutionary Power Reactors (EPR). The factors which ignited the resurgence of nuclear power include political vulnerability in the petroleum-rich Middle East, concerns over long-term import dependency, vulnerable energy supply lanes and demand for low carbon energy sources.

Global Energy Scenario and Growing Opportunities for Nuclear Power

The conventional dependency on hydrocarbon fuels as the major source of energy in many countries is subject to various politico-economic as well as environmental challenges. Political turbulence and civil-ethnic unrest in many of the major petroleum producing regions have grown tremendously in the past few decades. Countries in the Persian Gulf region which provide about 50 per cent of the total energy consumed in the world face serious political challenges which are major hurdles for the smooth operation of their oil producing industry. The physical infrastructure which supports oil and gas exploration and production also faces a potential threat from the non-state actors. Undoubtedly such challenges to the petroleum industry in these regions are detrimental to the energy security of the countries depending on overseas oil and gas supplies. The challenges also extend to the supply routes which include Sea Lanes of Communications (SLOCs) and overland pipelines.

Nuclear power sector has the potential to play a vital role in the energy security of countries which are depending heavily on fossil fuels. While nuclear power cannot be the panacea for the global energy security challenges, the main role it can play is in sharing the burden of meeting the growing energy demand along with other fuel types. Currently nuclear energy is in the energy mix of 32 countries, and more than 40 countries[1] are

Figure 1: Growing Global Nuclear Power Consumption



Source: Statistical Review of World Energy, British Petroleum, 2009.

1 Emerging nuclear countries (or emerging nuclear power countries) are those economies which are planning to build nuclear power facilities in order to meet their growing energy demand (not nuclear weapon states). These countries are referred to as emerging nuclear countries in this paper. There has been wide usage of this term by the World Nuclear Association.

seriously contemplating building nuclear power facilities. Among the emerging nuclear power countries, many of them already have clear timelines for getting their first nuclear plans operational. This indicates the growing importance of nuclear power in the world and a renewed interest in nuclear power generation.

The importance of nuclear power would grow significantly in the coming years as the concern of resource extinction prevails in the world. According to peak oil theory, originally propounded by King Hubbert, hydrocarbon resources are finite and many of the major deposits are expected to exhaust the producible reserves. As per the current reserve production ratio, global crude oil and natural gas reserves would only last for about 42 years and 60 years respectively.[2] This is one of the key energy security concerns for many of the countries that depend on petroleum sources. According to King Hubbert, the world appears to be on the threshold of an era which in terms of energy consumption will be at least to an order of magnitude greater than that made possible by fossil fuels.[3] This necessitates strategies for diversification of energy resources for those countries which depend heavily on petroleum sources. The prohibitive cost of large scale commercial development of renewable energy sources will also positively contribute to the development of the nuclear power industry.

Advanced Reactor Technology: A Key Driver for Nuclear Industry Development

The nuclear power industry worldwide has not reflected adequate growth in the past as a result of nuclear power plant accidents, lack of strong government policies to promote nuclear industry and anti-nuclear public perception. However, with the re-emergence of nuclear power as a viable source of energy in many countries, investment in nuclear facilities has been growing significantly. Private as well as government agencies and investors across the world play a significant role in re-establishing the global nuclear industry. The safety of the nuclear power generation facilities is one of the key determining factors for industry development. Among the existing nuclear fleet, majority belong to generation II which have proven technologies for ensuring safe operation and power generation. However, some of the accidents at nuclear power facilities in the past have adversely affected the industry. Concerns about nuclear safety grew significantly following accidents in the Three Miles Island and Chernobyl nuclear sites. For some time after the Chernobyl accident, many parts of the world witnessed major anti-nuclear sentiments.

The nuclear industry stands at a crucial juncture today where it needs to meet not only the growing demands for electricity, but also has to address global concerns about its

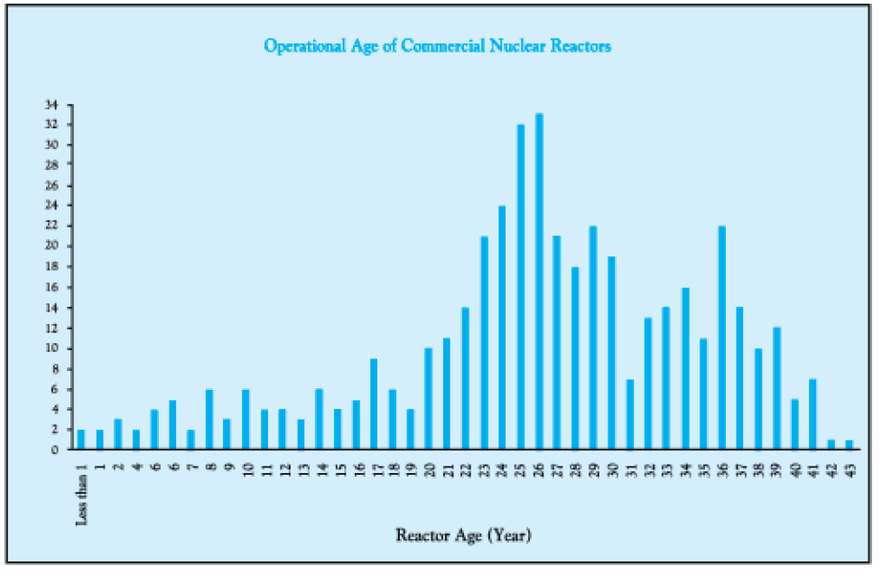
2 Statistical Review of World Energy, British Petroleum, June 2009, accessed from http://www.bp.com/statisticalreview (December, 2009)

3 Hubbert, King M, Nuclear Energy and Fossil Fuels, Publication No. 45, Shell Development Company, Exploration and Production Research Division, Texas, 1956, p-35

safety and issues related to radiation from its facilities. Current reactor technology has reached the fourth generation which meets the requirements of various industrial as well as geographical usages. Some of the potential features make it perfect for industrial use such as in hydrogen production and desalination. These functions are made possible by the reactor's high temperature (510 to 1000 degrees) compared to the conventional reactors which operate at less than 330 degrees (for light water reactors).[4] The convenience in building and installing reactors also make it suitable for use in some specific geographical areas where conventional large reactors cannot be brought in.

The majority of the nuclear electricity production in the world is done by reactors that are originally designed for defence use. Most of the reactors are, as mentioned earlier, belong to generation II, or designs with minor differences from the generation II reactors. However, the third generation reactors have addressed some of the key safety concerns related to the second generation units. The third generation reactors address concerns like cost, construction time and environmental damage. The major advantage of the third generation units is that many of them incorporate passive or inherent safety features which require no active controls or operational intervention to avoid accidents in the

Figure 2: Operational Age of Commercial Nuclear Reactors



Source: IAEA Power Reactor Information System

4 Generation IV Nuclear Reactors, World Nuclear Association, http://www.world-nuclear.org/info/inf77.html Accessed: 26/05/2010

event of reactor malfunction, and may rely on gravity, natural convection or resistance to high temperatures.[5] The safety measures of the second generation reactors were to be operated by electrical or mechanical power. Many new designs also offer as security features longer operating life of the plants, protection against aircraft impact, and reduced possibility of the core melt accidents.

The generation IV nuclear reactors are the next generation reactors which make optimum use of natural resources, while also addressing nuclear safety and proliferation resistance. The higher burn-up ensures minimum output of spent fuel compared to the conventional reactors. This would positively contribute to generating a pro-nuclear public opinion. Currently an international task force (Generation IV International Forum (GIF)) comprising 13 member countries is working on a new collaborative research and design for generation IV reactors, aimed at effectively addressing the flaws in earlier nuclear reactor designs that are operating worldwide. The Generation IV International Forum (GIF) was initiated in 2000 and formally chartered in 2001. Currently, there are six reactor designs being considered in generation IV. These are the Gas-Cooled Fast Reactor System, Lead-Cooled Fast Reactor System, Molten Salt Reactor System, Supercritical-Water-Cooled Reactor System, Sodium-Cooled Fast Reactor System and Very-High-Temperature Reactor System. All the above mentioned reactors operate at a higher temperature than the currently operating nuclear reactors, with four of them being fast neutron reactors.

The technological progress in nuclear reactor construction and the advanced safety measures have made the nuclear power industry more attractive. The generation III and IV reactors offer better safety mechanisms than the older generation reactors. This would positively contribute to the development of the nuclear sector worldwide. In the coming years the advanced technologies and their potential to offer much safer operation of nuclear facilities will be a key driver for the industry's growth.

Uranium Demand and Supply: Sufficient Supply of Fuel to Ensure Continued Growth of Nuclear Industry

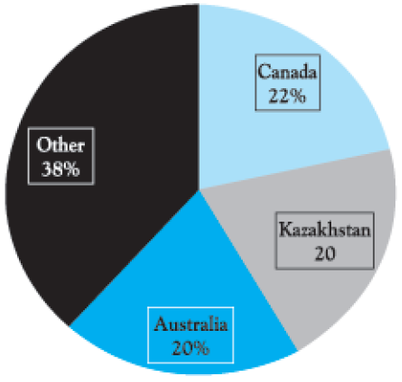
Currently 438 commercial nuclear power reactors are operating worldwide with a total installed capacity of 372,038 MW.[6] Majority of the reactors being built currently would be online by 2015 and would contribute to a significant increase in the demand for uranium. The installed nuclear power capacity in the world is expected to grow to 412,000 MW by 2015 with total power of about 2,800 Billion Kilo Watt Hours. There are different views about the uranium demand-supply scenario. Some industry analysis indicates that demand of uranium will outstrip supply which will eventually cause a supply crunch. But

5 Advanced Nuclear Power Reactors, World Nuclear Association, http://www.world-nuclear.org/info/inf08.html, Accessed: 26/05/2010

6 Power Reactor Information System of IAEA, Accessed from http://www.iaea.org/programmes/a2/ on 23 June 2010.

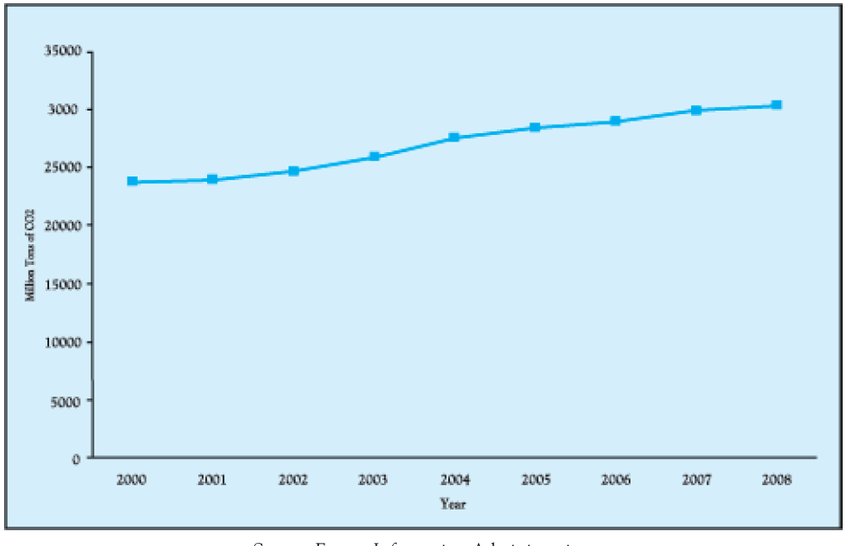
a much more reliable scenario projected by the Red Book (Joint Publication on Uranium by IAEA &OECD) shows that the global uranium industry will have adequate supply to meet the growing demand for uranium in the foreseeable future. Over the past few years, many new nuclear mines have begun operation which will add substantially to the existing worldwide production capacity. According to the Red Book, by 2025, world nuclear energy capacity is expected to grow to between 450 GWe and 530 GWe from the present generating capacity of about 370 GWe. This will raise annual uranium requirements to between 80,000 ton and 100,000 ton. The currently identified resources are adequate to meet this expansion. Australia, Canada and Kazakhstan together account for above 60 per cent of the total uranium production in the world. Globally, the total annual demand for uranium was close to 67,000 tU in 2005 which is expected to be more than 70,000 by 2015.

Figure 3: Global Uranium Production



Source: Percentage Share of Global Uranium Production, World Nuclear Association, 2010.

Figure 4: Global Energy Related Carbon Dioxide Emission (2000-2008)



Source: Energy Information Administration

Environmental Concerns and Demand for Cleaner Energy to Promote Nuclear Industry

Although uninterrupted energy supply is the key determinant for economic development, consumption of fossil fuels is one of the major sources of anthropogenic greenhouse emission. More than 75 per cent of the total anthropogenic carbon dioxide emission is related to the use of conventional fossil fuel burning. In order to minimise environmental damage and climate change hazards, it is important to reduce the energy-related emissions. This necessitates significant reduction in the share of fossil fuels in the energy mix of countries which depend heavily on conventional fuel sources. Nuclear power as a source of energy can contribute significantly to the alleviation of the risk of global climate change and greenhouse gas emission.

The carbon emission levels of many countries have been growing for the past many years primarily due to consumption of fossil fuels. Globally, energy-related emission has increased substantially in the past few years. During the period 2000-2008, the quantity of energy-related carbon dioxide emission grew from 23.8 billion ton to 30.3 billion ton, sending off alarm signals across the world for reducing carbon emission. 'The total life cycle GHG emissions of nuclear are less than 40g or CO2 equivalent per 1 kWh electricity (40 g CO2-eq/kWh), which is similar to those of renewable energy sources. Nuclear power is therefore an effective GHG mitigation option, especially through license extensions of existing plants enabling investments in retro-fitting and upgrading'.[7] However, the carbon emission from fossil fuels is significantly higher and is estimated to be about 400 gCO2/kWh (e).[8]

Nuclear power is being promoted by many countries as a potential alternative to meet the increasing demand for power. From a long-term perspective, non-electrical applications of nuclear energy, such as heat, potable water and hydrogen production, could also be developed, and these applications could expand nuclear power contribution to GHG emission reduction[9] significantly.

Adverse Public Perception will Continue to be a Challenge to Nuclear Industry Development Public opinion is one of the major factors that control the growth trajectory of the nuclear industry in the world. Over the past few years many countries

7 R.E.H. Sims, R.N. Schock, A. Adegbululgbe, J. Fenhann, I. Konstantinaviciute, W. Moomaw, H.B. Nimir, B. Schlamadinger, J. Torres-Martínez, C. Turner, Y. Uchiyama, S.J.V. Vuori, N. Wamukonya, X. Zhang, 2007: Energy supply. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

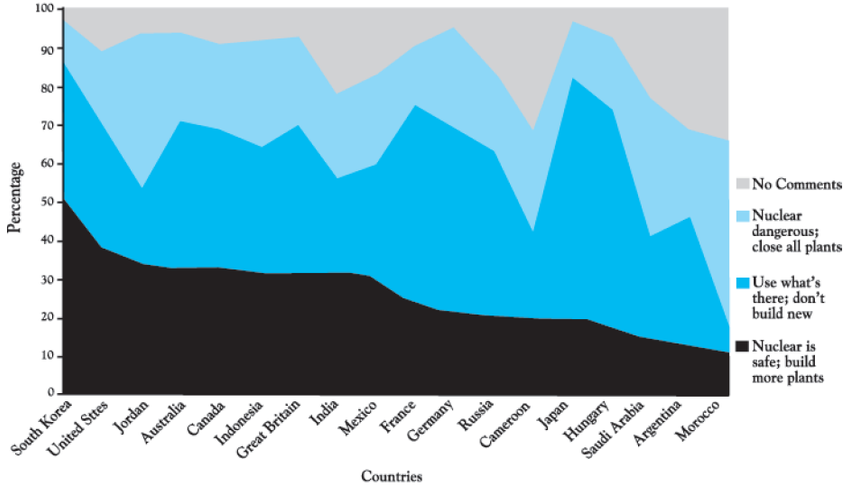
8 David JC MacKay, Sustainable Energy — without the hot air, Cambridge, 2009, p-169

9 Nuclear Power and Climate Change, Nuclear Energy Agency (OECD), accessed from http://www.nea.fr/ndd/climate/climate.html, 21 March 2010.

witnessed a significant transformation in anti-nuclear public opinion to a pro-nuclear approach. Although nuclear power has been considered a potential source for large scale power generation for decades, concerns regarding the proliferation of nuclear weapons, radiation fears and environmental hazards adversely affected the development of the industry for years. However, incidents of political volatility and its impact on global petroleum supply, price fluctuation and energy-related carbon emission have all contributed positively to a renewed interest in nuclear power. The growing technological capabilities in the nuclear power arena and its potential to meet the growing electricity demand also provide the feasibility for nuclear power generation.

Adverse public opinion will remain one of the key challenges to the growth of the nuclear industry worldwide. It has even adversely affected countries that already have nuclear power generation facilities. There was a significant level of opposition to nuclear power in the 1950's and 1960's, primarily due to some of the accidents in the nuclear power- related laboratory experiments. This reached a peak in the late 1970's following the Three Miles island incident and further escalated to widespread anti-nuclear sentiment in the aftermath of the Chernobyl accident. To a great extent, public opinion continues to be a key determinant in decision-making on the nuclear energy sector in all countries. A network of environmental groups provides the backbone to anti-nuclear organisations. In many countries the primary reasons behind public opposition are issues regarding nuclear waste disposal, concern about radiation from nuclear facilities and radiation problems in

Figure 5: Global Public Opinion on Nuclear Issues, 2005



Source: Globe Scan Public Opinion Survey Conducted for IAEA, 2005

uranium mining and processing.

In many countries the upsurge of non-state actors which in turn pose a challenge to the safety of nuclear facilities have also translated into adverse public opinion. Another major factor that contributes to adverse opinion is the campaign by ant-inuclear sections that nuclear power lacks economic feasibility. Though nuclear reactor fuel is cost-competitive, the expenses of capital costs, decommissioning and waste management are considered as additional burdens to nuclear power generation.[10] Often these factors are utilised by anti-nuclear campaigners within a country to suggest that going nuclear is not economically feasible.

In an emerging nuclear power country or in a country with a lower share of nuclear energy, this argument can create serious anti-nuclear sentiments than in the nuclear power countries where the use of nuclear energy has already become an integral part of daily life.

Historically anti-nuclear public sentiments across the world were shaped by factors such as the threat of weapons proliferation and nuclear plant accidents. However, increasing technological progress, demand for more electricity supply and the growing role of international bodies in controlling and regulating nuclear industry are shaping public opinion in favour of development of the industry. In many of the petroleum import-dependent developing economies, growing energy bill due to the surging crude price is also shaping pro-nuclear public opinion across the world.

Domestic Nuclear Industry Management Needs to be Improved in Nuclear Power Countries

Domestic factors often have a more important role to play than external factors in the development of the nuclear industry in a country. While it is important for a country to have international support and cooperation with inter-governmental agencies for developing nuclear industry, factors such as safety and security dimensions for nuclear facilities are largely dependent on the domestic environment. Hence for the smooth working of nuclear facilities, domestic challenges on the safety and security fronts are more severe than the external challenges which are mostly legal or political in nature. Many of the major shutdowns or outages of nuclear power facilities that happened in the past are security or radiation safety-related incidents, which happened due to improper management of nuclear facility operations.

It is important for nuclear power producing countries to strengthen management of domestic safety and security of the environment to make it feasible for the smooth operation of nuclear facilities. Radiation from the uranium mining and processing facilities is more challenging to the safety of the general public in some countries. In India,

10 Nandakumar J, India and Nuclear Power: Examining Socio-Political Challenges to Energy Security, Symposium proceedings, 33rd World Nuclear Association Annual Symposium, 2008, pp-110-116

Table 1: Reactors Under Construction Worldwide

Region	Country	No. of Units	Total MW(e)
Central and South America	Argentina	1	692
Europe	Bulgaria	2	1906
Asia	China	21	20920
Europe	Finland	1	1600
Europe	France	1	1600
Asia	India	4	2506
Asia	Iran	1	915
Asia	Japan	1	1325
Asia	Korea, republic of	6	6520
Asia	Pakistan	1	300
Europe	Russian Federation	8	5944
Europe	Slovak Republic	2	810
Europe	Ukraine	2	1900
North America	United States of America	1	1165
Total		54	50703

Source: IAEA Power Reactor Information System.

uranium mining facilities in Jaduguda and Meghalaya have been targets of public opposition due to the lack of adequate mitigation measures in the past. The inefficiency in managing radiation issues often turns into protests against the nuclear establishment and its facilities. Some political sections have capitalised on these issues to promote their anti-nuclear agenda. The governments need to address these challenges by strengthening radiation prevention and nuclear waste management measures. Without proactive steps by the government, the domestic challenges will continue to be serious concerns for the nuclear industry's development.[11] For emerging nuclear power countries which are planning to build nuclear power facilities, it is of critical importance to ensure that domestic factors are conducive for the development of the nuclear industry.

11 Nandakumar J, Ensuring India's Nuclear Energy Industry Growth, Article No: 3060, IPCS, http://www.ipcs.org/article/india/ensuring-indias-nuclear-energy-industry-growth-3060.html, Accessed: 15 Feb 2010

Asia and Europe to Continue to be Major Hubs for Nuclear Industry Growth

The Asian region will be the epicentre for nuclear industry development in the coming decades. Currently out of the 52 under construction reactors worldwide, the Asia region has 34 reactors, followed by Europe which has 16 upcoming reactors. There are two different factors that work as catalysts for the nuclear industry in these regions. First, the challenges to energy security of many of the countries in these regions have become more severe in recent years. The dependence on petroleum supplies from the politically volatile Persian Gulf region increased substantially, especially among the major Asian consumers. For European consumers, their conventional dependence on Russian oil and gas supplies have become a serious concern especially after Russia's price row with Ukraine that eventually led to gas supply shortages in Europe. More important for European consumers has been the growing domestic as well as external demand to meet its emission targets committed under the Kyoto Protocol.

Nuclear Knowledge Management: Industry knowledge base needs to be strengthened to sustain the growth of nuclear industry

Human resources play a critical role in the nuclear industry domain as skilled workforce is critical to smooth operation of the facilities. Today one of the major challenges faced by the global nuclear industry is the ageing workforce in nuclear facilities which leads to loss of those employees. It is important to preserve and to enhance the scientific, technical and legal knowledge for efficient application of nuclear technology so that nuclear knowledge management can play a major role. Nuclear knowledge management has to ensure:[12] (a) continued availability of key scientific, technical and legal information relevant to the use of nuclear energy; (b) enhanced information transformed into value-added knowledge from experience, insight and judgement; (c) continued availability of adequate numbers of qualified personnel who are able to benefit from, and further enhance, the accumulated nuclear knowledge base; and, (d) develop knowledgeable and enlightened leadership of organisations worldwide that are engaged in the peaceful application of nuclear science and technology.

Nuclear power generation being a highly technical endeavour, it is important to ensure that the knowledge acquired by the workforce is well preserved and shared among the workforce. At many phases in the nuclear plant life, tacit knowledge acquired by personnel is critical for a smooth and sustained operation of the facilities. Hence loss of employees who hold knowledge that is critical either to operations or safety poses an internal threat to the safety and operation of nuclear power plants. While the early nuclear reactors were designed to operate for about 30 years, the life span of reactors are often extended to about 50-60 years and majority of the workforce will not stay for the

12 Nuclear Knowledge Management Handbook, IAEA School of Nuclear Knowledge Management, Trieste, 2008.

entire reactor operation period. Moreover, many new power generation facilities are being constructed in Asia and Europe, and innovative new designs are being researched and developed under the banner of GIF. And the success of all these depend heavily on the availability of experienced personnel and management of their knowledge.

Despite the fact that technology has grown to significant levels where the machines can take care of safety measures efficiently, the role of human element is indispensible. It is vital for transferring the knowledge and expertise acquired by experienced professional to the new generation workforce in any country. It is also a strategic need for a country to ensure that adequate human resource management measures are in place with every nuclear facility or related organisation to address the need of employees. The human resource management need to focus on facilitating frequent interactions between experienced professional and the new workforce as a step towards knowledge retention. It is also important for nuclear facilities and organisations to have strong employee retention policies. Nuclear knowledge management as a critical practice will need to play a pivotal role for the growth of nuclear industry power industry worldwide.

Spent Nuclear Fuel and Waste Management to be Serious Concerns to the Industry

Spent fuel management will continue to be one of the major challenges to the global nuclear power industry. Used fuel is removed from the reactors initially to a wet storage facility and eventually moved to dry storage or for reprocessing after cooling down. Though spent fuel should ideally be going for reprocessing or disposal, in most cases those have been temporarily placed in the wet pool storage locations either at AR (At the Reactor) or AFR (Away from the Reactor) facilities primarily due to the lack of a clear policy on spent fuel. The concern over spent fuel management will continue as there is still lack of clear policy on the type of long-term storage, reprocessing, and nuclear waste disposal in many countries. The plan of the Obama government in US to stop funding for the Yucca mountain project[13] is a recent example of the ambiguity in spent fuel management. The halting of Yucca mountain project will potentially lead to additional

13 As a step towards waste nuclear management, the Department of Energy (DOE) under the United States has been considering Yucca Mountain in the state of Nevada as the potential geological repository. Since completion of the Yucca Mountain final environmental impact statement (FEIS) in 2002, DOE has continued to develop the repository design and associated construction and operational plans. The repository was planned for storing spent nuclear fuel assemblies packaged in transportation, aging and disposal (TAD) canisters. In June 2008, DOE submitted an application for license (LA) to the U.S. Nuclear Regulatory Commission (NRC) seeking authorization to construct America's first repository for spent nuclear fuel and high-level radioactive waste at Yucca Mountain, Nevada. However, In the Budget proposal for financial year 2010, Obama administration decided to terminate the funding for the Yucca Mountain program. Subsequently, in March, 2010, DOE filed a motion with the Nuclear Regulatory Commission to withdraw the license application for a high-level nuclear waste repository at Yucca Mountain. (Sources: DOE, US Government)

Table 2: Emerging Countries with Planned Nuclear Power Programs

Country	Proposed nuclear plants	Type of reactors/ technology	Probable site	Expected year of commencement
Italy	5	EPR	Flamanville 3	2013
Poland	1	CANDU	Visaginas	2015
Belarus	1	PWR	Mogilev	2016, 2018
Turkey	3	CANDU	Akkuyu/Sinop	2012-15
Iran	3	VVER	Bushehr, Darkhovin	2009, 2016
UAE	2	EPR, PWR		2017
Egypt	1	Russian technology	Daaba on Mediterranean	2015
Tunisia	1	French technology	Skhira site	2020
Bangladesh	2	-	Rooppur	2015
Indonesia	2	OPR-1000	Muria	2016, 2017
Ireland	1	Small scale plants	Carnsore	2035
Jordan	1	Enhanced CanDU	Yet to be decided	2015
Egypt	1	Russian technology	Daaba on Mediterranean	2015
Tunisia	1	French technology	Skhira site	2020
Nigeria	1	Iranian technology	Lagos/Ogun, Ekiti/Ondo, Benue states	2017
Kazakshtan	2	VBER- 300	Lake Balkhash	2010

Source: WNA

expenditure towards the expansion of other storage facilities such as AR wet facilities and dry facilities in the power plants. The major concern among many is that, more than 10,000 tHM (tons Heavy Metal) of spent fuel is discharged every year worldwide. By the end of 2010, there will be about 340,000 tHM and by the end of 2020 this could surpass to 445,000 tHM of used fuel.[14]

While some argue that permanent disposal is the better method for getting rid of the radioactive spent fuel, experts are of the opinion that maximum burn-up of fuel needs to be done through the use of advanced reactor technologies for reducing the quantity of waste. However, concerns regarding spent fuel management will continue as there are limited wet and dry storage facilities which are more expensive to maintain, compared to

14 Operation and Maintenance of Spent Fuel Storage and Transportation Casks/Containers, IAEA Paper No: IAEA-TECDOC-1532, January 2007, p-10.

long-term disposal at geological repositories. In the absence of an efficient and effective domestic strategy for spent fuel management in nuclear power producing countries, this would continue to be a major hurdle for the development of the nuclear industry.

New Nuclear Power Countries set to Emerge

Despite the decline in popularity of nuclear energy in the late 1970's and 1980's as a result of the two nuclear plant accidents, today nuclear energy is making a comeback. Though nuclear power is used for electricity generation in only 32 countries currently, many more countries are planning for nuclear power generation in order to address the domestic energy concerns. In 2006, Arab leaders of the Gulf Council met at Riyadh to chart out a plan for a joint nuclear energy development programme. This is primarily to increase their reliance on electricity production from nuclear facilities rather than depend on conventional petroleum fuels. The major partners in this plan include Algeria, Egypt, Morocco, Saudi Arabia, Tunisia and the United Arab Emirates. Though the nuclear plans of major countries in Europe is under consideration, some member states such as Turkey are facing lack of domestic consensus due to the Chernobyl radiation issues. With regards to Africa, which has about 18 per cent of the global uranium reserve, development of nuclear power could address some of the energy security concerns. Currently only South Africa has nuclear power generating facilities in the continent. The Asian region would evince significant prospects for the development of nuclear energy as many of the oil importing countries are already concerned about the long-term reliability of petroleum supply.

Government involvement plays a critical role in establishing the required infrastructure base for the building up of nuclear facilities. Despite the fact that some of these nations are economically advanced they do not possess the requisite technology and infrastructure for building nuclear power plants. These emerging countries also lack human resources with the necessary technical capabilities. Some of the emerging nuclear countries are planning to establish necessary ground by setting up nuclear departments for organising and coordinating the construction and operation of nuclear plants and cost monitoring. Hence, the emerging countries will serve as potential markets for technology suppliers, equipment manufacturers and other nuclear industry players.

Conclusion

For a country which depends on overseas supply of petroleum fuels, energy security is a perpetual concern. To a great extent this energy security concern will contribute positively to the growth of the nuclear sector worldwide. The trends in the global nuclear power sector for the past few years show the fact that the industry has been growing at a considerable pace. The longer life span of nuclear facility (including the conventional and life extension period), relatively cheaper fuel price and higher energy value, advanced

technology and improved safety mechanisms of new reactor types are making nuclear power attractive to many countries. Moreover, nuclear power is preferred in many countries as they need to reduce green house gas emissions, need to diversify energy supplies, need to reduce dependency on imported petroleum sources and to address the growing demand for electricity. Many more new reactors are set to join the existing fleet of 438 commercial nuclear power reactors as more countries hitch on to the nuclear bandwagon.

While some of the conventional challenges regarding spent fuel management and concerns regarding public opinion continue to exist, nuclear industry has become a viable source for power generation due to various factors. Advanced reactor technologies which address many conventional concerns related to safety, power generation efficiency, increased fuel burn-up and proliferation resistance are set to boost the global nuclear industry. The currently identified reserves and the existing uranium production facilities offer great potential for the global nuclear industry to grow. The environmental concerns about energy-related emissions and climate change mitigation efforts in many countries consider that going nuclear can help meet the growing domestic electricity demand while keeping carbon emissions minimum. However for sustained growth, countries need to pay attention towards nuclear waste management, domestic nuclear sector management which includes adopting policy and implementation of measures to check radiation effects, monitoring any possible radiation leak from the uranium mining and processing facilities, spreading awareness on nuclear energy among the general public and promoting nuclear knowledge management. A safer nuclear power industry in a country can be an answer to its concerns on emissions, quest for energy security and help achieve long term economic targets.

PROSPECTS OF NUCLEAR ENERGY IN INDIA

Introduction

Industrialisation and the rising concern over climate change have put India and other emerging economies in a unique position where these countries will have to negotiate a middle path between economic development and environmental sustainability. One of the primary challenges for India would be to alter its existing energy mix which is currently dominated by coal, to accommodate a greater share of cleaner and sustainable sources of energy. Among the various sources of clean energy (in comparison to coal and other fossil fuels) that have been explored, nuclear energy is perhaps the only robust and sustainable source of energy for large scale and continuous industrialisation and urbanisation. At present, only 3 per cent of India's total electricity comes from nuclear power plants. An assessment of India's nuclear sector, especially after the Indo–U.S. Nuclear Deal suggests that nuclear energy could be a sustainable and a robust alternative to fossil fuels in India. It could also reduce India's increasing dependence on petroleum imports.

Nuclear energy has been given importance with the conclusion of the Indo–U.S. Civilian Nuclear Agreement. The Agreement has also enabled India to envision a possible and realistic future of nuclear energy as it can now trade in civilian nuclear energy with various Nuclear Supplier Group (NSG) countries. The deal has made it possible for India to sign civilian nuclear agreements with countries like France, Russia and Canada. As per the Department of Atomic Energy, India plans to increase its nuclear energy production to 20,000 MWe by 2020 and 63,000 MWe by 2032.[1] Currently India has an installed capacity of 4560 MWe of nuclear power.[2] According to the Nuclear Power Corporation of India Limited (NPCIL) there are currently seven new nuclear reactors are under construction. There are two, thousand MWe each reactors (2 X 1000) being built in Kundakulam, which are expected to be operational by September 2010 and March 2011

1 "A strategy for the Growth of Electrical Energy in India." *DAE*. http://www.dae.gov.in/publ/doc10/index.htm

2 "Plants in operation." *NPCIL*. http://www.npcil.nic.in/main/AllProjectOperationDisplay.aspx

respectively; two, 700 MWe reactors each in Rajasthan (2 X 700) (June and December 2016), one, 220 MWe reactor in Kaiga district, Uttar Kannada, Karnataka, which is nearing completion and is expected to be operational by July 2010, and two 700 MWe reactors (2X700) in Kakrapar, Gujarat (June 2015& December 2015)[3]

This shows that efforts are being made to achieve the ambitious target of generating 20,000 MWe of power by 2020 from 4120 MWe at present. This will prove to be a herculean task because of the time taken and potential delays in building and operationalizing nuclear reactors. The seven reactors mentioned earlier are yet to be completed and made operational, two of which (2 X 700) will not be ready until 2016. The operationalization of these five reactors would add 5020 MWe to the existing 4120 MWe of nuclear power, taking the grand total to 9140 MWe by 2016.

Even as per the Department of Atomic Energy (DAE) table below, India is expected to generate 29.46 GWe by 2022, which is 29,460 MWe. This target is too ambitious. That being said, the DAE sounds confident about achieving the target of 20,000 MWe. As per the DAE, "The target set by DAE of installing 20 GWe nuclear power by the year 2020 will be achieved. This target includes 2.5 GWe of Oxide fuelled FBRs [fast breeder reactors] and 8 GWe of LWRs (Light Water Reactors)... R&D for using metal fuel in FBRs will be completed by the year 2020. Corresponding fuel cycle technologies will also be developed. Industrial capability to construct required numbers of FBRs of 1 GWe rating will be in place by the year 2021 and this capacity will be expanded subsequently."[4] It is noted by the DAE that "if only the already negotiated 2 GWe LWRs are imported then the installed capacity in 2052 will be 208 GWe instead of 275 GWe."[5]

The already negotiated 2 GWe LWRs refer to the two 1000 MWe each, Pressurized Water Reactors (PWR), (which are one of two types of Light Water Reactors (LWR)), nuclear reactors being built in Kundakulam, Tamil Nadu, which are nearing completion. There has been a delay of three years in completion. That being said, with AREVA set to build 6 more EPRs [1600 MWe each = > 1600 X 6 = 9600 MWe] by 2020[6], India would come close to the projected target of 20,000 MWe by 2020. India would be able to generate roughly about 18740 MWe, [9600 + 9140 = 18740 MWe]. The multiplier effect resulting from the breeder reactors [discussed in the next section] would further augment the fuel supply and the power generation. Assuming that production of 2500 MWe from Oxide fueled FBRs is achieved; the over all figure would be 21240 MWe. However, delays in

3 "Status of Projects Under Construction." *NPCIL*. http://www.npcil.nic.in/main/ProjectConstructionStatus.aspx

4 "A strategy for the Growth of Electrical Energy in India." ***DAE***. http://www.dae.gov.in/publ/doc10/index.htm

5 Ibid.

6 "Nuclear Power in India." (May 2010). World Nuclear Association. http://www.world-nuclear.org/info/inf53.html

construction and operationalizing reactors will have to be minimized to achieve the target of 20,000 MWe by 2020. If the time schedule for building nuclear reactors is followed, achieving the target of 20,000 MWe would be possible.

Cumulative Nuclear Power Installed Capacity Table. 1[7]

	PHWR, AHWR and FBR based on Pu from PHWR			LWR and FBR based on Pu from LWR			Sub Total		Grand Total
Year	Thermal (GWe)	Fast (GWe)		Thermal (GWe)	Fast (GWe)		Oxide (GWe)	Metal (GWe)	(GWe)
	Oxide	Oxide	Metal	Oxide	Oxide	Metal			
2002	2.40	0.00	0.00	0.32	0.00	0.00	2.72	0.00	2.72
2022	9.96	2.50	6.00	8.00	0.00	3.00	20.46	9.00	29.46
2032	9.40	2.50	33.00	8.00	0.00	10.00	19.90	43.00	62.90
2042	7.86	2.50	87.00	8.00	0.00	26.00	18.36	113.00	131.36
2052	4.06	2.50	199.00	8.00	0.00	61.00	14.56	260.00	274.56

According to Jeffery Bergner (Assistant Secretary, State Department, USA), the Indo–U.S. Civilian Nuclear Agreement will not only enable nuclear cooperation between U.S. and India, but will also lead to scientific cooperation between the two countries that would help make nuclear energy cheaper and safer. Furthermore, Indo–U.S. civilian nuclear cooperation can facilitate, "Indian involvement in the International Thermonuclear Experimental Reactor and Generation-IV Forum, which would prove to be beneficial, as it would expand the possibility of future innovations in nuclear energy."[8]

Three-stage Nuclear Programme

Nuclear energy programme in India has been divided into three stages. The first stage comprises of building pressurised heavy water reactors (PHWRs) and using natural uranium. The second stage includes setting up "Fast Breeder Reactors (FBRs) backed by reprocessing plants and plutonium-based fuel fabrication plants. In order to multiply the fissile material inventory, Fast Breeder Reactors are necessary for our (Indian) programme. The third stage will be based on the thorium-uranium-233 cycle..."[9]

7 "A strategy for the Growth of Electrical Energy in India." *DAE*. http://www.dae.gov.in/publ/doc10/index.htm

8 Bergner, Jeffrey, T. 2007. "Question for the Record submitted to Assistant Secretary Bergner by Chairman Tom Lantos House Committee on Foreign Affairs." *United States Department of State*. http://www.hcfa.house.gov/110/press090208.pdf

9 Kakodkar, Anil. 4 – 6 September 2002. "Nuclear Power in India: An Inevitable Option for Sustainable Development for a Sixth of Humanity." *World Nuclear Association, Annual Symposium*. pg. 3

Civilian nuclear technology is well established in India and the primary issue in front of the government is to scale up the nuclear sector and increase the amount of electricity generated by the nuclear reactors. This has to be done by running the existing power at full capacity and building new reactors to increase the over all electricity generation. This calls for construction of newer power plants and for securing uninterrupted supply of nuclear fuel for the reactors. To increase the nuclear power generation capacity, many international vendors have also started investing in India subsequent to the culmination of the Indo– U.S. Civilian Nuclear Agreement. For instance, Russia's Atomstroy has agreed to build six more light water pressurised reactors in Kundakulam by 2017 and four in Haripur after 2017. Areva has signed a memorandum of understanding with NPCIL to build a total of six European Pressurised Reactors (EPR). GE Hitachi Nuclear Energy has signed agreements with NPCIL and Bharat Heavy Electricals (BHEL) to build a multi–unit power plant using 1350 MWe Advanced Boiling Water Reactors (ABWR). Many other companies such as Atomic Energy of Canada Ltd. and Korean Electric Power Co. have also signed similar agreements with India regarding servicing India's existing PHWRs.[10] This process would strongly establish the first stage of the India nuclear energy programme comprising PHWRs and other reactors. The U.S. also stands to gain from the growth in India's nuclear sector. According to Assistant Secretary Jeffery Bergner, even if U.S. companies could secure contracts for two out of the 15 odd reactors India plans to import, it could add 3000–5000 direct jobs and 10,000–15,000 indirect jobs in America for Americans.[11] Hence, growth in India's nuclear energy sector would also provide a much needed economic stimulus to various companies in the West.

An important component, termed as the second stage of India's nuclear programme, in harnessing nuclear energy in India is the development of fast breeder reactors. Its significance was realised due to low uranium reserves in India. Spent nuclear fuel from a standard nuclear reactor could be reprocessed "into plutonium and residual uranium, and used in the fast reactors..."[12] Fast breeder reactors generate their own fuel, thereby increasing the electricity generation capacity exponentially, despite India's poor uranium reserves. Given that fast breeder reactors generate more plutonium, the breeder reactor

10 "Nuclear Power in India." (March 2010).
World Nuclear Association.
http://www.world-nuclear.org/info/inf53.html

11 Bergner, Jeffrey, T. 2007.
"Question for the Record submitted to Assistant Secretary Bergner by Chairman Tom Lantos House Committee on Foreign Affairs."
United States Department of State.
http://www.hcfa.house.gov/110/press090208.pdf

12 Kakodkar, Anil. 24.11.2004. "Fast breeder reactors more important for India"
THE HINDU.
http://www.igcar.ernet.in/press_releases/press11.htm

could be used as a source of fissile material for reactors and nuclear weapons. Although the Indo–U.S. Civilian Nuclear Agreement attenuates the fuel supply crunch India faced earlier, breeder reactors would give India not only a technological advantage, but would help in building a fuel surplus further strengthening India's energy security. But the importance of fast breeder reactor transcends the need for fuel supply. As per the Department of Atomic Energy (DAE), "It is assumed that the technology of Pu-U metal based FBRs having the fissile growth rate of 8.1 per cent a year, would have been developed by 2020."[13]

"A strategy for the Growth of Electrical Energy in India."***DAE.***
http://www.dae.gov.in/publ/doc10/index.htm

The strategic importance of fast breeder reactors can be understood by considering the questions: does India plan to conduct nuclear tests in the future? And what will be the strategic nuclear goals? Regardless of whether India plans to increase its nuclear weapons arsenal or nuclear fuel, fast breeder reactors would become important due to their fissile material generating capacity. There are those who believe that India will have to conduct nuclear tests to ensure the credibility of its nuclear deterrence. The possibility of a decision to conduct nuclear tests calls for continued efforts to develop fast breeder reactors from purely a fuel generation point of view. After all, nuclear trade with the rest of the world would very well end if India tested nuclear weapons sometime in the future. The Indo–U.S. Nuclear Deal also has a provision that allows the creation of a strategic reserve of nuclear fuel.

The fast breeder reactors provide a multiplier effect with respect to fuel generation. The fuel increases by a certain breeding rate each year. As per the DAE publication, the system growth rate or the breeding rate is 8.1 per cent per year.[14] Therefore, in a 1000 MWe reactor, 81 MWe worth of fuel will be generated at the end of one year. This will get compounded every year to generate more fuel than the previous year for no additional costs. As the overall installed capacity of nuclear energy increases, the fast breeder reactors will yield 8.1 per cent more fuel per year, increasing the over all fuel availability.

Another critical factor, the third stage of India's nuclear energy programme, that can perhaps play a decisive role in establishing nuclear energy as the primary source of energy in India is whether thorium emerges as a viable fuel option for India or not. India has low uranium reserves which, prior to the nuclear deal was restraining it from utilising nuclear power. Estimates suggest that India possesses about 90,000 tonnes of the metal. "After accounting for various losses including mining (15 per cent), milling (20 per cent) and

13 "A strategy for the Growth of Electrical Energy in India." DAE.
http://www.dae.gov.in/publ/doc10/index.htm.

14 "A strategy for the Growth of Electrical Energy in India." *DAE.*
http://www.dae.gov.in/publ/doc10/index.htm

fabrication (5 per cent), the net uranium available for power generation is about 61,000 tonnes."[15] However, given India's large reserves of thorium, it would be beneficial for it to develop the technology that is able to utilise thorium to produce power. "Although not fissile itself, thorium (Th-232) will absorb slow neutrons to produce uranium-233 (U-233), which is fissile (and long-lived)."[16] Current research suggests that India has made some progress in this field and may very well be on its way to develop thorium-based reactors.

According to Dr. Anil Kakodkar (former chief of the Atomic Energy Commission), nuclear energy programme based on thorium-uranium-233 cycle are under way. "An Advanced Heavy Water Reactor (AHWR) is being developed at Bhabha Atomic Research Centre (BARC) to expedite transition to thorium-based systems. The reactor physics design of AHWR is tuned to generate about 75 per cent power from thorium."[17]

At present, India is said to have about one quarter of the world's thorium reserves.[18] As per the DAE, "about 2,25,000 tonnes of thorium metal is available for India's nuclear power programme,"[19] which when utilised (assuming the availability of fast breeder reactors) can generate around 155,502 Gwe a year.[20] This suggests that in the event that thorium reactors are able to generate electricity, India will not be dependent on other countries for fuel. Small experimental reactors have been built in India which have yielded interesting results regarding the feasibility of thorium as a sustainable energy source.

Nuclear Energy and Climate

One of the reasons nuclear energy is considered to be a viable source of energy is because it is a clean source of fuel which will help reduce carbon emissions in the future. In addition to reducing emissions, water requirements for drinking purposes can be fulfilled by using nuclear power to desalinate sea water. For reactors near the sea, desalination plants would be used to turn sea water to industrially usable water. In addition to this, given the high energy requirements in desalinating sea water, nuclear power could be used to make potable drinking water. The water desalination units installed in reactors near the sea could also be used to replenish ground water thereby improving the ecosystem and

15 "A strategy for the Growth of Electrical Energy in India." *DAE*. http://www.dae.gov.in/publ/doc10/index.htm

16 "Thorium." (October 2009). *World Nuclear Association*. http://www.world nuclear.org/info/inf62.html

17 Kakodkar, Anil. "Nuclear Power in India: An Inevitable Option for Sustainable Development for a Sixth of Humanity." *World Nuclear Association, Annual Symposium*. 4 – 6 September 2002. pg. 3.

18 "Nuclear Power in India." (March 2010). *World Nuclear Association*. http://www.world nuclear.org/info/inf53.html

19 "A strategy for the Growth of Electrical Energy in India." *DAE*. http://www.dae.gov.in/publ/doc10/index.htm

20 Ibid.

increasing drinking water supply.

Steps have been taken to introduce and make desalination plants operational in India. As per a Department of Atomic Energy document, "BARC has developed desalination and water purification technologies on Reverse Osmosis (RO), Multi-Stage Flash (MSF), Low Temperature Evaporation (LTE), Hybrid System and Domestic Water Purifier...Indigenously designed 4500 m3/day Multi-Stage Flash (MSF) desalination plant capable of producing ultra pure water of less than 10 ppm, is at an advanced stage of construction with the installation of most of the equipment."[21] A desalination plant has been attached to the CIRUS reactor and is currently being constructed at Kalpakkam. Water desalination plants help to make sure 1) clean and potable drinking water can be produced using seawater thereby attenuating drinking water availability and 2) surplus (desalinated) water in the power plants could be pumped back into the ground from an ecological viewpoint or be used as a source of water for other domestic or industrial purposes, without affecting the ecology.

Major Critiques of Nuclear Energy

On the issue of environment and human health, while nuclear energy lessens the extent of carbon emissions, it nevertheless poses serious threats to environment and humans. The risk of a nuclear meltdown and an event similar to the Chernobyl catastrophe would haunt even the biggest proponents of nuclear energy. The former U.N. General Secretary Kofi Annan stated that "...the exact number of victims may never be known, but 3 million children require treatment and...many will die prematurely...not until 2016, at the earliest, will be known the full number of those likely to develop serious medical conditions...because of delayed reactions to radiation exposure..."[22] The Bhopal gas tragedy would be dwarfed if a nuclear meltdown happened in India, repercussions of which will have to dealt with and endured for much of the 21st Century.

But does this mean that nuclear energy should not be pursued? The point generally made is one incident of radioactive fallout is enough to affect a significant number of people and their subsequent generations for a long period of time. There is no doubt that international best practices in nuclear plant maintenance must be enforced diligently and people responsible for safety and operations of the nuclear power plant must be held accountable.

21 "Desalination of Water." Department of Atomic Energy. Pg. 9. http://www.dae.gov.in/ni/nimay05/PDF/Desalination%20Of%20Water.pdf

22 A. Yablakov, I. Labunska and I Blokov. April 2006. "The Chernobyl Catastrophe: Consequences on Human Health." *Greenpeace*. http://www.greenpeace.org/international/press/reports/chernobylhealthreport.

As discussed earlier, one of the reasons why nuclear energy is thought to be desirable is because it helps to reduce the overall carbon emissions. While nuclear reactors may be expensive, one must also think of all measurable and immeasurable costs that the world would incur if carbon emissions continue to rise. Effects of carbon emissions on human health would be significant, which in turn would affect quality of life and hence productivity of the labour force, which in turn would have significant economic consequences. Global warming which would cause the ice caps to melt further, would increase the sea levels thereby jeopardising many coastal cities and island states all over the world.

Another widely propagated idea is that nuclear energy in India would be much more expensive than fossil fuel based electricity.[23] As per the data given in the 2007-2008 annual report of NPCIL, nuclear fuel constitutes 20.48 per cent of the total expenditure. Fuel charges for the year 2007-2008 was Rs. 62753.99 (hundred thousand) and the total expenditure for the same year was Rs. 306324.60 (hundred thousand).[24] On the other hand, the data provided by the 2008-2009 annual report of the National Thermal Power Corporation (NTPC) suggests that fuel expenditure constitutes 71.53 per cent of the total expenditure incurred by NTPC. The total fuel expenditure was Rs. 273,464 million and the total expenditure was Rs.382,304 million.[25] This suggests that nuclear fuel is less sensitive to price fluctuations than coal, gas and petroleum (thermal energy sources).

Additionally, the Indo–U.S. Civilian Nuclear Agreement has enabled India to import nuclear fuel from Nuclear Supplier Group (NSG) countries which would help reduce nuclear fuel cost because the low quality of Indian uranium makes it expensive to exploit domestic uranium reserves. With the ability to reprocess the spent fuel in fast breeder reactors, more fuel could be produced in the future. Although nuclear energy may not be as cheap to harness unlike coal or oil, importing fuel certainly makes nuclear energy a viable long-term option, in spite of it being a little expensive compared to fossil fuels. The government has shown the willingness to invest in new nuclear reactors (imported and indigenous) as importing nuclear fuel from abroad would help in reducing fuel costs.

Many of the oil rich West Asian countries have now started to invest in nuclear energy and civilian nuclear technology. As per Mohamed Kadry, a Military and Technology advisor to the Al–Ahram Center for Political and Strategic Studies, "Most of the new nuclear-aspirant states in the Middle East announced their decision to go nuclear in terms of electricity needs, energy diversification, economic benefits of nuclear power,

23 Ramana, M.V. "Nuclear Power in India: Failed Past, Dubious Future." http://www.npec-web.org/files/Ramana-NuclearPowerInIndia.pdf

24 "Profit and Loss Account." (March 31, 2008). NPCIL Annual Report 2007- 08. pg. 71, 81. http://www.npcil.nic.in/pdf/annual_report07_08.pdf.

25 "Profit & Loss Account for the Year Ended 31st March 2009." (May 2009). NTPC Annual Report 2008. Pg. 187. https://www.ntpc.co.in/annualreports/2008-09/Consolidated_Financial_Statements09.pdf

seawater desalination, as well as an interest in the role of nuclear energy in efforts to retard global warming...The rising price of oil has also made nuclear energy more attractive."[26] When oil rich countries are also investing in nuclear energy keeping the future in view, India must invest seriously in the nuclear energy sector to secure its future as well.

Additionally, the three-stage nuclear programme (as discussed in this paper) was envisaged with the use of thorium being the culminating point (given India's rich thorium reserves).While the initial investment to increase overall capacity is bound to be expensive, imported nuclear fuel can be used to reduce overall production and consumption costs of nuclear energy. Continued use of fossil fuels leading to increasing carbon emissions and the resulting environmental degradation will lead to increase in costs of taking corrective measures. To be able to economically exploit nuclear energy in the future, investments have to be made now so that a smooth transition could be made from fossil fuel dominated energy mix, to an energy mix which would not wholly but substantially depend on nuclear energy. This is the reason why it is believed that coal will continue to dominate India's energy mix for the next decade or so (given the low cost of production and abundance in India). But growing environmental pressures will require India to alter its energy mix, making nuclear energy an important fuel source in the future.

Conclusion

The diversification of India's current energy mix, which is dominated by coal, is necessary if India is to increase its economic growth rate and at the same time constructively contribute towards reducing climate change. Therefore, it becomes necessary for India to reduce its coal and other fossil fuel consumption and consider other alternatives that do not emit as much greenhouse gases as do fossil fuels. At the same time, India needs to make sure that it employs sustainable energy sources which do not jeopardise its energy supply and therefore its economic growth. The country finds itself in a position where it has to constantly negotiate between sustained economic growth and reducing its carbon emission. Therefore, nuclear energy proves to be a viable option as it is a tried and tested technology and India has developed nuclear technology over the years and has a matured nuclear industry. Nuclear energy is therefore a sustainable source of energy and would significantly reduce total carbon emissions from India.

Another reason why nuclear energy proves to be a viable option for India is because India will continue to develop its civilian nuclear industry with indigenous efforts and from foreign investments made possible by the Indo–U.S. Civilian Nuclear Agreement. While significant contribution from nuclear energy towards the total energy needs of India in the short term (within the next decade) is suspect, it holds good promise in the

26 Kadry, Mohamed. (September 2009) "Civil Nuclear Energy Proliferation Challenges and Implications for the Middle East." *International Commission on Nuclear Non-proliferation and Disarmament.* pg. 1

long run, once the construction of the reactors is complete and they become operational.

In sum, prospects of nuclear energy in India are bright, but that is in the long run. The benefits of the nuclear deal coupled with a mature and well established nuclear sector in India suggests that nuclear energy has the potential to be a major source of electricity in future. India must continue to develop its fast breeder reactors regardless of the US nuclear deal to be at the forefront of technology development and to safeguard the country's strategic interests. Fast breeder reactors have the capability to produce more fuel by reprocessing spent fuel. This provides a multiplier effect which increases the amount of fuel available, and hence provides more fuel for the same amount of money spent. The fuel increases by a certain breeding rate each year. As per the DAE, the breeding rate is 8.1 per cent a year.

Research and Development (R&D) activities in the area of thorium-uranium-233 cycle must be pursued as not only is thorium a clean source of energy, but it is also found in abundance in India, which would make India resource independent. Nuclear energy can be used to run water desalination plants which can convert sea water into potable drinking water. This would help in increasing the supply of drinking water. Desalination plants can be used to pump in fresh water to replenish the ground water table which can have healthy ecological implications.

In the long term, India will benefit by employing nuclear energy as a source of electricity generation. Increasing environmental pressures will make it difficult for India to continue with the use of fossil fuels at existing levels in the future. While domestic nuclear ore is of low grade, and hence expensive to utilise, the Indo–U.S. Civilian Nuclear Agreement helps India to import nuclear fuel which would reduce fuel costs and hence the cost of nuclear power generation. The three-stage nuclear programme was set up which ultimately aims at developing technology which will enable India to utilise its thorium resources to generate energy. Thorium has the prospects of being a significant source of energy in the long term (perhaps 2050 and beyond).

PRIVATE NUCLEAR INDUSTRY REGULATION : BEST PRACTICES

Introduction

A nuclear industry directly or indirectly owned by the government or the private sector or industry has to abide by some fundamental rules and regulations. Adherence to the fundamental rules and regulations for operating a nuclear facility, especially a nuclear reactor is required for any foreign industry as well. A nuclear industry may operate as a foreign subsidiary or may register itself as a company according to the law of the country where it operates. However, there may be different rules and regulations for private industry and foreign companies in different countries. These rules may be in addition to the fundamental rules applicable to all the nuclear operators. Private domestic industry and foreign companies may not have to follow all the rules otherwise laid down for the government companies.

Similarly, there could be different rules for a facility which falls under different stages of the nuclear fuel cycle. For example, there could be rules and regulations guiding reactors, and different rules and regulations for uranium mining industry. Here, too, industry working on different stages of nuclear fuel cycle may have to follow some common or fundamental rules and regulation. The International Atomic Energy Agency (IAEA), in one of its publications[1], enumerates 11 basic principles for running nuclear energy and ionising radiation activities. These are:(a) the safety principle; (b) the security principle; (c) the responsibility principle; (d) the permission principle; (e) the continuous control principle; (f) the compensation principle; (g) the sustainable development principle; (h) the compliance principle; (i) the independence principle; (j) the transparency principle; and (k) the international co-operation principle.

This section examines the best practices in the key and leading nuclear energy producing countries or countries which have got a substantial nuclear science industry base. For the study, we have selected the United States (US), the United Kingdom (UK), South Korea and Japan. The US is the leading country in the nuclear business, even though after the Three Mile Island incident, it almost stopped adding nuclear power

1 Carlton Stoiber et al, Handbook of Nuclear Law, International Atomic Energy Agency: Vienna, 2003, p.5

reactor for electricity generation. Now, it has begun to construct a nuclear power plant. The UK is another leading nuclear country which has got a Parliamentary form of system. The Indian system may have been benefited with the British experience in regulating nuclear industry. Japan and South Korea, the two leading Asian countries, have a very advanced nuclear industry. Japan gets around 30 per cent of its electricity from nuclear energy and South Korea receives about 40 per cent of its electricity from nuclear energy. Both the Asian countries have very ambitious programmes to increase the share of nuclear energy in their electricity profiles. The study has also consulted documents published by the IAEA for regulating civil nuclear energy.

Issues

Safety

All countries have rules and regulations for the safety principle to address the concerns relating to health and environment. The regulatory frameworks of the relevant countries generally adopt both the prevention or precautionary and protection principles. The regulatory system for safety is also supposed to take into account other principles such as the transparency principle, the sustainable development principle, and the compliance principle. The responsibility principle demands that the operator of the activities own the primary responsibility of properly running nuclear science related activities. A country that allows operation of nuclear activities must factor in risks of radiological contamination transcending national boundaries. All the four countries mentioned above have more than one body of law for safety of nuclear activities.

In Japan, the Environment Impact Assessment Law[2] lays down the procedures for assessing the impact of large scale nuclear power plants on the environment. Though there is a specific act devoted for nuclear safety, all Japanese laws and regulations make it absolutely compulsory for the licensing authority to promote the safety principle for nuclear activities. There is a Law on Emergency Preparedness for Nuclear Disaster.[3] For nuclear reactor licensing, the licensing authorities have to take safety factors into account at all the three stages: approval of a particular site, the granting of a construction license, and permission for the operation of the plant.[4] To bolster the safety mechanism, the Japanese government has been amending its regulations and laws from time to time. Its regulatory framework has provisions such as periodic inspection and compulsory

2 See Government of Japan, Ministry of Environment, Environmental Impact Assessment Law, Law no 81, 1997, http://www.env.go.jp/en/laws/policy/assess/index.html; Government of Japan, Ministry of Environment, Environmental Impact Assessment, p.7, http://www.env.go.jp/en/policy/assess/pamph.pdf

3 Act on Special Measures Concerning Nuclear Emergency Preparedness, http://www.japaneselawtranslation.go.jp/law/detail/?ft=1&re=02&dn=1&co=01&x=36&y=18&ky=nuclear+safety&page=2&id=106&lvm=02

4 Ibid

notification of some activities. Japan has also acceded to the international conventions such as the Convention on Early Notification of a Nuclear Accident, Convention on Nuclear Safety, Convention on Nuclear Safety and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Like other leading nuclear operators, in South Korea, the licensing authorities have to ensure that the applicant has required technical and professional capability so that person, environment and property are not damaged because of the operation of a reactor. The country has a legal framework such as the Atomic Energy Act, Korea Institute of Nuclear Safety Act, Act on Physical Protection and Radiological Emergency, Nuclear Liability Act, Framework Act on Fire Services, Building Act, Industrial Safety and Health Act, and Basic Act on Management of Disasters and Safety. A nuclear power plant operator is supposed to employ a person holding a license to supervise the reactor's operation. This license is issued by a government department, but the owner of the plant has the option of selecting the supervisor. However, if the government finds that the supervisor is not doing his duty properly, it may remove that person. If the licensing authorities find that the operator of a nuclear reactor is not found to be complying with the safety principle, it may cancel the license. It undertakes this task through a number of regulatory and legal measures.

In the UK, there are several laws and regulations that deal with the safety aspect of nuclear activities. There are bodies of law such as the 1995 Environmental Act, the 1993 Radioactive Substances Act, the 1983 Health and Safety (Emissions into the Atmosphere) Regulations, the 2001 Radiation (Emergency Preparedness and Public Information) Regulations, the 1999 Ionising Radiations Regulations which guide the nuclear reactor operation in the UK to pay attention to the safety element. UK has ratified the 1986 Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency. Like any other democratic country, it is impossible to get a license and run a power reactor by ignoring the safety aspect. It seems the law does not make any distinction between the government-owned reactor and private reactor on the safety issue.

US has the legal framework such as the National Environmental Policy Act of 1969, and different regulations such as Regulatory Guide 4.1, "Radiological Environmental Monitoring For Nuclear Power Plants," Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programmes (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment"; NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," ; NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors"; and Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Demonstrating Compliance with 10 CFR Part 50, Appendix I".

To get a license for a nuclear power plant, an operator has to file an application to the licensing organisation for 'design certification rule making'. The US rules prescribe technically-relevant requirements for the safety of the design of the power plant. The application of the operator has to furnish information regarding inspections, tests, analysis, and acceptance criteria to demonstrate that the plant is going to be constructed according to the design. In the US, each reactor site has to undergo periodic inspections to ensure its safety. The site must have at least one senior resident inspector and a resident inspector to monitor when it is operating. The results of special inspections are made available to the public. An operator cannot make any change which may have safety implications without consulting and getting approval from the Nuclear Regulatory Commission.

The US has provisions in its system to provide emergency assistance related to safety. It also has an independent regulatory authority over safety in the transportation of radioactive material. The authority decides design standards for the carriers of licensed spent fuel, and reviews and certifies cask designs before their use. In some cases, state governors are to be informed about transportation of radioactive materials. The law does not allow air shipment of plutonium, though exceptions have been granted for medical uses. However, it is to be shipped in certified safe containers. No foreign aircraft can pass over US airspace if it carries plutonium without meeting the American standard for safe container. Periodic inspections are also conducted to ensure that safety-requirements are met during transportation of nuclear materials. The US regulation demands that an operator takes several preventive measures such as radiation protection equipment, survey of hazards, personnel monitoring, and display of signs, labels and signal. Besides, the US rules demand that site workers are given proper training about safety.

Enrichment and Reprocessing

Enrichment and reprocessing of source nuclear materials have to meet the compliance principle. In Japan, the private nuclear industry is under special restrictions to refine nuclear source material, in which case source material means uranium or thorium. As Japan does not have any thorium-based programme now, we may assume that the Japanese regulatory structure guides its industry regarding natural uranium and its refinement or its enrichment or later its reprocessing. On June 20, 1979, through an amendment the Japanese Prime Minister was empowered to allow private industry to reprocess. Since 2001, the power to grant authorisation was transferred to the Ministry of Economy, Trade and Industry if it wants to refine the source material. Now, the Japanese regulatory system demands that any non-governmental entity will have to take a license.

Article 1 of the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors lays down: "This Act, in accordance with the spirit of the Atomic Energy Basic Act (Act No. 186 of 1955), is enacted for the purpose of providing necessary regulation on refining activities, fabricating and enrichment activities, interim storage activities, reprocessing activities and waste disposal activities, as well as on the installment and operation, etc. of reactors, and also for the purpose of providing necessary regulations on the uses of international controlled material to execute treaties or other international agreements concerning the research, development and use of atomic energy, in order to ensure that the uses of nuclear source material, nuclear fuel material and reactors are limited to peaceful ones and carried out in a planned manner... ."[5]

Article 3 of the same Act lays down the procedure to apply for a license for 'refining' activities. Article 3 says that the application should provide the following information:

(i) The name and address of the applicant and, in the case of a juridical person, the name of its representative,

(ii) The name and address of the factory or place of activity where the refining equipment and auxiliary facilities or refining facilities are to be installed,

(iii) The location, structure and equipment of refining facilities, and the refining method,

(iv) A construction plan for the refining facilities.[6]

Article 4 of the Act lays down three criteria: (i) the approval of the application will not hinder the planned development and utilisation of nuclear energy, (ii) the applicant has sufficient technical capability and financial basis for executing the activity competently, and (iii) the location, structure and equipment of the refining facilities are such that they will not hinder the prevention of disasters resulting from nuclear source material or nuclear fuel material.[7] Under Article 14, in case of enrichment activities, the permission should not make the fabricating or enrichment capacity unduly excessive. The Japanese act also has detailed provisions for cancellation of the license, measures for physical protection of specific nuclear fuel, inheritance and so on.

South Korea has a number of regulatory and legal bodies which guide refinement and reprocessing of uranium. An entity has to apply for license to do these tasks. The operators or licensees have to notify officials in great details about reprocessing activities and the storage of spent fuel. Chapter VI on "Nuclear Fuel Cycling Business and Use of Nuclear Materials" in its section 1 under article 43 prescribes: "A person who intends to carry on the business of refining or processing nuclear raw materials or nuclear fuel materials (including the business of converting such materials) shall obtain permission from the Minister as provided by the Presidential Decree. The same shall also apply to the case where he/she intends to alter any permitted matters: *Provided*, that if he/she wishes to modify any minor matters prescribed by the Ordinance of the Ministry of Education,

5 Ibid

6 Ibid

7 Ibid

Science and Technology, he/she shall report it."[8] The article refers to the *Amendment by Act No. 5820, Feb. 8, 1999; Act No. 8852, Feb. 29, 2008*

In the UK, British Nuclear Fuels Limited is responsible for the full range of nuclear fuel cycle services. It means it is entitled for enrichment and reprocessing, if it decides to do. Its associated company Eurenco helps it in the enrichment of uranium. British Nuclear Fuels Limited, currently, is the wholly government-owned company, though it was set up as a private company. The UK government now wants the private-public partnership for an independent nuclear fuel cycle. Though the US allows enrichment and reprocessing under license, yet the regulatory body does not give up its authority for regulating the construction and operation of any uranium enrichment facility.

Security

Nuclear security related regulation may have to take into account the sustainable development principle along with the compliance principle. The Japanese rules demand that the operators must ensure physical protection for nuclear activities involving refining, manufacturing, reactor operation, storage of spent fuel, reprocessing, waste disposal and use of nuclear fuel material. Japan is a member of both the international conventions for nuclear security, namely, the Convention on the Physical Protection of nuclear Material and the International Convention for the Suppression of Acts of nuclear Terrorism. These international conventions are reflected in the domestic law and regulation of Japan required for nuclear security.

South Korea is also a member of both the international conventions. It too has elaborate domestic legal and regulatory systems for nuclear security. The Atomic Energy Act and the Act on Safeguards and Physical Protection of Nuclear Installations are two important legislations for nuclear security in the country. These domestic legislations reflect the international conventions signed by South Korea. Besides, these legislations have other provisions which guide the country in securing nuclear material and facilities from sabotage and theft. The legislations also lay down provisions for a state system for the accounting and control of nuclear materials. Each nuclear facility in South Korea is supposed to prepare procedure for the task and submit to the government for approval. There are also some procedures for safety such as transportation code which are also helpful for nuclear security.

The UK has the Official Secrets Acts 1911-1920, the Atomic energy Authority Act 1954, the Nuclear Installations Act 1965, Health and Safety Act 1974, the Radioactive Material (Road Transport) Act 1991, the Radioactive Substances 1948 Act, Nuclear Generating Stations (Security) Regulations 1996, the Radioactive Material (Road Transport) (Great Britain) Regulations 2002, the Carriage of Dangerous Goods by Road (Driver Training) Regulations 1996, the Packaging, Labelling and Carriage of Radioactive Material by Rail Regulations 2002, the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997, Merchant Shipping Notice No. M1755 (M), the International Maritime Dangerous Goods Code, the Air Navigation (Dangerous Goods) Regulations 1994, the Dangerous Substances in Harbour Areas Regulations 1987, and so on which guide nuclear security. There are some separate regulations for Northern Ireland. Besides, the UK follows some regional and European agreements such as European Agreement concerning the International Carriage of Dangerous Goods by Road, Convention concerning the International Carriage by Rail, Regulations concerning the International Carriage of Dangerous Goods by Rail, the Convention on the Physical Protection of nuclear Material and the International Convention for the Suppression of Acts of nuclear Terrorism.

US is the leader for nuclear security. Recently, it organised the Nuclear Security Summit. The country has very detailed rules and regulation for nuclear security. Private industry, other non-governmental organisations and the government agencies are deliberating on technical and legal bulwark to address the problem. The US has legal mechanisms such as the Energy Policy Act of 2005 which has provisions for nuclear security and which reflect the international conventions for nuclear security like the Convention on the Physical Protection of Nuclear Material and the International Convention for the Suppression of Acts of nuclear Terrorism. The regulatory system has provisions such as access authorisation to certain facilities, training and required qualifications for security guards, frequent testing of equipment, periodic security evaluations, and special communications with local law officials. Yet, there are a number of cases regarding nuclear security problems.

Nuclear Waste

In the Japanese system, the private sector has assumed a very important role in nuclear waste management. Apart from opening an institution, the private industry has the responsibility of disposing high-level radioactive waste. It is involved in the entire process of selection of the disposal sites. The Japanese regulation demands that the responsible organisation of private industry conducts a preliminary survey and later test the site to ensure that the selected site is not prone to geological disturbances set off by earthquakes and other potential natural disasters. The rule also asks the private industry to consult the local government before selecting a site. However, the government maintains a supervisory role over the private sector regarding nuclear waste disposal activities. When the agency of private sector becomes ineffective in managing nuclear waste, the rule provides the stepping in of the government. Japan is a party to the Convention on Prevention of Marine Pollution by the Bumping of Waste and Other Matters. Since 1994, no party to the Convention may dump any radioactive waste into the sea till 2019.

8 The Korean Ministry of Government Legislation, Ministry of Education, Science and Technology, The Atomic Energy Act, http://www.moleg.go.kr/english/korLawEng;jsessionid=hp36wUQGdpaGpLVqDNoc7MUXR2vJffG6fRkbDmtRH1sVpJbgRKo8ha23MKvbZz5B?pstSeq=52246&pageIndex=28 http://www.moleg.go.kr/english/korLawEng;jsessionid=hp36wUQGdpaGpLVqDNoc7MUXR2vJffG6fRkbDmtRH1sVpJbgRKo8ha23MKvbZz5B?pstSeq=52246&pageIndex=28

South Korea manages its nuclear waste through the Korean Electric Power Corporation. The Act on the Management of Radioactive Wastes and Special Financial Assistance Act are two South Korean legislations devoted to nuclear waste management. The South Korean regulation permits the establishment of low to medium level radioactive waste facilities. South Korea has an independent body for safe and more efficient management of radioactive waste generated in South Korea. It is a member of the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter as well as the Joint convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management.

The UK has a private-public partnership for radioactive waste disposal. The task is carried out through a private limited company called United Kingdom Nuclear Industry Radioactive Waste Executive Limited. In The government-owned companies and government organisations of the UK also have shares in this company. This company is responsible for solid, low and intermediate level radioactive waste. However, the United Kingdom Atomic Energy Agency and British Nuclear Fuel Limited — the government organisations — are responsible for the high-level nuclear waste disposal. There are laws and regulation for nuclear waste management. Protecting the environment is the primary concern. The UK is a member of several international conventions and ideas and premises of these conventions get reflected in different nuclear related legislation and regulation of the UK.

In the US, the issue of waste management is being debated. There are protests in the US about the site selection for waste disposal. The nuclear renaissance may put more pressure on the US vis-à-vis nuclear waste disposal. The US has legal mechanisms such as the Nuclear Waste Policy Act for management of high-level waste, the Low-Level Radioactive Waste Policy Amendments Act, the Marine Protection Research and Sanctuaries Act, and the Uranium Mill Tailings Radiation Control Act as well as regulatory mechanisms such as Regulatory Guide 1.21, “Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants” and three US agencies are involved in the management of nuclear waste. Besides, the US has ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management as well as the 1972 London Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter.

The US has rules for disposal of high-level radioactive waste and spent fuel underground in a deep geologic repository. The repository has to meet public health and safety standards. All the stages — the construction, operation, and decommissioning of the repository — have detailed description in the US statutory system. The US law has also provisions for the setting up of a Nuclear Waste Fund and a Defense Nuclear Waste Disposal Fund. The commercial low-level waste is to be disposed by states at the regional level. The US legal system recommends the establishment and operation of regional disposal facilities. The facilities of some states may be used by other states for a specified period. The Nuclear Regulatory commission has divided the low-level waste management into two categories — operational and post-operational. These are also called pre-closure and post-closure of the repository as well. The repository managers have to ensure that radiation level does not exceed the prescribed limit.

Liability

Despite holding the operator primarily responsible for any activities, normally liability of any negative side effects of nuclear activities is shared among different stakeholders. Liability law and regulation reflects the compensation principle of nuclear law and regulation.

Japan has not joined the 1960 Paris Convention or the 1963 Vienna Convention on Civil Liability for Nuclear Damage. Still, Japan has at least four domestic regulatory mechanisms through which it compensates for nuclear damage. In the Japanese legal system, the operator and the government both share the liability. There are detailed procedures regarding the method to give compensation to a victim. With an amendment to the Compensation Law the operation of a nuclear reactor has been kept outside the jurisdiction of the product liability law which otherwise would have dragged a supplier of nuclear reactor or nuclear fuel material into the litigation. Now, only the operator is responsible for any damage, not suppliers.

South Korea has laws such as Act no. 2094 and Act no. 2764 for the compensation of nuclear damage. Besides, it has Presidential decrees for the purpose. Although South Korea is not a member of the Vienna Convention on Civil Liability for Nuclear Damage, its regulations have borrowed from the convention. In the South Korean system, the operator is responsible for nuclear damage. The operator has been given exemptions in the case of armed conflicts, hostilities, civil war or insurrection. For an extraordinary incident, the government shares the burden. The government also shares the burden when nuclear damage is set off by tidal waves, floods, storms or lightening and complications relating to insurance claims.

The UK is a signatory of the Vienna Convention on Civil Liability for Nuclear Damage, but it has not ratified it. It is also a signatory of the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention and the Paris Convention on Third Party Liability in the Field of Nuclear Energy. The UK has Nuclear Installations Act 1965 that addresses nuclear third party liability in the country. This Act has incorporated in it the provisions of the 1960 Convention on Third Party Liability and the 1963 Brussels Convention Supplementary to the Paris Convention. Moreover, this act was amended by the Energy Act 1983 and the Atomic Energy Act 1989 to refine the arrangements for third party liability. Through different amendments it has been increasing the lower limit of compensation. If any changes occur in the Paris Convention regarding the limit of Convention, the UK domestic law has a provision for automatically changing it. There will be no need for introducing primary legislation. In the UK law, the limit of compensation is related to the size and nature of the nuclear site.

Institution

Institution is generally associated with the permission principle and continuous control principle of nuclear activities. In different countries, the permission principle is reflected through different terms such as authorisation, licensing, permission, designation, certification and approval. This principle is normally vested in the regulatory authority of a country. Independence principle guides the institutional framework for nuclear reactor regulation.

Independence of the regulatory institution has been one of the most important issues in nuclear business. The government in general is held responsible for regulating nuclear affairs. In regulating some sectors such as safety, security, safeguards, and nuclear waste the government role is considered quite significant. In an age of public-private partnership, the arrangement for burden and responsibility sharing is very important. All the countries, generally, have an institution that issues regulation for private nuclear industry or nuclear industry in general.

In Japan, the Atomic Energy Commission and the Nuclear Safety Commission are the two principal bodies under the Prime Minister's Office. The Ministry of Economy, Trade and Industry is another important institution which is responsible for safety, licensing for the entire nuclear fuel cycle starting from mining and milling to refinement to nuclear waste management passing through enrichment and reprocessing. The METI has several agencies such as the Agency for Natural Resources and Energy, the Nuclear and Industrial Safety Agency, ad Nuclear Waste Management Organization. The Japanese government is also assisted by independent bodies such as the Nuclear Safety Commission which has an advisory role in the licensing process and the Japan Atomic Energy Agency which basically does research and advisory work on technical feasibility of nuclear fuel cycle. The Nuclear Waste Management Organization came up in 2000, in Japan. The Nuclear Waste Management Organization is a private law company which was established with the funding of the Japanese private industry. The organisation has been entrusted with the task of final geological disposal of high-level radioactive waste.

In South Korea, too, a network of institutions undertakes nuclear business. The Atomic Energy Commission, the Ministry of Education, Science and Technology, and the Ministry of Knowledge Economy are principal institutions for nuclear licensing and supervision. The Korean Radioactive Waste Management Corporation is responsible for the construction and operation of a disposal facility for low-level and intermediate-level radioactive waste, the management of spent fuel and related research work. There are advisory and other public bodies such as Atomic Energy Commission, Nuclear Safety Commission, the Korean Atomic Energy Research Institute, and the Korean Institute for Nuclear Safety and Korean Electric Power Company which contribute to the nuclear energy regulatory arrangement in South Korea.

In the UK, no single organisation has been assigned the task of managing nuclear energy. The task is carried out through a number of ministries and departments. Of course, the overall control of Parliament does exist. The Secretaries of State for Trade and Industry and for the Environment, Transport and the Regions are involved in regulating different aspects of nuclear energy activities. The United Kingdom Atomic Energy Authority is responsible for the general development of nuclear energy. The Secretary of State has the authority to demand information on materials, plant and processes. He is fully entitled to enter and inspect any premise or authorize any other person to do so. It is his responsibility to ensure international nonproliferation obligations including safeguards obligations enshrined in the Euratom Treaty and the safeguards agreements with Euratom and the IAEA are complied. The Office of Civil Nuclear Security, advisory bodies such as the Medical Research Council, Nuclear Safety Advisory Committee, Radioactive Waste Management Advisory Committee, and other organizations such as Health and Safety Commission and Executive, National Radiological Protection Board British Nuclear Fuel Plc, the Scottish Environment Protection Agency, Amersham International plc, the National Nuclear Corporation Ltd., United Kingdom Nirex Ltd., and British Energy Generation Ltd are active in the regulation making and implementing for US nuclear energy.

In the US, all the layers of the government — the federal, state and local — are involved in managing nuclear energy production. However, the major responsibility has been assigned to the federal government and its departments and agencies. Generally, state governments are responsible for emergency planning. The state governments take care of public health, law enforcement, the environmental aspect, and waste disposal activities as well. The US law permits the agencies of even local governments to play a role in managing civil nuclear energy. The Nuclear Regulatory Commission is the Federal agency that undertakes regulatory responsibilities. The licensing of a power plant is granted by the Nuclear Regulatory Commission. It is an independent body responsible to the President. It operates by setting standards, making rules, commissioning studies on technical issues, issuing licenses, permits and authorizations and undertaking inspection, investigation and evaluation of operating experience. It has several offices specialised in different functions.

The Department of Energy is another important institution. It is involved in both military and nuclear energy management roles. The Department of Energy is responsible for production, processing, and utilisation of technologies, assessment of environmental impact, and research in fundamental nuclear physics, management of high-level radioactive waste and spent fuel, international efforts to ensure nuclear safety, prevention of nuclear proliferation, and supply of energy in crises. There are several other agencies such as the Department of Labor, Department of Transportation, Environmental Protection agency, Department of Commerce, Department of Defense and so on which are also engaged in regulating different aspects of civil nuclear energy in the US.

In sum, it is found that all the leading nuclear energy producing countries have regulatory and legal arrangements for nuclear commerce in general and nuclear reactor operation in particular. No country compromises on safety and security. Countries have

varied regulatory systems for reprocessing and enrichment. In some countries, private players have been given license to enrich and reprocess, while some other countries have yet not reposed faith in the private sector. Notwithstanding the permission, all the countries keep a tight control over enrichment facilities. Similarly, the countries also have regulatory arrangements for controlling exports of all the items relating to nuclear reactors. Of all the countries, the US has very comprehensive legal and regulatory systems backed by different government departments and institutions. There could be one licensing authority for nuclear reactors, but all the countries are using multiple agencies for regulating nuclear activities, including the operation of a nuclear reactor. Lastly, as for liability, of course, the nuclear operator has to pay for the damage, yet the government has been sharing the financial burden. The arrangement, level and share of the government depend on the legislation and regulation of the country. Not all the leading countries have signed the International Conventions for Compensation for Nuclear Damage. However, one overriding trend after the study of the best practices of the leading nuclear energy producing countries emerges: the regulatory framework is not static; it changes to reflect the changing demand.

NUCLEAR ENERGY : BRIEF SURVEY OF EXISTING LEGAL FRAMEWORK

Introduction

The establishment and regulation of the nuclear energy regime in India has largely been effected through the provisions of the Atomic Energy Act, 1962 ('1962 Act' hereinafter). Although the essential scope of this enactment has been to facilitate the development of atomic energy, the range of the regulatory arm of this enactment is much longer and broader to include any activity that relates to or involves a radioactive substance. In other words, any substance, whether a material or a mineral that could be regarded as radioactive substance, could come under the purview of this enactment. The precursor to the 1962 Act has been the Atomic Energy Act, 1948, a legislation enacted soon after India's independence by the Constitutient Assembly. This also shows the urgency and the perception with which the immediate political establishment of post-independent India sought to locate the development and use of nuclear energy. The 1948 enactment envisaged the constitution of an Atomic Energy Commission (AEC). The Department of Atomic Energy was established in 1954. The 1962 Act replaced the 1948 enactment.[1]

The atomic energy regulatory framework as envisaged under the 1962 Act is an umbrella legislation that, inter alia, provides for a broad canvas covering areas such as identification, siting, installation, operation and safety of the atomic reactors. Mining and other related issues are also covered within the framework of the 1962 Act. Further, to carry out all these activities, the 1962 Act requires more specific details to be worked out by various rules and regulations. Accordingly, rules and regulations have been formulated and all of them together form the entire nuclear regulatory framework within India. For example, Section 17 provides for the safety aspects and accordingly it authorises the Central Government to make such rules as are necessary to take care of safety aspects relating to "...premises are places, in which radioactive substances are manufactured, produced, mined, treated, stored or used by any radiation generating plant, equipment or appliance..."

1 Repealed vide Section 32 of the 1962 Act.

The institutional framework relating to the Indian atomic energy establishment has a three-tier structure. On top is the Atomic Energy Commission which could be regarded as the highest policy making body. The second tier is the Department of Atomic Energy which generally oversees research and development, industrial and other organisational structures of atomic energy-related issues. The Atomic Energy Regulatory Board which was established in 1983 is an independent body whose primary mandate is to oversee and constantly monitor the safety aspects of the atomic energy sector. It works directly under the Atomic Energy Commission.

The following study proposes to briefly outline and critique the existing legal and regulatory framework relating to the atomic energy sector. The effort is to understand the working of the legal, institutional and regulatory framework with a view to suggest certain changes that may be required in the context of the emerging new regime for trade in nuclear energy within India. The scope of this study, however, will not discuss or include elaborate discussion, except to the extent necessary, on technological and other technical aspects relating to nuclear energy.

Salient Features of the Atomic Energy Act, 1962

The formal legal framework to regulate atomic energy was put in place by 1948 by passing the Atomic Energy Act by the then existing Constitutient Assembly. It should be noted that India was still in the process of framing its Constitution and was also taking a relook at several colonial legislations. This perhaps reflects the keenness of India not to fall behind in harnessing the peaceful uses of atomic energy. It was felt at that time that nuclear science held out great potential for future developmental aspects in India. It should be noted that India in the post-colonial context was a pioneer among developing and newly emerging countries to enact such a law relating to atomic energy[2]. Major countries of the time that had the requisite technological know-how relating to atomic energy also had just put in place legislative mechanisms to develop, control and regulate activities relating to this form of energy[3]. For India, the tangible result was not only creation of such legal and institutional structures, it also resulted in the establishment of Bhaba Atomic Research Centre (BARC) in 1954 and two research reactors in quick succession, namely APSARA (1956) and CIRUS (1960).

2 The key policy framework has been to become self-reliant in the area of nuclear energy. The idea of strategic use of the nuclear sector perhaps was not a key factor at that time. The decade of 1950s and 1960s were essentially a period in which the Cold War was at its peak. India was attempting to take a middle path at that time. Initial help and assistance both in material and academic terms came from US and Canada.

3 United States had enacted its Atomic Energy Act in 1946 which came into effect in 1947. This 1946 law was criticised as being very narrow. Accordingly, the 1946 law was revised in 1954 to bring into effect a more comprehensive law on atomic energy. United Kingdom also enacted a law in 1949 which was replaced by a more comprehensive law in 1989 termed as Atomic Energy Act of 1989. Russia (Soviet Union at that time) had passed an Atomic Energy Law in 1956. Australia had passed its Atomic Energy Act in 1953.

The strategy adopted at that time was to put to use the country's modest and vast thorium resources. In line with this approach a three-pronged strategy was adopted and one could see the reflections of this strategy in the newly enacted 1962 Act. The salient features of this strategy were:

- the first stage, based on setting up pressurised heavy water reactors (PHWRs) using indigenously available natural uranium and plutonium to produce electricity;
- the second stage, based on plutonium fuelled fast breeder reactors (FBRs) producing electricity and additional quantity of plutonium and also uranium 233 from thorium; and
- the third stage, based on thorium-uranium 233 cycle.

In the following discussion we will briefly examine and outline some of the salient features of the 1962 Act.

Sole Authority with the Central Government

This enactment essentially provides for the "development, control and use of atomic energy for the welfare of the people of India and for other peaceful purposes and for matters connected therewith"[4]. Although the tenor of the enactment is limited to the regulatory regime on 'atomic energy' per se, the actual scope and reach of the provisions include a much larger nuclear canvas. Section 3 of the Atomic Energy Act could be regarded as the fulcrum of the entire nuclear energy regulatory mechanism for it vests general powers with the Central Government "to produce, develop, use and dispose of atomic energy either by itself or through any authority or corporation established by it or a government company and carry out research into all matters connected therewith".[5] It gives the Central Government complete authority to create and manage a company.

As of now, unless modified or amended, this provision does not allow any private participation in the arena of nuclear energy. The phrase "any entity or corporation duely established under the relevant laws of India" could be added to broaden the scope of participation to entities other than those established by the Central Government. The US Atomic Energy Act of 1954, on the other hand, allows limited private participation subject to stringent licensing mechanism and monitoring by competent authorities.

The 1962 Act, therefore, vests complete authority with the Central Government. The Act also confers a larger mandate on the Government to "manufacture or otherwise produce any prescribed radioactive substance or articles which in its opinion are, or likely to be required in connection with the production, development or use of atomic energy or

4 Preamble to the Atomic Energy Act, 1962

5 See Section 3 of the 1962 Act. This clause was added in 1987 vide the Atomic Energy (Amendment) Act 1987 (No. 29 of 1987)

such research as aforesaid, and to dispose of such radioactive substance or any such described article manufactured or otherwise produced".[6] In other words, it is clear that the Central Government has the complete mandate and authority to handle 'radioactive substances' that (in its opinion) are 'likely' to be required for the production and development of atomic energy. The language of this clause in Section 3 of the Atomic Energy Act while vesting complete authority on the Central Government, also appears to provide it with some kind of discretionary authority as well to decide on the issues concerning nuclear energy or related issues.

Regulating Use of All Radioactive Materials

The Central Government has been conferred complete authority under the 1962 Act to deal with radioactive materials wherever it is. The Act, accordingly, provides for broad definitions in Section 2. It seeks to define various terms that are used in the enactment. These definitions and the technological details provided therein should be regarded as unique or India-specific, taking into account its three-pronged strategy to develop atomic energy[7].

There are three different substantive definitions in Section 2 of the Atomic Energy Act that define 'atomic energy', `fissile material' and 'radioactive substances' separately[8]. The basic thrust of all these seemingly overlapping definitions appears to include within the regulatory framework all the 'radioactive materials'.[9] According to the 1962 Act, atomic energy is simply "energy released from atomic nuclei as result of any process, including the fission and fusion processes". The phrase 'any process' should be noted. A 'fissile material', according to the enactment is 'uranium-233, uranium-235, plutonium or any material containing these substances. This would essentially include within the ambit "any material" thorium as well.

The definition further includes and provides the Central Government with the authority to even include or declare "any material containing these substances or any other material that may be declared as such by notification. A 'radioactive substance' or 'radioactive material' is one which spontaneously emits radiation in excess of the levels prescribed by the Central Government. The definition of 'radiation' has also been couched in a broad descriptive language to include 'gamma rays, X-rays, and rays consisting of alpha particles, beta particles, neutrons, protons and other nuclear and sub-atomic particles, but not sound or radiowaves or visible, infra-red or ultraviolet light'.

6 See Section 3 of the 1962 Act. This clause was also substituted in 1987.

7 India's three-pronged strategy to develop atomic energy has already been discussed.

8 Section 2 has other definitions as well, such as 'Prescribed Substance', 'Minerals' and what actually constitutes 'radiation'.

9 Section 4 requires that any discovery of uranium or thorium should be reported to the Central Government. The 1962 Act vests with the Central Government the power to compulsorily acquire any minerals from which, in its opinion, any of the prescribed substance (as defined in the enactment itself) could be obtained. It should be noted that Section 11A was added in 1986 to make it clear that what has been envisaged in the 1962 Act is 'compulsory acquisition' not 'sale'. The enactment also envisaged payment of compensation.

The Central Government has the authority to prescribe any substance or mineral which in its view could be used for "...the production or use of atomic energy, or research into matters connected therewith and would include uranium, plutonium, thorium, beryllium, deuterium or any of their respective derivatives or compounds or other materials containing any of the aforesaid substances".[10] As mentioned above, Section 3 provides general powers to the Central Government "to produce, develop, use and dispose of atomic energy" and it can do that by itself or by forming a an "authority or corporation or a government company".[11]

Creation of NPCIL

Section 3 of the 1962 Act was amended in 1987 to allow creation of an authority, corporation or a government company. This amendment paved the way for the creation of a separate public sector company, the Nuclear Power Corporation of India (NPCIL) with a view to build and operate nuclear reactors. No other entity, public or private, unless authorised by the Central Government could enter the atomic energy sector. All attendant powers were conferred on this company that would facilitate its functioning keeping in view the necessary restrictions as envisaged under the 1962 Act. The authority conferred on this company, inter alia, included the following: (a) to prevent radiation hazards; (b) secure public safety and safety of persons handling radioactive substances or radiation generating plants; (c) ensure safe disposal of radioactive wastes; (d) to produce and supply electricity from atomic energy and other related functions[12].

The scope of the power and authority conferred on the Central Government are much broader. These are not limited to production of atomic energy only. The 1987 amendment to Section 3 of the enactment stated that the Central Government has the power to "manufacture or otherwise produce any prescribed radioactive substance or articles which in its opinion are, or are likely to be required in connection with the production, development or use of atomic energy or research...and to dispose of such described radioactive substance or articles manufactured or otherwise produced".[13] It is further provided that the Central Government has the sole power to buy, acquire, store, transport and dispose of radioactive substances.[14] Any information relating to the location, quality and quantity of radioactive substances or any other related information such as (a) theory, design, construction and operation of plants for the treatment and production of radioactive substances and for the separation of isotopes; (b) any theory, design, construction and operation of nuclear reactors; and (c) any research and

10 See the explanation given in the definition of 'Prescribed Substances' in Section 2 (g) of the 1962 Act.

11 See Section 3 (a) of the Atomic Energy Act, 1962

12 See National Report to the Convention on Nuclear Safety, Fourth Review Meeting of Contracting Parties, Atomic Energy Regulatory Board (AERB), Government of India, September 2007. India is party to the Convention on Nuclear Safety.

13 See Section 3 (b) of the Atomic Energy Act, 1962

14 See Section 3 (bb) of the Atomic Energy Act, 1962

technological work relating to these areas could be made 'restricted' by the Central Government.[15] The Central Government also has the responsibility to prevent radiation hazards, to secure public safety and the safety of persons handling radioactive substances or radiation generating plants and to ensure safe disposal of radioactive wastes.

Network of Rules and Regulations

The 1962 Act, as stated above, is a framework legislation providing, inter alia, broad areas for regulation specifically of the use and development of radioactive substances. Section 30 of the 1962 Act itself specifies areas in which rules and regulations are needed. If one looks at these broad areas it is clear that these rules and regulations are necessary for effective implementation and operation of the 1962 Act.[16] These are, briefly,

- restrictions on information and to prescribe measures to guard against unauthorised dissemination or use of such restricted information;
- declaring any area as prohibited area and prescribing measures to provide against unauthorised entry into or departure from this area;
- reporting of information relating to the discovery of uranium, thorium and other prescribed substances and payment of rewards for such discoveries;
- control over mining or concentration of substances containing uranium;
- regulating by licensing and encouraging by award of concessions including rewards, floor prices and guarantees, mining and prospecting for other prescribed substances;
- compulsory acquisition of prescribed substances, minerals and plants;
- regulating the production, import, export, transfer, refining, possession, ownership, sale, use or disposal of the prescribed substances and any other articles that in the opinion of the Central Government may be used for, or may result as a consequence of the production, use or application of atomic energy[17];
- regulating the use of the prescribed equipment[18];

15 Section 3 also authorises the Central Government to declare any area as 'prohibited area' where research, design or development is carried out in respect of the production, treatment, use, application or disposal of atomic energy or any radioactive substance.

16 Section 30 (4) requires that each rule made under the 1962 Act be laid before the Parliament.

17 For the definition of what is a 'prescribed substance' (which is very often used in the 1962 Act and rules framed) see Section 2 (g) of the 1962 Act according to which "any substance including any mineral which the Central Government may, by notification, prescribe, being substance which in its opinion is or may be used for the production or use of atomic energy or research into matters connected therewith, and includes uranium, plutonium, thorium, beryllium, deuterium or any of their respective derivatives or compounds or other materials containing any of the aforesaid substances".

18 For the definition of what constitutes a 'prescribed equipment' see Section 2 (f) of the 1962 Act according to which, "any property which the Central Government may, by notification, prescribe, being a property which in its opinion is specially designed or adapted, or which is used or intended to be used for the production or utilisation of any prescribed substance, or for the production or utilisation of atomic energy, radioactive substances, or radiation, but does not include, mining, milling, laboratory and other equipment not so specially designed or adapted and not incorporated in equipment used or intended to be used for any of the purpose aforesaid".

- regulating the manufacture, custody, transport, transfer, sale, export, import, use or disposal of any radioactive substance;
- regulating transport of such prescribed substances as are declared dangerous to health (under Section 17 (2) of the 1962 Act)
- developing, controlling, supervising and licensing the production, application and use of atomic energy; fees for issue licenses; manner of serving notices etc. and
- promoting co-operation among persons, institutions and countries in the production, use, application of atomic energy and in research and investigation in the field.

A survey of the available and notified rules and regulations shows that some of them are in place and some are not. Some of these rules are extremely crucial for the regulation and disposal of radioactive substances e.g. radiation protection rules, safe disposal of nuclear wastes and safety aspects of atomic energy.

Although the 1962 Act provides the basic regulatory framework for the regulation of nuclear energy-related activities, other laws, as they are applicable, also form part of this regulatory framework. These include a large number of related laws and regulations such as Factories Act, 1948, Indian Electricity Act, 2003, the Environment (Protection Act), 1986, Disaster Management Act, 2005, The Water (Prevention and Control of Pollution) Act, 1974, The Air (Prevention and Control of Pollution) Act, 1981, The Water (Prevention and Control of Pollution) Cess Act, 1977, Indian Explosives Act, 1884 and enactments relating to the management and handling of hazardous wastes.

A preliminary assessment of these rules and regulations framed pursuant to Section 30 of the 1962 shows that they are drafted in a manner making some of the provisions broad enough to allow private participation. The definition of 'person' in all these rules and regulations, for example, is broad and includes, besides government entities and companies, individuals, corporate entities and other similar bodies.

In the following discussion an attempt has been made to outline some of the salient features of these rules.

Radiation Protection Rules

The Atomic Energy (Radiation Protection) Rules ('Radio Protection Rules' hereinafter) were initially framed in 1971 and revised in 2004. These rules were framed to establish the requirement of consent for carrying out any activity for nuclear fuel cycle facilities and use of radiation for the purpose of industry, research, medicine, etc. The scope of these rules is limited to "practices adopted and interventions applied with respect to radiation sources".[19] According to these rules, no person could handle radioactive

19 Clause 1 (2) of the Radiation Protection Rules, 2004

material, or operate any radiation generating equipment except in accordance with the terms and conditions of a licence.[20] Licence from the competent authority as designated by the Central Government[21] is necessary to (a) to establish a radiation installation for siting, design, construction, commissioning and operation; and (b) decommission a radiation installation. These rules outline the sources and practices for which licence is required. These licensing procedures are at three different levels based on the intensity of radiation.

An express 'licence' is required for nuclear fuel cycle facilities, land-based high intensity gamma irradiators other than gamma irradiation chambers, neutron generators and others.[22] For some sources 'authorisation' is sufficient such as for example nuclear medicine facilities, gamma irradiation chambers and others. A simple 'registration' is enough in cases such as biomedical research using radioactive material, analytical x-ray equipment used for research and such similar situations. A 'consent' is necessary in some instances such as, for example, approval for siting, design, construction, commissioning and decommissioning of a radiation installation; approval for sealed sources, radiation generating equipment and equipment containing radioactive sources for the purposes of manufacture, supply and other similar sources.

These rules lay down elaborate procedures and conditions for issuing licences[23] that include (a) compliance with relevant safety codes and safety standards; (b) handling procedures; and (c) training required for performing intended tasks. If these conditions are not fulfilled or adhered to, the licence could be suspended, modified or withdrawn.[24] The rules also require that the radiation symbol or warning sign should be conspicuously displayed at all times. The responsibilities of the employer has also been outlined according to which he shall be "the custodian of radiation sources in his possession and shall ensure physical security of the sources at all times"[25]. According to the definition provided in the rules, an 'employer' could include "an individual or a company or association or body of individuals, whether incorporated or not; or Central Government or a State Government". So, these rules appear to be broad enough to take into account all kinds of situations.

Rules relating to Safe Disposal of Radiation Wastes

The Atomic Energy (Safe Disposal of Radiation Wastes) Rules, 1987, provide the requirements for the safe disposal of radioactive wastes in the country. Any 'person' who has been duely authorised by these rules could safely dispose of radiation wastes. A 'person', according to these rules, "includes (i) any individual, corporation, association of

20 Clause 3 of the Radio Protection Rules, 2004

21 See Section 27 of the Atomic Energy Act, 1962.

22 For complete list of these sources see Clause 3 (3) of the Radiation Protection Rules

23 Validity of these licenses is for five years; see Clause 9 of the Radiation Protection Rules.

24 Clause 10 of the Radiation Protection Rules.

25 These rules vest investigative and supervisory roles under Clause 22 to a Radiological Safety Officer.

persons whether incorporated or not, partnership, estate, trust, private or public institution, group, government agency, or any state or any political sub-division thereof or any political entity within the state, any foreign government or nation or any political sub-division of any such government or nation or other entity; and (ii) any legal successor, representative or agent of each of the foregoing". It should be noted that the definition of 'person' is broader here to include 'any foreign government or nation or any political sub-division of any such government or nation or other entity'. The disposal will have to be done in accordance with terms and conditions specified in the authorisation which inter alia, would include the following: (a) the process, materials and equipment generating radioactive wastes in the installation; (b) environment around the installation; (c) safety devices and other equipment in the installation for conditioning, treatment and disposal of radioactive wastes; (d) estimates of annual releases, discharges and leakages in normal conditions and its anticipated environment impact; (e) potential accidents, design features and monitoring equipment to control the release of radioactivity; and (f) procedure to be followed in the safe collection of radioactive wastes.

It should be noted that Hazardous Waste (Management and Handling) Rules, 1989 provide that these rules will not apply to radioactive wastes (Rule 2 e). The radioactive wastes are covered under the provisions of the 1962 Act and rules made thereunder. Further, Rules 2 (b) and 3 of Manufacture, Storage and Import of Hazardous Chemicals Rules (1989) under the Environment (Protection) Act, 1986, has notified AERB as the authority to enforce directions and procedures as per the 1962 Act with respect to radioactive substances.

Rules relating to the Control of Irradiation of Food

The Atomic Energy (Control of Irradiation of Food) Rules, 1990 (revised in 1996) seek to regulate the irradiation of foods in the country. An 'irradiated food', according to these rules, mean articles of food subjected to radiation by (i) gamma rays; (ii) x-rays generated from machine sources operated at or below an energy level of 5 million electron volts; and (iii) sub-atomic particles, namely electrons generated from machine sources operated at or below any energy level of 10 million electron volts, to dose levels as specified in the rules (Schedule I). The procedures outlined are similar and require prior authorisation from the Central Government.

Other Rules and Notifications[26]

- The Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984 regulate the activities pertaining to mining, milling, processing and/or handling of prescribed substances.

26 As per the 1962 Act the Central Government has appointed the Chairman, AERB as the competent authority to exercise powers under the following rules: Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substance) Rules, 1984; Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987; Atomic Energy (Factories) Rules, 1996; Atomic Energy (Control of Food Irradiation) Rules, 1996; and Atomic Energy (Radiation Protection) Rules, 2004.

- While all the above rules and regulations have their origin from the substantive provisions of the 1962 Act, the Atomic Energy (Factories) Rules, 1996, takes its effect from the enabling provisions of the Factories Act, 1948[27] read in accordance with Section 23 of the 1962 Act. These rules were originally framed in 1984 and were revised in 1996 and they seek to administer the requirement of Factories Act in the nuclear establishment of the country to ensure industrial safety.
- The Atomic Energy (Arbitration Procedure) Rules, 1983 were framed to give effect to Section 21 of the 1962 Act to regulate arbitration procedure for determining compensation.
- There are several notifications issued to give effect to some of these regulations such as: Radiation Surveillance Procedures for Medical Applications, 1989 (GSR-388); Radiation Surveillance Procedures for persons using Sealed Sources in Industrial Radiography, 1980 (GSR – 735). AERB has been designated as the competent authority to implement these notifications. Its primary responsibility is to enforce protection of occupational workers and other persons on site, protect the public and the environment from possible adverse effects arising from nuclear and radiation facilities. Issuing of consent for nuclear and radiation facilities is one of the principal regulatory activities by which AERB discharges this responsibility. The regulatory consents contain conditions, which refer to such codes and standards and make them mandatory to the consentee for their authorised activities.
- Guidelines for Nuclear Transfers (Exports) were issued by the Department of Atomic Energy in February 2006 with a view to regulate the export of certain prescribed substances, prescribed equipments or transfer of related technology to any country and to outline export controls with regard to nuclear transfers to any country. Pursuant to this, guidelines for implementation of arrangements for cooperation concerning peaceful uses of atomic energy with other countries were also issued on June 4, 2010 vide notification no.1/10/8/2009-ER.

III. Electricity Act, 2003

The supply and transmission of electricity is regulated by the Indian Electricity Act 2003[28] which provides for the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to the development of the electricity industry, promoting competition therein, protecting interests of consumers and supply of electricity to all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and

27 See Sections 41, 49, 50, 76, 83, 112 and all other enabling sections of the Factories Act, 1948, read with Sections 23 and 30 of the Atomic Energy Act, 1962.

28 The Indian Electricity Act, 1910, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998 was replaced in the year 2003 with Indian Electricity Act 2003.

environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commission and establishment of Appellate Tribunal for matters connected therewith. The 2003 consolidated Electricity Act prohibits any person from transmission or distribution or trading in electricity unless he is authorised to do so by a licence issued under the Section 14, or is exempt under Section 13 of the Act.

IV. Environment (Protection) Act, 1986

The Environment Protection Act, 1986, and Environment (Protection) Rules, 1986, are applicable in all atomic energy projects. These laws provide for the protection and improvement of the environment and matters connected therewith. It empowers the Central Government to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution. All projects or activities, including expansion and modernisation of existing projects or activities, require prior environmental clearance from the Central Government in the Ministry of Environment and Forests (MoEF) on the recommendations of an Expert Appraisal Committee (EAC).[29]

AERB is also empowered to perform the functions under Section 10 (1) (power of entry) and Section 11 (1) (powers to take samples) of Environment (Protection) Act, 1986 and Rule 12 (agency to which information on excess discharge of pollutants are to be given) of the Environmental Protection (Amendment) Rules, 1987, with respect to radioactive substances. It should be noted that Section 52 of Air (Prevention and Control of Pollution) Act, 1981, provides that for radioactive air pollution the provisions of Atomic Energy Act will apply.

V. Conclusions

In this brief survey an attempt has been made to outline the broad contours of the Indian legal framework relating to atomic energy. The Atomic Energy Act, 1962, provides the basic legal structure and it overrides all the existing legislations when it states in Section 28 that, "the provisions of this Act shall have effect notwithstanding anything inconsistent therewith contained in any enactment other than this Act". Section 29 provides immunity to the Government from any "suit, prosecution or other legal proceeding...in respect of anything done by it or him in good faith in pursuance of this Act

29 There are some other applicable legislations whose provisions have to be met for locating and operating NPPs in the country. These legislations include
- The Water (Prevention & Control of Pollution) Act, 1974
- The Air (Prevention & Control of Pollution) Act, 1981
- The Water (Prevention & Control of Pollution) Cess Act, 1977
- The Hazardous Waste (Management & Handling), Rules 1989
- Indian Explosive Act 1884 and Indian Explosive Rule 1983
- Disaster Management Act 2005

or any rule or order made thereunder". The following broad conclusions could be drawn from the survey of the existing regulatory framework relating to atomic energy:

- There are no provisions that relate to transparency or liability that arise out of any accident. There is some provision for compensation for certain matters relating to mining and other related areas.
- The 1962 Act does not have any reference to nuclear commerce or to any other purpose for which it might want to use nuclear energy. As the Preamble puts it, the essential objective of the 1962 Act is to "use atomic energy for the welfare of the people of India and for other peaceful purposes". In this regard, if one could make a reference to the 1954 US Atomic Energy Act, it is comprehensive and addresses an entire range of issues.
- The Indian legal framework, in this sense, looks sketchy and details have been left out, perhaps deliberately, to be outlined in greater detail in rules and regulations.
- There have been a number of rules and regulations that have been framed to carry out the essential objectives of the 1962 Act. In fact, it is incumbent on the Central Government to give effect and implement the provisions of the 1962 Act.
- The enactment also seeks to exclude the jurisdictions of the courts and other bodies on issues that come within the purview of the 1962 Act if done in good faith. That reflects perhaps the necessity to facilitate the unhindered growth of the nuclear regime and the attendant industry.
- At this juncture, some of these exclusionary clauses need a re-look so as to make the emerging nuclear regime in India more responsive and accountable to the needs of public at large.

THE INDIAN NUCLEAR ENERGY LAW: WAY FORWARD

Introduction

The economic growth and energy security are inextricably linked. One way to achieve these twin goals is to look for new avenues to produce and augment energy resources. Until now, the contribution of the nuclear energy sector to the Indian energy basket could be regarded as minimal, despite its ambitious expansion targets.[1] However, in recent times, it appears that India is on the verge of a rapid and new phase of expansion in the arena of nuclear energy. The saga of this new phase began with the July, 18, 2005 Statement issued on behalf of India and the United States (US).[2] This Statement offered the prospect, "for ending India's nuclear isolation" and it also offered the "prospects for cooperation not only with the United States but with countries like Russia, France and other countries with advanced nuclear capabilities, including those from the Nuclear Suppliers Group (NSG)".[3] This ending of 'nuclear isolation' provided India with many options in the development of civil nuclear energy. The July 2005 Statement aptly sums up some of these options when it noted that the scope for cooperation in energy-related research would vastly expand and so would cooperation in nuclear research activities. The 2005 Statement further noted that India would be able to join the

1 While noting that the major source of electricity generation (about 66 per cent) is contributed by fossil thermal power (like coal), the National Report submitted by the Atomic Energy Regulatory Board points out that, "The integrated energy policy of the country recognises that nuclear energy is capable of providing long-term security and is based upon judicious utilisation of the nuclear resource profile of the country". See *National Report* to *the Convention on Nuclear Safety*, Fourth Review Meeting of Contracting Parties, April 2008, Government of India.

2 PM's *suo motu* statement on discussions on civil nuclear energy cooperation with the US: Implementation of India's Separation Plan on March 7, 2006. For the full text of the Statement see www.dae.gov.in (last visited on April 24, 2010). Reference should also be made to the joint statement issued by India and France on September 12, 2005 almost immediately after the joint Indo-US Statement.

3 Ibid. The Prime Minister while replying to a discussion in Rajya Sabha on Civil Nuclear Energy Cooperation with the US on 17.8.2006 noted "...that an international negotiation on nuclear energy cooperation particularly when it involves dismantling restrictive regimes that have lasted for over three decades is a complex and sensitive exercise. What we are attempting today is to put in place new international arrangements that would overturn three decades of iniquitous restrictions."

international mainstream and occupy its rightful place among top countries of the nuclear community. It also noted that there would be a quantum jump in India's energy generating capacity with a consequential impact on its GDP growth. Alongside, the July 2005 Statement stated that it would also ensure India's participation as a full partner in cutting edge multilateral scientific effort in the nuclear field such as ITER and Generation IV Initiative.[4]

These initiatives are the renewed global civil nuclear energy cooperation arrangements necessitated for India, formulation and implementation of a host of new responsibilities and practices such as, for example, identifying and separating civilian and military nuclear facilities and programmes in a phased manner and filing a declaration regarding its civilian facilities with the International Atomic Energy Agency (IAEA); taking a decision to place voluntarily its civilian nuclear facilities under IAEA safeguards; signing and adhering to an additional protocol with respect to civilian nuclear facilities; continuing India's unilateral moratorium on nuclear testing; working with the US for the conclusion of a multilateral Fissile Material Cut- off Treaty; refraining from transfer of enrichment and reprocessing technologies to states that do not have them and supporting international efforts to limit their spread; and ensuring that the necessary steps had been taken to secure nuclear materials and technology through comprehensive export control legislation and through harmonisation and adherence to Missile Technology Control Regime (MTCR) and NSG guidelines.[5]

While accepting and accommodating these international obligations arising out of these agreements and arrangements, it is crucial as well for India to put in place a more responsive, viable and an effective domestic legal regime that could facilitate nuclear commerce without compromising public concerns on safety, environment and liability.

The present study proposes to examine the contours of this domestic legal and regulatory regime that may be required in India in the context of envisaged huge expansion in the civil nuclear energy sector with the possible infusion of huge investments pursuant to conclusion of wide ranging bilateral nuclear cooperation agreements and arrangements. There exists some possibility of participation of the private sector. It has been argued that a well structured legal framework is necessary for meeting the technical and management requirements designed to protect public health, safety and the environment. Accordingly, the study will begin initially sketching and critiquing, *albeit* briefly, the existing atomic energy regulatory regime. The second part of the study will outline the salient elements of a possible regulatory regime and relating it to improvements and amendments to the existing legal regime with a specific focus on the Nuclear Liability Bill.

4 Ibid.

5 See the text of Indo-US Joint Statement issued after the delegation-level meeting between the Prime Minister, Dr. Manmohan Singh and the US President Mr. George W. Bush, in Washington DC on July 18, 2005. For the full text see www.dae.gov.in.

Implementing Nuclear Treaties: Limits of 1962 Act

India has been concluding and taking upon itself several treaty obligations relating to nuclear energy. Earlier in the 1950s, India had a fuel-supply arrangement with the US with regard to its Tarapur reactor. This ran into some trouble and the fuel supply was stopped pursuant to India's Pokharan I nuclear test. During this period and thereafter, India had to face harsh and restrictive nuclear trade regime. India was kept outside the purview of global nuclear energy trade. For this reason, international obligations relating to nuclear energy were less onerous at that time. There were hardly any obligations and most of its nuclear regime was policy-driven (through bilateral contractual arrangements in most cases) despite the enactment of Atomic Energy Act, 1962. However, all this seemed to have changed with the Indo-US Joint Statement of July 2005.

The Indo-US Joint Statement, 2005, located the initial broad policy framework so as to actually facilitate and also to outline broad contours of a legally-binding agreement.[6] This was immediately followed by an Indo-French Joint Statement in September 2005. Later, the Indo-French Cooperation Agreement was concluded in September 2008. The agreement with Russia to build some reactors and other related issues were more in the realm of a contractual arrangement. In February 2010, a Joint Statement with the United Kingdom also followed outlining the elements of nuclear trade.

Apart from these bilateral treaties and arrangements, India is also party to few international conventions administered by IAEA.[7] These are: (a) Convention on the Physical Protection Nuclear Material[8]; (b) Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency[9]; and (c) Convention on Nuclear Safety.[10] India, however, is not party to any of the liability conventions, specifically IAEA's Vienna Convention on Civil Liability for Nuclear Damage.

How will India implement all these obligations that have been flowing from these treaties concluded at this point of time with three major countries, namely, the US, France and UK? There is future possibility of concluding many more such bilateral treaties and arrangements. Is India prepared for it with appropriate legal regime as this would create a host of obligations for India? Most importantly, the emerging legal regime and its

6 Some of these broad policy frameworks relate to: (a) preventing WMD proliferation; (b) goals of promoting nuclear power and achieving energy security; (c) to not only adjust US laws to help India to begin nuclear commerce with it and also to work with friends and allies to adjust international regimes to enable full civil nuclear energy cooperation and trade with India (d) expeditious consideration of fuel supplies for safeguarded nuclear reactors

7 India acceded to IAEA Statute in July 1957.

8 India joined this Convention on April 2002 and it also ratified the Amendments to the Convention in September 2007.

9 Although India signed this Convention in September 1986, the ratification process was completed in February 1988.

implementation should allow proper remedial measures for future course of actions that may arise within India. The other question is – what is the legal source for implementing these treaties? Does it emanate from the 1962 Act? Is this enactment fully equipped to handle future nuclear trade and commerce? Or do we need more laws and enactments to facilitate nuclear commerce? The draft Civil Liability for Nuclear Damage Bill, 2010 which is now before the Parliament is also an attempt to give effect to India's international obligations. Liability is a crucial legal issue that has close links with national law and practice. Is this bill consistent with relevant Indian law and practice? While this liability bill is pending one should note that India is not even a party to any of the multilateral liability regimes, including IAEA's Vienna Convention nor does it have a domestic liability regime. In the following discussion the study proposes find answers to some of these questions.

2005 Statement and Agreement with US

We begin our analysis with the Indo-US 2005 July Statement as that opened up various possibilities for India. There is a view that the July 2005 Statement was simply a statement of intent and accordingly, did not create any binding obligation on either of the two countries. It nevertheless, laid the framework for future negotiations. The Statement, at least, made it sufficiently clear to India as to what would be the nature of its obligations if it wishes to end its 'nuclear isolation'. In that sense, the July 2005 Statement could be regarded as a signpost and a 'soft' legal instrument articulating a certain intent expressed in terms of written commitments. This document had only limited legal effects.[11] Some of these intended obligations required reciprocal initiatives (not actual implementation) though some were specific and definitive to India.[12]

The 2007 Agreement for Cooperation between the Government of India and the Government of the United States of America Concerning Peaceful Uses of Nuclear Energy ('2007 Cooperation Agreement' hereinafter) created a set of binding obligations between both countries. These obligations needed to be performed through various means, some were specific and some were not.[13] The Cooperation Agreement specifically provided that the obligations undertaken in the agreement could be implemented, "in accordance with its respective applicable treaties, national laws, regulations and licence requirements..."[14] The US obligations were more in the realm of facilitation i.e., (a)

10 India signed this Convention in September 1994 and ratified it almost after 11 years in June 2005.

11 Pemmaraju Srinivasa .Rao, "The Role of Soft Law in the Development of International Law: Some Random Notes", *Essays in International Law*, Asian-African Legal Consultative Organisation, 2007; also see www.aalco.int.

12 Such as, for example, the Separation Plan, Safeguards Agreement with IAEA, modalities concerning the reprocessing of spent fuel and implications arising out of testing of nuclear devices.

13 Separation Plan, Safeguards Agreement with IAEA and others.

14 See Article 2 (1) of the 2007 Cooperation Agreement between India and the USA.

assurance of regular fuel supply and to persuade other countries such as France, Russia and United Kingdom to fill the gap in supply, if needed; (b) adjustment of NSG Guidelines by persuading members of NSG to do so; (c) approval of India-specific Safeguards Agreement with IAEA and others. In contrast, India had more specific obligations to perform and we will discuss that in the next section while examining the 1962 Act.

1962 Act: An Inward-looking Enactment

The basic legal framework of the implementation process within India, particularly with regard to atomic energy, though put into effect through policy decisions, emanated from the Atomic Energy Act, 1962. The 1962 Act, it should be noted, was enacted in an entirely different era and in a different context. At that point in time, India had been attempting to develop its own scientific research base concerning nuclear energy, knowing fully well the strategic significance of this move. The 1962 Act was framed in the context of India's quest for self-reliance in the field of nuclear energy. In that sense, the 1962 Act was an inward-looking enactment with certain limited areas to regulate. It had neither envisaged at that time (or even later) any large scale trade in nuclear energy nor had it thought about private participation in the development of nuclear energy. The US Atomic Energy Act, 1946, for example, when it was enacted was also a restrictive and inward-looking enactment and that was changed in 1954 with the enactment of new Atomic Energy Act which paved the way for private participation in the US atomic energy sector.

The 2007 Cooperation Agreement with the US changed this perception as it specifically refers to nuclear trade.[15] The obligation is to "facilitate nuclear trade" and also "...where appropriate, trade between third countries. The agreement also required that "industry in both the Parties needs continuing reassurance that deliveries can be made on time in order to plan for the efficient operation of nuclear installations. The agreement also included a separate provision on, 'transfer of nuclear material...sensitive nuclear technology, heavy water production technology, sensitive nuclear facilities, heavy water production facilities and major critical components of such facilities'. However, the transfers of dual-use items that could be used in enrichment, reprocessing or heavy water production facilities would be subjected to respective applicable laws, regulations and license policies.

The scope and objectives of the 1962 enactment, therefore, were limited, though its preamble asserted firmly that it was, "an Act to provide for the development, control and use of atomic energy for the welfare of the people of India and for other peaceful purposes". The enactment, in fact, did not define what it meant by 'peaceful purposes'. This should be seen in the context of the military and strategic agenda of the Indian

15 Article 4 of the 2007 Agreement

nuclear framework.[16] The Department of Atomic Energy (DAE) was created in 1954 and its mandate, *inter alia*, refers to 'national security'. Its policy mandates were, briefly: Increasing the share of nuclear power through deployment of indigenous and other proven technologies, and also to develop fast breeder reactors, and thorium reactors with associated fuel cycle facilities; Building and operation of research reactors for production of radioisotopes and carrying out radiation technology applications in the field of medicine, agriculture and industry; Developing advanced technologies such as accelerators, lasers, supercomputers, advanced materials and instrumentation, and encouraging transfer of technology to industry; Support to basic research in nuclear energy and related frontier areas of science; interaction with universities and academic institutions; support to research and development projects having a bearing on DAE's programmes and international cooperation in related advanced areas of research; At the policy level this agenda was clear and apparent. The 1962 enactment clearly avoided any reference to what could be termed as 'peaceful'. The 2007 Cooperation Agreement, on the other hand, defined what could be termed as a 'peaceful purpose' as something which "is carried out under arrangements that will not contribute to the proliferation of nuclear weapons or other nuclear explosive device".

There were other respective commitments as well such as (a) safety and security of peaceful uses of nuclear energy; (b) adequate protection of nuclear material; and (c) to put in place an effective national export control regime. The 2007 Cooperation Agreement clearly outlined the difference between what could be termed as a 'peaceful purpose' and a 'military purpose'. There is no legal framework in India, including the 1962 Act that makes such a clear distinction. The limits of the 1962 Act are many. It, for example, did not define a 'reactor' while the 2007 Agreement termed it as "any apparatus" wherein "...self-sustaining fission chain reaction is maintained". The 1962 enactment lacked this precision and does not clearly define many of these terms. It does not seem to keep pace with the current interpretative matrix concerning nuclear energy.

The Indo-French Cooperation Agreement on the Development of Peaceful Uses of Nuclear Energy does not even refer to domestic laws for the implementation of the treaty. Reference is made to the (a) provisions of the agreement; (b) principles of international law, in good faith; and (c) in accordance with the principles governing their respective

16 The Department of Atomic Energy (DAE) was created in 1954 and its mandate, *inter alia*, refers to 'national security'. Its policy mandates were, briefly: Increasing the share of nuclear power through deployment of indigenous and other proven technologies, and also to develop fast breeder reactors, and thorium reactors with associated fuel cycle facilities; Building and operation of research reactors for production of radioisotopes and carrying out radiation technology applications in the field of medicine, agriculture and industry; Developing advanced technologies such as accelerators, lasers, supercomputers, advanced materials and instrumentation, and encouraging transfer of technology to industry; Support to basic research in nuclear energy and related frontier areas of science; interaction with universities and academic institutions; support to research and development projects having a bearing on DAE's programmes and international cooperation in related advanced areas of research; Contribution to national security; see www.dae.gov.in.

policies as well as their respective relevant international obligations.[17] Is this because the 1962 Act does not cover areas or patterns of nuclear trade outlined in the agreement? It appears so as the implementation process is done through varied policy options. The 2007 Indo-US Agreement, on the other hand, refers, *inter alia*, to 'respective applicable treaties, national laws, regulations, and licence requirements'. The reasoning for this reference to a 'national law' emanates from US legal instrument i.e., Atomic Energy Act, 1954.

The implementation of Separation Plan as envisaged by the July 2005 Statement brings up this policy dichotomy to the forefront. To put it differently, for the implementation of the soft obligations arising out of the July 2005 Statement and the subsequent Agreement for Cooperation between India and the US concerning the peaceful uses of nuclear energy[18], the existing Indian legal framework even in the form of the 1962 enactment hardly has any relevance. This also becomes clearer when India agreed to negotiate a Safeguards Agreement with the International Atomic Energy Agency (IAEA) for mandatory verification process and that too on a perpetual basis. All these issues were outside the purview of the existing 1962 Act as it did not clearly delineate or reflect these issues either in its Preamble or in any of its provisions.[19] The 1962 Act neither had any provision that could have facilitated nuclear commerce at the global level nor did it have any provision that allowed for the effective regulation of international cooperative arrangements. A revision of the 1962 Act to facilitate global nuclear commerce in an effective way, therefore, is essential.

Modernising the 1962 Act

This is not to devalue the importance of the 1962 enactment. On the contrary, this study argues for the strengthening of the 1962 enactment so as to reduce the enlarging of policy space of the Indian nuclear establishment. There is no precise legal source from which these decisions originate and the 1962 Act does not provide any basis for such decisions. Majority of these decisions are based on broad policy options though Section 30 of the 1962 Act provides for the framing of rules and regulations that eventually will have to be laid before the Parliament. Pursuant to this, it should be noted, several rules have been framed to give effect to some of these policy options adopted by India. However, in the current context this is not sufficient. If there is going to be a substantial expansion in the atomic energy sector as it may be opened up to other countries, it is sure to affect rights and obligations of citizens. There is no properly articulated liability regime.

17 See Article 1 of the Cooperation Agreement between the Government of the Republic of India and the Government of the French Republic on the Development of Peaceful Uses of Nuclear Energy concluded in September 2008, www.dae.gov.in.

18 Agreement for Cooperation between the Government of India and the Government of the United States of America Concerning Peaceful Uses of Nuclear Energy (Agreed Text as on August 3, 2007) see www.dae.gov.in.

19 In contrast, the Atomic Energy Act, 1954 of the United States clearly lays down its objectives as both civil and military. The US enactment has a long list of policy guidelines relating to strategic aspects of nuclear energy and it outlines clearly as to what it seeks to do with this strategic partnership with other countries.

The transparency requirements are also inadequate. The earlier notion of secrecy with regard to nuclear energy as a whole will have to be transformed once private participation in civil nuclear energy sector sets in. The civil nuclear energy sector should be allowed to be in the public domain, while strategic and military aspects of atomic energy may continue with the existing regulations. Security considerations, of course, would form an important exception.

Considering the growing importance of India in the global context[20] and also increasing transparency requirements that have been put in place within its domestic legal front[21], it is pertinent for India to outline some of these policy issues in clearer legal terms. The legal articulation of these pure policy formulations will allow affected parties to take recourse to appropriate remedial measures. In the absence of proper legal articulation of these policy measures the effectiveness of the entire implementation process of any international obligation arising out of any nuclear energy-related agreements would remain adhoc and inadequate. A clear legal articulation of these obligations in a domestic legislation will also assure the entities who wish to engage in nuclear commerce a measure of predictability.

State-Centric Approach: Loosening the Grip

The existing 1962 enactment, as it should be, is state-centric though there was an amendment incorporated in 1987 to allow public sector participation. It vests general authority of managing and developing atomic energy within India with the Central Government.[22] The Central Government has all the powers and continues to have the complete authority to produce, develop, use and dispose of atomic energy either by itself or through any authority or corporation established by it[23]. This law primarily outlines a

20 The July 2005 Statement regarded India as a responsible state with advanced nuclear technology and for that reason it should acquire the same benefits and advantages as other such states. Both the US and the French Cooperation Agreements recognise India as a State "with comprehensive capabilities in advanced nuclear technologies, including in the nuclear fuel cycle"; Also see the text of the Cooperation Agreement between the Government of the Republic of India and the Government of the French Republic on the Development of Peaceful Uses of Nuclear Energy, available on www.dae.gov.in.

21 Right to Information Act, 2005, for example and reference should also be made to the Supreme Court decision in January 2004 (vide Civil Appeal No. 4294 of 1998) in the case of *People's Union for Civil Liberties and another v. Union of India and others*, 2004 INDLAW Supreme Court 62 wherein disclosure of information from respondents relating to purported safety violations and defects in various nuclear installations were sought. This case before the Supreme Court arose out of judgments and orders dated January 30, 1997 passed by the High Court of Judicature at Bombay in Writ Petition Nos. 1785and 1792 of 1996. 22 See Section 3 of the Atomic Energy Act, 1962

23 This reference to Corporation and Government Company was inserted through an amendment to the 1962 enactment in 1987 and that paved the way for the creation of Nuclear Power Corporation of India Ltd (NPCIL).

regulatory framework for the mining[24], acquisition[25], manufacturing, identification and disposal of uranium and other related radioactive sources that are needed for the generation of atomic energy. The law points out that when any such radioactive source is found, the same will automatically vest with the Central Government and that the Government has all the powers such as to "prohibit the manufacture, possession, use, transfer by sale or otherwise, export and import and in an emergency, transport and disposal of any radioactive substance".[26] The law also refers to compensation, reward, and punishment for those who find or do the mining of these radioactive materials without informing the Central Government.

With India ending its 'nuclear isolation' all these basic regulatory requirements also need change. Till this point of time India was outside the purview of the nuclear trade regime. The change in the US perception towards India, particularly concerning nuclear energy, has been attributed to various factors. The economic factor emerges as the primary reason as this deal would have given a lease of life to the fledging US nuclear industry.[27] The other factor is India's emerging influence in global affairs with its faster growth rate. Yet another factor, a more convincing one at that, seems to be the one wherein it has been argued that by ending India's nuclear isolation it could be indirectly (and through various bilateral arrangements) tied down to the global non-proliferation regime.[28] Whatever be the *raison d'etre* of the 2005 Statement followed by the 2007 Cooperation Agreement emphasising primarily on energy security, one cannot be oblivious to the fact that both these instruments had a broader global agenda relating to a host of issues. A specific and clearer legal articulation of these obligations would have facilitated delinking some of the global policy agenda pursued in connection with certain stated interests. For this reason, the 1962 enactment requires a thorough revision and amendment, as suggested above, with a view to transform India's existing nuclear energy policy into a more definitive binding legal commitment.

There are some indications that India has been attempting to bring in some change in its atomic energy-related legal framework. For example, the Civil Liability for Nuclear Damage Bill, 2010 is on the anvil. There are number of legal issues that need consideration. The next section will deal with that.

24 See Sections 4, 5 and 6 of the Atomic Energy Act, 1962 which refers to Control over mining or concentration of substances containing Uranium and its disposal as well.

25 See Section 10, 11 and 12 of the Atomic Energy Act, 1962 that outlines these issues concerning acquisition, compensation to be paid etc.

26 See Section 16 of the Atomic Energy Act, 1962

27 According to one estimate it would have allowed a business of nearly 20 billion US dollars for the US nuclear industry.

28 India's objections to the existing non-proliferation regime is that it is discriminatory and non-verifiable. India has said it will not join the NPT regime until and unless these aspects are taken into account.

Indian Liability Regime: Some Basic Issues

The proposal by the Government of India to enact a law relating to Civil Liability for Nuclear Damage appears to be a move to put in place a broad-based legal regime in response to an emerging need. Until now, India is neither a party to any multilateral legal regime relating to liability for nuclear damage nor does it have any separate law on the subject. India is not the only country to do so. Globally, though about 30 countries have some form of domestic legal regime relating to nuclear liability, majority of these countries (that includes US, UK, France, China and Japan)[29] are not even party to the existing multilateral regime on nuclear liability such as (a) IAEA's Vienna Convention on Civil Liability for Nuclear Damages, 1963[30]; (b) OECD's Paris Convention on Third Party Liability in the Field of Nuclear Energy[31] concluded in 1960. Both these conventions have not been ratified by major nuclear powers though both the Conventions are in force. As fae as India is concerned, it is not party to either of these regimes though it has ratified three of the IAEA treaties that include issues concerning physical protection of nuclear material, safety and radiological protection.

For India, its emerging treaty arrangements with other countries obligate it to put in place such a regime. It has been reported that the US regards this as a prerequisite to give effect to the Indo-US Nuclear Agreement, although there is nothing in the agreement that actually refers to the establishment of nuclear liability regime. The Cooperation Agreement with the US, however, obligates both India and the US to put in place all such mechanisms that are necessary to implement or operationalise the agreement. Liability regime is one such requirement and US is treating this as a prerequisite for any effective nuclear trade with India. Indo-French Cooperation Agreement, on the other hand, is more specific. It, for example, specifically refers to the need to establish such a regime when it states "...for the purpose of compensating for damage caused by a nuclear incident...each Party shall create a civil nuclear liability regime based upon established international principles".[32]

Understanding Legal Dimensions of Liability

All human endeavours and activities involve risks. The degree of risk may vary depending upon the nature of the activity. The law requires that such endeavours and

29 Price-Anderson Act, 1957 provided for the first time a basis for working out financial security through insurance to all nuclear reactors.

30 Vienna Convention was concluded in 1963 and it came into force in 1977. Parties to the Vienna Convention are mainly from outside Europe, namely, Argentina, Bulgaria, Czech Republic, Hungary, Lithuania, Mexico, Poland, Romania, Russia and Slovakia.

31 Parties to the Paris Convention are all Western European countries except Ireland, Austria, Luxembourg and Switzerland.

32 Article VIII of the Indo-French Cooperation Agreement. It also specifies in Clause 1 that while implementing the agreement Parties shall "deal with liability issues, including civil nuclear liability in specific agreements".

activities should not affect innocent third parties and due care should be taken while conducting the activity. The concept of third party has been stretched and could now include environment and related things. Any effect, direct or indirect, resulting in an injury on account of the activity could entail liability. In other words, liability and its determination are case-specific as it needs to establish (a) casual link between the activity and the consequent injury inflicted; (b) computation or quantification of the injury; and (c) the quantification of reparation or compensation is linked to the extent of due care and due diligence as these could act as mitigating factors in determining liability.

Liability, though crucial, is a complex issue in terms of its specific implementation and determination. It arises only when an unspecified incident occurs and it results in certain damage to humans, environment, property or other related issues. Broadly, it could also relate to change of certain situations and circumstances affecting *status quo*. Although it is difficult for the law to exactly envisage or frame these situations and circumstances, nothing prevents it from prescribing certain kinds of remedies. There can be different degrees or levels for constituting liability in certain circumstances. For this reason, liability regimes and remedies have essentially been developed through judicial interventions which have been generally known as 'tort'. Tort remedies are, therefore, court-developed legal principles and mechanisms. Some of these principles could find their way into well constructed legal articulation in terms of a 'liability legislation' or a 'liability convention'.

The first principle of liability is that whoever brings in or deals with a subject matter that is inherently dangerous (knowingly or unknowingly), they should pay for the damage, if any, inflicted by that object. This strict liability principle was laid down way back in 1868 by the House of Lords in the case of *Rylands v. Fletcher*. The House of Lords ruled that a "person who, for his own purposes, brings on his land and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and, if he does not do so, is *prima facie* answerable for all damage which is the natural consequence of its escape". This case has been regarded as the beginning of what has been known in tort law concerning liability as the 'strict liability' principle.

Approach of Indian Courts

The Indian Supreme Court has laid down and reaffirmed the strict liability principle in several cases. In *M.C.Mehata v. Union of India*[33] the Court held that "in plants run by enterprises which are engaged in hazardous or inherently dangerous activity that poses a potential threat to the health and safety of persons, such enterprises have an absolute and non-delegable duty to ensure that no harm results to anyone". The Supreme Court reaffirmed this view in the case of *Indian Council of Enviro-Legal Action v. Union of India* and stated that, "once the activity carried on is hazardous or inherently dangerous, the

33 It is known famously as Oleum Gas Leak Case. See All India Reporter (AIR) 1987 Supreme Court 1086 quoted in page 1098.

person carrying on such activity is liable to make good losses caused to any other person by his activity, irrespective of the fact that he took reasonable care while carrying on his activity. The rule is premised on the nature of the activity carried on... that the enterprise (carrying on hazardous or inherently dangerous activity) alone has the resource to discover and guard against hazards and dangers, and not the person affected, who for practical reasons, could not foresee the impending damage".[34] The "responsibility for repairing and remedying the damage is that of offending industry and it has the obligation for carrying out necessary remedial measures to repair the environmental damage caused." In India, "The Polluter Pays" principle as interpreted by this Court means that the absolute liability for harm to the environment extends not only to compensate the victims of pollution but also to the cost of restoring environmental degradation.

The Court in *Vellore Citizens' Welfare Forum v. Union of India*[35] ruled that the "Remediation of the damaged environment is part of the process of Sustainable Development and as such the polluter is liable to pay the cost to the individual sufferers as well as the cost of reversing the damaged ecology." After this 1996 *Vellore* case the Indian Supreme Court has reiterated the principles enunciated therein to many other cases such as *Karnataka Industrial Areas Development Board v. Sri C. Kenchappa and Others*[36] wherein the Court dealt with issues concerning environmental degradation and its consequences. References should also be made to *Andhra Pradesh Pollution Control Board v. MV. Nayudu*[37] and *Narmada Bachao Andolan v. Union of India*[38].

Although these cases deal essentially with environmental degradation, the Court's *obiter* on the question of liability outlines the approach of the Court in general. In two recent cases the Indian Supreme Court has interpreted these issues of liability in the context of 'public trust' doctrine. This doctrine was laid down by the Court in *M.C. Mehata v. Kamal Nath*[39] in 1997 and the same was reiterated in a crucial 2006 case, namely, *Intellectual Forum v. State of Andhra Pradesh*[40]. While dealing with the 1997 *Kamal Nath* case, the Court stated "the classic struggle between those members of the public who would preserve our rivers, forests, parks and open lands in their pristine purity and those charged with administrative responsibilities who under the pressure of the changing needs of an increasingly complex society, find it necessary to encroach to some extent upon open lands heretofore considered inviolate to change"[41]. The Court further noted, "Our legal system—based on English common law —includes the public trust doctrine as part of

34 1996 (3) Supreme Court Cases 212 in page 246.

35 1996 (5) Supreme Court Cases 647.

36 All India Reporter (2006) Supreme Court 2038. Also see 2006 (6) Supreme Court Cases 371.

37 Manu/Supreme Court/0032/1999

38 See (2002) 10 Supreme Court Cases 664.

39 Manu/Supreme Court/1007/1997.

40 2006 (3) Supreme Court Cases 549.

41 See for a discussion on this doctrine David Takacs, The Public Trust Doctrine, Environmental Human Rights and The Future of Private Property, 16 *New York University Environmental Law Journal* 711 (2008); also available on www.ielrc.org.

its jurisprudence. The State is the trustee of all natural resources which are by nature meant for public use and enjoyment. The public at large is the beneficiary of the sea-shore, running waters, airs, forests and ecologically fragile lands. The State as a trustee is under legal duty to protect natural resources. These resources meant for public use cannot be converted into private property ownership".

Above cases are cited to show the somewhat far-reaching trend or approach that could be adopted by the Indian courts and these could be extrapolated to liability issues. It is also important to note here that the Indian courts are innovative and are not averse to laying down certain norms that could develop the existing regime. This also applies to the court-developed liability regime as well.

Trends in International Law

International law has a slightly different approach to these issues. It retains a distinction between the term 'responsibility' and 'liability'. Initially when the legal regime relating to what has been termed as 'state responsibility' was taken up for discussion and codification by the United Nations International Law Commission (ILC) almost three decades ago, international lawyers had not predicted what kind of legal regime would emerge.[42] States usually agree that breach of an international obligation by any one of them would entail State Responsibility. It obliged a State to provide reparation or compensation.

Liability, on the other hand, emerged as a separate concept under international law, almost as an offshoot of the State responsibility principle. Liability, though, was developed as a distinct principle and was a concept that was applied mostly in the case of transboundary environmental damages. The principles of 'prevention', 'prior informed consent' 'precautionary principle' and 'inter-generational equity' constituted the core of the international legal norm relating to 'liability'. Under international law the 'liability' regime primarily focusses on 'prevention', 'harm' or 'significant harm'. The definition of 'harm' and 'significant harm' and the criteria to determine this constitute an important element under international legal regime relating to liability, specifically in a transboundary context.[43]

Liability, accordingly, continues to be a domestic legal concept, breach of which would entail remedy within domestic jurisdiction. Domestic laws treat issues of 'liability' more as breach of a 'due care' obligation. The degree of 'care' and 'due diligence' would constitute the core of 'liability' within domestic laws. The principle of 'strict liability', as mentioned above, does not consider any of these principles while adjudicating the matter,

42 See generally First Report on the Legal Regime for Allocation of Loss in case of Transboundary Harm Arising out of Hazardous Activities, International Law Commission, 123, U.N. GAOR, 55th Session., U.N Doc. A/CN.4/531 (March 2003)

43 Ibid.

if one is handling an inherently hazardous material. The interpretations of these concepts, particularly what could constitute 'due care' would differ from country to country. The scope and application of this criterion is essentially decided by the domestic law and policy of a State. For this reason, formulation of a broad-based and legally binding liability regime is yet to materialise in international law. The existing multilateral regimes, including in the nuclear energy sector, lay down broad framework for implementation. Details are to be outlined by domestic laws. The domestic legal regime is the one which takes the first call on the issue as the so called 'incident' or 'damage' actually occurs there. A survey of such existing liability regimes under international law, specifically under International Environmental Law shows that they are essentially sector- specific and are loosely connected. Most importantly, the role of international law in regulating or implementing a liability regime is limited as the actual implementation is a domestic concern.[44]

Proposed Indian Nuclear Liability Bill

The Civil Liability for Nuclear Damage Bill, 2010, has been introduced in Parliament.[45] This draft bill on nuclear liability, more or less, follows the language of the Vienna and Paris Conventions. The Statement of Objects and Reasons to the bill points out that the geographical scope of damage caused by a nuclear accident many not be confined to national boundaries and it may have trans-boundary effects. Therefore, the Statement of Objects and Reasons points out (a) it is desirable that protection is accorded to victims of such incident or accident by a third party liability regime; and (b) to give compensation to persons if they suffer nuclear damage as a result of a nuclear incident. It is also noted that the 1962 Act has no provision on the nuclear liability or compensation for nuclear damage due to nuclear accident or incident, and no other law deals with nuclear liability for nuclear damage in the event of nuclear incident.[46] Some adaptation has been made to suit Indian requirements. The Vienna Convention, it should be noted, is a framework law. Accordingly, it leaves the details of procedure and computation of compensation to the respective domestic legal system. The provisions of the Indian law will be briefly examined in the following sections.

The Indian draft law on nuclear liability has 49 sections and is spread over seven chapters.[47] Chapter II (Sections 4 to 8) is important as it deals with substantive aspects of nuclear liability. It also provides for the appointment of a Claims Commissioner who would look into all claims that might arise from nuclear incidents. The short Preamble to the Bill sums up the functional aspects of the law as "to provide for civil liability for nuclear damage, appointment of Claims Commissioner, establishment of Nuclear Damage Claims Commission and for matters connected therewith or incidental thereto".[48]

The Bill, however, raises several issues that are now in the realm of discussion. Some of these issues are:

- How does it define a 'nuclear damage'?
- Is this definition too narrow?
- How is this definition different from 'nuclear incident'?
- Who is an operator?
- What essentially is the definition and scope of an 'operator'?
- What are the limits and scope of operator's liability?
- Does this Bill subsidise the operator for his liability? If yes, to what extent? Is this consistent with the existing international practice?
- Are time limits to bring claims in nuclear damage cases too short?
- Does this law extinguish all liability, civil or criminal, once the requisite amount of claim is paid out?
- Does this law exonerate equipment suppliers from liability?
- Is the time-frame to bring claims adequate?

Defining 'Nuclear Damage'

One of the most important aspects of the draft bill relates to the definition of 'nuclear damage'. Damage is the basis for civil liability. Accordingly, it is important to know as to how this draft bill defines 'nuclear damage' in Section 2 (f). The language of this draft is similar to the Vienna Convention definition on 'nuclear damage'. This definition broadly categorises situations and circumstances that could be regarded as 'damage'. These are - (a) personal injury; (b) damage to property and the consequent economic loss; (c) damage to environment and costs of restoring it; and (d) any other economic loss (other than the one caused by impairment of environment) permitted by general law on civil liability in force in India[49]. This definition is broad enough to include all situations, and the last criterion keeps the doors of Indian tort law open. Any damage that is not covered in any of the

44 Both Vienna and Paris Conventions provide that the jurisdiction to try these cases lies exclusively with the courts of the Contracting Party in whose territory the nuclear incident occurred.

45 This Bill was introduced in the Lok Sabha on May 7, 2010. The opposition to this bill is broadly on the following lines: (a) that it limits the liability in case of a nuclear accident; (b) that it limits access to courts.

46 Statement of Objects and Reasons introduced by the Government of India on February 11, 2010 concerning the draft Indian bill.

47 The Civil Liability for Nuclear Damage Bill, 2010 (Bill No. 19 of 2010). This Bill was introduced in Parliament (*Lok Sabha*) for discussion. The Government decided to withhold its introduction with a view to allow for more consultations. Now, the Bill has been proposed to be sent to the Parliamentary Standing Committee for examination.

48 Ibid.

49 According to Section 2 (f) 'nuclear damage' means "(i) loss of life or personal injury to a person; or (ii) loss of, or damage to property". This should have been caused by a 'nuclear incident' and it could also be (a) any economic loss; (b) costs of measures of reinstatement of impaired environment caused by a nuclear incident, unless such impairment is insignificant; (c) loss of income deriving from an economic interest in any use or enjoyment of the environment, incurred as a result of a significant impairment of that environment caused by a nuclear incident; (d) the costs of preventive measures, and further loss or damage caused by such measures; and (e) any other economic loss, other than the one caused by impairment of the environment...and in so far as it is permitted by the general law on civil liability in force in India and not claimed under any such law.

above three criteria could be taken up in the last one. It is, however, not clear as to what could be termed as "general law on civil liability in force in India". This aspect needs further elaboration and clarification. Does this mean that it refers to tort law that has been developed by courts or is there anything that could be termed as the 'civil liability' law in India? There is nothing unusual about this definition of 'damage'. In general terms, it can be applied anywhere and at any time. In other words, this law does not completely extinguish liability forever. As per the general civil liability law of the land, the citizen has the right to pursue his claims.[50]

What distinguishes this definition from other situations is that this damage should take place in the context of the use of a radioactive substance in nuclear installation. The last paragraph of this definitional clause further says that the loss that has taken place should result from "ionizing radiation emitted by any source of radiation inside a nuclear installation, or emitted by a nuclear fuel or radioactive products or waste in, or of, nuclear material coming from, or originating in, or sent to, a nuclear installation..." In other words, this paragraph essentially limits the nuclear damage to the occurrences within a nuclear installation. The phrase 'nuclear damage' is caused when a 'nuclear incident'[51] takes place. The definition of 'nuclear incident' is a bit abstract as the linkage between these two concepts is not clear. The Indian law does not adopt the Vienna Convention definition concerning 'nuclear incident' in *toto*. The Vienna definition links the 'nuclear accident' with radioactive material. That part has been deleted in the Indian draft. The Indian draft should, therefore, adopt a proper language for the definition of 'nuclear incident'.

Who is an Operator?

According to Section 2 (l), an 'Operator' "in relation to a nuclear installation, means the person designated by the Central Government as the operator of the installation". It is clear that the Central Government has the full power and authority to decide the status of an entity as an operator. It could be public sector Company like the NPCIL or any other entity. To give effect to this provision, relevant part of the 1962 Act also needs change or amendment. This is important in the context of Section 4 (1) which, *inter alia*, provides that the "operator of the nuclear installation shall be liable for nuclear damage caused by a nuclear incident"

Section 4 essentially refers to the liability of the Operator and it also lists various circumstances wherein an Operator could be determined. It is not necessary that the 'nuclear damage' could take place only in the context of a nuclear installation. In other

50 Refer to the discussion above on the approach of the Indian Courts.

51 A 'nuclear incident' has been defined in Section 2 (h) as "any occurrence or series of occurrences having the same origin which cause nuclear damage or, only with respect to preventive measures, create a grave and imminent threat of causing such damage".

words, there could be different operators in a particular transaction chain and the liability settles in accordingly. There could be different operators at any given point of time in a given transaction chain. Section 4 of the draft bill attempts to outline this kind of a scenario. We could briefly outline some of these scenarios such as, for example, (a) while the nuclear material is coming to a nuclear installation – e.g., while in transit; (b) the nuclear material would have passed on to another operator; (c) nuclear material designated for an installation in India could be in transit in a foreign territory – who is the operator there? What liability will apply if a 'nuclear incident' takes place there? In any case, it has been made clear that, "Where more than one operator is liable for nuclear damage, the liability of the operators so involved shall, in so far as the damage attributable to each operator is not separable, be joint and several".[52] In all such cases, along with this draft law, the rules of private international law will also apply. The rules of private international law help in determining what law should be applied depending upon the (a) cause of action; and (b) the concurrence of parties to apply a specific law. Some of these issues are beyond the purview of the present bill and this should be either noted or incorporated in the draft bill. The US law, particularly its Atomic Energy Act, 1954 (as amended) provides for the operation of a private international law regime when the competent authority of the Government authorises or licenses an entity to act as an operator.

Both Vienna and Paris Conventions, the existing multilateral regime on nuclear liability, provide that it is the operator of the nuclear installation who would be exclusively responsible. These Conventions also provide that the liability of the operator is absolute i.e., operator is held liable irrespective of fault, except for acts of armed conflicts, hostilities, civil war and insurrection.

When Operator Is Not Liable

Section 5 lists circumstances in which an operator is not held liable. The Indian exceptions are: (a) a grave natural disaster of an exceptional character; or (b) an act of armed conflict, hostility, civil war, insurrection or terrorism. The strict liability rule, as stated above, does not allow these exceptions, although these factors could act as mitigating factors in computing compensation. The cases decided by the Indian Supreme Court make this point amply clear. This provision appears to be somewhat inconsistent with the understanding of the existing multilateral legal regime i.e., Vienna and Paris regimes, that the operator is strictly liable irrespective of whatever happens. In other words, exceptions are not permitted. However, the present Indian draft proposal appears to take a middle path. In one sense, these exceptions are too broad and could act as

52 Section 4 (2) of the draft bill.

mitigating factors while computing claims. The other justification for the creation of such a broad exclusionary clause is that it is done keeping in view the concerns of insurers. It is expected that, as per the Indian draft bill as well, all operators should obtain insurance. How to obtain insurance against a 'strict liability' clause? This provision has been framed keeping in view the insurance regimes that may have to be developed in the Indian context. This was done in the US in the 1950s and 1960s when the Price-Anderson Nuclear Industries Indemnity Act (`Price-Anderson Act' hereinafter) was passed in 1957 by the US to develop insurance regimes that could take care of nuclear liability. It took nearly three decades for the US to develop such an insurance regime.

Limits on Liability

Section 6 of the Indian draft sets out the pecuniary limits on liability for an operator. It is Rs. 500 crore for each nuclear incident although the Central Government has been given the power either to increase or decrease the amount of liability of the operator, taking into account the risks involved in a nuclear installation.[53] However, it cannot go below Rs. 100 crore. The maximum amount of liability, as this provision puts it, in respect of each nuclear incident is rupee equivalent of 300 million Special Drawing Rights.[54] Section 7 of the draft Bill makes the Central Government liable for nuclear damage if the liability exceeds the amount of liability of an operator. This has been termed as 'subsidy'. Should the nuclear industry be given such flexibility and that too from the public exchequer? Will it not raise legal and Constitutional issues on the ground that this treatment to a specific industry is discriminatory? The draft Bill also provides that the operator, before beginning operation of his nuclear installation should take out an insurance policy or such other financial security to cover his liability.[55]

Price-Anderson Act Experience

The above legislative scheme has been adopted from the Vienna and Paris models although major nuclear power producing States have not formally signed or ratified it. Both the Vienna and Paris Conventions provided for a compensation package up to 300 million special drawing rights. The Paris Convention has recently increased it to 360 million special drawing rights. Indian draft law adopts, more or less, the same model that has been reflected in the Vienna and Paris Conventions with same liability limits. This kind of state-funding of compensation funds relating to nuclear power has been widely criticised as a "billion dollor bailout for the nuclear power".

The idea of State indemnifying nuclear power industry originated in the US with the passing of the Price-Anderson Nuclear Indemnify Act, 1957. This law was passed with a view to get private participation in the nuclear power industry. The passing of this US enactment in 1957 was felt necessary as an incentive to private production of nuclear energy. The private nuclear industry was unwilling to meet with the potential and unquantified risks relating to nuclear accidents without some limits on the liability. No insurance company was willing to indemnify a company against such a huge potential liability nor could an insurance company make a commitment beyond its own resources.

The Price-Anderson Act provided these limits and it sought to govern liability related issues for the non-military nuclear facilities constructed within the United States. Now, this US law is applicable till 2026. It has been extended from time to time, although its original envisaged time span was ten years. In other words, this US law was to end in 1967. That did not happen. It continued and the latest extension was given in 2005 for a period of 20 years. The major purpose of this US enactment is to partially indemnify the nuclear industry against liability claims arising from nuclear incidents while still ensuring compensation package for the general public. The US enactment establishes a 'no-fault insurance' type system in which the first $10 billion is provided by the nuclear industry.[56] Any claim above $10 billion would be funded by the US Government. These funding mechanisms are subjected to strict procedural mechanisms such as that the President of the US should estimate and accordingly recommend to the Congress about the funding of the nuclear incident in the event of existing funding by insurance etc. being insufficient to meet the claims made by the public.[57]

In 1978, the constitutional validity of the Price-Anderson Act was challenged in the case of *Duke Power Co. V. Carolina Environment Study Group* before the US Supreme Court on the grounds that (a) it did not ensure adequate compensation for victims of accidents; and (b) as violating the equal protection clause of the fourteenth amendment by treating nuclear accidents differently from other accidents. The American Supreme Court finally upheld the validity of the Price-Anderson Act stating that the classification made within the enactment with regard to nuclear accidents was proper.

53 The amount liability will not include any interest or cost of proceedings.

54 The amount in Indian rupees, it is estimated, may approximately come to Rs. 2100 crore. The SDR (Special Drawing Rights) unit is defined as a weighted sum of contributions of four major currencies, re-evaluated and adjusted every five years and computed daily in terms of equivalent United States dollars. Special Drawing Rights are not a currency, but they represent potential claims on the currencies of the IMF members. SDRs obtain their reserve asset power from the commitments of the IMF member states to hold and honour them for payment of balances.

55 Section 8 of the draft Bill.

56 Each reactor company is obliged to contribute $111.9 million in the event of an accident. Accordingly, as of 2008-2009 $11.6 billion is available if all the reactor companies pay up.

57 It should be noted that so far the nuclear insurance pools in the US have paid out about $ 51 million ($70 million of which is related to the Three Mile Island accident) while the Department of Energy paid out $65 million. The total pay out under the Price-Anderson Act so far has not exceeded $200 million.

Extinction of Claims

According to Section 18 of the Indian draft bill the right to claim compensation for any nuclear damage caused by a nuclear incident extinguishes within ten years. A claim should be made within ten years. The provision says that it cannot, in any case, go beyond 20years in cases wherein nuclear material had been stolen, lost, jettisoned or abandoned. There is a view that this period should be extended to beyond ten years. If one could show a nexus between the effects of the nuclear incident, then, nothing prevents the courts from taking up these claims. The causal nexus must be established clearly. That could be a difficult task for the common man. Therefore, the presumption should be that the claim exists until and unless it is proved to the contrary by the defendant. The defendant, with all the information and resources, will be in a better position to establish or denounce the casual link that could exist between the nuclear incident and its effect beyond ten or 20 years as the case may be. It should be noted that both the Vienna and Paris Conventions follow the 'ten year' rule. Legislations of many countries, including that of the US follow this rule.

Nothing, however, prevents the Indian courts from deciding the issue on merit, if the matter really warrants that. An amendment to that effect could be included in the provision to Section 18 of the draft bill.

Conclusions

The present study examines in the first part, *albeit* briefly, the limits of the Atomic Energy Act, 1962. The discussion is placed in a context and attempts to configure the various provisions of the 1962 Act. The enactment of this law should be seen in the context of India's aspiration to achieve self-reliance in the field of nuclear energy research and also to augment strategic use of nuclear power. These are the twin objects. These objects do not find any mention in the 1962 Act. Considering the limited scope and application of the 1962 Act, it has been termed as an 'in-ward looking' enactment when compared to the legislations of other countries, specifically the United States Atomic Energy Act, 1954, that outlines broad contours of its atomic energy laws that, *inter alia*, includes references to military, strategic, peaceful and other purposes. The study also notes that the ending of 'nuclear isolation' and the increasing range of bilateral arrangements with other countries and institutions (such as IAEA and NSG), both subsisting ones and the future ones, open new vistas for the Indian nuclear energy scenario. This is what the Government hopes to achieve. The first part of the study while examining the implementation of the bilateral and multilateral arrangements relating to nuclear energy attempts to outline the limits of the 1962 enactment and strongly recommends its revision. The study also attempts to sketch the contours of this revision as well.

The other part of the study relates to the examination of some of the basic issues relating to the Civil Liability for Nuclear Damage Bill, which is presently before the Parliament for consideration. There are several key issues, with regard to this bill, that need answers such as, (a) limits of liability; (b) the Indian law on civil liability and its application; (c) time limits for claims and other related issues. The experience gained in the operation and implantation of Price-Anderson Act has also been briefly outlined. The most important element is – how to work out the financial mechanism? The nuclear power sector is still in the domain of the Government. What are the problems and prospects for expansion and consequently participation by the private entities? How to create an insurance regime that would be responsive to the expansion of the nuclear industry in India?

The Indian courts, of course, have their stated position on liability issues and it is not possible and feasible either to exclude jurisdiction of the courts. Everything will have to be ultimately tested in the context of the Constitution. As noted in the study, the Price-Anderson Act went through this process within US in 1978 when its Constitutional validity was challenged on many counts. The Indian draft law on liability needs fine-tuning as suggested in the relevant parts. While some reference has been made to the substantive aspects, the entire procedural aspect to pursue a compensatory claim needs further examination. For a common man, this procedural aspect is too cumbersome and difficult. This needs further elaboration.

Finally, as regards safety and other aspects, consideration could be given to according Atomic Energy Regulatory Board an entirely independent existence, possibly something akin to the Controller and Auditor General (CAG). This will surely enhance the requirements of transparency and predictability requirements. In the present institutional structure it is still bound by the existing hierarchical structures and for that reason, safety and other assessments made by it could be regarded as implementing governmental policy.

THE INDIAN CIVIL NUCLEAR LIABILITY ACT

Need for a liability Act

Nuclear energy is expected to play an important role in India's future generation of electricity. This is, and will be, necessitated by a number of global factors such as environmental concerns about carbon emission, the uncertainties about the availability of traditional hydrocarbon energy resources and the need to maintain a degree of energy security. It is expected that by the mid-century nuclear energy will contribute not less than 40 per cent of total electricity generation in India, in line with the current scenario in some of the advanced developed countries such as the United States (US), France and Japan. The Indian public perception of nuclear power is, unlike in many of the developed countries, quite positive about nuclear power plants.

The Indian experience with operation of nuclear power plants (NPP) has been quite successful and incident-free. This has been partly due to the technology used as well as the strict control over NPP operations, primarily as a result of such operations being strictly in the public domain with the operating personnel being trained under a strict regime. Nevertheless, as the number and types of NPPs increase with the entry in nuclear power generation of private players as well, it is time for India to consider establishing some form of domestic legal mechanism to provide compensation to victims of any possible nuclear incident. As will be discussed next, while the Indian record - and that of the global operations of NPP in general - has been good, given the unique nature of nuclear accidents - which may involve radiation effects - it is necessary that a start be made in enacting such a legislation now rather than later. Needless to state, such a mechanism should have the interests of the public as its primary focus with the interests of other interested parties being accommodated after public interest is taken care of.

Nuclear incidents

Worldwide the NPP industry has collectively accumulated over 1700 reactor years of operation. During this period the industry has had a fairly safe record, the two notable exceptions being the Three Mile accident in 1979 and the Chernobyl accident in 1986, which was the last major nuclear accident. Since then there have been no major nuclear accidents, certainly none with off-site damage.

After Chernobyl, in response to proposals to develop an international event rating scale similar to scales already in use in other areas (such as those comparing the severity of earthquakes), the International Atomic Energy Agency (IAEA) in collaboration with the OECD Nuclear Energy Agency (OECD/NEA) developed the International Nuclear and Radiological Event Scale (INES) in 1990 which was refined subsequently in 1992.

In INES events are classified on the scale at seven levels: Levels 4–7 are termed "accidents" and Levels 1–3 "incidents". Events without safety significance are classified as "Below Scale/Level 0". Events that have no safety relevance with respect to radiation or nuclear safety are not classified on the scale

The aim in designing the scale was that the severity of an event would increase by about an order of magnitude for each increase in level on the scale (i.e. the scale is logarithmic). The 1986 accident at the Chernobyl nuclear power plant is rated at Level 7 on INES. It had widespread impact on people and the environment. One of the key considerations in developing INES rating criteria was to ensure that the significance level of less severe and more localised events were clearly separated from this very severe accident. Thus the 1979 accident at the Three Mile Island nuclear power plant is rated at Level 5 on INES, and an event resulting in a single death from radiation is rated at Level 4. Incidents at Levels 0-2 are not considered significant from the viewpoint of their offsite impacts. Currently nearly 60 IAEA members use the INES to classify national nuclear incidents which are voluntarily reported to IAEA.

Since the Chernobyl accident there has been no incident at any of the NPPs worldwide that has reached Level 3 in the INES scale. In India, according to the Significant Event Report (SER) compiled by the Atomic Energy Regulatory Board, during the five year period 2003-2008, there was only one incident at INES level 2, with all other incidents being at levels 0-1, mostly Level 0.

Nuclear liability laws

From the early days of nuclear power, States that began to engage in nuclear related activities concluded that general tort law is not an appropriate instrument for providing a liability regime adequate to the specifics of nuclear risks, and they have enacted special nuclear liability legislation.

Further, States recognised at an early stage that the possibility of transboundary nuclear damage required an international nuclear liability regime. Over the period of time, a number of international conventions, at both regional and international level, came into being, with many of them undergoing amendments over time, as is to be expected. These conventions are:

International:

i) The 1963 Vienna Convention on Civil Liability for Nuclear Damage with 36 Contracting Parties which came into force only in 1977. The 1963 Vienna Convention was amended in 1997, but it came into force only much later in 2003,

with only 5 Contracting Parties;

ii) The 1988 Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (the Joint Protocol) which came into force in 1992 and has 26 Contracting Parties;

iii) The 1997 Convention on Supplementary Compensation for Nuclear Damage, which is yet to come in force.

Regional:

i) The 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy, which came into force in 1968 and has 15 Contracting Parties. It was revised in 1964, 1982 and 2004. The 2004 revisions are yet to come into force.

ii) The 1963 Brussels Convention Supplementary to the Paris Convention (the Brussels Supplementary Convention) which entered into force in 1974 and has 12 Contracting parties. It was revised in 1964, 1982 and 2004. The 2004 revisions are yet to come into force.

Requirements of a nuclear liability act

By and large these conventions established certain norms as being fundamental to a good nuclear liability act. These were:

I) Strict liability

Notwithstanding the relative safety of NPPs, there are certain unique features associated with nuclear accidents. First of all, the damage caused by ionizing radiation to living cells, especially human cells, may not be immediately recognisable; it may be latent for a long time. Since the radiation doses received by living cells have cumulative effects, there may be damage caused by different sources of radiation. In many cases there is no typical radiation injury. Moreover, cancer may result from a radiological accident or from, for example, smoking.

Second, detrimental effects of a major nuclear accident may extend far beyond the territory of the accident State as was seen in case of Chernobyl accident.

Third, under the normal laws governing tort cases involving liability, the plaintiffs have to prove that the defendants were negligent. In nuclear incidents the proof of causation depends upon presenting sophisticated scientific evidence given the nature of NPP operations. Such proofs may well be beyond the means of most plaintiffs and would in case, require substantial time to be established. The nature of damage in some major nuclear accidents would require, in public interest, that the plaintiffs be given compensation as soon as possible.

Fourth and finally, in case of offsite nuclear damage, it is a case of unilateral accident, i.e. one which the plaintiffs neither will be able to nor can in any manner prevent the accident with the defendant or the operator of the NPP being solely able to control the risk of accident.

For all these reasons a nuclear liability bill should incorporate the principle of strict liability. The operator of a nuclear installation should be held liable, regardless of fault. The plaintiff need not prove negligence or any other type of fault on the part of the operator.

Therefore, the first requirement of a civil nuclear liability bill should be the principle of strict liability on the part of the operator.

ii) Financial security

Winning in court does not by itself guarantee that the plaintiff will be able to recover the award. If the losses to victims exceed the operator's ability to pay, the operator may as well declare bankruptcy, in which case the victims will not be able to recover the full award. It is, therefore, necessary that the law directs the operator to maintain insurance or provide other financial security covering its liability for nuclear damage in such amount, of such type and in such terms as may be decided by the legislature or the executive of the state. The amount so determined will be dependent on a number of factors such as the state of the capital market, the ability of the operators to get insurance coverage or arrange other types of financial security. It will be immediately apparent that it would be impossible to get such a financial coverage for an unlimited amount. There has to be some limit on such financial coverage.

Different countries have different limits for such financial coverage depending on the international convention to which they subscribe or their domestic laws. In addition, these limits have changed over time with the member states agreeing to higher limits. The limit will however, be influenced by the capital market, type of coverage etc. Both the 2004 Protocol to Amend the Paris Convention and the 2004 Protocol to Amend the Brussels Supplementary Convention on Nuclear Third Party Liability agreed to raise the operator's financial coverage to Euro 700 million. Although more than six years have passed since the Protocols were agreed to by the member States, they are yet to come in force. According to reports one of the reasons for this situation is that nuclear operators apparently failed to obtain insurance coverage for this substantial amount.

There have been reports also suggesting that the UK government is considering instead providing billions of pounds worth of commercial insurance itself.

The second requirement for a good nuclear liability bill will be the need to require a minimum level of financial coverage by the operators to safeguard the interests of the public taking into account the operator's constraints as well.

iii) Absolute liability

While in theory it may be possible to suggest that all parties connected with the operation of a nuclear facility - the operator of the facility, the supplier of technology and

equipment- all should be held responsible for a share of the damages, in practice this may prove difficult, if not impossible. In particular, if the nuclear accident is sufficiently serious, the special environmental conditions - such as radiation hazards, high temperature melting or fatalities among operating staff - prevailing after the accident may prove it impossible for a sufficiently provable forensic linkages to be established between the different parties involved. In any case, when the principle of strict liability is invoked, it may well be advisable to let the apportionment to damages between various parties liable for action be decided between these parties themselves according to the contracts entered into by them prior to the event. As long as the damages are awarded to the plaintiffs, it does not matter from which involved party the resources come. As the Exposé des Motifs of the Paris Convention (as revised and approved by the OECD Council on 16 November 1982) remarked, "Two primary factors have motivated in favour of this channelling of all liability onto the operator as distinct from the position under the ordinary law of torts. Firstly, it is desirable to avoid difficult and lengthy questions of complicated legal cross-actions to establish in individual cases who is legally liable. Secondly, such channelling obviates the necessity for all those who might be associated with construction or operation of a nuclear installation other than the operator himself to take out insurance, and thus allows a concentration of the insurance capacity available."

Therefore, there is ample case for making the liability of the operator not only strict but also absolute and legally channelling the liability solely on to the operator of the nuclear installation. This is the third requirement of a good civil nuclear liability act.

iv) Channelling of claims

The law should allow for only one court, special or otherwise, to have jurisdiction to deal with claims arising out a nuclear incident. Preferably that court should be in the State in which the nuclear incident occurs. The reasons for such a requirement are obvious. The concentration of procedures would create legal certainty and simplify procedures. As for the requirement that the court be in the State where the incident occurred, it is best to quote when in the Southern District of New York, John F. Keenan, Judge passed an order affirming that the Union Carbide case should be tried in India. As that district court found, "the record shows that the private interests of the respective parties weigh heavily in favour of dismissal on grounds of *forum non conveniens*. The many witnesses and sources of proof are almost entirely located in India, where the accident occurred, and could not be compelled to appear for trial in the United States. The Bhopal plant at the time of the accident was operated by some 193 Indian nationals, including the managers of seven operating units employed by the Agricultural Products Division of UCIL, who reported to Indian works managers in Bhopal. UCIL kept at the plant daily, weekly and monthly records of plant operations and records of maintenance as well as records of the plant's Quality Control, Purchasing and Stores branches, all operated by Indian employees. The great majority of documents which have a bearing on the design, safety, start-up and operation of the plant, as well as the safety training of the plant's employees,

is located in India. Proof to be offered at trial would be derived from interviews of these witnesses in India and study of the records located there to determine whether the accident was caused by negligence on the part of the management or employees in the operation of the plant, by fault in its design, or by sabotage. In short, India has greater ease of access to the proof than does the United States." What was relevant then in the Bhopal case would be much more so, in case of nuclear accidents, especially those that are significant. Because of radiation problems, and other associated issues vividly described by Judge Keenan, it would be almost impossible for any court in any State other than the one where the nuclear accident occurred to be able to handle such cases.

iv) Operator liability

Finally there is the issue of whether or not there should be a total overall cap on the nuclear liability over and beyond the financial guarantee 6 required from the operators. Without such an express limitation, the liability of the operator would be unlimited. Certainly there is no bar on requirement of unlimited liability on part of the operator even if an unlimited financial coverage is not possible. A small number of countries with NPPs –Austria, Germany, Japan and Switzerland - apply the concept of unlimited on the operator of the nuclear installation. All the other states with NPPs that currently have some form of nuclear liability laws, 24 out of 28, limit the total amount of liability that can be awarded in case of an nuclear accident. However, it must be understood that the financial security required from the operator has to be equal to or less than the operator liability. In case of unlimited liability, since the insurance industry will not underwrite an unlimited amount, it will be necessary to specify a finite amount.

The Indian Civil Nuclear Liability Bill and international practice

There are currently 30 countries that operate 436 civil nuclear power plants (NPP). Of these 30 countries, covering the operation of 416 NPPs, have some sort of nuclear liability act in force in their territory either as a result of adherence to some international liability regime – either the IAEA's Vienna Convention for Nuclear Damage of 1963 or the OECD's Paris Convention on Third Party Nuclear Liability in the field of Nuclear Energy of 1960 - or enacting a national liability law. Around 22 of the 28 countries are party to one of the two international conventions and 12 are contracting parties to the Vienna Convention and 10 to the Paris Convention. The other six - Canada, China, Japan, Republic of Korea, South Africa and Switzerland - have national laws on nuclear liability. Only two countries operating 20 NPPS between them - India (18) and Pakistan (2) - are neither members of any international convention nor have any national legislation. All these 28 countries however, have incorporated in their domestic laws, the principles that were discussed earlier. The proposed Indian act is in line with the provisions of the Convention on Supplementary Compensation (CSC).

The proposed bill has drawn criticism on a number of accounts. The principal reasons for opposition from those who may be otherwise inclined towards such a bill are:

1) That it limits the liability of the operator of the facility to Rs. 500 crores; it is low.

2) That it limits total liability for damage to SRD 300 Million (equivalent to Rs. 2100-2300 crores); this is again low.

3) That the public will have to bear substantial costs of damage by way of payments.

4) That it exonerates suppliers of equipment, both foreign and domestic, from any liability charges.

It must be understood clearly that the operator limits and total financial liability limits are subject to future amendments to the bill. Other countries, too, had frequently changed both these limits. Under the current form, the Indian limits are neither the lowest nor the highest. The operator liability in Canada and China, for example, are much less than in the case of India. Most states, including China, provide state assistance in case the total damage exceeds the operator limit. However, as stated, these limits are subject to constant changes. China, for instance, had only as late as 2007 increased the operator's liability from RMB 18 million to RMB 300 million (about Rs. 200 crores, still far less than the Indian limit of Rs. 500 crores). Hence reasons (1) and (2) above are issues that can be resolved with informed debate with inputs from industry, insurers, nuclear industry experts and public interest groups. *These will not, however, require any modification to the principles of the bill.*

It is true that the bill exonerates the equipment suppliers from liability damages. It does so but without any geographical restrictions. It protects equally Indian, US and all other foreign suppliers. Would making the supplier also liable, in certain cases, be in public interest? It is debatable.

First of all it must be clearly understood that all civil nuclear equipment suppliers require that the national nuclear liability acts follow the international convention guidelines that exempt suppliers from liability. The case of French and Russian suppliers has been cited as examples of countries that do not insist on a nuclear liability act. Nothing can be further from the truth. The French have repeatedly said that they require a liability bill. Indeed the Chinese put in place their liability regime, in March 1986, only to address the concerns of foreign suppliers, mainly the French, who were to work on the construction of the second Chinese NPP at Daya Bay. The France-India nuclear cooperation agreement specifically states (Art. VII) 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, each Party shall create a civil nuclear liability regime based upon established international principles." In fact, far from being indifferent to a civil nuclear liability legal system in India, the French have made such a law mandatory for cooperation.

What about Russia? Russia is a signatory to the Vienna Convention which makes the operator solely responsible for liability damage. The only exception, as per the Convention, is when the operator has recourse only when this is expressly provided for

by a contract in writing. That being the case, and in the absence of anything in the public domain to the contrary, it is uncertain if the Russian supplier would agree to nuclear liability damage in India in the absence of such a specific condition being part of the India-Russia agreement on Koodankulum. It would be interesting to know if the Koodankulum contract specifically addresses the issue of supplier liability. An agreement by Russia to supply equipment to nuclear installations without any specific agreement exempting the Russian supplier from liability claims would be contrary to what the Russians themselves had experienced when agreeing to supplies from France and Germany.

According to Article III of the "Agreement between the Government of the French Republic and the Government of the Russian Federation on Third Party Liability for Nuclear Damage Caused in Connection with Deliveries from the French Republic for Nuclear Installations in the Russian Federation" (20 June 2000), "The Russian Party shall grant the French Party and the suppliers appropriate legal protection and shall exempt them from liability for damages in the event of claims by third parties on grounds of nuclear damage resulting from a nuclear incident which has taken place within the territory of the Russian Federation."

Russia had earlier signed a similar agreement with Germany which also required that "The Russian Federation agrees not to institute liability proceedings against Germany or against any German supplier and to ensure that they will receive sufficient legal protection and will not be held responsible in respect of claims made by third parties."

It is, therefore, quite likely that the Russians had insisted on an agreement of the type they themselves had to agree to when importing supplies from France and Germany. This, of course, is not verifiable since *no India-Russian nuclear agreement* is in public domain. Thus it is most likely that even under current conditions the Indian public will have no recourse against a foreign supplier. On the other hand, since 18 of the 24 reactors currently operated by NPCIL are totally indigenous, the Indian suppliers will be liable under current Indian laws. The current bill only gives Indian suppliers to Indian nuclear operators a level playing field.

Conclusions.

Notwithstanding of the current bill being in compliance with the international norms, it could be amended without detracting from its adherence to these norms. In particular the following changes, which should go a long way towards satisfying some of the critics' misgivings, can be considered by the government when amending the bill. It deals with only with substantive elements not requiring legal interpretation of Indian constitution etc. These legal issues will no doubt be addressed by the courts later, if so required.

1) Sec. 17 (b)

Sec. 17(b) is an almost verbatim copy of Art. 4(1) of the Korean "Act on compensation for Nuclear Damage". Art. 4(2) of the Korean Act is a modified version of

Art. 17(a). Art. 17(c) is the standard format in all the international conventions. In reality Art 17(b) and Art. 17(c) are not much different. The addition of Art. 17(b) does not add much to Art. 17(c). It can be dropped without detracting from the force of Art. 17. On the other hand, retention of Art. 17 (b) should have no influence on the behavior of international suppliers. All major nuclear equipment suppliers- US, France, Canada, Germany etc- have been supplying reactors and nuclear equipment to Korea without raising any objection to Art. 4(1) of the Korean liability bill. Hence they can have no objection to Art. 17(b) either.

Therefore, even though Art. 17(b) does not add much to Art. 17(c), it can be retained in the Indian bill without having any detrimental effect.

2) Operator liability.

According to Sec. 6(2) the liability of the operator is limited to Rs. 500 crores. Vienna convention does not set any maximum limit of operator liability and India cannot sign Paris Convention which is restricted to OECD members only. Hence the operator liability can be set at any level by India and be still in line with International conventions on nuclear liability.

Therefore, Sec. 6(2) can be modified, if so desired by the Committee, at any finite level of liability or even unlimited liability.

3) Maximum Liability

Obviously the maximum liability set out in Art. 6(1) will have to be adjusted according to the level set in Art. 6(2) keeping in mind two principles.

a) The maximum liability cannot be less than the operator liability.

b) In case of unlimited operator liability, the maximum liability has also to be unlimited.

c) In particular, the operator and maximum liability can be the same, without requiring any public subsidy except in extreme circumstances as explained in Section 4 of this Note.

4) Public subsidy.

A liability bill will have to take into account a situation wherein the total compensation exceeds the maximum liability defined in Sec. 6(2). There is no required format on this issue in any of the international conventions. It is entirely upto the Indian legislature and executive to decide on this matter. The longer report gives some examples of how other countries have tried to address this matter. The current version of the bill is silent on this matter and needs to be resolved.

Therefore, the committee needs to examine this issue and make amendments to the bill to reflect some consensus between the executive and the legislature on how compensation will be given in cases where the total compensation exceeds maximum liability or where the total resources available with the operator are insufficient to discharge compensation obligations i.e. the operator becomes insolvent.

5) Operator's financial Security.

While in principle, it is open to set the financial security to be provided by the operators under Sec. 8 to any amount, not more than the operator's liability, practical considerations, especially from the viewpoint of the insurer has to be taken into account. There are two options available.

a) Private insurers, either individually or in a cooperative manner, as a consortium, are willing to issue insurance to the extent specified under Sec. 8. The views of the insurance companies need to be taken into consideration before deciding on the financial security limits.

b) If private insurers are not able, or willing to insure to the limit of financial security, the government may choose to underwrite the shortfall, charging the operators a premium for issuing such guarantees. This system is followed in some countries.

6) Insurance limitations.

At the present moment from all indications international insurers, who maybe asked for reinsurance by Indian insurance companies, are unwilling to underwrite insurance policies which have environmental liabilities. This may be cross checked with IRDA. In such a case only Indian insurers will have to bear the full insurance liability or the government may have to give guarantees.

7) Time Limitation.

Sec. 18 of the bill specifies a period of ten years for extinction of right to claim. This can be modified for a longer duration, again taking into account, insurance companies' ability and willingness to extend the period much longer. Generally the insurers are reluctant to insure for very long claims period. This, too, can be discussed with the insurance industry. If they are willing to do so, a longer period, 20 to 30 years, can be proposed. If they are unwilling, then the government may have guarantee financial security.

8) Operator Cess.

A suggestion not considered in the bill. A Re. 0.05 cess per unit of electrical generation, will net approximately Rs. 36 crores per year from the operation of a 1000 Mwe plant. India will soon have 10,000 Mwe capacity which is expected to reach 20,000 Mwe, if not more, by end of this decade. 10,000 Mwe capacity will yield Rs. 360 crores per year and 20,000 Mwe Rs. 720 crores per year. Such a move will build a nuclear liability reserve of excess of Rs. 10,000 crores within a decade. And even a much larger reserve, if the plans to build nuclear capacities of 40,000 – 50,000 Mwe capacity are realized by the thirties and forties.

9) Final cautionary note.

If it is felt that India's long term energy security will need substantial reliance on nuclear power, and that such plans will be realized in a shorter period with imports of

reactors and equipment, then any Indian bill, that goes beyond the norms on international conventions in assigning supplier liability will result in denial of reactors and nuclear equipments by foreign suppliers and hence will be counter productive. This is an absolute bottom line condition as of today. If in future, India as a major nuclear supplier can influence changes in this, well and good. Today, it cannot do so. Hence changes in supplier liability need to be carefully drafted. *The current Sec. 17 formulation is good and should be retained.*

POLICY RECOMMENDATIONS

1. **Diversifying Energy Mix:** Steady and sustained high rates of growth of the Indian economy in the coming decades, inline with the growth experienced during this past decade, points to a rapidly increasing energy demand. To satisfy these demands, keeping in view the changing pattern of fuel consumption worldwide and the uncertainty about future hydrocarbon supply and prices, India must diversify its energy mix. The current very low share of nuclear energy in India's total energy supply coupled with the recent changes to the international rules governing nuclear commerce points to the possibility of rapidly increasing the share of nuclear energy in India's future basket of energy sources.
2. **Fast Breeder Reactors:** In view of the very limited reserves of natural uranium in the country and the advanced nature of fast reactor science and technology in the country, there is an urgent need to expedite the oprationalisation of the Fast Breeder Reactors [FBRs]. Once developed and functional, additional FBRs must be constructed and made operational in the shortest time period possible. This will help India reprocess spent fuel and will provide multiplier effect thereby accelerating the progress of civil nuclear energy generation in the country.
3. **Three Stage Nuclear Energy Programme:** India has one the largest deposits of thorium in the world and India is one of the leaders today in research in studying the properties of thorium and its utilization in energy generation. The long standing three stage strategy of the Indian nuclear energy program to exploit thorium in the last stage must be pursued vigourously to rapidly expand India's nuclear energy generation capacity in the coming decades leading upto the second half of the century.
4. **The Atomic Energy Act of 1962:** The rapid and accelerated development of nuclear energy in the country calls for major changes in the manner in which nuclear sciences and technologies have been planned and directed in the country. In particular expansion of nuclear power generation and the attendant required large capital infusion calls for entry of private capital in the field. Therefore, The Atomic Energy Act of 1962 needs to be amended suitably in the context of the changed circumstances under which the Indian civil nuclear program is intended to be developed.

5. **The Atomic Energy Regulatory Board:** The Atomic Energy Regulatory Board (AERB) regulates all aspects of civil uses of nuclear energy. There is a need to make the AERB an independent regulatory agency separate and distinct from and independent of the Department of Atomic Energy (DAE). It should be a statutory board accountable only to the Indian Parliament entrusted with the licensing and regulation of all civil nuclear activities in India both in the public and private domains.

6. **Fuel Supply Assurance:** In view of the limited domestic reserves of natural uranium in the country and the need to rapidly increase the availability of reliable source of energy, the Licensing authority and regulatory agencies must ensure that all potential nuclear power plant operators have assurance of fuel supply for the life cycle of the plants before being given any license for operations.

7. **Export Controls and safeguards:** India has so far maintained an impeccable record in maintaining high standards of safety and security in the area of nuclear materials and technology. India is also one of the leading countries in the field of nuclear science and technology. In addition in the coming years the private sector in India is expected to play a leading role in the field of nuclear energy generation. Increasing global concerns about non-state actors gaining access to nuclear material and technology for illicit purposes, therefore, points to the need for India to enact strict laws and regulations for strict export controls on nuclear commerce and trade. Further the safeguards to be applied on the nuclear facilities and nuclear material in the civilian nuclear activities must be transparent and applied strictly and rigourously.

8. **Civil Nuclear Liability Bill:** If India is take advantage of the opportunity afforded by the relaxation of the Nuclear Suppliers Group (NSG) Guidelines in respect of international civil nuclear commerce with India, it is necessary to enact a civil nuclear liability bill in line with international practice in respect of such liability laws. The proposed Civil Liability for Nuclear Damage Bill, 2010 is inline with the international norms. However, if desired, changes can be made in some of the clauses of the bill without detracting from its adherence to international conventions. The report discusses the bill in depth and offers some suggestions on the scope and limits to changes in the bill that can be made, if considered necessary, and still keep the bill within the requirements of the international conventions on nuclear liability regimes. As a matter of fact many of the recommendations of the parliamentary Standing Committee on Science and Technology that examined the proposed fall in this category. Such a legislation must be enacted as soon as possible to operationalise the many nuclear cooperation agreements that India has signed so far with a large number of countries including some of the major international nuclear suppliers such as Russia, US, France, UK etc.

POSTSCRIPT

Prospects of Nuclear Energy in India

The Nuclear Liability bill as passed by the Lok Sabha has the potential to hamper the growth of civilian nuclear reactors in India. The controversial inclusion of the right to recourse against supplier can be discouraging for foreign suppliers who initially intended to cooperate with India. If the international suppliers feel that the Bill in its current form assigns more than usual liability on the suppliers, few reasons would be left for them to invest in India. In countries like France, which is supposed to be a major exporter of nuclear reactors to India in the coming years, there is no provision giving the right to recourse against suppliers. The fundamental question then is: would countries that themselves do not provide right to recourse against suppliers be comfortable with the Indian Bill that seeks to provide this right? Furthermore, given the fact that the Russians, who have historically supported India's civilian nuclear program have already signed an inter – governmental agreement with India that assures it of freedom from liability in the event of an accident.

So what does this mean for the growth of nuclear energy in India? If most of the foreign governments and companies keep out due to the supplier's liability issue, the only solution would be: 1) to amend the Bill to relieve suppliers of any liability and/or 2) Russian government, companies and the Indian government will have to build many more reactors, which otherwise may have been built by other foreign companies and governments. While this may prove to be a possible alternative, it would at the same time obviate the need for the Nuclear Liability Bill, making the whole exercise futile as the Russians are protected by the inter – governmental agreement signed with India and the Indian government would have been liable in case of an accident with or without the Liability Bill. Therefore, while the hesitation of foreign suppliers would delay the growth of nuclear energy in India, with the Russian being the only foreign partner willing to trade with India.

Legal Frameworks:

The Civil Liability for Nuclear Damage Bill after its stormy passage through

Parliament has now been enacted into law. Before passing this Bill, Parliament introduced several amendments into it to safeguard the larger public interest. Two of these amendments could be regarded as crucial. First, the liability limit, in one sense, has now been removed. As per Section 6, the Central Government could now specify by notification "...such higher amount" as it deems fit. Further, it has been provided that the Central Government could now assume full liability for a nuclear installation not operated by it, if it was of the opinion that it was necessary in public interest. Second, Section 17 concerning what has been termed as `right of recourse" has three independent clauses, namely, (a) that it has been expressly provided for by a contract in writing; (b) act of suppliers or his employees which include supply of equipment or material (the word used after the phrase "supply of equipment or material" is `or'; it should perhaps be read as `with') or patent or latent defect or substandard services; (c) the nuclear incident resulting from the act of commission or omission of an individual done with intent to cause nuclear damage.

Although this new enactment specifically makes the Operator fully liable for any nuclear incident, it is, in fact, the Central Government which would be taking the entire liability. As of now and as per the definition of the 'operator', an operator is the one who has been authorized or created by the Central Government. The new liability enactment, as in the 1962 Act, continues to be essentially an "inward-looking enactment". It does not allow nuclear commerce with the participation of private parties. In other words, as of now, the enactment does not create or facilitate creating a nuclear liability regime wherein a private party could be held responsible as an 'operator'. If the State continues to be the sole operator or guarantor, it is not clear as to how one would expect to see the development or evolution of an Insurance Industry that would take care of the financial aspects of the nuclear liability. However, one of the amendments passed by the Parliament now envisages a mechanism for the creation of a Nuclear Liability Fund in future.

The right of recourse by the operator against suppliers, as provided now in Section 17, has become contentious. Already potential suppliers have raised certain reservations through their respective State machineries about the structure of this provision and the possible implications. As mentioned above, it now provides for three different grounds which, *inter alia*, include (a) contract in writing to exclude liability; (b) latent and patent defects in the material supplied; (c) acts done with an 'intent' to cause damage. It is clear that the scope of right of recourse under the amended bill has been expanded.

The important question to be asked is – whether Section 17 of the Indian enactment is consistent with international conventions on nuclear liability and other existing State practice? Specifically, Article 10 (appearing in the Annex to the 1997 Convention which all parties must strictly adhere to) of 1997 The Convention on Supplementary Compensation for Nuclear Damage provides only two grounds (a) a contract in writing;

(b) 'intent' requirement. This Convention does not refer to any kind of "latent and patent" or any 'material defects'. One argument could be that the reference to 'latent and patent defect' clause is crucial for India, considering its experience in the context of Bhopal case. The operation of a liability regime in India in the context of global developments is still in its infant stages and it is evolving. The other argument would be that - the clause relating to 'intent' could always be invoked under the existing Tort Law regimes in India or elsewhere despite any specific reference made to it under the General Civil Liability Law. The tort law concepts such as "reasonable care", "negligence", "no fault liability" and other similar factors are to be determined based on facts and on a case to case basis. Tort law is entirely a court-made law. For that reason threshold of standards differ from State to State.

The other important question would be - Where and how to prove these grounds that have been set out in Section 17 of the Indian enactment? Should that be done in our Courts or should the recourse be taken at the Courts where the suppliers are located or where the transaction has taken place? In either of the scenarios concrete proof will have to be adduced either in the domestic courts of the operator where he would decide to invoke his right to recourse or in foreign jurisdictions where the operator would want to invoke his right to recourse. This issue of 'what law would apply' or what could be termed as 'applicable law' to a particular supply-transaction would depend on the contract that could be concluded between the parties.

Both the scenarios could present difficulties in terms of procedure and the existence of non-existence of a well-oiled Tort Regime. In one sense, the Indian legal framework is still grappling with the evolution of such a tort regime for disasters of huge proportions. The existing tort law (with 'no fault liability' clause in the Nuclear Liability Law) does not entirely preclude the operator from taking such recourse unless that right of recourse has been excluded or given up through a proper written contract. In such a scenario, nothing precludes the Indian State to indemnify the suppliers unless there is a specific 'intent' to cause damage. The existence of 'intent', it should be noted, would clearly bring in criminal liability. That seems to be the practice internationally and accordingly suppliers seek such absolute and fool-proof protection fearing that they may be hauled up in domestic jurisdictions. The potential suppliers of nuclear equipments to India, as done with other countries, may seek such clear exclusions through written contracts before embarking on nuclear commerce with India. The crucial question is – how to balance the need to protect Indian public interest vis-à-vis need to engaging in nuclear commerce?

The 1997 Convention and other national legislations provide for such exclusions. Whether such a provision, as worded in Section 17, in the present enactment will meet the requirements of 1997 Convention or other existing regimes such as Vienna and Paris regimes is not clear. As of now, India is not a party to any of these international conventions. These issues will perhaps emerge once India decides to become a party to

these Conventions, specifically to the 1997 Convention on Supplementary Compensation to which this enactment seems to be closer.

The Indian Civil Nuclear Liability Act

Since the writing of this chapter, the Indian parliament has passed the Civil Liability for Nuclear Damage Act, 2010. This Act incorporates a number of amendments to the original bill as was proposed earlier. Many of these amendments are in line with international conventions on nuclear liability. The operator's liability has been increased to Rs. 1500 crores and the maximum liability to rupee equivalent of 300 Million SDRs. Correspondingly the operator's financial security coverage has been increased to Rs. 1500 crores. Another change has been with respect to the time limit for claiming damages. It has been increased to twenty (20) years. Further the operator's liability has been graded according to the type and size of the nuclear installation. Further the act makes provision for instances where the total compensation awarded exceed the maximum amount specified under the act. The act also empowers the government to establish a "Nuclear Liability Fund" by charging a levy from the operators to build a corpus of fund to pay compensation where the award exceeds the operator's financial security. Other amendments are of administrative nature which do not affect the requirements of the international conventions although they may domestic implications on the growth of civil nuclear energy in India such as the stipulation that the act applies only to the Nuclear Installation owned or controlled by the Central Government either by itself or through any authority or corporation established by it or a Government company. The exclusion of private operators from civil nuclear energy generation may have some effect on the rate of growth of civil nuclear energy in India in the long run.

However, these are of minor consequences compared to the amendment to the original section on the "Operator's right of recourse". (Sec. 17). While Sec. 17(a) and 17(c) were retained in their original format, Sec. 17(b) was radically amended from the original "the nuclear incident has resulted from the wilful act or gross negligence on the part of the supplier of the material, equipment or services, or of his employee;" to the amended version "The Nuclear Incident has resulted as a consequence of an act of suppliers or his employees, which includes supply of equipment or material or patent or latent defects or sub standard services;"

While the original formulation of Sec. 17(b) as discussed earlier was the same as a corresponding section of the South Korean liability act and had not encountered any problem with suppliers, the amended version goes beyond the international conventions- which include only Sec. 17(a) and 17(c) - and could be held to be contrary to the international convention norms. In such a case, foreign suppliers may choose to boycott the Indian market. Of course as matters stand now, the only suppliers who will not be affected by the Indian liability act are those from Russia. Art. 13.1 of the India-Russia Inter Governmental Agreement in the construction of Russian designed nuclear power plants stipulates that "the Indian side and its authorized organisations at any time and at all stages of the construction and operation of the NPP (Nuclear power Plant) power units to be constructed under the present arrangement shall be the operator of power units of the NPP at Kudankulum Site and be fully responsible for any damage within and outside the territory of the republic of India caused to any person and property as a result of a nuclear incident occurring at NPP and also in relation with a nuclear incident during the transportation, handling or storage outside the NPPs of nuclear fuel and contaminated materials or any part of NPP equipment both within and outside the territory of the Republic of India." The Russian suppliers are fully protected against any action by the operator in exercising the right of recourse.

It is only non-Russian suppliers- both foreign and Indian- who will be affected by the changes to Sec. 17(b). It must be noted. However, that the India-France agreement on civil nuclear cooperation specifically required both the countries to enact nuclear liability laws in line with the international conventions. France is already a signatory to one such convention namely the Paris Convention. The India nuclear liability bill, however, in not in line with the international conventions. It remains to be seen how the French government and the French nuclear suppliers respond to the Indian act. If they either choose to ignore the Indian act or agree that it is in conformity with the international conventions, then French suppliers too may agree to supply nuclear equipment and systems. If they do so, it may also induce the Indian suppliers to respond to the Indian market. If, however, the French along with others, especially the US suppliers, maintain that the Indian act is not in line with the international conventions and decide to boycott the Indian market, it may also influence the Indian suppliers and in such a case, the growth of the Indian civil nuclear energy will come to a halt and the share of nuclear energy in India's total energy generation will begin to decline from its already low share of less than 3 per cent.

Hence the future of civil nuclear energy will depend much on the response of international suppliers, other than the Russians, as also the Indian nuclear suppliers. One can only wait and see how the scenario develops in the coming years.