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Nuclear policy issues in India

Now that the heat and dust of the debates around the Indo-US nuclear agreement and the NSG waiver have settled down, it is time to look more closely at the nuclear energy scene and policy in India. This issue of *Energy Security Insights* seeks to create a larger debate around nuclear policy issues in India. That this energy source is being seen as a key option within India's energy choices is evident in two key Government of India reports: The Integrated Energy Policy of 2006, and recently updated, and the National Action Plan on Climate Change announced in June 2008, which states that 'Nuclear energy theoretically offers India the most potent means to long-term energy security'. This renewed focus on nuclear energy comes from the need to increase India's energy options given its growing requirements. While coal and oil will remain the dominant fuels over the next 20 years, domestic coal reserves are expected to last for 40–45 years and oil reserves for another 10. Natural gas prospects are improving, but reserves are still only for 28 years, and renewable energy is still perceived to be in its infancy. Hence, nuclear is seen as an option that can contribute to the mix of potential solutions to energy security. In the context of climate concerns and the need for less carbon intensive fuels, nuclear energy is seen as useful in the context of replacing coal power plants, although not itself carbon-free.

Despite the investment opportunities and the new global access to technology and fuel that the NSG waiver creates, there are a number of challenges that nuclear energy development in India faces. Some of these are addressed in this issue. There are also some concerns that cause the opinion within India on nuclear energy to remain fractured. One body of opinion argues that nuclear energy is central to India's energy security and climate policy agenda; there is another that is waiting to be convinced of its benefits and feasibility; and a third that argues categorically that it has failed in the past and has a very dubious future. The jury is thus still out and would benefit from a greater knowledge on a number of issues, including the following: safety, environment, and health concerns of an expanded civil nuclear programme; increased risks of proliferation and terrorism; treatment and disposal of high-level and low-level radioactive waste, discussed in this issue; true costs of nuclear power plants; and land and water requirements for large-scale deployment of the programme and associated 'not in my backyard' concerns.

Many unknowns exist in the domestic programme and responsible nuclear energy will need a revised regime that will ensure greater transparency of the nuclear industry, while enabling a shared view of risks and precautions that will help create a more engaged public opinion.

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Accelerating growth of nuclear power in India

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Introduction

India ranks fifth in electricity production, third in coal production, sixth in coal imports, seventh in net oil imports, and seventh in generation of hydro-electricity (IEA 2007). These facts point to the size of India's energy market in relation to the world's energy market. It also indicates that policies pursued by India for meeting its growing energy needs are bound to have worldwide ramifications in all aspects, including availability of resources, price movement, and environmental implications. As a consequence, it is necessary for India to pursue policies aimed at ensuring the diversity of the sources of its energy supply, both in terms of fuel and technologies, and lead the world in innovations in this important area. India, however, is not endowed with plentiful energy resources: its hydrocarbon reserves are miniscule, hydro potential modest, and coal reserves are substantial, but sufficient only for a few decades to meet its energy demands. The NPCIL (Nuclear Power Corporation of India Ltd) has the expertise to design, construct and operate PHWRs (pressurized heavy water reactors), while Indian industry has the expertise to manufacture equipment and components needed for a PHWR, but India is not in a position to accelerate deployment of nuclear reactors in view of its poor uranium reserves.

At present, India imports about 30% of its energy requirements. Until recently, India was not in a position to import uranium to expand its nuclear power programme due to the prevailing control regime. Export controls on nuclear trade originate in the NPT (Treaty on the Non-Proliferation of Nuclear Weapons). Article III (2) of the NPT states that each NPT party (Nuclear Weapon State or a Non-Nuclear Weapon State) undertakes not to provide: (a) source or special nuclear material, or (b) equipment or material specially designed or prepared for the processing, use or production of special fissionable material to any Non-Nuclear Weapon State for peaceful purposes, without IAEA (International Atomic Energy Agency) safeguards (IAEA 2007a). While the objective enshrined in Article III (2) can be accomplished by applying facility-specific safeguards, this was implemented by the NSG (Nuclear Suppliers Group) by demanding comprehensive safeguards in the recipient state (IAEA 2007b; IAEA 2006). The NPT does not impose any restriction on a State party with regard to imports from a non-NPT state such as India.

Until recently, it was not possible for Indian manufacturing and consulting companies to participate in international civil nuclear trade. In short, NSG guidelines had created a non-tariff barrier with regard to international civil nuclear trade with India. India's initiative to open up international civil nuclear trade seeks to expand its nuclear installed capacity so as to ensure that the share of nuclear in its electricity mix increases from its present low level to a significant percentage, thereby diversifying its energy supply mix.

Growth of nuclear power generation in India

India has two options in the context of the growth of nuclear power generation.

- Pursue an aggressive programme to locate more uranium resources in the country. This, however, will take a while to realize.
- Take policy initiatives to open up international trade in uranium and
  - import uranium and set up more PHWRs based on indigenous technology, or
  - import uranium and set up LWRs (light water reactors) in technical collaboration with other countries.

In order to provide energy to support high-octane economic growth and to increase diversity in the energy supply mix, the need to accelerate nuclear power growth was realized and therefore, both the above options are being pursued. New mines have already been opened in the Singhbhum belt in Jharkhand and a new mill has been set up there. Work on opening a new mine at Tumallapalle in Cuddapah basin in Andhra Pradesh has also begun. Efforts are on to get all statutory clearances for opening a mine at Domiasiat in Meghalaya.

In parallel, steps were taken to work with other countries to relax NSG guidelines to open up international civil nuclear trade with India. It involved having dialogues and negotiating agreements of cooperation with friendly countries, formulating a separation plan, negotiating an ISSA (India-Specific Safeguards Agreement) with IAEA and approval of the ISSA by the Board of Governors of the IAEA (MEA 2008). Due to all these efforts, guidelines for civil nuclear trade with India were relaxed by the NSG on 6 September 2008 (IAEA 2008).

Subsequently, agreements of cooperation have been signed with France, the US, and Russia. To actualize this initiative, the following steps have to be taken.

- Signatures on the India-Specific Safeguards Agreement.
- Notification by India about its entry into force.
- Filing a declaration by India about its civilian facilities after all conditions conducive to the accomplishment of the objectives of the ISSA have been met.
- Subsuming existing safeguards agreements in the ISSA.
- Notification by India offering civilian facilities for safeguards in a phased manner.

In parallel, NPCIL and interested vendors from other countries have to work out contracts for setting up reactors. While negotiations for setting up new reactors is a time-consuming exercise, contracts for supply of uranium for operating PHWRs can be concluded in a short time frame. Imported uranium can be available to a reactor only after it has been offered for safeguards to the IAEA. The exact time frame for all these steps has to be decided by India after satisfying itself that all conditions conducive to the smooth implementation of the initiative are in place.

For the past three decades, India has been engaged in an autarchic nuclear power programme, which has provided India with the opportunity to develop its indigenous strength. India has a strong R&D base, capability to design, engineer and execute nuclear power projects, infrastructure in industry to manufacture complex equipment needed for the nuclear industry, and an efficient regulatory framework. While executing its nuclear power programme, several innovations were made by scientists and engineers to make the projects competitive and to ensure manufacturability of all equipment by Indian industry. The fact that India's uranium reserves are modest has made India follow a closed fuel cycle approach and India is now constructing a 500-MWe PFBR (prototype fast breeder reactor). Whereas other countries have wavered in their approach towards fast breeder reactors, India has been steadfast in its approach towards development of fast reactor technology. Therefore, it will not be an exaggeration to say that India has a lead in this area.

This has been acknowledged by experts, as can be surmised from excerpts from the testimony of Siegfried S Hecker at the Hearing of the US Senate Committee on Appropriations Subcommittee on Energy and Water Development, on 30 April 2008 (Hecker 2008).

> *I found that whereas sanctions slowed progress in nuclear energy, they made India self-sufficient in nuclear technologies and world leaders in fast reactor technologies, while much of the world's approach to India has been to limit its access to nuclear technology, it may well be that today we limit ourselves by not having full access to India's nuclear technology developments. Such technical views should help to advise the diplomatic efforts with India*.

A similar viewpoint has been expressed by Popov, Marleau, and Olekhnovitch (2008).

> *Nuclear technology transfers for power reactors between India and Canada were fairly unidirectional some 40 years ago when they started. Today, however, it is clear that both the Indian and the Canadian designers teams may profit from the other Party's experience and innovations*.

During the course of dialogue with experts from other countries, we found that most were aware of the technological strengths of India in the field of nuclear science and engineering and also about the shortage of uranium in India. In particular, there is appreciation in the world scientific community of India's fast breeder reactor programme and the fact that real benefit to India's energy security will be from recycling domestic as well as imported uranium in the fast breeder reactors. A manifold increase in the energy potential of uranium by the pursuit of closed fuel cycle made reprocessing consent an important element in the negotiations of bilateral cooperation agreements.

Although India continued to expand its nuclear power programme at a steady pace, other countries failed to do so. Therefore, reviving the nuclear industry is a difficult task for many countries. They face a shortage of trained manpower both at the level of graduate engineers and technicians. Industrial infrastructure, which was earlier used to manufacture nuclear equipment, is either being used for other purposes or has been dismantled. Reviving infrastructure in their home countries will be expensive for any nuclear supplier and to be competitive, it will be necessary for other countries to manufacture most of the nuclear equipment in India. In order to be competitive and to overcome constraints imposed by the shortage of industrial infrastructure and trained manpower, foreign vendors will have to use the manufacturing infrastructure in India. Indian industry has to be careful so as not to fritter away the gains acquired by it during the three decades of its indigenous voyage. The gains are in the form of intellectual property acquired by Indian industry for manufacturing sophisticated equipment for the nuclear sector. While entering into arrangements for manufacturing equipment for foreign vendors, they have to ensure that the arrangement does not make them lose the freedom of using their own intellectual property. The acceptance of any constraints by the Indian nuclear industry on the use of their own expertise will retard the implementation of the three-stage nuclear programme. Furthermore, this will defeat the very purpose of the initiative to open up international trade in civil nuclear power, that is, to provide additionality to the ongoing domestic programme.

Structure of the nuclear industry

There has been debate in the media about the possible evolution of the structure of the nuclear industry. Let us first examine the structure in other countries, which have a large nuclear programme. One may divide the nuclear industry in the following broad segments.

(i) Utilities which own and operate nuclear power plants
(ii) Architect-engineers which design and construct nuclear power plants
(iii) Equipment manufacturers
(iv) Fuel manufacturers

In France, all the segments are in the public sector and in the US, all are in the private sector. Therefore, for the large-scale expansion of nuclear power, any structure can be successful and India has to decide about the structure based on its specific situation.

In India, the Atomic Energy Act permits manufacture of nuclear equipment by private sector under a license,[1] but a nuclear utility has to be a government company.[2] NPCIL has been constructing and operating nuclear power plants and has the wherewithal to simultaneously construct several reactors at different sites and can be used as a vehicle to accelerate the growth of nuclear power in India.

There are several special features of a nuclear plant, which require a careful approach towards plant operation. These arise from the fact that a nuclear power plant continues to generate heat even when shut down. It is for this reason that it

[1] Article 14 (1) (ii) (d) of the Atomic Energy Act states that the Central Government may subject to such rules as may be made in this behalf and by order prohibit except under a license granted by it the acquisition, production, possession, use, disposal, export or import of any prescribed equipment.

[2] Article 3 (a) of the Atomic Energy Act states that subject to the provisions of this Act, Central Government shall have power 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 any matters connected therewith.

requires uninterrupted cooling, physical security as per specific standards, and calls for safeguards as per set norms. This makes it necessary for any newcomer to acquire adequate experience in all these areas before embarking on nuclear plant operation. The present legal provisions in India do permit a learning experience in terms of nuclear utility business under Indian conditions by allowing the setting up of new ventures with the participation of the private sector as a minority stakeholder with NPCIL.

A vision exercise conducted by the Department of Atomic Energy envisaged setting up an installed nuclear capacity of 20 GWe by the year 2020. This included 8 GWe based on LWRs to be set up in technical collaboration with other countries. Two reactors under construction at Kudankulam are a part of this 8 GWe. With the opening up of international civil cooperation, it will now be possible to work out contracts not only for the remaining 6 GWe of LWRs, but also scale up the goal of setting up 20 GWe by the year 2020 to a much higher number. One can also set up more PHWRs and use imported uranium to fuel them. It appears that this option might be quite competitive (Grover, Purniah, and Chandra 2008). Setting up of more reactors requires identifying new sites and this is a complex task. However, in view of India's long coastline, it should not be difficult to identify sufficient coastal sites for the setting up of 10 GWe at each site.

Conclusion

Policy initiative taken by the government would lead to an increase in installed nuclear capacity in India and provide additionality to the ongoing three-stage programme. It would strengthen energy security, provide expanded business opportunities for manufacturing companies and engineering consultancy organizations, and would help in expanding electricity generation base in an environmentally sustainable manner. All the steps that the stakeholders in the government and the industry take in the future would need careful calibration so as to preserve indigenous capability and autonomy of decision-making in the new business environment. India has followed a responsible path with regard to nuclear proliferation and this has to continue in the future as well.

References

Grover R B, Purniah B, and Chandra S. 2008
Nuclear Energy and India
Atoms for Peace: an international journal, **2**(1): 68–82 pp.

Hecker S S. 2008
Hearing of the United States Senate Committee on Appropriations Subcommittee on Energy and Water Development
Details available at http://appropriations.senate.gov/Hearings/2008_04_30_-Energy-_Testimony_of_Siegfried_S_Hecker_at_the_ April_30_ Energy_and_Water_Subcommittee_ Hearing.pdf?C FID=16933820&CFTOKEN=62010511, last accessed on 15 December 2008

IEA (International Energy Agency). 2007
Key Energy Statistics
Paris: IEA

IAEA (International Atomic Energy Agency). 2006
Communications received from Certain Member States regarding Guidelines for Transfers of Nuclear-related Dual-use Equipment, Materials, Software and Related Technology
IAEA Information Circular, INFCIRC/254/Rev.7/Part 2, 20 March 2006
Details available at, www.nsg-online.org/PDF/infcirc254r6p2-050223.pdf, last accessed on 16 December 2008

IAEA (International Atomic Energy Agency). 2007a
Treaty on the Non-proliferation of Nuclear Weapons
IAEA Information Circular, INFCIRC/140
22 April 1970
Details available at http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf, last accessed on 16 December 2008.

IAEA (International Atomic Energy Agency). 2007b
Communication received from the Permanent Mission of Brazil Regarding Certain Member States Guidelines for the Export of Nuclear Material, Equipment and Technologies
IAEA Information Circular, INFCIRC/254/Rev.9/Part 1
7 November 2007
Details available at http://www.nuclearsuppliersgroup.org/PDF/infcirc254r9p1-071107.pdf, last accessed on 17 December 2008

IAEA (International Atomic Energy Agency). 2008
Communication dated 10 September 2008 received from the Permanent Mission of Germany to the Agency regarding a Statement on Civil Nuclear Cooperation with India
IAEA Information Circular, INFCIRC/734 (corrected)
19 September 2008
Details available at http://iaea.org/Publications/Documents/Infcircs/2008/infcirc734c.pdf, last accessed on 17 December 2008

MEA (Ministry of External Affairs). 2008
Agreement between the Government of India and the International Atomic energy Agency for the Application of Safeguards to Civilian Nuclear facilities
Details available at http://www.meaindia.nic.in/cgi-bin/db2www/meaxpsite/coverpage.d2w/coverpg?sec=pr&filename=pressrelease/2008/07/07pr02.htm, last accessed on 15 December 2008

Popov A V, Marleau G, and Olekhnovitch A. 2008
The Third Generation of Heavy-Water Moderated Reactors
Paper presented at the 16th Pacific basin Nuclear Conference - Pacific Partnership toward a Sustainable Nuclear Future at Aomori, Japan on 13-18 October
Details available at, http://www.pbnc2008.org/ProgramTS2.html, last accessed on 15 December 2008

Legal and regulatory challenges for promotion of civil nuclear energy in India

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Introduction

The Indo-US civil nuclear energy cooperation initiated in 2005 was successfully concluded in 2008 with the NSG (Nuclear Suppliers Group) waiver to India and final approval by the US Congress. These approvals allowed India to enter into international civil nuclear trade and commerce after almost three decades of international nuclear isolation. In order to be part of the international nuclear community, India agreed on a separation plan to bifurcate its combined nuclear energy programme into independent military and civilian facilities. As a result of this separation plan, all civilian facilities will be subjected to India-specific IAEA (International Atomic Energy Agency) safeguards, whereas military facilities will continue to be free from any such safeguards (IAEA 2008). This arrangement is, in a nutshell, the benefit accorded to the NWS (Nuclear Weapons State) under the NPT (Nuclear Non-Proliferation Treaty) system.

The conclusion of the international legal formalities that allow India to access the civilian nuclear market has set in motion possibilities of large-scale expansion of nuclear energy production in the country. This upscaling is expected to be carried out through the participation of public and private companies in addition to the DAE's (Department of Atomic Energy) expansion plans. At present, other than the DAE, there are no other players in the production and operation of nuclear energy in India. Plans of opening up in order to allow the participation of domestic and foreign players requires a well thought strategy and an open and transparent law-making debate for the safe use of nuclear energy.

This paper broadly describes the current atomic energy-related legal and regulatory structure and addresses two issues which the author believes are crucial requirement towards the large-scale deployment of civil nuclear power in the country.

Control and regulation of nuclear energy facilities and associated activities

The Government of India (Allocation of Business) Rules, 1961 transacts the business of the Government of India in nuclear energy. Under these rules, DAE was made responsible on matters pertaining to the AEC (Atomic Energy Commission) and AERB (Atomic Energy Regulatory Board), the administration of the 1962 AEA (Atomic Energy Act), and all other functions that relate to atomic energy in the country.[1]

Law and regulation applicable to atomic energy in India

The AEA 1962 is the principal legislation that covers the whole range of atomic energy production and its associated activities in India. This law has been amended several times, the last being in 1987, mainly to strengthen government control over nuclear facilities and activities. The AEA 1962 gives the central government monopoly over production, development, usage, and disposal of atomic energy. Under the provisions of the law, the central government undertakes the above activities either by itself or through any authority or corporation established by it or through a government company (DAE 1962).[2] The AEA 1962 defines 'Government Company' as a company in which not less than 51% of the paid-up share capital is held by the central

[1] From the beginning of India's nuclear programme, the government conceived a unique three-stage programme, towards the ultimate utilization of thorium, an abundantly available resource in India, which was considered at the time a risky technological initiative, but was followed nevertheless.

[2] Section 3 (a) of the Atomic Energy Act 1962

government (DAE 1962).[3] Until 1987, the DAE was directly responsible for all nuclear energy activities under its supervision.

In order to distance itself from the construction and operation of nuclear power plants for power generation, DAE established NPCIL (Nuclear Power Corporation of India Ltd) in 1987 and BHAVINI (Bharatiya Nabhikiya Vidyut Nigam Ltd) in 2003. Both NPCIL and BHAVINI are public sector enterprises under the administrative control of the DAE and incorporated as public limited companies. NPCIL was established with the objective of operating the atomic power stations and implementing atomic power projects for the generation of electricity (NPCIL 2008). BHAVINI was established with the objective of constructing and commissioning the first 500-MWe FBR (fast breeder reactor) at Kalpakkam in Tamil Nadu and to pursue construction, commissioning, operation, and maintenance of subsequent FBRs for generation of electricity (BHAVINI 2008).

Licensing and participation in the atomic energy programme

Participating in the business of nuclear energy activities is a restricted activity of the Government of India, unless a license is obtained from the central government. There has not been much judicial interpretation on the provisions of AEA 1962, and a reading of the law clearly suggests that under the rules, the central government can issue a license for production, application, and use of atomic energy, and for handling nuclear materials and equipment (DAE 1962).[4] As of today, Annexure 1 of the Industrial Licensing Policy of 1991, which reserves certain strategic industries for the Public Sector, has reserved 'atomic energy' alone for the public sector utilities (Ministry of Commerce and Industry 2008). It is understood that the provisions amending the AEA of 1962 have been in Parliament for several years seeking to address private participation and several other key issues.

With the NSG waiver, India has committed itself to opening its civilian nuclear energy industry for broader participation of both domestic and foreign companies. The Government of India recently clarified that large-scale private participation is planned for only when the required legal and other regulatory structures are put in place (Airy 2008). However, bilateral agreements between NPCIL and supplier countries like France and Russia have been negotiated and entered into. Since each country follows different models for their nuclear industry, there are different legal requirements to be applied to such entities. For example, the Russian nuclear industry is fully government-run. In France, although there is private participation, large stakes are held by the government, while in the US, there is full private ownership. In the normal course, a business presence in India by a foreign entity can be established and incorporated through the following.

- Incorporating an Indian company with 100% foreign equity, operating as a wholly owned subsidiary;
- Incorporating a JVC (joint venture company) with an Indian partner and/or with the general public and operating as a listed company; or
- Incorporating a JVC with an Indian partner and operating as an unlisted company.

Till date, it is not clear what plans the Government of India has for such foreign company formations. In case of points (2) and (3), the government can be a partner. In case the government is the only partner allowed for the time being for strategic reasons, we will see whether it will hold a minimum stake of 26% or majority stake of 51%.

Moreover, the government has not issued any draft of any new nuclear law or given any indication of what kind of private participation is planned. The AEA 1962 is clear that a government company is very well qualified, but in respect to private sector, rules are not yet in place for them to be in the business of nuclear energy. Since this

[3] Section 1 (bb) of the Atomic Energy Act 1962

[4] Section 20 (1) and Section 30 (2) (k) of the Atomic Energy Act 1962

is a strategic industry, the government could even think of new stakeholding altogether.[5] Liberal interpretation of this provision would mean that even under present legal conditions, the private sector can already participate in nuclear power generation with minority equity participation.

Once fully allowed, Indian companies stand to benefit because of India's competitive advantage. Building nuclear technology from scratch is out of the question because of the time and cost factor. While entering into JVs, especially with foreign companies, Indian companies should be in a position to take advantage of the JVs for technology transfer, build and improve on it, and use the cost advantage of India to export in future. To achieve all this, there is a requirement of a well-thought-out strategy by Indian companies supported in the initial stages by the appropriate policy and strategic advice by the Government of India. The first step would be to take another look at the AEA 1962 along with Indian Patents Act that fortifies the government's legal control over the atomic energy industry. The Indian Patents Act (1970) and the Patents Amendment Act (2005)[6] prohibit the grant of patents in respect of an invention relating to atomic energy, which falls within Section 20 (1) of AEA 1962.[7]

Nuclear liability principles and India

The growth of the nuclear energy industry worldwide is largely attributed to the existence of institutional structures and legal regimes that mitigate the consequences of nuclear accidents through timely and adequate compensation. The concerns in respect of fixing responsibility in case of an accident and the nuclear industry's concern about unlimited liability claims, once the responsibility is fixed on them, has set the development of a unique nuclear international legal regime.[8] The principles that have been developed over time in terms of nuclear liability are as follows (IAEA 2004).

- Strict liability of the nuclear operator. This relieves the victim from proving fault (referred to in the Conventions as 'absolute liability')
- Exclusive liability of the operator of a nuclear installation (legal channelling of liability, regardless of the accident's cause)
- Limitation of liability in amount and in time
- Mandatory financial coverage of the operator's liability (the operator must maintain insurance covering its liability)
- Exclusive jurisdiction (only courts of the state in which the nuclear accident occurs have jurisdiction)

The above international liability principles that have been developed address these twin concerns of the public as well as the industry. Improving on the existing international regime, two important instruments were adopted in 1997. One is the Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage,[9] which was adopted in 1997 and entered into force in 2003 (IAEA 1998a). The second is the CSC (Convention on Supplementary Compensation for Nuclear Damage) (IAEA 1998b).[10] The 1997 Protocol and the CSC are considered milestones in legal terms, as these contain important improvements, such as the amount of compensation available,[11] it broadens the scope

[5] As explained above, AEA has defined a Government Company as '.....in which not less than 51% of the paid-up share capital is held by the central government'.

[6] Section 4 (Inventions relating to Atomic Energy): Indian Patent Act 1970 and Patents (Amendment) Act 2005.

[7] Section 20 (Special provision as to inventions)

[8] Convention on Third Party Liability in the Field of Nuclear Energy (of 29 July 1960), as amended by the Additional Protocol of 28 January 1964 and by the Protocol of 16 November 1982 (see NEA 2008) and the IAEA-sponsored 1963 Vienna Convention on Civil Liability for Nuclear Damage (IAEA 1996).

[9] Only five members have ratified the Convention.

[10] This has not yet been ratified.

[11] The protocol amending the IAEA Vienna Convention sets the possible limit of the operator's liability at not less than 300 million SDRs (Special Drawing Rights) (about EUR 360 million) and the Convention on Supplementary Compensation for Nuclear Damage defines additional amounts to be provided through contributions by States Parties collectively on the basis of installed nuclear capacity and a UN rate of assessment, basically at 300 SDRs per MW thermal (that is, about EUR 360 million in total).

of damages covered[12] and the allocation of jurisdiction.[13] Furthermore, the 1997 Protocol mandates access to compensation by residents of non-Contracting Parties and extends the period during which claims may be brought for loss of life and personal injury. The CSC provides the framework for establishing a global regime with widespread adherence by nuclear and non-nuclear countries and establishes an international fund to supplement the amount of compensation available under national law.

In India, the AEA 1962 provides for licensees liability in respect of damages caused by ionizing radiations or radioactive contamination either at the plant or surrounding areas (DAE 1962).[14] However, the fact remains that till date, there has been no licensee for the production and operation of nuclear plans under AEA 1962. Moreover, since the government, through the DAE is the sole institution handling nuclear energy activities, there has been no immediate requirement to frame a nuclear liability law. This is based on the assumption that, given the government's sovereignty, it has full responsibility to ensure safety of its people and property in case of an accident. Recently, a move towards framing a nuclear liability regime was considered, when DAE started constructing Koodankulam Nuclear Power Project, located near the coast of Tamil Nadu. In case of an accident in Koodankulam, it is likely to have a transboundary effect on Sri Lanka. Notwithstanding this, tort liability principles have been largely applied for liabilities arising out of dangerous and hazardous industry, which has been on a continual development, mainly through the hands of the Supreme Court. The concept of strict liability under *Ryland vs. Fletcher case*[15] was taken up and strengthened by the decision of the Supreme Court in *M C Mehta v. Union of India (Oleum Gas Leak Case)*[16] where the concept of 'absolute liability', was expounded and elaborated for the first time. In this case, the court stated 'an enterprise which is engaged in a hazardous or inherently dangerous activity that poses a potential threat to the health and safety of persons and owes an *absolute* and *non-delegable duty* to the community to ensure that no harm results to anyone'. The principle of absolute liability is operative without any exceptions, unlike the strict liability. The Supreme Court has reiterated this principle in *Indian Council of Enviro-Legal Action* vs *Union of India*,[17] where the court stated that industry alone has the resources to discover and guard against hazards and dangers caused by its actions. In this case, the court held the company responsible to meet the cost of remedial action to remove and store sludge in a safe and proper manner. The company was made liable for the loss and suffering caused to the village where the industrial complex was located. This at present is the existing law of India. This 'absolute liability' and the possibility of unlimited compensation, which comes without a codified liability law, has been the issue with the nuclear industry worldwide.

An option for India would be to consider becoming member of CSC. CSC is a freestanding instrument and offers the means to become part of the global regime without also having to become a member of the Paris Convention or the Vienna Convention. Another option is to have a dedicated national law, like the Price Anderson Act of 1957 of the United States. In any case, clarity in terms of a liability law is a requirement for both the

[12] The 1997 Protocol and the CSC enhance the definition of 'nuclear damage' by explicitly identifying the types of damage that must be compensated. In addition to personal injury and property damage, which are included in the existing definition, the enhanced definition includes five categories of damages relating to impairment of the environment, preventive measures, and economic loss.

[13] The 1997 Protocol and the CSC reaffirm the basic principle of nuclear liability law, which is, that exclusive jurisdiction over a nuclear incident lies with the courts of the member country where the incident occurs, or with the courts of the Installation State if the incident occurs outside any member country. The major development has been that protocol amending the Vienna Convention provides for jurisdiction of coastal states over actions incurring nuclear damage during transport.

[14] Section 20 (3) (d) & (e) of the Atomic Energy Act 1962

[15] Rylands v. Fletcher (1868), L.R. 3 H.L. 330; [1861–73] All E.R.

[16] AIR 1987 SC 1086.

[17] AIR 1996 SC 1466.

people of India and the emerging nuclear industry. Clarity in terms of liability law will only enhance the public acceptability of the overall nuclear energy programme.

Conclusion

India's integration into the world nuclear energy community is both an opportunity and challenge to the existing nuclear legal and regulatory systems. A whole new range of rules and procedures are to be developed that address the issues relating to nuclear safety, security, and transparency with planned large-scale expansion. Towards this, legal certainty in terms of company structure, its role in handling sensitive items and facilities, liability in the event of an accident, government's regulatory oversight and so on, are issues in the field of nuclear law that require special attention. Building capabilities in the field of nuclear law, including the international politics it brings along with it, will be a test of India's legal competence. Immaturity of our legal system and the inability of the long arm of the law, for example, in the case of Bhopal and to some extent in Enron, should be a lesson that should not repeat itself with the nuclear industry in India.

References

Airy A. 2008
No Private Role in N-power for Now
Financial Express
8 September 2008
Details available at, http://www.financialexpress.com/news/no-private-role-in-npower-for-now/358594/, last accessed on 20 December 2008

BHAVINI (Bharatiya Nabhikiya Vidyut Nigam Ltd). 2008
Memorandum of Association of Bharatiya Nabhikiya Vidyut Nigam Ltd
Details available at, http://bhavini.nic.in/MOU.pdf>, last accessed on 14 December 2008

DAE (Department of Atomic Energy). 1962
Atomic Energy Act 1962
Details available at, http://www.dae.gov.in/rules/aeact.pdf, last accessed on 20 December 2008

IAEA (International Atomic Energy Agency). 1996
Vienna Convention on Civil Liability for Nuclear Damage
INFCIRC/500
Details available at, http://www.iaea.org/Publications/Documents/Infcircs/1996/inf500.shtml, last accessed on 26 December 2008

IAEA (International Atomic Energy Agency). 1998a
Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage
INFCIRC/566
Details available at, http://www.iaea.org/Publications/Documents/Infcircs/1998/infcirc566.shtml, last accessed on 26 December 2008

IAEA (International Atomic Energy Agency). 1998b
Convention on Supplementary Compensation for Nuclear Damage
INFCIRC/567
Details available at, http://www.iaea.org/Publications/Documents/Infcircs/1998/infcirc567.shtml, last accessed on 26 December 2008

IAEA (International Atomic Energy Agency). 2004
Civil Liability for Nuclear Damage
GOV/INF/2004/9-GC(48)/INF/5, 2 September 2004
Details available at, http://www.iaea.org/About/Policy/GC/GC48/GC48InfDocuments/English/gc48inf-5_en.pdf, last accessed on 20 December 2008

IAEA (International Atomic Energy Agency). 2008
The Conclusion of Safeguards Agreements and Additional Protocols
GOV/2008/30, 9 July 2008
Details available at, http://www.isis-online.org/publications/southasia/India_IAEA_safeguards.pdf, last accessed on 20 December 2008

Ministry of Commerce and Industry. 2008
Statement on Industrial Policy
Details available at, http://siadipp.nic.in/publicat/nip0791.htm, last accessed on 20 December 2008

NPCIL (Nuclear Power Corporation of India Ltd). 2008
About Us
Details available at, http://www.npcil.nic.in/main/AboutUs.aspx, last accessed on 14 December 2008

Nuclear Energy Agency. 2008
Convention on Third Party Liability in the Field of Nuclear Energy of 29th July 1960, as amended by the Additional Protocol of 28th January 1964 and by the Protocol of 16th November 1982
Details available at, http://www.nea.fr/html/law/nlparis_conv.html, last accessed on 30 December 2008

The Indian Patents Act. 1970
Controller General of Patents Designs and Trademarks, Government of India
Details available at, http://www.patentoffice.nic.in/ipr/patent/patents.htm, last accessed on 26 December 2008

The Patents (Amendment) Act. 2005
Controller General of Patents Designs and Trademarks, Government of India
5 April 2005
Details available at, http://www.patentoffice.nic.in/ipr/patent/patent_2005.pdf, last accessed on 26 December 2008

Radioactive waste management in India: present practices and future trends

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Introduction

India has adopted the concept of a closed fuel cycle with the objective of tapping the full energy potential in nuclear fuel materials through the use of recycling technologies. The salient features of the closed fuel cycle are recovery and recycle of uranium and plutonium for reconversion as fuel. Emphasis is also being given to separation of useful isotopes of cesium and strontium for use in healthcare and in heat source applications and partitioning of minor actinides for transmutation. This finally leaves a very small percentage of material present in the spent fuel as radioactive waste, which needs to be managed.

The generation of radioactive waste takes place at various stages of the nuclear fuel cycle, namely mining and milling of uranium ore, fuel fabrication, reactor operation, and reprocessing of spent fuel. Radioactive waste is also generated in production of radioisotopes and their application in research, healthcare, and industry. Radioactive waste is likely to be generated in the future as the existing nuclear facilities in India age and require to be decontaminated and decommissioned. Management of radioactive waste has received high priority in India's nuclear programme right from its inception.

Radioactive waste classification

Radioactive waste streams are classified into different categories on the basis of various parameters, for example, their physical, chemical, radiological, and biological properties. Classification also takes into account the origin of waste and criticality. Classification of waste serves many useful purposes during segregation, selection of appropriate treatment process, storage, and disposal of various waste streams. It also helps in proper communication and documentation with respect to various categories of radioactive waste among waste generators, managers, and regulators.

Radioactive waste is generated in various forms like solid, liquid or gas. Depending upon the source of generation, the specific concentration of radioactivity in the waste also varies. Accordingly, radioactive liquid waste streams are commonly classified as low-level waste ($37–3.7 \times 10^6$ Bq/l), intermediate-level waste ($3.7\times10^6–3.7\times10^{11}$ Bq/l) and high-level waste (above 3.7×10^{11} Bq/l). During classification of the liquid wastes, the concentrations of long-lived radionuclides and tritium are also taken into account. Solid radioactive wastes are classified as compressible or non-compressible and combustible or non-combustible depending upon their corresponding physical nature. These wastes are further classified as short- or long-lived waste based on type and half-life of radionuclide present in the waste.

Policy and strategy

The radioactive waste management policy is based upon universally adopted philosophy of (a) delay and decay of short-lived radionuclides, (b) concentration and containment of radioactivity as much as practicable, and (c) dilution and dispersion of the resultant effluents of very low-level radioactivity to the environment; well below the nationally accepted levels which are in line with international practices. Radioactive waste management policy in India is broadly as follows.

i) The spent nuclear fuel is seen as a resource material and needs to be processed for recovery and recycle of fissile and other useful materials.
ii) High-level and alpha contaminated liquid waste from spent fuel processing and other

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radio metallurgical operations are immobilized in a suitable matrix and stored in the interim storage facility with appropriate cooling and surveillance for a given period, as necessary. Thereafter, these solidified waste products will be emplaced in a suitably engineered deep geological repository.

iii) Low- and intermediate-level solid/solidified waste is emplaced in specially engineered NSDF (near-surface disposal facility), which is collocated with other nuclear installations. The regulatory body determines the period for which active control of NSDF involving monitoring, surveillance, and remedial work should be maintained by the waste management agency. Institutional control may span a period of 300 years comprising, typically, 100 years of active control and 200 years of passive control so as to allow decay of most of the radionuclides present in the waste, thus rendering them innocuous.

iv) Alpha contaminated waste not qualifying for near-surface disposal is provided suitable interim storage pending its processing for recovery of useful material and volume reduction leading to conditioned residual waste product for disposal in a deep geological repository.

v) SRS (spent radiation sources) are either returned to the original supplier or handed over to the radioactive waste management agency identified by the regulatory body. The Waste Management Division of BARC (Bhabha Atomic Research Centre) manages SRS from all over the country from various R&D institutions, medical centres, and industry.

vi) After treatment, resultant effluents are discharged through gaseous, liquid, and terrestrial routes, keeping radioactive discharges from the facility as low as reasonably achievable—technical, economic, and social factors taken into account.

Regulations

The underlying objective governing the management of radioactive waste is protection of human beings and environment, now as well as in future. To achieve this objective, the necessary codes and guidelines have been framed by the AERB (Atomic Energy Regulatory Board) in conformity with the principles of radiation protection laid down by the International Commission on Radiation Protection. AERB is entrusted with the responsibility of enforcement of various provisions of the *Atomic Energy (Safe Disposal of Radioactive Wastes) Rules 1987 under the Atomic Energy Act, 1962*. These rules have been formulated (AERB 2007) so that all radioactive wastes are managed and disposed of in a controlled manner with adequate monitoring. This can help in ensuring that any unacceptable hazard is not caused to the workers, the public, and the environment.

` Safety regulations for management of radioactive waste in accordance with these Rules are specified in the AERB *Safety Code on Management of Radioactive Waste*. AERB has also published a number of ‘Safety Guides’ that provide guidance on the means for meeting the requirements laid down in the ‘Safety Code’.

Present practices

The development work for diverse treatment technologies for a variety of radioactive wastes was started in the early 1960s in BARC at Trombay. This was followed up by indigenous development of various equipment and assemblies related to radioactive waste processing and remote handling with relevant safety features. On the basis of this strength, radioactive waste management facilities were established at various sites in the country (Raj, Prasad, and Bansal 2006). During the last five decades, valuable expertise has been developed in design, construction, and operation of such facilities. A brief description of present practices vis-à-vis major radioactive waste streams is as follows.

Management of high-level liquid waste

HLW (high-level liquid waste) is generated during reprocessing of spent nuclear fuel and contains about 99% of the radioactivity produced in the nuclear fuel cycle. Like other countries with matured atomic energy programme, India too has adopted a three-step strategy for management of HLW. These steps are (a) immobilization of waste in stable and inert matrix such as glass and ceramics, (b) interim retrievable storage of the immobilized waste with continuous cooling and surveillance, and (c) disposal of waste in deep geological formations.

Immobilization

The technology for immobilization of HLW has many challenges due to (i) acidic nature of waste involving handling of concentrated nitric acid (ii) high temperature (~1050 °C) essential for vitrification, and (iii) intense radiation field requiring remote operation and control of all processes and handling equipment. BARC has over the years indigenously developed glass matrices, high Ni-Cr alloys, processing furnaces, and various types of remotization gadgets, namely servo and articulated manipulators and shielding windows, in collaboration with various national institutions and Indian industry. Based on these developments, industrial scale vitrification facilities have been set up at Trombay and Tarapur and another one is being commissioned at Kalpakkam. Waste Immobilization Plant at Trombay uses induction heated metallic melter technology (Mehta, Tejas, Morzaria, *et al.* 2008), whereas joule-heated ceramic melter technology has been adopted at Advanced Vitrification System at Tarapur (Dani, Kulkarni, Banerjee, *et al.* 2008), and Waste Immobilization Plant at Kalpakkam. In all these facilities, borosilicate glass system is used which gives the vitrified waste product of desired properties like chemical durability, thermal and radiation stability, mechanical strength, and homogeneity. The Central Glass and Ceramic Research Institute at Kolkata has played an important role in the development of borosilicate matrix and glass frit for the Indian vitrification facilities.

Interim storage

Canisters containing vitrified high-level waste product are stored for a period of about 30 years under constant cooling to dissipate decay heat due to radioactivity contained in the product. Design of an interim storage facility is based on the principle of passive air-cooling by a self-regulating thermosyphon system. Such a system has been finalized after thermal hydraulic studies in collaboration with Indian Institute of Technology, Mumbai. The first interim storage facility is operational at Solid Storage Surveillance Facility at Tarapur and second one is being set up at Kalpakkam (Ozarde, Haldar, and Sarkar 2008).

Geological disposal

Solidified high-level radioactive waste contains high concentration of radionuclides as well as some very long-lived radionuclides. In many countries, including India, studies are being carried out for disposal of solidified high-level waste in suitable deep geological formations, which will provide long-term isolation of waste from the human environment.

A programme to investigate host rock characteristics for waste repository in granites is in progress at BARC for the last two decades, based on certain criteria for site selection. A depth of 500 to 600 metres is being considered for placement of solidified high-level waste in specially constructed underground chambers, adopting a multi-barrier system (Goel, Prasad, Swarup, *et al.* 2003). After placement of waste using remotized equipment, the chambers will be back-filled using naturally occurring clays and minerals which arrest and retard movement of radionuclides. Various mathematical models are also being developed to assess the safety of the disposal system. In view of very low-waste volume of high-level solidified waste associated with the present nuclear power programme, the need for a deep repository will arise after several decades. Indian scientists and engineers are, however, carrying out development work and also keeping themselves abreast of the latest technological developments worldwide in this area.

Management of low- and intermediate-level wastes

LILW (low and intermediate level wastes) are generated in almost all stages of the nuclear fuel cycle. These are treated by various techniques, namely, chemical co-precipitation, ion exchange, evaporation or membrane processes. Organic liquid wastes are conditioned using the saponification process. The resultant concentrates and chemical sludges are immobilized using composites of cement and naturally occurring clay minerals. Various types of polymeric materials, like polyester styrene, are being used for immobilization of spent ion-exchange resins from nuclear power stations and other facilities.

A variety of primary solid waste is also generated during operation and maintenance of nuclear facilities. This type of solid waste is associated with low and intermediate level of beta and gamma radiation and, in some cases, with low level of alpha contamination. The processes used for treatment of solid wastes include decontamination by electro-polishing, chemical-complexing, sand blasting, and ultrasonic methods. Volume reduction by compaction of metallic and non-metallic materials and melt-densification of plastics is also practiced.

The conditioned low- and intermediate-level wastes are disposed in a near-surface disposal facility in engineered disposal modules like reinforced concrete trenches and tile holes with provisions of shielding and water-proofing. The disposal site is provided with a network of monitoring bore holes and other surveillance systems.

Future trends

In the coming years, newer types of radioactive waste streams are expected with the introduction of the Fast Breeder and Advanced Heavy Water Reactor systems and reprocessing of their spent fuel. This waste generation will be characterized with respect to radioactivity content and presence of noble metals. The volume of solid radioactive waste will also increase in view of the expanded atomic energy programme as well as decommissioning of some of the present nuclear facilities. In order to prepare ourselves to meet these challenges, various initiatives have been taken during the last few years and the thrust areas for research and development have been identified (Wattal and Majumdar 2006 and 2007). Some of the areas are (a) reduction in radiotoxicity of the waste by separation of minor actinides from HLW, (b) photochemical oxidation of organic waste, (c) development of suitable matrices for incorporation of thorium, and (d) development of ceramic matrices for incorporation of higher concentration of noble metals and actinides. Development of cold crucible induction melter technology is an example of the preparedness to treat future HLW from Fast Breeder and Advanced Heavy Water Reactors (Sugilal and Benny 2008). As regards the disposal, present near-surface disposal facilities are being upgraded and expanded. Wherever feasible, concept of multi-tier disposal modules is being introduced to make maximum utilization of the available land area. As a policy, it will be ensured that all new nuclear facility sites also have co-located waste management facility from the planning stage itself. Super compaction and pyrolysis of solid waste are being evaluated for minimization of their volume, especially of those generated during decontamination and decommissioning.

Public awareness

The DAE, AERB, and several professional associations like the INS (Indian Nuclear Society), NAARRI (National Association for Applications of Radiations and Radioisotopes in Industry), the IANCAS (Indian Association of Nuclear Chemistry and Allied Sciences), and HVSP (Hindi Vigyan Sahitya Parishad) are engaged in conducting various activities to educate the people about India's Atomic Energy programme, including safe management of radioactive waste. Some of the major activities are as follows.

a) Public awareness programmes in various institutions, namely, schools, colleges, universities, and professional groups.
b) Arranging visits of students, teachers, villagers, and other members of public to the nuclear facilities.
c) Display of exhibits in various exhibitions.
d) Annual essay writing competitions in Hindi, English, and various regional languages on aspects of atomic energy for school/college students.
e) Awareness workshops for the media.
f) Organization of 'Prashan Manch' competitions on atomic energy for school students.

Human resources

Radioactive waste management programme in the country draws human resources for design and development mainly from the training school run by the DAE. Functioning since the late 1950's the school offers a one-year orientation course in nuclear science and engineering. In parallel, specific training programmes for the operation and maintenance of radioactive waste management facilities have been running for the last two decades. These programmes are of one- and two-year duration, for supervisory and technical staff respectively, with an emphasis on remote operation, radiological safety, and so on.

In the area of R&D for newer waste treatment technologies, besides in-house efforts, DAE has also involved various academic institutions by awarding specific projects through BRNS (Board of Research in Nuclear Sciences). This and the setting up of HBNI (Homi Bhabha National Institute) in the year 2005 has boosted the manpower input for DAE's training programmes.

To keep abreast of the latest developments worldwide in the area of radioactive waste management, Indian waste management professionals regularly interact with experts from other countries through bilateral arrangements and through international organizations, for example, IAEA (International Atomic Energy Agency). Indian expertise has been shared with IAEA in waste safety standards including codes and guides related to radioactive waste management and also for training nationals of regional countries using the infrastructure developed for in-house training.

Conclusion

Radioactive waste management practices in India have roots in indigenous research and development in view of the importance accorded to it from the very inception of the country's nuclear energy programme. India's experience in the management of radioactive waste from research and power reactors, fuel reprocessing, and allied facilities is rich and comparable with international practices. A valuable base of human resources has been built up, which comprises scientific and technical personnel with expertise in R&D, design, construction, commissioning, operation, and maintenance of waste management systems. This expertise is being shared with other international bodies in preparation of international waste safety documents and training of professionals on various aspects of radioactive waste management.

With the expansion of the Indian Atomic Energy Programme and introduction of newer reactor systems, development efforts are directed towards identifying thrust areas for the study of alternative advanced processes and equipment. Attention is also being paid to meet the required additional human resources for handling related waste management systems and for enhancing public awareness about safe management of radioactive waste.

On the basis of India's extensive experience in all aspects of radioactive waste management, from design to safety analysis, availability of skilled human resources, indigenous R&D base, and manufacturing capability of Indian industry for various components; it can be concluded that India is poised to successfully meet the demands of managing higher quantities and newer types of radioactive waste likely to be generated on account of the expansion of the Indian Atomic Energy Programme.

References

AERB (Atomic Energy Regulatory Board). 2007
Management of Radioactive Waste
AERB/NRF/SC/RW
Mumbai, India

Dani U, Kulkarni Y, Banerjee K, Changrani R D. 2008
Industrial Scale Vitrification of HLW-Experience at AVS, Tarapur
Indian Nuclear Society News **5**(3): 11–18 pp.

Goel R K, Prasad V V R, Swarup A, Dwivedi R D, Mohnot J K, Soni A K, Misra D D. 2003
Testing of Rock Samples and Design of Site Specific Underground Research Laboratory
Technical Report GC/MT/R/1/2000-2001
Roorkee: Central Mining Research Institute

Mehta D, Tejas A G, Morzaria N, Tomar S, Verma B B. 2008
Industrial Scale Vitrification of HLW-Experience at WIP, Trombay
Indian Nuclear Society News **5**(3): 5–10 pp.

Ozarde P D, Haldar K K, and Sarkar S. 2008
Interim Storage of Vitrified HLW
Indian Nuclear Society News **5**(3): 29–32 pp.

Raj K, Prasad K K, and Bansal N K. 2006
Radioactive Waste Management Practices in India
Nuclear Engineering and Design **236**(1): 914–930 pp.

Sugilal G and Benny G. 2008
Development of Cold Crucible System for Vitrification of HLW
Indian Nuclear Society News **5**(3): 18–28 pp.

Wattal P K and Majumdar S. 2007
BARC Highlights: nuclear fuel cycle golden jubilee year
Trombay, Mumbai: Scientific Information Resource Division

The NSG exemption and possibilities for nuclear commerce with India

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The historic exemptions accorded by the extraordinary plenary meeting of the NSG (Nuclear Suppliers Group) in September 2008 proffer India the chance to expand its nuclear energy possibilities in the coming decades. The NSG is an informal multilateral export control arrangement that controls nuclear trade through guidelines and technology annexes. These informal guidelines, though not legally binding internationally, are enforced through national laws and regulations in member countries consistent with the regime's guidelines. Any decision in the NSG is taken by consensus and operates through two sets of guidelines. Part 1 controls nuclear material, that is, nuclear reactors and equipment required for it, non-nuclear material for reactors, plant and equipment for reprocessing, enrichment and conversion of nuclear material as well as for fuel fabrication and heavy water production, and technology required for all the above mentioned items. Part 2 of the guidelines control the transfers of dual-use technology (IAEA 2006a).

Amendments to the NSG guidelines

The nuclear export control regime today stands considerably modified in favour of India. Admittedly, there is still some scope for improvement. As almost all the major suppliers of nuclear goods to India were members of the NSG, it was difficult for India to procure goods from them. The September 2008 NSG plenary meeting through the revisions in Part 1 and Part 2 of its guidelines sought to remove the existing difficulties. Part 1 of the guidelines demand full-scope or comprehensive safeguards for non-nuclear weapon countries. Thus, it requires application of safeguards on all sources and special material, implying an application of safeguards ranging from natural uranium to spent fuel to nuclear waste. Part 2 of the NSG guidelines, as mentioned above, pertain to the transfers of nuclear-related dual-use equipment, materials, software and related technology. As all the countries of the NSG are members of the NPT (Nuclear Nonproliferation Treaty), and given the fact that the NPT still holds 1 January 1967 as the cut-off date for dividing the world into nuclear and non-nuclear weapons states, India was treated as a non-nuclear weapon country.

From 4-6 September 2008, the NSG met to discuss the US proposal for civil nuclear cooperation with India. On 19 September 2008, the IAEA (International Atomic Energy Agency) published India-specific exemptions (IAEA 2008). The revision in the guidelines of the NSG was sent for publication to the IAEA through a communication by its current Chair—Germany. Transfer of a trigger list item requires safeguards under paragraph 4(a) of Part 1 guidelines, which states that 'suppliers can transfer trigger list items or related technology to a non-nuclear weapon state only when the receiving state has brought into force an agreement with the IAEA requiring the application of safeguards on all source and special fissionable material in its current and future peaceful activities' (IAEA 2006: 1). The 6 September revisions however allowed India to undertake nuclear commerce in Part 1 annex or trigger list items without embracing full scope safeguards with all 45 member countries of the NSG. The rationale behind amending paragraphs 4(b) and (c) appears to be for reinforcing the point. These paragraphs did not in any case come in the way of the transfer of Part 1 goods and technologies to India. In fact, paragraph 4(b) discusses exemption from full scope safeguards for safety and paragraph 4(c) pertains to an exemption for the agreement conducted before or on 3 April 1992 and at the time of application of safeguards for a new adherent country. Furthermore, India concluded an India-Specific Safeguards Agreement with IAEA for its civil nuclear programme (PMO 2008).

The 6 September revision interestingly did not make any exception or revision in paragraphs 6 and 7 of the guidelines mentioned in Part 1. Paragraph 6 calls upon members to exercise restraint in the transfer to national plants of 'sensitive facilities, technology and material', which can be used for nuclear weapons or other nuclear explosive devices (IAEA 2006a: 2). If a member country transfers enrichment or reprocessing facilities, equipment or technology, it is either advised to enter a joint project with the recipient or persuade the recipient to opt for appropriate multinational participation in the facility. Paragraph 6 also asks member countries to encourage 'international (including IAEA) activities concerned with multinational regional fuel cycle centres' (IAEA 2006a:2). In sum, this paragraph discourages a supplier to transfer any sensitive item to a national plant in a recipient country. Paragraph 7 refers to special controls on export of enrichment facilities, equipment and technology (IAEA 2006a:2). It stipulates that a recipient of any enrichment facility, equipment or technology should not use the transferred facility for production of greater than 20% enriched uranium without the consent of the supplier nation, of which the IAEA should be advised (IAEA 2006:2).

Part 2 of the NSG guidelines deals with dual-use technology, and categorically prohibits cooperation that may contribute to the development of a nuclear explosive, an un-safeguarded nuclear fuel cycle activity or nuclear terrorism. The 6 September revision also made changes in the principles laid down in paragraphs 4 (a) and 4(b) in Part 2 of the guidelines. With the exception of paragraph 4(a), the NSG countries were asked to ignore the guideline that encourages suppliers to authorize transfers to only those recipient countries who are members of the NPT, the Treaty for the Prohibition of Nuclear Weapons in Latin America, 'similar international legally-binding nuclear non-proliferation agreement' (IAEA 2006b: 2), or if the recipient country has undertaken IAEA safeguards on all its peaceful nuclear activities.

The question then emerges: had the exceptions not been made for the two paragraphs in Part 2 of the guidelines, would it still have been possible for India to procure listed dual-use goods and technology? Answer to it is yes, but only for safeguarded facilities.[1] The amendment aims at removing any irritant which may emerge in the future. However, the statement on the revision clarified that any transfer to India has to meet all the other criteria prescribed in the guidelines for procuring dual-use goods and technology. The exemption statement stressed the significance of paragraph 16 of the guidelines in Part 1. This paragraph advises diplomatic consultations in specific sensitive cases which may lead to conflict and instability. The paragraph discusses a situation arising due to a violation of supplier/recipient understanding. Explosion of a nuclear device and illegal termination of IAEA safeguards by a recipient country have been specifically mentioned. The paragraph asks to 'determine and assess the reality and extent of the alleged violation' (IAEA 2006a), and advises suppliers to not act in haste. Paragraph 16(d) of the guidelines in Part 1 suggest suppliers should consider suspending the transfer of trigger list items to a recipient state which has been reported by the IAEA to be in breach of its obligation to comply with safeguard agreements and, during the time such a state is under investigation (IAEA 2006a:5).

The NSG waiver: implications for nuclear commerce with India

The exemptions in the NSG signify several possibilities for India. Due to the September

[1] In the second part of its guidelines, the NSG defines un-safeguarded activities as research on or development, design, manufacture, construction, operation or maintenance of any reactor, critical facility, conversion plant, fabrication plant, reprocessing plant, plant for the separation of isotopes of source or special fissionable material, or separate storage installation, without any compulsion to allow IAEA safeguards at the pertinent facility or installation, existing or future, when it holds source or special fissionable material. It also covers heavy water production plants without any obligation for embracing IAEA safeguards on any nuclear material produced by or used in connection with any heavy water produced from it.

2008 relaxations, technically all the 45 member-countries of the NSG can now transact with India in the permitted category of nuclear goods for civil nuclear energy. In fact, the Indian government geared into action immediately after the NSG exemptions were inked. The Indian Prime Minister informed that his government had already contacted the US, Russia, France, UK, Canada, Kazakhstan and others for cooperation in the nuclear energy field.

On 30 September 2008, India and France signed an intergovernmental agreement on civil nuclear energy cooperation. France was the first country with which India signed the agreement after the NSG waiver. Though the September 2008 agreement is merely a framework agreement because the India-Specific IAEA Safeguards system is yet to become operational, still, the agreement has activated hectic business activities. Companies are exploring concrete sectors to start their work. Spadework for the current phase of nuclear cooperation between India and France had already begun, but had been held up for the new safeguards agreement and the NSG exemptions to take place. India and France had issued a joint statement during the January 2008 visit of the French President Nicolas Sarkozy. The joint statement carried a section for civil nuclear cooperation and this was considered part of the strategic partnership between the two countries. The joint statement visualized a 'wide ranging bilateral cooperation from basic and applied research to full civil nuclear cooperation including reactors, fuel supply and management' (MEA 2008). However, the most significant feature of the visit was an agreement between the two countries on nuclear research. Accordingly, the Department of Atomic Energy (DAE) is to participate in the research project the Jules Horowitz Reactor, to be constructed by the Commissariat à l'énergie atomique (French Atomic Energy Commission) at Cadarache, France. A Memorandum of Understanding was signed between the Bhabha Atomic Research Centre and the Tata Institute of Fundamental Research from the Indian side, and the GANIL (Grand Accélérateur National d'Ions Lourds) from the French side. India and France decided to strengthen exchanges between the scientists of both countries in the nuclear field as well as develop institutions for training and research on nuclear safety. However, future industrial cooperation is going to be the key element of cooperation between France and India.

India is testing new players to make them partners in its long-term nuclear energy strategy and programme. However, Prime Minister Manmohan Singh's trip to Tokyo was quite disappointing for Indian nuclear commerce. Though the Indian Prime Minister advocated civil nuclear energy cooperation before departing to Tokyo, yet the Japanese Foreign Ministry spokesman and the Japanese Prime Minister ruled out any engagement with India in the nuclear energy sector (Bagchi 2008). Quite interestingly, the Japanese nuclear industry has elicited keenness to do business with India. Delegation after delegation of the nuclear industry is exploring possibilities for future business in India. With a highly developed nuclear industry, Japan can become an important partner of India's nuclear power development.

Japan's reservations notwithstanding, India's nuclear engagement with East Asia is quite old and interesting. In partnership with the IAEA, India began its first regional collaborative agreement with the Philippines in 1964. This agreement led to the establishment of the RCA (Regional Cooperative Agreement) in 1972. The RCA is an intergovernmental agreement for promotion and coordination of joint research and development, training projects in nuclear science and technology through the relevant national institutions of the member countries. India is engaged with many of the Asian countries at various levels. Some engagement has already begun with Japan as well. South Korea, which has a 40% nuclear energy component in its national energy mix, could be an important partner for India in the future. China supplied India nuclear fuel for its Tarapur reactor in the past, and already has a broad understanding that nuclear energy may be useful for both countries. In fact, there is no denying the fact that China and India can collaborate on nuclear energy if the political atmosphere allows them to.

Despite supporting India-specific exemptions in the NSG, proliferation concerns vis-à-vis India have not been resolved. Apart from Japan, Australia too has raised proliferation as a concern with regard to India. In order to deal with these concerns, India may have to adopt a two-pronged strategy. First, Indian diplomacy must use the goodwill generated by the India-specific exemptions in the NSG to get the NPT restructured and become a member as a nuclear weapons country. Second, a deeper engagement with NPT countries that continue to question India's non-proliferation credentials, will help in removing misapprehensions vis-à-vis India.

In recent years, several proposals for multilateral nuclear fuel cycle have appeared: through the IAEA Expert Group on MNA (Multilateral Approaches to the Nuclear Fuel Cycle), the 2004 Report of the UN Secretary-General's High Level Panel on Threats, Challenges and Change, the 2005 Conference on Multilateral Approaches for the Nuclear fuel Cycle, Russian President Putin's proposal to create a system of international centers for nuclear fuel cycle services, Global Nuclear Energy Partnership, Concept for a Multilateral Mechanism for Reliable Access to Nuclear Fuel and so on. Besides, some old proposals like Asiatom are still shaping the debate about multilateral nuclear fuel cycle. India can now engage itself in a deeper manner with a regional nuclear energy project of its choice.

References

Bagchi I. 2008
Japan refuses to commit on N-pact
23 October 2008
The Times of India
Details available at http://timesofindia.indiatimes.com/India/Japan_refuses_to_sign_N-pact/articleshow/3628971.cms, last accessed on 15 January 2009

IAEA (International Atomic Energy Agency). 2006a
Communications Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment and Technology
INFCIRC/254/Rev.8/Part 1a
Details available at http://www.nuclearsuppliersgroup.org/PDF/infcirc254r8p1-060320.pdf, last accessed on 15 January 2009

IAEA (International Atomic Energy Agency). 2006b
Communications Received from Certain Member States Regarding Guidelines for Transfers of Nuclear-related Dual-use Equipment, Materials, Software and Related Technology
INFCIRC/254/Rev.7/Part 2a
Details available at http://www.nuclearsuppliersgroup.org/PDF/infcirc254r7p2-060320.pdf, last accessed on 15 January 2009

IAEA (International Atomic Energy Agency). 2008
Communication dated 10 September 2008 received from the Permanent Mission of Germany to the Agency regarding a Statement on Civil Nuclear Cooperation with India
IAEA Information Circular, INFCIRC/734 (corrected), 19 September 2008.
Details available at http://iaea.org/Publications/Documents/Infcircs/2008/infcirc734c.pdf, last accessed on 17 December 2008

MEA (Ministry of External Affairs). 2008
India-France Joint Statement issued on the occasion of the Visit of H.E.Mr Nicolas Sarkozy, President of the Republic of France, to India
Details available at http://meaindia.nic.in/pressrelease/2008/01/24js01.htm, last accessed on 16 January 2009

PMO (Prime Minister's Office). 2008
Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities
Details available at http://pmindia.nic.in/IaeaIndiaSGADrft.pdf, last accessed on 15 January 2009

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CeRES (Centre for Research on Energy Security) was set up on 31 May 2005. The objective of the Centre is to conduct research and provide analysis, information, and direction on issues related to energy security in India. It aims to track global energy demands, supply, prices, and technological research/breakthroughs – both in the present and for the future – and analyse their implications for global as well as India's energy security, and in relation to the energy needs of the poor. Its mission is also to engage in international, regional, and national dialogues on energy security issues, form strategic partnerships with various countries, and take initiatives that would be in India's and the region's long-term energy interest. *Energy Security Insights* is a quarterly bulletin of CeRES that seeks to establish a multistakeholder dialogue on these issues.

Previous issues of this newsletter are available at <http://www.teriin.org/div_inside.php?id=41&m=3>.

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