DIIS REPORT

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Rajiv Nayan

# Governing Uranium in India

DIIS Report 2015:02

DIIS · DANISH INSTITUTE FOR INTERNATIONAL STUDIES

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Layout: Allan Lind Jørgensen
Printed by Eurographic Denmark

ISBN 978-87-7605-737-4 (print)
ISBN 978-87-7605-736-7 (pdf)

Price: DKK 50.00 (VAT included)
DIIS publications can be downloaded
free of charge from www.diis.dk
Hardcopies can be ordered at www.diis.dk

*This report is part of the larger global 'Governing Uranium' project led by DIIS which is made possible by support from the John D. and Catherine T. MacArthur Foundation.*

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# Contents

## Tables and Maps

## Introduction

India is one of the few countries in the world which has mastered all the stages of nuclear fuel cycle – starting from uranium exploration, mining, extraction and conversion, through fuel fabrication, to reprocessing and waste management. India also possesses nuclear weapons under a doctrine of credible minimum deterrence. Agriculture, medicine, industry and basic research are some of the important areas that are witnessing application of nuclear science and technology in India. But it is the generation of electricity using nuclear energy which has been dominating the discourse in India as in other parts of the world vis-à-vis Indian nuclear science and technology.

A rising economy requires a continuous supply of energy; however, India's available sources of energy are not sufficient. India requires new sources and is focusing on nuclear energy, maintaining that nuclear reactors become cost effective after some years of operation.[1] India is both a producer and importer of uranium and given its limited reserves it consumes all the uranium it produces. So far, it has not exported uranium. India is also relying on a three-stage nuclear energy programme to cut costs, make it somewhat renewable, and ultimately, overcome a limited supply of uranium. In addition, Indian nuclear energy supporters, including the Indian Government, consider nuclear energy environment-friendly.

The July 2005 India-U.S. civil nuclear energy and the India-specific exemptions in the guidelines of the Nuclear Suppliers Group (NSG) have further brought Indian nuclear energy in the limelight. In fact, India is considered one of the drivers of the present phase of global nuclear renaissance. At present, 21 nuclear power reactors are operating with the capacity of 5780 MWe, generating around three percent of India's electricity.[2] However, one reactor of 100 MWe is 'under extended shutdown for techno-economic assessment.'[3] Seven more are currently being constructed with plans for an additional 25 more (the number may increase).[4]

1 Anil Kakodkar, "Technology Options for Long-Term Nuclear Power Deployment", *Nu-Power*, 23(1-4),, 2009, pp. 22-28

2 Government of India, Ministry of Power, "Power Sector at a Glance 'ALL INDIA' at http://www.powermin.nic.in/JSP_SERVLETS/internal.jsp

3 Government of India, Department of Atomic Energy, Lok Sabha, Starred question no. 128, "Shortage of Atomic Fuel", July 16, 2014, at http://dae.nic.in/writereaddata/parl/budget2014_2/lssq128.pdf

4 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 2053, "Atomic Power Plants", December 5, 2012, at http://dae.nic.in/writereaddata/parl/lsus2053.pdf and Nuclear Power Corporation of India Limited, "A Brief on Jaitapur Nuclear Power Project", at http://npcil.nic.in/main/A_Brief_on_JNPP.pdf

The Department of Atomic Energy (DAE) maintains that a reactor with a capacity of 220 MW needs 45 tonnes of UO2 annually, a reactor of 540 MW 100 tonnes of UO2 and the reactor of 700 MW capacity 125 tonnes of UO2.[5] This is for the Annual Fuel Requirement at 85 per cent Capacity Factor. Similarly, India is going to import Light Water Reactors (LWRs), mostly around 1000-1150 MW. For the same Annual Fuel Requirement at 85 per cent Capacity Factor, 1000 MW reactor needs 27 tonnes of Low Enriched Uranium(LEU) per reactor. Only Jaitapur will have reactors with the capacity of 1650 MW European Pressurised Reactor from France. However, the term of the contract requires the life time supply of fuel from the French company.[6]

To address apprehensions that an increase in nuclear reactors may usher a new phase of proliferation in the international community, non-proliferation efforts have strengthened, such that the global quest for nuclear energy needs to assure the world on safety, security and safeguards. The Fukushima incident has forced the world to multiply its existing safety measures. The recent campaign for nuclear security has advocated synergising safety and security mechanisms and ideas. All these measures have become vital instruments of global nuclear governance. India has positively responded to safeguards, safety and security demands of nuclear governance in general and uranium governance in particular.

The paper maps the status of uranium in India and the legal and regulatory mechanisms to govern uranium in the country. This research analyses the Indian nuclear industry's demand for natural uranium, its sources of supply and the legal framework that regulates the use of nuclear material in India. It has been conducted as a part of the global 'Governing Uranium' project, led by the Danish Institute for International Studies (DIIS). The project studies the governance of the production and trade of natural uranium. It has focused on the front end of the nuclear fuel cycle. The objective of the project is to find any existing gaps in the global uranium governance and make recommendations for improving transparency, regulation and best practice in natural uranium.

[5] Government of India, Department of Atomic Energy, Lok Sabha, Starred question no. 44, "Uranium Resources", August 7, 2013, at http://dae.nic.in/writereaddata/parl/mansoon2013/lssq44.pdf

[6] Nuclear Power Corporation of India Limited, "A Brief on Jaitapur" at http://www.npcil.nic.in/main/a_brief_on_jnpp.pdf

# 1. India's Nuclear Industry Demands for Natural Uranium

The Indian nuclear scientific establishment, for a long period, has been pursuing the path of the three-stage nuclear energy development programme following the closed-cycle approach. In the first stage of the programme, natural uranium is used to feed Pressurised Heavy Water Power Reactors (PHWR); in the second stage, spent fuel is used for fast breeder reactors and finally, the third stage marks a transition to thorium-based technology, utilising Advanced Heavy Water Reactors (AHWRs). India assigns significance to the use of all the three principal fissionable materials—uranium 235, plutonium and uranium 233.

The Indian nuclear fuel cycle involves several institutions for different stages of the fuel cycle. In the front end of the nuclear fuel cycle, the Atomic Minerals Directorate (AMD) for Exploration and Research (AMD) undertakes survey, exploration and evaluation of uranium, thorium, niobium, tantalum, beryllium, zirconium, lithium, yttrium and rare earth elements used for production of indigenous atomic energy in India. The Uranium Corporation of India Ltd. (UCIL) is responsible for mining and processing of uranium ore, and the Indian Rare Earths Ltd. is for minerals sand which have both thorium and rare earth elements.

The Nuclear Fuel Complex (NFC) fabricates fuel and zircaloy for Indian nuclear power reactors. The NFC has a center at Hyderabad and Tutocorin and a few more units are likely to become operational in coming years.The NFC was established in the early 1970s. In the beginning, its production capacity was just 100 tonnes per year (TPY),[7]. However, it has increased gradually, and currently is '850 TPY fuel bundles'[8]. The NFC is now capable of meeting fuel requirements of India's indigenous 700 MW PHWRs and prototype fast breeder reactor. India has a plan to use Slightly Enriched Uranium (SEU) for its under construction indigenous 700 MW PHWRs.[9] SEU is different than LEU in that it is specifically $U^{235}U$ concentration of 0.9% to 2%. Madras Atomic Power Station (MAPS) with 220 MW is conducting test and trial for SEU.[10]

7 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 5359, "Nuclear Fuel Complex", May 9, 2012, at http://dae.nic.in/writereaddata/lsus5359.pdf

8 Ibid.

9 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No. 2437, "Use of uranium", March 28, 2012, at http://dae.nic.in/writereaddata/lsus2437.pdf

10 Ibid.

The Nuclear Power Corporation of India Limited (NPCIL) operates both PHWRs and LWRs of the country for electricity generation. India has both types of LWRs-boiled water and pressurised water reactors. The Government of India maintains, "With the use of SEU fuel for operating PHWRs, the LWR spent fuel can be reused and LWR spent fuel inventory reduced. With increased burn up of SEU fuel in PHWRs, the requirement of fuel and the overall fuel cycle cost will be reduced. These are the advantages of using SEU in PHWRs from LWR spent fuel."[11] The Heavy Water Board is another institution that feeds the front end of the nuclear fuel cycle in India. As the name suggests it operates most of India's heavy water plants.

India has invested in back-end nuclear fuel cycle for its closed nuclear energy programme. A number of institutions have been developed and evolved for the back-end. There are three reprocessing plants[12]—one each at Trombay, Tarapur and Kalapakkam to extract plutonium from spent fuel. India has already signed agreements with USA, France, Russia, Kazakhstan and Canada to reprocess spent fuel procured from nuclear material purchased or otherwise acquired from these countries.[13] India has waste management facilities;[14] such as a Waste Immobilisation Plant, Effluent Treatment Plant, Decontamination Centre and Radioactive Solid waste Management Site (RSMS) are located at Trombay. Tarapur Radwaste Augmentation Plant, Low-level liquid Waste Treatment Plant, Sold Waste Management Facility, Decontamination Centre, Waste Immobilisation Plant, Solid Storage & Surveillance Facility are at Tarapur. There is a facility for the immobilisation of waste in a cement matrix at Kalpakkam.

Moreover, there are a number of institutions such as the Raja Ramanna Centre for Advanced Technology and the Tata Institute of Fundamental Research which provide research & development to the Indian nuclear programme. The Indian private sector has also played a very important role in supporting the Indian nuclear programme. Larsen & Toubro, Walchundnagar and Godrej Precision Engineering, among others, are contributing immensely to the Indian nuclear energy programme.

[11] Ibid.

[12] Government of India, Department of Atomic Energy, Bhabha Atomic Research Center, "Back End of Nuclear Fuel Cycle", at http://www.barc.gov.in/about/anushakti_benfc.html

[13] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No. 2036, "Reprocessing of Spent Fuel", July 23, 2014, at http://dae.nic.in/writereaddata/parl/budget2014_2/lsus2036.pdf

[14] Bhabha Atomic Research Center, "Back End of Nuclear Fuel Cycle", at http://www.barc.gov.in/about/anushakti_benfc.html

The Indian Department of Atomic energy (DAE) maintains that the NPCIL—one of the principal Indian companies responsible for nuclear power generation in India—along with other Indian institutions has advanced knowledge of PHWR technology.[15] According to one of the former heads of the DAE, "Nearly 55 per cent of the scientific publications in the field of PHWRs originated from India in the year 2006."[16] Needless to add, India has to rely on an indigenous pool of manpower and technology for its fast breeder reactors and the Advanced HWRs because other countries with advanced nuclear technology are not investing much in such scientific and technological programmes. The former DAE head highlighted similar kind of Indian dominance in the literature on fast breeder and AHWRs as well.[17]

Given its nuclear energy ambitions, India follows a policy of not only developing its own indigenous nuclear power reactors but also taking help from foreign companies. Nuclear energy may constitute an important element in India's energy mix. India's 21 operating nuclear power reactors generate a mere 2.25 percent of India's electricity. As discussed earlier, India has 18 operational PHWRs of which one plant has the capacity of 100 MWe, one of 200 MWe capacity, fourteen of 220 MWe capacity and two plants have 540 MWe along with four 700 MW PHWRs that are under construction. The much-awaited Kudankulam nuclear power plant-1 constructed in collaboration with Russia is the latest reactor to become operational. In November 2014, Koodankulam-2 is also expected to become operational;[18] each Kudanlulam reactor has the capacity of 1000 MWe. On March 31, 2013, the chairman of the Nuclear Power Corporation of India Limited (NPCIL) informed that the overall capacity factor of the then existing 20 nuclear power plants was 80 per cent and "the weighted average Availability Factor was 90%."[19] In addition, he said that ten power plants achieved greater than 90 per cent Availability Factor during the financial year 2012-2013.

The 500 MW prototype fast breeder reactor to be fuelled by plutonium for the second stage is under construction. The nuclear establishment is set to operationalise

15 Government of India, Department of Atomic Energy, "Energy Vision", **at** http://dae.nic.in/?q=node/105#

16 Anil Kakodkar, "Evolving Indian Nuclear Programme: Rationale and Perspective", Lecture at Indian Academy of Sciences, Bangalore, July 4, 2008, at http://www.igcar.gov.in/igc2004/111FILE.pdf

17 Ibid.

18 Nuclear Power Corporation of India Limited, "Kudankulam Atomic Power Project", at http://www.npcil.nic.in/main/ConstructionDetail.aspx?ReactorID=77

19 K. C. Purohit, Chairman's Statement at the 26th Annual General Body Meeting-2013, Nuclear Power Corporation of India Limited, July 5, 2013, at http://www.npcil.nic.in/pdf/CMD_Statement_2013.pdf

it in the early months of 2015 though it was scheduled to become operational in September 2014.[20] The government has also decided to construct more fast breeder reactors to generate enough fuel for the third stage, which will be based on thorium. The DAE has promised to roll out 300 MWe technology demonstrator AHWR for large-scale commercial utilisation of thorium at the end of the 12th Five Year Plan.[21] The DAE maintains that the proper operationalisation of the third stage may still take 3-4 decades; however, the designs of all the systems of the reactor are completed.[22]

At least 12 reactors are going to be constructed with foreign collaborations. NPCIL has already signed agreements with foreign operators and companies. It has also signed agreements with other Indian Public Sector Undertakings (PSUs)[23] such as Indian Oil Corporation Limited, National Aluminium Company Limited and National Thermal Power Corporation. Further, the fast breeder reactors will be managed by another PSU—BHAVINI.

Admittedly, the programme has been facing problems and has missed deadlines. By 2020, the Indian nuclear energy programme needs to generate 20,000 MW of energy, though it does not appear to be meeting that target. In general, the nuclear power plants are completed much beyond their original schedules. For years, the Indian nuclear establishment has been claiming that the operation of technology denial regimes or multilateral export controls regimes like the NSG forced them to develop key nuclear technology indigenously. The scarcity of uranium also made the nuclear power plants to run below their capacities. The three-stage programme needs the second stage to become operational, indicating that there needs to be mass production of spent fuel to advance the third stage. In an answer to a question, the Indian Government replied: "several technological challenges are being encountered during the equipment manufacture and construction; and BHAVINI has been successfully overcoming these challenges through indigenous research efforts."[24]

[20] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No812, "Fast Breeder Reactor", July 16, 2014, at http://dae.nic.in/writereaddata/parl/budget2014_2/lsus812.pdf

[21] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 280, "Shortage of Uranium", December 12, 2012,at http://dae.nic.in/writereaddata/lssq280.pdf

[22] Ibid.

[23] In India, Public Sector Undertakings are corporations owned either by the Central or State Governments of India, at http://india.gov.in/spotlight/public-sector-undertakings-india

[24] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3463, "Fast Breeder Reactor", February 12, 2014, at http://dae.nic.in/writereaddata/parl/budget2014/lsus3463.pdf

The 2011 Fukushima incident, which raised a question on the safety of nuclear power plants, to an extent, also influenced the Indian public opinion. The Kudankulam power plants and the NPCIL-Areva joint nuclear energy reactors complex at Jaitapur witnessed strong protests. At other proposed sites, too, anti-nuclear energy activists and local people raised questions about the feasibility and safety of nuclear energy. Various foreign companies and some key supplier countries like the U.S. have also been raising issues with respect to the Nuclear Liability Act. The Indian Government had to answer queries regarding the feasibility, safety and security of nuclear energy on one hand, and at the same time needs to convince the supplier companies and countries about the need for the Nuclear Liability Act. It continues its commitment to the policy of energy mix, wherein nuclear energy is going to become an important component. India considers it beneficial to pursue nuclear energy for its growing economy. Besides, the nuclear establishment highlighted and made public aware of India's nuclear safety and security commitment quite successfully after the 2011 Fukushima incidents.

## 2. Status of Uranium Production

Citing 'public interest', the Government of India does not disclose the exact quantity of uranium produced in India.[25] However, the information about the country's uranium reserves is available in the public domain, which can be accessed via different publications of the DAE and other organisations. As mentioned earlier, PHWRs use natural uranium as fuel. The currently operating PHWRs need about 1000 tonnes of UO2 annually. The further expansion needs more production or more procurement from outside the country. In an answer to a question in the Indian Parliament, the Indian Government stated, "The Country's Uranium requirement in the 12th Five Year Plan period, which has started from 2012 and will end in 2017, is estimated to be 5057 tonnes. This includes 318 tonnes of low enriched uranium for Tarapur Atomic Power Station (TAPS) -1&2 and Kudankulam (KK) -1&2."[26] Though India has relatively large reserves of thorium oxide,[27] its uranium reserves are comparatively modest.

Table 1. Uranium Reserves

| *State* | *Established Uranium Resources (In Tonnes)* |
|---|---|
| Andhra Pradesh | 93.492 |
| Jharkhand | 53,079 |
| Meghalaya | 20,457 |
| Rajasthan | 7,244 |
| Karnataka | 4,682 |
| Chhattisgarh | 3,986 |
| Uttar Pradesh | 785 |
| Uttarakhand | 100 |
| Himachal Pradesh | 784 |
| Maharashtra | 355 |
| *Total* | *184,964* |

*Source:* Reproduced from Government of India, Department of Atomic Energy, Lok Sabha, starred Question No 379, "Untapped Uranium/Thorium Reserves" December 19, 2012, http://dae.nic.in/writereaddata/lssq%20379.pdf

[25] Government of India, Department of Atomic Energy, Lok Sabha, starred Question No 379, "Untapped Uranium/Thorium Reserves", December 19, 2012, at http://dae.nic.in/writereaddata/lssq%20379.pdf

[26] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 396, " Requirement of Uranium", December 21, 2012,at http://dae.nic.in/writereaddata/lssq396_211211.pdf

As of March 31, 2013, uranium reserves in India stand at 186,650 tonnes[28]and as of May 2014, 211,473 tonnes in situ $U_3O_8$ (179,329 tonnes uranium) reserves.[29] In December 2012, in an answer to a question in the Indian Parliament, the DAE, in a tabular form, gave the state-wide breakup of established in situ uranium reserves, which at that time stood at about 184,964 tonnes (see Table 1).

## Exploration

India has been surveying and exploring uranium since 1949. On July 29, 1949, the Rare Minerals Survey Unit was set up.[30] Later, it was renamed as "The Raw Materials Division." In 1958, it was again renamed as the "Atomic Minerals Division." In 1974, Hyderabad became the headquarters of the Atomic Minerals Division. On July 29, 1998, Atomic Minerals Division was re-launched as today's Atomic Minerals Directorate (AMD) for exploration and research. Today, it has seven regional offices. AMD's responsibilities include survey and exploration of atomic mineral reserves in India—particularly, to harness uranium resources required for the development of the nuclear programme of the country.

Survey of nuclear material was apparently one of the three initial necessary activities in the plan of Homi Jahangir Bhabha, who was arguably the chief architect of Indian nuclear science; the other two were development of human resources and programme for instrumentation.[31] In fact, after independence, when the Indian dominion legislature passed the Atomic Energy Act in April 1948 one of the three objectives of the Act was to locate minerals for atomic energy, such as uranium.[32]

[27] 8.56 lakh tonnes of thorium Oxide as per Government of India, Department of Atomic Energy, Lok Sabha, starred Question No 379, "Untapped Uranium/Thorium Reserves" December 19, 2012, at http://dae.nic.in/writereaddata/lssq%20379.pdf

[28] Government of India, Department of Atomic Energy, *Annual Report 2012-13*, at http://dae.nic.in/writereaddata/areport/ar1213_big.pdf

[29] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 5033, "Atomic Minerals Deposit", August 13, 2014, at http://dae.nic.in/writereaddata/parl/budget2014_2/lsus5033.pdf

[30] Government of India, Department of Atomic Energy, Atomic Minerals Directorate for Exploration and Research, "Historical Perspective", downloaded on September 2, 2013, at http://www.amd.gov.in/about/history.htm

[31] Subodh Mahanti, "Homi Jehangir Bhabha: The Architect of India's Nuclear Programme",

Government of India, Vigyan Prashar, downloaded on September 2, 2013, at http://www.vigyanprasar.gov.in/dream/jan2000/article1.htm

[32] Government of India, Department of Atomic Energy, Atomic Minerals Directorate for Exploration and Research, "Charter of Duties", downloaded on September 2, 2013, at http://www.amd.gov.in/about/charter.htm

In 1951, India discovered uranium deposits at Jaduguda in the Singhbhum district of Jharkhand.[33] In subsequent years, more uranium mines were discovered in the belt. The first borehole was drilled with the help of Associated Drilling Company of London in 1951.[34] In 1956, uranium reserves were discovered at Umra in the Udaipur district of Rajasthan, and in 1973, at Bodal in the Rajnandagaon district of Chhattisgarh. In 1984, sandstone-type uranium deposits were discovered at Domiasiat in the West Khasi Hills district in Meghalaya. In 1991, uranium deposits were found at Lambapur in the Nalgonda district in Andhra Pradesh, and in 1997, at Gogi in the Gulbarga district of Karnataka.In all the aforementioned states more uranium mines was discovered later.

India has adopted a policy of extensive exploration to locate new uranium deposits in the country. In recent years, it has identified new uranium deposits. The Indian nuclear establishment strongly believes that because of India's geological situation, parts of India other than those already identified may have uranium reserves too.[35] The AMD has identified some thrust areas for the exploration of uranium. Many of these thrust areas lie in the districts of some states where uranium deposits have already been discovered. However, some new states and new districts with uranium deposits have also been explored. The Indian nuclear establishment has put these new thrust areas in various categories such as New Delhi fold belt and Chhattisgarh group.

To locate uranium deposits, the AMD has established a highly technical process involving different survey and analytical tools.[36] Over the years, it has developed an integrated validation system connected to a database. Although in the beginning, India had to import instruments for drilling and other exploratory work, now it develops many of the exploratory instruments indigenously. Several foreign companies also participate in exploration for uranium reserves.[37] The AMD undertakes integrated geological-geophysical-geochemical-radiometric surveys, heliborne geophysical surveys, mapping and reconnoitre/exploratory/stratigraphic

33 Government of India, Department of Atomic Energy, Atomic Minerals Directorate for Exploration and Research, "Milestones", downloaded on September 2, 2013, athttp://www.amd.gov.in/about/milest.htm

34 Ibid.

35 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3692, "Shortage of Uranium", March 20, 2013, athttp://dae.nic.in/writereaddata/parl/bud2013/lsus3692.pdf

36 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 4014, "Exploration of Uranium Resources", August 18, 2010, at http://dae.nic.in/writereaddata/ls180810.pdf#page=2

37 Government of India, Department of Atomic Energy, Rajya Sabha, Unstarred Question No 2731, "Exploration of Uranium Resources", August 19, 2010, at http://dae.nic.in/writereaddata/rs190810.pdf#page=5

## Table 2. Exploration of Uranium Reserves (Figures in Tonnes)

| *2008-09* | *2009-10* | *2010-11* | *2011-12* | *Total* |
|---|---|---|---|---|
| 12,688 | 16,520 | 22,628 | 14,263 | 66,099 |

*Sources:* Table adapted fromGovernment of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 378, "Shortage of Uranium", March 14, 2012, http://dae.nic.in/writereaddata/lsus378.pdf and 2011-12 data from Government of India, Department of Atomic Energy, *Annual Report 2012-13*, http://dae.nic.in/writereaddata/areport/ar1213_big.pdf

## Table 3. Recent Major Action/Thrust Areas for Uranium Exploration

| *State* | *District* | *Areas* |
|---|---|---|
| Andhra Pradesh | Kadapa | 1.Tummalapalle<br>2. Rachakuntapalle |
| | Guntur | Koppunuru |
| | Nalgonda | Chitrial |
| | Mahboobnagar | 1.Akkawaram<br>2. Bamanapalli<br>3. Kappagattu |
| Chhattisgarh | Surguja | Chattanpani |
| | Rajnandgaon | Donagarh near Duwalgudra and Pandutola |
| Jharkhand | East Singhbhum | Singridungri-Banadungri |
| | Seraikella-Kharsawan | Bangurdih |
| Karnataka | Yadgir | Gogi |
| | Gulbarga | Bhima |
| | Belgaum | Badami basin |
| Madhya Pradesh | Betul | KotaVillage |
| | Dhar | Bhimpura-Mogra |
| | Alirajapur | Salkhera |
| Meghalaya | West Khasi Hills | 1.Wahkut<br>2. Umthongkut |
| Rajasthan | Sikar | 1. Rela<br>2. Rohil<br>3. Sirsori ki dhani<br>4. Kalakhera<br>5. Kalakota |
| | Jaipur | Dangarwala |
| | Bundi | Umar |
| | Bhilwara | Gaga Ka Khera |
| | Nagaur | 1. Didwana<br>2. Singh Talab |
| Tamil Nadu | Vellore | Near Kalarpatti/Ponmalai/ Almarakottai |

*Sources:* (Adapted from) Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3601, "Uranium Reserves", August 24, 2011, http://dae.nic.in/writereaddata/3601_lsus240811.pdf and Government of India, Department of Atomic Energy, *Annual Report 2012-13*, http://dae.nic.in/writereaddata/areport/ar1213_big.pdf drilling, etc. to locate uranium.[38] In exploring uranium, the first step is remote sensing studies/airborne surveys; the next step is geological, geochemical and geophysical surveys; these surveys are taken at different scales. Once the possibility of uranium is indicated, core/non-core drilling and, at times, exploratory mining are carried out. Under the AMD system, the laboratory studies are performed alongside actual exploration to "evolve models for exploration and for optimising the recovery parameters."

## Mining and Processing of Uranium Ore

After the AMD completes the final exploration of uranium, it hands over information/data to Uranium Corporation of India Limited (UCIL). In India, UCIL is the only organisation responsible for mining and processing of uranium ore for commercial purposes. Uranium mined by the UCIL is used for weapons and civil nuclear programmes both. The imported uranium is used for civil nuclear energy purposes only. The UCIL is a Public Sector Undertaking (PSU) under the DAE and was formed on October 4, 1967, to mine and process uranium. It regularly assesses the "techno-economic viability" of extraction and development of uranium resources. Although UCIL is not supposed to conduct any exploration activities of uranium reserves;[39]it works with the AMD to establish uranium reserves.[40] On various occasions, mining and exploration of uranium reserves have been discontinued because of the low economic feasibility.

Consequently, not all uranium deposits explored by the AMD are mined and processed. The Indian Government once informed the Indian Parliament:

> Factors such as problems on land acquisition, rehabilitation/resettlement of affected persons, environmental sensitivity due to proximity of drinking water sources, reserve forest/tiger sanctuary locations, socio-political issues, availability of water, environmental and forest issues, public consensus, etc. influence the decisions on mining and exploitation of established uranium and thorium resources in the country. The Department [Department of

[38] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 378, "Shortage of Uranium", March 14, 2012, at http://dae.nic.in/writereaddata/lsus378.pdf

[39] Government of India, Department of Atomic Energy, Lok Sabha, starred Question No 280, "Shortage of Uranium", December 12, 2012, at http://dae.nic.in/writereaddata/lssq280.pdf

[40] Government of India, Department of Atomic Energy, Atomic Minerals Directorate for Exploration and Research, "Uranium Investigations", at http://www.amd.gov.in/work/uranium.htm

> Atomic Energy] is continuously making efforts to establish the presence of more uranium and thorium reserves in the country; and exploit the same through mining and processing for utilisation to meet the needs of the country.[41]

For example, AMD undertook survey and exploratory mining at Bodal Mines, Rajnandgaon district in Chhattisgarh; however, it discontinued further exploration because of low economic viability.[42]

The Government of India maintains that "It is not in the public interest to disclose information on the quantum of uranium used in the nuclear power reactors in the country."[43] The DAE also instructs UCIL not to put information on the following in the public domain:

i. Licensed capacity
ii. Installed capacity
iii. Actual production
iv. Raw material purchased or acquired
v. Opening and closing stocks of goods produced[44]

Although, it allows auditors who audit the report to see relevant documents, but are not encouraged to reveal the data or put it in the public domain. The nuclear establishment maintains that nuclear power companies follow the principles of corporate social responsibility and corporate governance. The Comptroller and Auditor General (CAG) exercises the right of audit, including the performance audit. Needless to add that there is parliamentary oversight and control over UCIL. Even if peer review in nuclear security is not accepted, India has mechanisms to validate the security system of uranium mines and its transportation. Besides, the DAE is accountable to the Indian Parliament which exercises considerable political oversight.

[41] Government of India, Department of Atomic Energy, Lok Sabha, starred Question No 379, "Untapped Uranium/Thorium Reserves"
December 19, 2012, at http://dae.nic.in/writereaddata/lssq%20379.pdf

[42] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3072, "Revival of Uranium Mine", December 12, 2012, at http://dae.nic.in/writereaddata/lsus3072.pdf)

[43] http://164.100.47.132/LssNew/psearch/QResult13.aspx?qref=5936

[44] Uranium Corporation of India Limited, 44th Annual Report- 2010-2011, July 27, 2011, at http://www.ucil.gov.in/web/Annual%20Report10-11-English.pdf

## Location

At present, the UCIL has a few mines and a processing plant operating mainly in Jharkhand; nevertheless, soon several uranium mines and processing plants may become operational in the other states of India too. All the existing and proposed processing centres have been deliberately located near the uranium mines. Currently, UCIL is running six underground mines and one opencast mine in Jharkhand. The mines at Jaduguda and Bhatin are not only producing good quantity of uranium but also improving further the mining operation. The UCIL is constructing two more underground mines in Jharkhand and one underground mine in Andhra Pradesh. Lambapur area of Andhra Pradesh may have another mine after UCIL obtains licence. Another underground mine is at the pre-project stage in Karnataka. The UCIL may start a few mines in Meghalaya soon.

Additionally, the UCIL receives tails means waste from other mines extracting minerals like Zinc. The UCIL is responsible for extracting uranium from these left over materials. Though extracting uranium from secondary sources such as fertiliser is at the research and development stage and, India has not yet been able to procure substantial uranium through this source.

UCIL runs two processing plants in Jharkhand. However, it is constructing one processing plant with a capacity to process 3,000 tonnes of ore per day in Andhra Pradesh.[45] Another processing plant may come up near the proposed Lambapur mine in Andhra Pradesh. Even in Karnataka, one processing plant is at the pre-project stage. UCIL has also sought clearance for a processing plant in Meghalaya.

### *Mines*

Jaduguda[46]

- Mining operations since 1967
- First uranium mine of India
- About 160 km in length and 1 to 10 km in width
- East & West Singhbhum districts of Jharkhand
- Ore goes to the adjoining processing plant by a conveyor

[45] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3601, "Uranium Reserves", August24, 2011, athttp://dae.nic.in/writereaddata/3601_lsus240811.pdf

[46] Uranium Corporation of India Limited, "Jaduguda Mines", at http://www.ucil.gov.in/web/jaduguda_mine.html

- Highly folded and sheared rocks
- Thinly disseminated form

Bhatin[47]

- Mining operations since 1983[48]
- 3 km away from Jaduguda
- An underground mine
- In East Singhbhum district of Jharkhand
- Has all other features and infrastructure of Jaduguda

Turamdih[49]

- Mining Operations since 2003
- Located about 24km west of Jaduguda
- An underground mine
- In East Singhbhum district of Jharkhand

Bagjata[50]

- Mining operations since 2008
- 25 km east of Jaduguda
- An underground mine
- In East Singhbhum district of Jharkhand

Narwapahar[51]

- Mining operations since April 1995
- An underground mine
- In East Singhbhum district of Jharkhand
- High productivity because of its infrastructure-friendly structure
- Improved drilling productivity

[47] Uranium Corporation of India Limited, "Bhatin Mines", athttp://www.ucil.gov.in/web/bhatin_mine.htmll

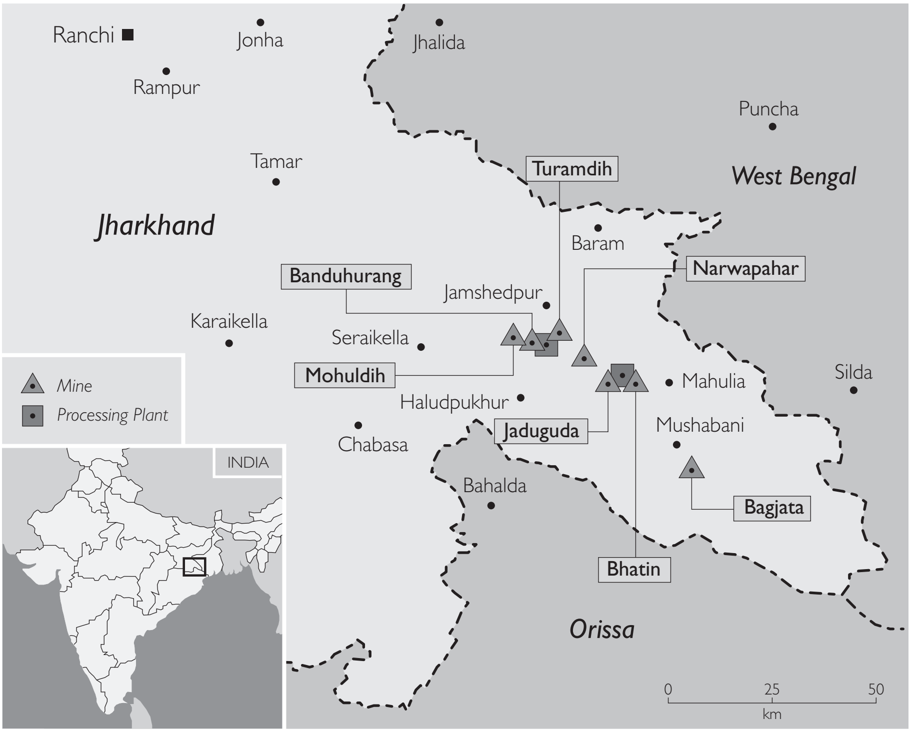
[48] Find reference in Uranium Corporation of India Limited, "Environmental Impact Assessment & Environmental Management Plan For Bhatin Mine", December 2010, http://www.indiaenvironmentportal.org.in/files/EIA-bhatin_mine.pdf

[49] Uranium Corporation of India Limited, "Turmadih Mines", at http://www.ucil.gov.in/web/turmadih_mine.html

[50] Uranium Corporation of India Limited, "Bagjata Mines", at http://www.ucil.gov.in/web/bagjata_mine.html

[51] Uranium Corporation of India Limited, "Narwapahar Mines", at http://www.ucil.gov.in/web/narwapahar_mine.html

## Map 1. Jaduguda Uranium Mines (Jharkhand)




Mohuldih[52]

- Mining operations since April 2012
- Modern underground mine
- Seraikella-Kharsawan district of Jharkhand
- To produce 500 tpd at 100 per cent capacity
- Ore to go to the Turamdih processing plant,which is situated about 7 km East

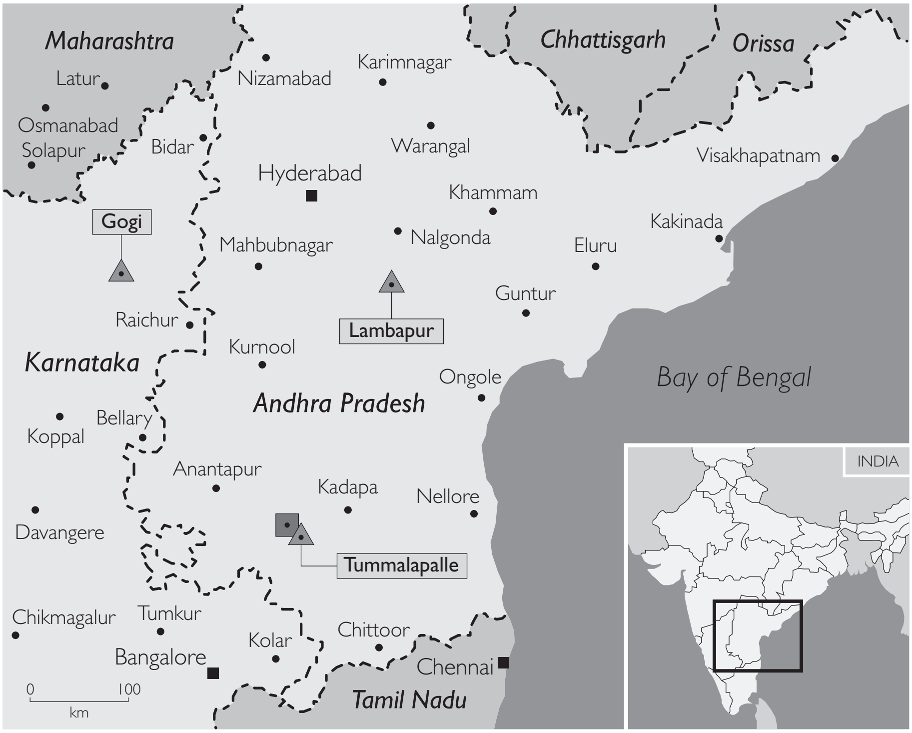
Banduhurang[53]

- Mining Operations since April 1995
- Only operating opencast mine
- Seraikella-Kharsawan district of Jharkhand
- Use of high productivity machinery
- First fully mechanised mine

52 Uranium Corporation of India Limited, "Mohuldih Mine", at http://www.ucil.gov.in/web/mohuldih_mines.html

53 Uranium Corporation of India Limited, "Banduhurang Mine", at http://www.ucil.gov.in/web/banduhurang_mine.html

Map 2. Andhra Pradesh & Karnataka Uranium Mines




Tummalapalle[54]

- Under construction
- An underground mine
- Up to a depth of 300m
- Kadapa district of Andhra Pradesh

Lambapur[55]

- Nalgonda district of Andhra Pradesh
- In the process of obtaining clearances for construction of three underground and one open cast mines

[54] Uranium Corporation of India Limited, "Tummalapalle Uranium Project", at http://www.ucil.gov.in/web/tummalapalle_uranium_project1.html

[55] Uranium Corporation of India Limited, "Lambapur Uranium Project", at http://www.ucil.gov.in/web/lambapur_uranium_project1.html

Gogi[56]

- Under pre-project stage
- An underground mine
- Yadgir district of Karnataka

Kyelleng-Pyndengsohiong, Mawtahbah[57]

- In West Khasi Hills district of Meghalaya
- Plan to construct opencast mines
- Site activities soon

## Map 3. Meghalaya Uranium Mines


[56] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3601, "Uranium Reserves", August24, 2011, at http://dae.nic.in/writereaddata/3601_lsus240811.pdf

[57] Uranium Corporation of India Limited, "KPM Uranium Project", at http://www.ucil.gov.in/web/kpm_uranium_project1.html

*Processing Plants/Mills*

Jaduguda[58]

- Modernised over the years
- Ore from Jaduguda, Bhatin and Narwapahar
- Extraction by hydro-metallurgical process
- Ore undergoes two stages of wet grinding after three stages of crushing
- Turned into magnesium di-uranate ($MgU_2O_7$), or "Yellowcake"
- Thickened, washed, filtered and dried in the spray dryer, and finally packed in drums and then sent to Nuclear Fuel Complex at Hyderabad for further processing into UO2 pellets

Turamdih[59]

- Ore produced from Turamdih and Banduhurang mines
- Modernised and getting expanded to treat more ore
- Uses the Jaduguda process to send uranium to Nuclear Fuel Complex, Hyderabad

## Issues/Challenges

Safety and security implications of heaps of uranium mining wastes are questioned but the Indian nuclear establishment assures that there are no hazardous implications of the generated heaps.[60] A study acknowledges some of the challenges of mining and processing in India.[61] The study notes:

> Rising ore production from forthcoming new mines calls for some innovative approach of physical beneficiation of valuable uranium bearing minerals, which will reduce the volume of ore transportation and processing. The available flow-sheet also needs modification for improvement in recovery under different mineralogical conditions. The

58 Uranium Corporation of India Limited, "Jaduguda Process Plant", at http://www.ucil.gov.in/web/jaduguda_mill.html

59 Uranium Corporation of India Limited, "Turamadih Process Plant", at http://www.ucil.gov.in/web/turamdih_mill.html

60 Government of India, Department of Atomic Energy, Rajya Sabha, Unstarred Question No 1399, "Uranium Mining Waste", August 22, 2013, http://dae.nic.in/writereaddata/parl/mansoon2013/rsus1399.pdf

61 R Gupta and A K Sarangi, "Emerging Trend of Uranium Mining: the Indian Scenario", Presented in the IAEA symposium on "Uranium production and raw materials for the nuclear fuel cycle- Supply and demand, economics, the environment and energy security", Vienna, June 20, 2005, at http://www.ucil.gov.in/web/Papers-Sarangi/Emerging%20trend%20in%20U%20mining.pdf

> plants, with a shorter processing route, need to incorporate measures to maximise the re-use of water, high recovery of the product and minimum discharge of effluents. In the field of tailings management, long-term stability of tailings restricting the movement of contaminants, strengthening of embankment system, maximum re-use of effluents and reclamation of the existing ponds are some of the challenging areas for continuous research and improvement. However, rapid progress has been made in some of these areas by absorbing technology through fundamental transformations.

Solid wastes with less than 0.015 per cent of Uranium Oxide $U_3O_8$ radioactivity generated in a mine is dumped in waste landfills under the Atomic Energy Regulatory Board (AERB), Directorate General of Mines Safety guidelines and norms. Liquid wastes are treated at the Effluent Treatment Plant (ETP) of uranium ore processing plant.[62] Jaduguda also has three well structured, designed and properly fenced tailing ponds constructed under prescribed guidelines. AERB conducts periodic review as well. UCIL's website provides the following information:

> Two types of wastes are generated while processing Uranium ore i.e. liquor depleted in Uranium from ion exchange unit after Uranium recovery and filtered cake depleted in Uranium from filtration of leached slurry. Both are neutralized with lime stone and lime slurry to precipitate the remaining radio nuclides along with heavy metals like manganese, iron, copper etc. The neutralised slurry is classified and the coarse fraction is pumped back to the mines for back filling the voids. The fine particles are pumped into the tailing pond where slime settles and clear water is decanted through decantation wells and sent to the Effluent Treatment Plant for re-treatment. The Tailings Pond is a well-engineered containment having an earthen dam on one side while the other three sides are protected by hills.[63]

[62] Government of India, Department of Atomic Energy, Rajya Sabha, Unstarred Question No 1339, "Uranium Mining Waste", August 22, 2013http://dae.nic.in/writereaddata/parl/mansoon2013/rsus1399.pdf

[63] Uranium Corporation of India Limited, "Tailings Treatment & Disposal", http://www.ucil.gov.in/web/tailings_treatment.html

## Purity of Uranium

Experts find Indian uranium deposits "generally small, lean in tenor and complex in nature of mineralisation."[64] Indian uranium ore is found as pitchblende ($U_3O_8$).[65] In response to a question asked in the Indian Parliament, the DAE replied, "...in comparison to world occurrences, uranium deposits established in India are mostly of low-grade (less than 0.15per cent U). The average grade of Indian Uranium deposits range from 0.030 to 0.180 per cent $U_3O_8$. The uranium deposits world over have a wide range of average grade, starting from 0.01 – 0.03 per cent U at Witwatersrand, through 0.13 – 0.22 per cent U at Ranger Deposits, Australia, to as high as 17.8 per cent at McArthur River deposit, Canada (source: IAEA Tech Doc.1629, 2009)."[66]

## Agreements for Importing Uranium

The three-stage nuclear energy programme of India is intended for the "maximum utilization of the limited uranium resources," yet the expansion of the first stage requires natural uranium to feed the existing and newly constructed reactors. The Indian nuclear establishment maintains that the known uranium deposits can feed nuclear power plants with a capacity of about 10,000 MWe only.[67] Although the known uranium reserve has been increasing steadily, India still has to import uranium from other countries to feed its planned future nuclear reactors. According to the DAE, as of March 2013, "out of 19 operating Nuclear Power Reactors in the country with installed capacity of 4680 MW, ten nuclear power reactors with a capacity of 2840 MW are fuelled with Indigenous uranium, which is not available in the required quantity. The remaining nine nuclear reactors with a capacity of 1840 MW are under International Atomic Energy Agency (IAEA) safeguards. These nine reactors use imported uranium, which is available in required quantity."[68]

64 R Gupta and A K Sarangi, "Emerging Trend of Uranium Mining: the Indian Scenario", Presented in the IAEA symposium on "Uranium production and raw materials for the nuclear fuel cycle- Supply and demand, economics, the environment and energy security", Vienna; Jun. 20-24, 2005, at http://www.ucil.gov.in/web/Papers-Sarangi/Emerging%20trend%20in%20U%20mining.pdf

65 Government of India, Atomic Energy Regulatory Board, *Radiological Safety in Uranium Mining and Milling,* AERB Safety Guidelines No. AERB/FE-FCF/SG-2, August 2007, at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/SG-FCF-2.pdf

66 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3278, "Uranium Reserves", December 14, 2011, at http://dae.nic.in/writereaddata/3278-lsus141211.pdf

67 Ibid.

68 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3692, "Shortage of Uranium", March 20, 2013,at http://dae.nic.in/writereaddata/parl/bud2013/lsus3692.pdf

However, in yet another statement, the DAE stated that imported uranium is being used in ten reactors under IAEA safeguards.[69]

The DAE admitted that shortage of uranium affects the functioning of the power plants. The UCIL has been 'exploring the possibility of participation in uranium properties with the companies'[70] of countries such as Namibia and Mongolia. Several countries such as Australia[71] and Canada[72] have signed agreements for supply of uranium to India. India is negotiating with these countries for detailed administrative/contractual agreements. As of now, India has purchased uranium from France, Russia, Kazakhstan[73], and Uzbekistan.[74] The Uzbek Company, M/s. NMMC Uzbekistan will supply 2000 MT of Uranium in the form of Uranium Ore Concentrate during 2014-2018.[75]

The government is also planning to "acquire stakes" in uranium mine in foreign countries.[76] NPCIL and UCIL may form a joint venture company for the task.[77] India may be partnering with Russia or any other country. The government intends to create a reserve for uranium for the future.

69 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3601, "Uranium Reserves", August24, 2011, athttp://dae.nic.in/writereaddata/3601_lsus240811.pdf

70 Government of India, Ministry of Atomic Energy, Lok Sabha, Acquisition of Uranium Mines Abroad, Unstarred Question no 3547, answered on July 29, 2009

71 Government of India, Ministry of External Affairs, "Joint Statement on the State Visit of Prime Minister of Australia to India", September 5, 2014 at http://www.mea.gov.in/bilateral-documents.htm?dtl/23976/t+Statement+on+the+State+Visit+of+Prime+Minister+of+Australia+to+India; , Government of India, Ministry of External Affairs, "MOUs/Agreements signed during the visit of Prime Minister of Australia to India (4-5 September, 2014)", September 5, 2014, at http://www.mea.gov.in/bilateral-documents.htm?dtl/23975/g+the+visit+of+Prime+Minister+of+Australia+to+India+45+September+2014

72 Government of India, Ministry of External Affairs, "Note on Agreement and MOUs signed with Canada during PM's visit", June 27, 2010, at http://www.mea.gov.in/media-briefings.htm?dtl/2989/Note+on+Agreement+and+MOUs+signed+with+Canada+during+PMs+visit; Prime Minister of Canada Office, "Canada-India Nuclear Cooperation Agreement", http://www.pm.gc.ca/eng/news/2012/11/06/canada-india-nuclear-cooperation-agreement

73 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3692, "Shortage of Uranium", March 20, 2013, at http://dae.nic.in/writereaddata/parl/bud2013/lsus3692.pdf

74 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No. 4894, "Agreement for Supply of Uranium", August 13, 2014 at http://dae.nic.in/writereaddata/parl/budget2014_2/lsus4894.pdf

75 Ibid.

76 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 378, "Shortage of Uranium", March 14, 2012,at http://dae.nic.in/writereaddata/lsus378.pdf

77 Government of India, Department of Atomic Energy, Rajya Sabha, Unstarred Question No 1246, "New Uranium Mines in the Country", August 23, 2012, http://dae.nic.in/writereaddata/rsus1246.pdf

## Table 4. Details of Capacity Utilisation and Profit of NPCIL during the Last Three Years

| | *2009-10* | *2010-11* | *2011-12* |
|---|---|---|---|
| Capacity Utilisation (%) | 61 | 71 | 79 |
| Profit after Tax (Indian Rupees in Crores) | 416 | 1,376 | 1,945* |

* Provisional

*Source:* Table reproduced from: Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 6550, "Supply of Uranium", May 16, 2012, http://dae.nic.in/writereaddata/lsus6550.pdf

## Table 5. Details of Orders Placed for Supply of Uranium (May 16, 2012)

| *Serial Number* | *Firm/Country* | *Year of Order* |
|---|---|---|
| 1. | M/s. AREVA, France | 2008 |
| 2. | M/s. JSC TVEL Corporation, Russia | 2009 |
| 3. | M/s. NAC Kazatomprom, Kazakhstan | 2009 |

*Source:* Table reproduced from Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 6550, "Supply of Uranium", May 16, 2012, http://dae.nic.in/writereaddata/lsus6550.pdf

## Table 6. Details of the Total Amount Paid for the Import of Uranium (in Rupees)

| *Firm/Country* | *Year* | | | | |
|---|---|---|---|---|---|
| | *2008-09* | *2009-10* | *2010-11* | *2011-12* | *2012-13* |
| M/s. AREVA, France | 120.54* | 145.54* | 0.00 | 0.00 | 0.00 |
| M/s. JSC TVEL, Corporation, Russia | 57.92** | 273.78** | 312.50** | 425.55** | 98.98** |
| | 127.77@ | 352.70@ | 0.00 | 0.00 | 0.00 |
| M/s. NAC Kazatomprom, Kazakhstan | 0.00 | 0.00 | 379.84* | 328.28* | 0.00 |

* Payment towards import of Uranium in the form of Natural Uranium Ore Concentrate.
** Payment towards import of Uranium in the form of Natural Uranium Di-oxide Pellets.
@ Payment towards import of Uranium in the form of Enriched Uranium Di-oxide Pellets.

*Source:* Table reproduced from Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 6550, "Supply of Uranium", May 16, 2012, http://dae.nic.in/writereaddata/lsus6550.pdf

## Table 7. Details of Quantity of Uranium Imported during the Last Four Years (in Metric Tonnes)

| *Firm/Country* | *Total Quantity Ordered* | *Quantity Received So Far* | | | | |
|---|---|---|---|---|---|---|
| | | *2008-09* | *2009-10* | *2010-11* | *2011-12* | *2012-13* |
| M/s. AREVA, France | 300* | 60.49* | 239.38* | Nil | Nil | Nil |
| M/s. JSC TVEL, Corporation, Russia | 2,000** | Nil | 150.33 | 179.79 | 296.08 | 59.43 |
| | 58@ | Nil | 58.29 | Nil | Nil | Nil |
| M/s. NAC Kazatomprom, Kazakhstan | 2,100* | Nil | Nil | 600 | 350 | Nil |

* In the form of Natural Uranium Ore Concentrate (UOC).
** In the form of Natural Uranium Di-oxide ($UO_2$) Pellets.
@ In the form of Enriched Uranium Di-oxide ($UO_2$) Pellets

*Source:* Table reproduced from Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 6550, "Supply of Uranium", May 16, 2012, http://dae.nic.in/writereaddata/lsus6550.pdf

## Table 8. Quantity of Uranium imported during the last three years by country

| *Year* | *Firm/Country* | *Material* | *Quantity (in MT)* |
|---|---|---|---|
| 2011-12 | M/s. JSC TVEL Corporation, Russia | Natural Uranium Di-oxide Pellets | 296.08 |
| | M/s. NAC KazatomProm, Kazakhstan | Natural Uranium Ore Concentrate | 350.00 |
| 2012-13 | M/s. JSC TVEL Corporation, Russia | Natural Uranium Di-oxide Pellets | 295.64 |
| | M/s. NAC KazatomProm, Kazakhstan | Natural Uranium Ore Concentrate | 402.50 |
| 2013-14 | M/s. JSC TVEL Corporation, Russia | Natural Uranium Di-oxide Pellets | 296.31 |
| | M/s. NAC KazatomProm, Kazakhstan | Natural Uranium Ore Concentrate | 460.00 |

*Source:* The Table Reproduced from Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 4894, "Agreement for Supply of Uranium", http://dae.nic.in/writereaddata/parl/budget2014_2/lsus4894.pdf

## 3. Safeguards

India has evolved its approach towards the safeguards system over the years. Since a long period, India along with many other developing countries and the socialist bloc considered the safeguards system a spider's web suspecting it to throttle the scientific and technological development of the non-western world in general and the developing world in particular. However, later, it accepted safeguards on some of its facilities. In recent times, India has been attaching great importance to safeguards activities and been quite active in IAEA meetings.

The famous July 18, 2005 joint statement issued by the Indian Prime Minister Manmohan Singh and the then the U.S. President George Bush paid considerable attention to a safeguards arrangement that India may embrace for the future nuclear commerce. It intones:

> The [Indian] Prime Minister conveyed that for his part, India would reciprocally agree that it would be ready to assume the same responsibilities and practices and acquire the same benefits and advantages as other leading countries with advanced nuclear technology, such as the United States. These responsibilities and practices consist of identifying and separating civilian and military nuclear facilities and programs in a phased manner and filing a declaration regarding its civilians 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....

As India did not join the Nuclear Non-proliferation Treaty (NPT), it was not under compulsions to embrace the safeguards arrangements structured for the NPT member countries. India continued to stick to the Type 66 safeguards arrangement, based on the document contained in INFCIRC/66/Rev.2 of the IAEA. As the name suggests, it is the second revised version of the original document. This document was approved by the board of governors of the IAEA in 1965. Before the advent of the NPT a country that had to safeguard its nuclear facility used this document for developing safeguards arrangements with the IAEA. It is supposed to hinder diversion of any material to "further any military purpose."

So far, India has signed international safeguards with only one inspection agency—the IAEA. Before July 18, 2005, it had already signed agreements with the IAEA to put six reactors under safeguards. All these reactors were placed under the provisions of the IAEA document INFIRCIRC/66/Rev.2. Moreover, India had accepted facility-specific safeguards on those installations. Nevertheless, when the July 18, 2005 India-U.S. joint statement proposed to separate India's nuclear facilities into civilian and military/ strategic, it agreed to place several of its facilities under IAEA safeguards.[78]

India signed an umbrella safeguards agreement with the IAEA in 2008.[79] India ratified an Additional Protocol which it had signed in 2009. This Additional Protocol entered into force on July 25, 2014.[80] India deposited its instrument of accession of the Convention on the Physical Protection of Nuclear Material on March 12, 2002, and the Amendment of the Convention on September 19, 2007.[81] It signed the International Convention for the Suppression of Acts of Nuclear Terrorism on July 24, 2006 and ratified it on December 1, 2006.[82] It has also extended political support for the Code of Conduct on Safety and Security of Radioactive Sources.

78 International Atomic Energy Agency, "Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities: Addition to the List of Facilities Subject to Safeguards Under the Agreement", INFCIRC/754/Add.1, November 12, 2009, at http://www.iaea.org/Publications/Documents/Infcircs/2009/infcirc754a1.pdf; International Atomic Energy Agency, "Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities: Addition to the List of Facilities Subject to Safeguards Under the Agreement", INFCIRC/ /754/Add.2, April 7, 2010, at http://www.iaea.org/Publications/Documents/Infcircs/2010/infcirc754a2.pdf; International Atomic Energy Agency, "Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities: Addition to the List of Facilities Subject to Safeguards Under the Agreement", INFCIRC/ /754/Add.3, December 16, 2010, at http://www.iaea.org/Publications/Documents/Infcircs/2010/infcirc754a3.pdf; International Atomic Energy Agency, "Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities: Addition to the List of Facilities Subject to Safeguards Under the Agreement", INFCIRC/ /754/Add.4, December 19, 2012, at http://www.iaea.org/Publications/Documents/Infcircs/2012/infcirc754a4.pdf

79 International Atomic Energy Agency, "Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities", INFCIRC/754, May 29, 2009, http://www.iaea.org/sites/default/files/publications/documents/infcircs/2009/infcirc754.pdf

80 Abha Dixit, "India's Additional Protocol Enters into Force", International Atomic Energy Agency, July 25, 2014, http://www.iaea.org/newscenter/news/indias-additional-protocol-enters-force and International Atomic Energy Agency, "Protocol Additional to the Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities", INFCIRC/754/Add.6, August 1, 2014, http://www.iaea.org/sites/default/files/infcirc754a6.pdf

81 Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3196, "Ratification of Amendments in IAEA", December 12, 2012, http://dae.nic.in/writereaddata/lsus3196.pdf

82 United Nations Treaty Collection, "International Convention for the Suppression of Acts of Nuclear Terrorism" Audiovisual Library of International Law, January 4, 2015,https://treaties.un.org/Pages/ViewDetailsIII.aspx?&src=UNTSONLINE&mtdsg_no=XVIII~15&chapter=18&Temp=mtdsg3&lang=en#Participants

India participated in and became a party to the communiqués issued during the three Nucleear Security Summits held in April 2010 in Washington, March 2012 in Seoul and in The Hague in March 2014 . For a long period, India has also been active in international bodies such as the IAEA and World Association of Nuclear Operators to promote nuclear safety.

The umbrella safeguards agreement[83] in its preamble attaches nuclear fuel supply assurance as a condition for accepting the new safeguards arrangement. It declares:

- India will place its civilian nuclear facilities under Agency safeguards so as to facilitate full civil nuclear cooperation between India and member states of the agency and to provide assurance against withdrawal of safeguard nuclear material from civilian use at any time;
- An essential basis of India's concurrence to accept agency safeguards under an India-specific safeguards agreement…is the conclusion of international cooperation agreements creating the necessary conditions for India to obtain access to the international fuel market, including reliable, uninterrupted and continuous access to fuel supplies from companies in several nations, as well as support for an Indian effort to develop a strategic reserve of nuclear fuel to guard against any disruption of supply over the lifetime of India's reactors; and
- India may take corrective measures to ensure uninterrupted operation of its civilian nuclear reactors in the event of disruption of foreign fuel supplies.

On August 1, 2008, the IAEA board of governors approved the agreement for India-related safeguards. This agreement is also called the model safeguards or the 'umbrella agreement.' This may provide an enabling document for any future bilateral or multilateral civil nuclear agreement concerning India. The agreement has covered nuclear material along with nuclear facilities; non-nuclear material; equipment; components; special fissile material generated with the help of safeguarded facility or goods; heavy water and so on. The general principle of the agreement is to ensure that safeguarded nuclear material is not withdrawn or transferred whenever and wherever India wants. It has to follow certain procedures and protocols. Certainly, India cannot use uranium for weapons or any other military purposes. Under this agreement, previously concluded safeguards agreement may be continued if all parties give their consent.

[83] Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civilian Nuclear Facilities

First, imported uranium is to be used in a facility which is under safeguards. Such facilities are to be notified to the IAEA by India. The import of uranium is to be notified within four weeks of its arrival. India also has to inform the IAEA about all the facilities which are using imported uranium and the precise amount of uranium in each nuclear facility. Second, if any uranium under safeguards is to be transferred to any other facility, it has to be designated by India. Section E of the agreement has provisions for conversion plants, enrichment plants and fabrication plants. Special procedures have been laid down for reports, inspections, residues, scrap and waste and blending of nuclear materials at these sites.

The Paragraph 19 of the agreement demands that the list submitted to the IAEA should have "to the extent relevant, the nuclear and chemical composition, physical form and quantity of the nuclear material; the date of shipment; the date of receipt; the identity of the consigner and the consignee; and any other relevant information, such as the type and capacity of any facility (or parts thereof), ...." However, the agreement allows exemptions, for example, if there are ten or less than ten metric tonnes in total of natural uranium at a given time. The agreement also expects India to keep accounting records of safeguarded nuclear material like uranium. The records are to be routinely reported to the IAEA. Paragraph 52, requires a special report for loss or destruction of nuclear material for any explained or unexplained reasons.

Moreover, the agreement requires design information of the facility in which uranium is going to be used such that any modification done needs to be conveyed to the IAEA. However, India may restrict transmission of data to the IAEA. In that case, the IAEA may come to the Indian facility to review the design. The agency may undertake a routine or special inspection to audit records and reports, verification of uranium through physical inspection, measurement and sampling and for any unanticipated event. The frequency of a routine inspection is to be decided by the amount of uranium or any other nuclear material. For example, a facility using more than 15 and less than 20 kilograms of uranium may have 4 maximum routine inspections every year. Details have been given in Paragraph 67 of the agreement. The agreement has provisions for routine reports and inspections for safeguarded nuclear material outside principal nuclear facilities, keeping uranium in sealed storage and so on.

Like the previous agreements the option of termination and suspension of safeguards would continue in the current umbrella or India-specific agreement.

The suspension, however, is for lesser amount of uranium not exceeding 10 metric tonnes at a time in India. Generally, it is granted when the facility where uranium is being used is under repair or maintenance. The agreement talks of a range of conditions in which safeguards are terminated. If uranium is returned to the original supplier, the safeguards arrangement may be terminated. The agreement also allows termination if uranium remains unimproved during safeguards, or becomes unusable or irrecoverable. When uranium is used for non-nuclear purposes, termination is permitted.

Like the previous agreements, the new model has provisions for transfer of nuclear material or any good from one facility to another. Section F of the model umbrella agreement in four paragraphs details the method and manner in which transfer is to take place.[84] The detailed criteria include: return of material to the original supplier, removal of material from a principal nuclear facility, consumption and dilution of nuclear material in a way that it becomes useless for nuclear activity from the point of view of safeguards, some fissionable isotopes with special weight and the enrichment level, the replacement of the same amount of heavy water or by better quality for terminating safeguards on heavy water and so on and so forth. Of course, if any material or good has been procured under the safeguards agreement, the IAEA would have to be informed, and safeguards would continue to operate wherever an item is transferred.

The model agreement through Section V lays down the necessity of physical protection of the facilities and nuclear material procured under it. Like some past agreements, it recommends India to take into account guidelines provided through the IAEA document INFCIRC/225. The umbrella agreement asks to take into account recommendations of not only the fifth version but also any subsequently revised version of INFCIRC/225. Other safeguards agreements also took into account the version that existed at the time of drafting of a particular agreement.

Moreover, Article XII C of the IAEA Statue would continue to guide in non-compliance with the agreement. The Article XII C of the Statute states:

> The staff of inspectors shall also have the responsibility of obtaining and verifying the accounting referred to …and with all other conditions of the project prescribed in the agreement between the Agency and the State or

[84] Ibid

> States concerned. The inspectors shall report any non-compliance to the Director General who shall thereupon transmit the report to the Board of Governors. The Board shall call upon the recipient State or States to remedy forthwith any non-compliance which it finds to have occurred. The Board shall report the non-compliance to all members and to the Security Council and General Assembly of the United Nations. In the event of failure of the recipient State or States to take fully corrective action within a reasonable time, the Board may take one or both of the following measures: direct curtailment or suspension of assistance being provided by the Agency or by a member, and call for the return of materials and equipment made available to the recipient member or group of members. The Agency may also, in accordance with article XIX, suspend any non- complying member from the exercise of the privileges and rights of membership.[85]

The umbrella agreement greatly differs from the previous arrangements for dispute resolution. Section 105 of the agreement prefers the approach of consultations and negotiations regarding interpretation or application of any provision of the agreement. India may explain its position to the IAEA board of governors. In the pre-1975 India-related safeguards agreements, there was no explicit dispute resolution section. In the later agreements, generally, the provision for an *arbitral tribunal* was made for a dispute not settled by negotiations. Such a tribunal was/

Table 9. Indian Reactors under Safeguards

| *Unit* | *Location* | *Capacity (MW)* |
|---|---|---|
| TAPS 1&2 | Tarapur, Maharashtra | 2 x 160 |
| RAPS 1* | Rawatbhata, Rajasthan | 100 |
| RAPS 2 | | 200 |
| RAPS 3&4 | | 2 x 220 |
| RAPS 5&6 | | 2 x 220 |
| KAPS 1&2 | Kakrapar, Gujarat | 2 x 220 |
| KKNPP 1&2 | Kudankulam, Tamil Nadu | 2 x 1000 |

* under extended shutdown since October 2004.

Table reproduced from: Government of India, Department of Atomic Energy, Rajya Sabha, Unstarred Question No 3078, "Nuclear Reactor under IAEA Safeguards", August 7, 2014, http://dae.nic.in/writereaddata/parl/budget2014_2/rsus3078.pdf

85 International Atomic Energy Agency, Statute of the IAEA, at http://www.iaea.org/About/statute_text.html#A1.13

is to be composed of three persons: one designated by India, another by the IAEA and the third a chairman to be elected by both the arbitrators. In case within 30 days of the notice for adjudication another party does not designate an arbitrator, the party giving notice may approach the president of the International Court of Justice. The president of International Court of Justice may also be approached if the third arbitrator is not elected after the designation of the second arbitrator.

## 4. India's Domestic Regulation

As the control of atomic energy lies with the central government, its body or delegated authorities such as the DAE, its body AMD and the PSU like UCIL undertake regulatory or other atomic energy activities. Yet, a number of other central and state-level institutions -Ministry of Environment & Forests, State Pollution Control Boards, AERB, and Directorate General of Mines Safety-regulate uranium relating activities with the help of laws and regulations which may not have any direct nuclear manifestation. These are general laws and institutions meant to regulate industrial activities in general and other related activities.

The Companies Act, 2013 is another industrial law relevant for uranium industry in India.[86] The 2013 Act has replaced the Companies Act, 1956. The act wants a company to constitute a board and asks the management of the company to follow set procedures in running the company. The 2013 act has provisions for corporate social responsibility policy for Indian companies and constitution of National Financial Reporting Authority. Under Section 135 (5) of the Companies Act 2013, a company with 'net worth of rupees five hundred crore or more, or turnover of rupees one thousand crore or more or a net profit of rupees five crore or more during any financial year'[87] is supposed to spend 'at least two per cent of the average net profits of the company made during the three immediately preceding financial years.'[88] For the functioning of a company, the act maintains that annual general meeting, records, inspection of the records, maintenance and even inspection of documents in electronic form, annual returns, audited financial statement, Internal audit, appointment of auditors well defined powers and duties of auditors and auditing standard and so on are necessary.

The act also prescribes prohibitions and restrictions regarding political contributions, winding up of company, obstruction of investigation proceedings, disclosure of certain Information and so forth. It has provisions for tribunal, punishment, books and papers of company to be evidence, and penalty for furnishing false statement, mutilation, destruction of documents. However, it protects action taken in good

[86] Government of India, Ministry of Law and Justice, "The Companies Act 2013", the Gazette of India, August 30, 2013, at http://www.mca.gov.in/Ministry/pdf/CompaniesAct2013.pdf

[87] Government of India, Ministry of Law and Justice, "The Companies Act, 2013", the Gazette of India, August 30, 2013, http://indiacode.nic.in/acts-in-pdf/182013.pdf

[88] Ibid

faith. The government uses act to make rules and issues circulars, notifications, guidelines, and orders to implement the act.

Uranium mines have to comply with forest related rules and regulation. India has Forest (Conservation) Act, 1980 with Amendments made in 1988, Forest (Conservation) Rules. 2003, amended in 2004 along with guidelines and clarifications. The legal and regulatory mechanisms require project details, justification for locating the project in forest areas, cost of the project, details of

Table 10. Select Rules of the Ministry of Corporate Affairs

| |
|---|
| Companies (Central Government's) General Rules and Forms |
| Companies Regulations |
| Companies (Branch Audit Exemption) Rules |
| Companies (Court) Rules |
| Companies (Preservation and Disposal of Records) Rules |
| Companies (Public Trustee) Rules |
| Companies (Particulars of Employees) Rules |
| Public Trustee (Destruction of Records) Rules |
| Companies (Disclosure of Particulars in the Report of Board of Directors) Rules |
| Companies (Appointment and Qualifications of Secretary) Rules |
| Company Law Board Regulations |
| Company Law Board (Qualifications, Experience and Other Conditions of Service of Members) (Amendment) Rules |
| Company Law Board (Qualifications, Experience and Other Conditions Of Service of Members) Rules |
| The Companies (Compliance Certificate) Rules |
| The Companies (Passing of the Resolution by Postal Ballot) Rules |
| Disposal of Records (in the Offices of the Registrars of Companies) Rules |
| 1. Companies (Cost Audit Report) Rules<br>2. Companies (Auditor's Report) Order |
| 1. Companies(Accounting Standard), Rules<br>2. Companies (Cost Accounting Records) Rules |
| 1. Companies (Filing of documents and forms in XBRL) Rules<br>2. Companies (Filing of Documents and Forms in Extensible Business Reporting Language) Rules |
| Companies (Central Government's) Rules |
| Companies Directors Identification Number (Amendment) Rules |

*Source:* Government of India, Ministry of External Affairs, "The Companies Act", http://www.mca.gov.in/MinistryV2/companiesact.html displacement of people as well as rehabilitation plan and phased reclamation of mine area. The forest related rules ask the UCIL to take an undertaking for bearing the cost of raising and maintenance of compensatory afforestation. When underground mining is done, law requires that surface areas are to be fenced and afforested. There are provisions for punishment of a person or persons guilty of offences under the act. For the entire exercise, the nuclear establishment is supposed to undertake cost-benefit analysis.

Uranium mining has to comply environmental laws and policies of the government of India as well. And India has very impressive legal and regulatory framework for environmental protection. The Water (Prevention and Control of Pollution) Act, 1974, amended 1988, the Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003, the Water (Prevention and Control of Pollution) Cess Act, 1977, amended 1992, the Air (Prevention & Control of Pollution) Act, the Environment Protection Act, the National Environmental Tribunal Act, the National Environment Appellate Authority Act the Forest Conservation Act, 1980, the Public Liability Insurance Act and the National Green Tribunal Act are some of the relevant laws. All the laws are implemented through rules and notifications issued by different government agencies. The objectives of the national environment policy are conservation and efficient use of environment.

Mines and Minerals (Development and Regulation) Act as well as Mineral Conservation & Development Rules along with Mineral Conservation Rules further guide mining and exploration of uranium. The act requires license for reconnaissance, prospecting or mining operations in any area. The UCIL has to take license and have to seek the land on lease from the state government. In fact, the Indian court stopped production of uranium ore because of delay from the state government on the renewal of area where uranium had been mined.[89] The act has the provision for royalties for leasing mine. Under the act, the Government of India regulates excavation or collection of minerals from a mine. It also asks to be taken by mine operators for the purpose of beneficiation of ores to take necessary steps. The mining body is expected to keep record of all the major changes and activities, including new borings and shaft sinking.

89 Probal Sanatani, "Jharkhand Orders Uranium Mine Shut, Supplies Hit", *the Hindustan Times*, September 09, 2014, http://www.hindustantimes.com/india-news/jharkhand-orders-uranium-mine-shut-supplies-hit/article1-1261967.aspx

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 is the new law in India except for one state.[90] The law demands Social Impact Assessment before acquiring any land even if it is for mining. The report has to be made public under this law. It asks for public hearing before acquisition of tribal land. All the rehabilitation and resettlement plans are to be made public. The government through its district-level official is supposed to lay down criteria for land acquisition, and keep an eye on it. Before this act, the Government of India had to act under the Land Acquisition Act of 1894, which was subsequently amended several times. India also has the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 and Panchayats (Extension to the Schedules Areas) Act to regulate land acquisition.

Indeed, self-regulation is the dominant philosophy of the Indian atomic establishment. Yet, the nuclear establishment codifies through mechanisms other than the 1948 Act, which was later replaced by the current Atomic Energy Act in 1962. This Act was amended a few more times. In the initial years, the most significant is the following oft-quoted Bhabha's Directive:

> "Radioactive material and sources of radiation should be handled in Atomic Energy Establishment, in a manner, which not only ensures that no harm can come to workers in the Establishment or anyone else, but also in an exemplary manner so as to set a standard which other organisations in the country be asked to emulate".

India regulates uranium with laws, rules, codes and directives. These controlling regulatory mechanisms have evolved over the years. Currently, the Indian regulatory system categorises natural uranium as a Low Specific Activity (LSA)-1 material. Although the Atomic Energy Act of 1948 was the first law of independent India to govern nuclear energy and relevant activities like uranium exploration, mining and processing, yet directives and different rules and notifications issued by the executive authority have been playing a major role in managing uranium in the country. In India, the industrial policy of 1948 has given the power to undertake atomic science related activities to the central government. Thus, the central government controls nuclear energy; however, maintenance of law and order is a state subject. Security

[90] Government of India, Ministry of Law and Justice, "The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013," the Gazette of India, September 27, 2013, http://indiacode.nic.in/acts-in-pdf/302013.pdf

and safety of mines and transportation of nuclear materials involve security and threat assessment. As a result, state and centre may have to undertake combined or coordinated efforts at some stage of activities relating to uranium.

The Atomic Energy Act 1962 designates uranium as a "prescribed substance", and the use of "prescribed substances" is to be carried out in provisions of the Atomic Energy Act 1962, and the Atomic Energy (working of mines, minerals and handling of prescribed substances) Rules 1984. The Atomic Energy Act of 1962 provides detailed authority to the central government for uranium governance in the country. As uranium governance is multi-dimensional in nature, the provisions for this may be located in different sections of the act. For example, provisions for 'prescribed substance' 'minerals for atomic energy' and even the direct mention of uranium give the mandate for uranium governance in India.

For regulatory and safety tasks, the nodal central government agency is the AERB. A presidential order deriving its mandate from the Atomic Energy Act of 1962 established the AERB on November 15, 1983. It is part of India's Atomic Energy Commission, earlier created in August 1948,[91] reconstituted by the president in August 1954 and came under the DAE in a March 1958 resolution. The Secretary of DAE constitutes the AEC board's full and part-time members. The AEC board also have governmental and non-governmental/retired nuclear scientists both.

For its safety and regulatory work, AERB takes assistance of other DAE bodies. For example, UCIL's website states the following:

> Health Physics Unit and Environmental Survey Laboratory of Bhabha Atomic Research Center carries out in-plant and environmental monitoring of all the UCIL units. The laboratory also evaluates and ensures overall safety in accordance with the standards prescribed by the national and international regulatory bodies like AERB and the International Commission on Radiological Protection (ICRP). Monitoring of radioactivity and radiation level in different matrices in the mine, mill and surroundings is carried out in routine basis and analysed. This facilitates continual improvement in working and living environment. Samples of soil, grass, vegetables, food

[91] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3737, "Permission to Private Sector for Uranium Mining," March 20, 2013, at http://dae.nic.in/writereaddata/parl/bud2013/lsus3737.pdf

stuff and aquatic organisms like algae fish etc. are also analysed to study the environmental impact.[92]

AERB documents reflect publications and guidelines of the IAEA and other multilateral and international bodies. However, if the AERB finds that IAEA codes and guidelines are inadequate for its purposes, it adds its own provisions. Even some of the codes and guidelines for uranium have such provisions. It is also responsible for safety reviews of transportation and training programmes. However, in undertaking all these activities, the AERB has to take into consideration the basic law of the land for nuclear energy governance—the Atomic Energy Act of 1962. The Environment Protection Act of 1986 also provides statutory authority in environment-related regulation and control.

The Atomic Energy Act of 1962 has several provisions for exploration, mining, milling and other activities relating to uranium. Section three (a) and (b) of the act which was added into it through an amendment made in 1987, authorises the central government to constitute a corporation or any other authority for atomic energy and related material work. The section gives authority for production and use of nuclear materials for nuclear energy. Different sections authorise the Indian Government to buy or otherwise acquire, store, transport, restrict or obtain information regarding different activities relating to uranium. The Section four of the act deals with notification of discovery of uranium. Under this section, any person who comes to know about discovery of uranium has to inform the central government about it.

Section five discusses the situation in which a person has been allowed to undertake mining to extract materials other than uranium or other nuclear material. If the person's mining activities lead to extraction of uranium, the central government can either impose certain conditions on the mining or stop mining altogether in that area. Depending on the situation, the central government may give compensation to the person who was given the authority to mine non-nuclear material. However, the law does not mention taking into consideration market price or strategic significance for determining the compensation for taking over the mine. The authority to decide compensation lies with the central government, though a person can go to court to appeal against the verdict.

92 Uranium Corporation of India Limited, Radiological & Environmental Policies", at http://www.ucil.gov.in/web/radiological.html

Section six of the Act prohibits any person to dispose any material or mineral which holds natural uranium; the person may be given compensation, however, it is not mandatory. The amount of compensation in this case too will be determined by the central government. The AMD has been given the "exclusive right to buy from private mine owners" any uranium discovered during mining for other economic activities. The price is determined by the Government of India for any such purchase. Through the Ministry of Mines Note No.3/1/2005.M.VI dated19.12.2008 UCIL is expected to give 2 percent royalty on the compensation it receives to the states where mines are located.[93]

A licence is required to mine, mill and process uranium. As atomic energy is an exclusive subject of central government, only an authority appointed by the central government is empowered to grant licences. This is possibly because the private sector or private company is not allowed to explore, mine or mill uranium. Quite naturally, no foreign entity can get a license for mining, milling and processing uranium in India. All the work comes under the government and the government-owned company under the New Exploration Licensing Policy of Ministry of Petroleum and Natural Gas.[94]

The Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984 explicitly lays down in Section three: "No person shall mine, mill, process and/or handle any ore mineral or other material from which any one or more of the prescribed substances can be extracted, without obtaining a licence in Form B from the Licensing Authority and except in accordance with the terms and conditions of such licence…."[95] Form B is issued by the licensing authority of the DAE; it sets 17 conditions for granting the licence. (See Appendix)

## Safety

For safety of natural uranium-related activities, India has comprehensive legal, regulatory and institutional frameworks. The Directorate General of Mines

[93] Government of India, Department of Atomic Energy, Rajya Sabha, Unstarred Question No 745, "Uranium Deposits in Country", at http://dae.nic.in/writereaddata/rsus040310.pdf#page=7

[94] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3737, "Permission to Private Sector for Uranium Mining," March 20, 2013, at http://dae.nic.in/writereaddata/parl/bud2013/lsus3737.pdf

[95] Government of India, Department of Atomic Energy, "Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984", April 1984, at http://dae.nic.in/writereaddata/AE(WMMPS)%201984.pdf

Safety in India is responsible for general industrial safety; the AERB is the agency responsible for radiation-related safety and State Pollution Control Board too monitors uranium mining activities. The legal framework like the Atomic Energy Act provides general statutory authority. The regulatory framework that contains some general regulatory codes and guidelines applicable to general nuclear activities suggests some concrete provisions. The preparation of these documents takes into account internationally accepted safety criteria for design, construction and operation of nuclear facilities.

The AERB prepares four types of documents: first, safety codes and safety standards; second, safety guides and methods; third, guidelines and fourth, safety manuals. The Indian atomic establishment's own experience combined with the international practices help in formulating these documents. The AERB documents guides on siting, design, construction, commissioning, operation and decommissioning of facilities. Compliance of minimum requirements laid down in relevant safety codes and safety standards is considered mandatory for nuclear facilities. The safety guides and methods basically elaborate the criteria and requirements laid down in safety codes and safety standards. Although compliance of safety guides is not mandatory, however, the concerned authority will have to show to the AERB that the alternative method or plan is better than what is proposed in the guide. Guidelines are formulated in areas where no code exists. They are designed as explained criteria or requirements which do not need safety guides. A safety manual is basically a technical and procedural document for a precise activity or a set of activities.

In India, safety measures for front-end of the nuclear cycle mainly, mining, milling or conversion are found in codes for nuclear power cycle facilities. However, there are specific codes, guidelines, directives and other orders for uranium mining and milling. Safety Review Committee of the DAE came out with the document titled *Radiation Protection Manual for Nuclear Facilities* in 1982. For a long period, this document was referred for radiological safety. At present, *Radiological Safety in Uranium Mining and Milling* (AERB Safety Guidelines No. AERB/FE-FCF/SG-2) is an important document to enforce safety in uranium milling and mining.

The principal statutory document, the Atomic Energy Act of 1962, has useful provisions for nuclear safety. Section eight of the Atomic Energy Act empowers the authority to enter into any site for inspection and when required, safety related inspections may be made. The section 17 explicitly states that the site may be inspected within "reasonable hours" and details safety of facilities including those engaged in mining and processing of natural uranium. Moreover, it instructs the concerned authority to perform periodic health check of people working on the sites, decide on their working hours and days, impose restrictions on working hours if necessary and ensure that people working on the sites have special qualifications required for such work. It authorises the government to prescribe necessary requirements to construct or alter any structure on these sites. The Act allows seizure of materials and other necessary action against the facility if the concerned authority perceives any damage to human beings or property.

Section 24 of the Act lays down penalty for violation of the Act. A person found guilty in a court of law may be imprisoned for up to five years and fined. The person may be given either or both the penalties. Section 25 treats offences by companies like UCIL, its subsection one maintains: "Where an offence under this Act has been committed by a company, every person who at the time the offence was committed was in charge of, and was responsible to, the company for the conduct of the business of the company as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly….". The section covers "director, manager, secretary or other officer of the company." However, the Act notes that if an event happens without the knowledge of the concerned person or company or despite efforts made by them to avert the event, the offence clause will not apply. Yet, the affected party may be compensated. Section 14 of the Act provides compensation for any victim affected by the radiation emitted on any site.

Regulatory provisions for safety to workers, environment and people in general are also in the Environmental Protection Act and the Factories Act, 1948. The Environmental Protection Act does not explicitly mention uranium or nuclear material causing environmental damage; however, it does lay down procedures for any hazardous materials, which may be environmental pollutants. Even the Factories Act of 1948 is general in nature, but its statutory authority to deal with hazardous process is useful for regulatory work for uranium. In general, the Act prescribes providing proper tools, machinery and safe building at the workplace, mechanisms to prevent dangerous occurrences, prevention of employment in case of serious hazards, and so on. Occupational health surveys, offences by workers and liability are important provisions of the Act for ensuring safety. The 1984 Bhopal gas tragedy effected amendments in the Factories Act in 1987 for example, the existing Atomic Energy (Factories) Rules, 1984 got amended to as the Atomic Energy (Factories) Rules, 1996. In fact, even before the Bhopal tragedy, different DAE bodies and the committees appointed by the DAE and the AERB had recommended amendments to the 1984 Rules. In 1996, the AERB started the tradition of appointing its officials as inspectors under the Factories Act, 1948. The amended rules or existing Atomic Energy (Factories) Rules, 1996 apply broad requirements of the Act for nuclear installations, including sites which undertake activities related to natural uranium. The rules lay down provisions for medical inspectors and assign their detailed responsibilities.

*The Atomic Energy (Radiation Protection) Rules, 2004* ensure safety by laying down requirements for radiation symbol or warning sign; development of safety standards and safety codes, surveillance procedures; radiation monitoring systems, dose limits and other regulatory constraints, follow-up actions in cases of exposure in excess of regulatory constraints, including steps to prevent recurrence of such incidents and so on. The 2004 Rules also require employment of radiological safety officer, prohibition of employment of persons under the age of 18, records of workers, health surveillance reports, modifications in work condition of a pregnant worker. Section 20 of the Rules requires reporting of any accident involving a source or loss of a source to the higher authority within 24 hours.

*Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984* stipulates that a company which has been licensed to undertake mining, milling and processing should submit the design of the facility. In the design, the rules expect the site manager to illustrate spots which may generate dust, fumes, toxic gases, liquid effluents and solid wastes containing radioactive as well as toxic substances. The 1984 rules also require information about the local and general ventilation system, methods and equipment available to contain and control the spread of surface contamination, safety devices, protective clothing and appliances. Though duties and responsibilities of the radiological safety officer are mentioned in other rules, the 1984 rules add more responsibilities for safety officer and radiological safety officer to handle uranium mining and milling.

*The Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987* restricts the disposal of contaminated items. Details are provided in different forms which are attached to the annexure of the rules. Though the 1987 rules continued with some of the provisions which other rules had to ensure safety of the site, yet some new mechanisms like making an annual assessment of hazardous substances which may have adverse impact on people and the environment have been included. The rules' provision for quarterly reports may be useful for the competent authority to make an assessment of emerging situations in and around a uranium site.

The AERB does not undertake industrial safety review of uranium mines; however, as mentioned earlier, its safety guidelines on "Radiological Safety in Uranium Mining and Milling" are considered extremely relevant for enforcing radiological safety parameters in uranium mining and milling. The former chairman of the AERB in the very introduction of the document highlights its significance. He writes, "[It] provides guidance for ensuring radiological safety in site selection, design, construction, commissioning, operation, maintenance, waste management, decommissioning and controlling of radiation and occupational health hazards of the uranium mining and milling plants. This document is one of the series of guidelines being prepared by AERB to be followed at various stages of uranium mining and milling with an overall objective of protecting the workers and the public from the harmful effects of radiation associated with nuclear fuel cycle facilities. This document addresses administrative, legal and regulatory framework on radiological monitoring, occupational health aspects and emergency plan for mining and processing of uranium. It also provides guidance for the management of decommissioning of such facilities and monitoring and regulatory control during pre-operation, operation, closure and post-closure period."[96]

The guidelines for radiological safety in uranium mining and milling provides specific course of action to deal with uranium. The guidelines are quite detailed for different aspects of uranium mining and milling activities. Some of main points are as follows:

- Compilation of food/milk production and dietary habits in the area
- Database of the current and the forecast population of permanent residents in the adjacent area
- Meteorological conditions like cyclone
- Hydrological condition
- Seismicity of the area
- Codes and standards for specific design
- Design of the site should contain proper
  - Pumping
  - Material handling equipment
  - Tailings management facilities

[96] Government of India, Atomic Energy Regulatory Board, *Radiological Safety in Uranium Mining and Milling,* AERB Safety Guidelines No. AERB/FE-FCF/SG-2, August 2007, at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/SG-FCF-2.pdf

- Proper analysis of ventilation in the underground mine through mechanically forced air flow
  - Maximisation of ventilation efficiency quotient
  - Mine ventilation monitoring
- Mill Ventilation
  - Equipment and processes producing airborne dust, radon gas and radon daughters need to be segregated and enclosed in confinement
  - Prevent escaping of fine dust and radioactive gases generated during the processes to active areas
  - Complete confinement in the dry material handling and dry concentrate areas.
  - The entire conveyor belt and especially the transfer points fitted with appropriate enclosures.
  - Other appropriate tools
- Prevent formation of dead ventilation zones
- Sufficient exhaust for product drum filling area
- Mechanised packaging and handling of uranium ore and compounds
  - Personal protective equipment (PPE)
- Reports on safety related unusual occurrences (SRUO)
- In-service inspection manual
- Recommendation of the International Commission on Radiological Protection for Airborne Radioactivity
- Monitoring of
  - Radon and radon daughters
  - Long-lived alphae Emitters
  - Gamma radiation
  - Internal contamination
  - External radiation
  - Surface contamination
- Handling of
  - Long-lived radionuclides
  - External radiation
  - Surface contamination
- Radiation exposure records
- Environmental monitoring
- Outline the procedure decommissioning of the uranium mine and mill
- Emergency crew

Radiation Protection for Nuclear Fuel Cycle Facilities (AERB Safety Code NO. AERB/NF/SC/RP) elucidates various necessities and ways to implement safety laws and rules prescribed under different acts and rules. Though this Code is useful for several other activities of the nuclear fuel cycle, Section 1.3 (a) of the Code explicitly mentions its application for uranium mining and milling. The Code uses *Design Basis Accident Conditions* for both situations—normal and accident. Radiation protection programme of the code has several useful details for safety. It expects the licensing authority to check whether radiation shielding and appropriate radiation zoning requirements are in order or not. The fulfilment of these requirements control radiation exposure. It also assigns importance to lay down criteria for design and construction materials for radiation shielding.

The code for radiation protection has developed other provisions to ensure safety. It requires the site to have a proper ventilation system to control the release of radionuclide concentrates in air. It asks the competent authority and designated people to test equipment and structure to prevent any accident. It emphasises on training people undertaking activities relating to uranium. Like other regulatory documents it too prohibits employment of any person under 18, but it goes a step beyond and prohibits any apprenticeship or trainee recruit to a person who is under 16.

## Security

The Indian nuclear establishment has a legal and regulatory framework for uranium security. Whereas safety demands general awareness and dissemination of information, security prefers confidentiality and provides only needed and reasonable information in the public domain. India is a signatory of both the international treaties for nuclear security. It also supports the code of conduct. As a result, India's legal and regulatory frameworks contain provisions of these treaties as well as the code of conduct.

India has refined its existing legal, regulatory, cultural and institutional frameworks to manage the risk and consequences of unauthorised removal of radioactive materials, and sabotage at nuclear power plants. However, the most important aspect of India's nuclear security is the prevalence of a nuclear security culture. The motto that there should not be any complacency is the biggest hallmark. The Indian government undertakes its own threat perception exercise involving its specialised agencies and departments. The threat perception or "Design Basis Threat" guides nuclear security preparedness. India's legal and regulatory framework has adopted the international standards.

Significantly, before the safety and security interface became a dominant theme in the 2012, Seoul Nuclear Security Summit, for the Indian policy making community and the nuclear regulator, the synergy between nuclear security and safety was considered a practical step to optimise resources. For a long period, the legal and regulatory framework echoed the need to maintain the domestic regulatory interface between nuclear security and safety. For example, Clause number 2.19 of AERB document on Nuclear Security Requirements for NPPs [Nuclear Power Plants] notes:

> To maintain interface between safety and security, proper interaction should exist between the site security committee/unit level security committee and station operations review committee (SORC).
>
> Whenever any change is proposed in security plan to meet the security requirements, such changes should be reviewed in SORC also to ensure that these changes will not affect safety.
>
> Similarly, any change made/ outage taken for safety systems (for which credit has been taken in analysis for deciding vital areas) should be reviewed by security committees and alternate security measures should be provided (if required) till the changes in safety systems are completed.

Equally significant is that security emphasises the interface. India has setup a three-tiered review system for nuclear security. The first tier review involves Committee for Reviewing Security Aspects of Nuclear Facility, Committee for Review of Nuclear Security dealing with radiation facilities and for transport of radioactive materials and an overarching Advisory Committee on Security. At the second tier, the safety-security synergy is focused. At this stage, the work is done mainly through safety-related committees, which review the first tier report. Finally, the third stage review is conducted by the top level of the AERB.

India's principal law—the Atomic Energy Act of 1962 also reflects this synergy and interface. Section four, which is about the notification of discovery of uranium, is relevant for nuclear safety and security. Similarly, Section five authorising control over mining or concentration of substances containing uranium; Section six detailing disposal of uranium and Section seven empowering to seek information about materials, plan or processes provide statutory authority for both safety and security. Section eight granting power of entry and inspection to inspector to "make copies of or extracts from any drawing, plan or other document found in the mine, premises or land and for the purpose of making such copies or extracts, may remove any such drawing, plan or other document after giving a duly signed receipt for the same and retain possession thereof for a period not exceeding seven days…" could be relevant for both purposes. Section 14 of the Act controlling production and use of uranium, Section 15 authorising to demand any substance for extracting uranium and Section 16 for allowing control over radioactive substances too have uses for both security and safety.

Of course, there are some separate provisions for uranium security and uranium safety in the Act. For example, Section 17 is exclusively for safety purposes. In the same way, Section 19, which denies access to "prohibited areas" is more useful for nuclear security. This Section restricts taking of "any photograph, sketch, pictures, drawing, map or other document" in the restricted area designated by the central authority.

Atomic Energy (Radiation Protection) Rules, 2004 stipulate physical verification of radioactive material from time to time and an inventory of materials. If there is any loss of material, the competent authority, and the local police are to be informed. The employer has to inform the competent authority within twenty four hours.[97] A licensee has to inform the competent authority and enforcement agency. Though the time limit has not been given in the 2004 rules, yet the action is to be taken within twenty four hours, preferably immediately, after the loss is established by the licensee. The Rules also require proper investigation and maintenance of its record. The Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987 also includes a provision for proper procedures for entry into areas marked as "restricted." It disallows not only entry of unauthorised persons from outside but also restricts entry of insiders or employees working on the site. Even employees who are not working in these restricted areas are not allowed to go.

Indeed, the nuclear security regulatory framework has details for physical protection and material security. The regulation demands that the main plant boundary must have provisions such as watchtowers, patrolable roads and radiation monitors. Security agencies are supposed to undertake routine surveillance of the

[97] Government of India, Department of Atomic Energy, "Atomic Energy (Radiation Protection) Rules, 2004", the Gazette of India, September 11, 2004 at http://dae.nic.in/writereaddata/RPR2004.pdf

nuclear facilities and possess adequate equipment to shield and protect against explosions, missiles, plane crashes, and any other manmade outcome. A facility must have proper access control for personnel, vehicle and material. Even parking of vehicles is controlled. Its design, submitted for approval has to spell out the number of entry points. Section four of the Code for Radiological Safety in Uranium Mining and Milling has an explicit provision titled—Nuclear Security. This section asks the concerned authority to make an assessment of "a) Impact of site and surroundings on nuclear security and (b) Physical protection system, physical barrier, communication etc."

India has taken several other measures for nuclear security. It has constituted a response force. The force responsible for nuclear security conducts mock drills periodically. The concerned body combines planned and surprise inspections to keep the security system efficient and vibrant. The central and alternate central alarm station and distress alarm systems are provided to help security forces in preventing as well as quickly countering any sabotage. The agency responsible for physical security delineates vital areas and new fuel storage areas, sets up communication systems and power supplies and devises contingency plans.

The AERB is responsible for many of the vital nuclear security-related activities. It is the licensing authority, and at the time of granting licence it scrutinises information on nuclear security. As many of the requirements are to be met at the design stage, it ensures that all the parameters for nuclear security are met at this stage. It monitors different activities, including nuclear security-related at the implementation and operational stages of the power plant. The AERB synergises efforts for nuclear security and safety, which optimises resource utilisation as well.

## Transportation

In India, the Safety Code (AERB/SC/TR-1) governs transportation of radioactive material. This Code has also been issued by the AERB. The IAEA document Regulations for the Safe Transport of Radioactive Material has basically shaped the Indian Safety Code. Now, as the IAEA has the revised 2012 version of Regulations for the Safe Transport, Specific Safety Requirements No SSR-6, the AERB is revising the Indian Safety Code. As a result, the India Safety Code is also undergoing changes. The AERB has another guidebook for governing transportation of nuclear materials. This guide is Security of Radioactive Material during Transport (AERB Safety Guide No AERB/NRF-TS/SG-10) published in January 2008.

In the Indian regulatory system, natural uranium needs industrial packaging. As discussed earlier, uranium ores and ore concentrates or "other radioactive material which is essentially uniformly distributed in small quantities in large mass of non-radioactive medium "are treated as low specific activity material. For this kind of material, the regulatory system recommends less stringent transportation mechanisms. For higher radioactive sources, the regulatory system prescribes different kinds of packaging such as

Type A and Type B (U)/B (M) packages. For smaller quantity of items, the code recommends 'Excepted Packages.' However, all the packages are supposed to contain and check contamination so that radiation does not seriously affect cargo handlers and public.

The Indian Code gives consignor means the entity sending the package the most important or primary responsibility to implement rules, regulation and guidelines. The entity sending the package has to choose the right kind of package for transportation. It has to determine the level of radioactivity of materials being transported and accordingly take further action. The Indian regulatory system has "procedures for preparation of packages." A consignor has to follow these procedures for deciding the container in which to send the item. Procedures identify detailed steps for preparing the package and labelling it later. They are as follows:

1. Transport the source only in an approved transport container. Or use the original container in which the fresh source was received. Ensure that it is in good condition.
2. Load the source in the container properly and carefully.
3. Secure the source within the shielded container by means of appropriate locking mechanisms incorporated in the design of the shielded container.
4. Close the lid of the container so that the source is not released during the transport.
5. Load the container in an outer sturdy container such as a wooden or metallic box provided with spacers within for preventing movement of the shielded container inside during the transport. Ensure that the outer container deployed is in a sound condition and is provided with locking facility and strong lifting handles.
6. Lock the outer container and tie it with crossed metal straps and seal it. This is referred to as the 'transport package.'
7. Using a working radiation monitor, measure the maximum radiation levels

on the outer surface of the package and at a distance of 1 meter from the surface and record them. The maximum radiation level at one meter expressed in mSv/h multiplied by 100 is called as the TRANSPORT INDEX of the package (TI).[98]

The Code prescribes that the consignment needs durable, clear and legible marking on the exterior of the package. The regulation demands that on the industrial package provide other details such as addresses of sender and recipient, UN number and proper shipping name. As natural uranium is classified as LSA-1 material, the consignee is free to select any transport for movement of uranium. It may choose one or more than one of these routes—road, rail, sea or air. However, the Code prohibits sending the consignment by shared taxi, bus, the passenger compartment of a train and the passenger cabin of an aircraft. Moreover, the consignment has to clearly demonstrate in document or otherwise that the item in transportation is a radioactive item.

The Safety Code allows the container to go as an item of cargo, but in no case it may go by post. A key is to be carried during transportation, and this key is to be delivered to the recipient, and no one else. In case, the recipient is not found or any emergency situation arises, the competent authority and the DAE are to be informed. The regulation asks the transporter to carry some documents such as Transport Emergency Card (TERMCARD), other emergency related instructions and sender's declaration. Some of the important instructions for the transporter are as follows:

- Transport by the most direct route
- Keep away from Intermediate off-loading and reloading
- Appropriate tool for heavier item
- Avoid Transportation with other dangerous goods such as explosives and inflammables.
- Avoid transportation with photosensitive films/plates.
- No one should sit on the package
- Avoid spending unnecessary time near the package
- Restricted number of packages in a single vehicle
- Consignment to be delivered to a consignee only

[98] Government of India, Atomic Energy Regulatory Board, "Transport of Radioactive Material", at http://www.aerb.gov.in/AERBPortal/pages/English/transport/transport_jsp.action

Security of Radioactive Material During Transport gives highly useful guidelines based on international practices for securing material during transport. The guide aims at preventing "unauthorised removal, sabotage and other malicious acts."[99] This guide has acknowledged practices prescribed in international law and organisations. For example, the guide makes special reference of Annexures 17 and 18 of the Convention on International Civil Aviation and the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air. It also discusses the IAEA method of categorisation in which Category one is the most dangerous and Category five the least dangerous; it recommends improvisation by covering all types of radioactive materials. The idea behind reworking on materials reorganisation is to help parties involved in transportation of materials to make out the level of security for a particular package and consignment. The AERB has listed radioactive materials based on India's own security requirements.

Interface between safety and security for even transportation of uranium is very explicitly mentioned in the foreword of this document. The foreword written by the former Chairman of AERB notes: "Any breach in security during the transport of radioactive material, could have safety consequences resulting in radiation exposure to workers and / or the public in excess of the dose limits."[100] This guide, which is basically developed to secure radioactive materials, uses categorisation made for safety to secure materials during transportation. For industrial packages, the guide maintains that "Prudent Management Practices" are appropriate. For other materials, it wants higher security levels such as Basic Security and Enhanced Security.

As mentioned earlier, natural uranium is categorised as a LSA-1 nuclear material; it has to follow a somewhat relaxed set of procedures. However, it does not mean that it will not follow general procedures related to radiological items. Transportation of LSA-1 item has to follow some general instructions for movement of radioactive material. The guide recognises some key or common requirements during transportation. These are listed as follows:

- Design features
- Access control

[99] Government of India, Atomic Energy Regulatory Board, *Security of Radioactive Material during Transport,* AERB Safety Guide No. AERB/NRF-TS/SG-10, January 2008, at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/sg-10.pdf

[100] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 6550, "Supply of Uranium", May 16, 2012, at http://dae.nic.in/writereaddata/lsus6550.pdf)

- Administrative control (e.g. personnel verification)
- Information control
- Specific training of carrier's personnel (formalised familiarisation programme)
- Tracking of shipment
- Alerting state authorities prior to and during shipment

The guide lays down different kinds of security principles. It provides some basic security principles such as some formal security plans, infusing security culture among stakeholders, proper evaluation of threats and maintaining confidentiality. It gives importance to providing information on a need to know basis. The prominent transport security principles in the guide are quite relevant. It puts emphasis on proper management of transport schedules and route of shipment. It wants the concerned parties not to follow routine kind of routes.

The guide recommends mechanisms to "deter, detect and delay" unauthorised access, identification of malicious acts and alert systems. For different kind of activities different parties have been given responsibility. The government is expected to give proper idea about security threats. Operator or sender is supposed to implement procedures and mechanisms to prevent any malicious act. The consignor has to give its security plan to the government and take security clearance for persons handling transportation of uranium. In fact, consignor is the key point where the determination of the level of security and the required mechanisms for ensuring security of the consignment is determined. Transporter or carrier has responsibilities such as following instructions, keeping a verifiable record and reporting any wrongdoing in the course of transportation. In addition, the recipient has to receive the package/consignment personally or through an authorised person within the stipulated time.

The AERB wants all those involved in transportation to ensure that when responsibility is changed at different stages of transportation, the person responsible for transferring or assuming responsibility must follow the prescribed procedures. It wants advance notification when the responsibility is transferred between two authorities. For the proper management of chain, the AERB document recommends communication and tracking of a shipment. The AERB guide also underlies importance of "physical security measures," and demands that loading, inspection, guarding and surveillance should be done with persons trained for specific purposes, and who are properly equipped.

The guide, in one of the appendixes, discusses how to impart training to parties involved in transportation of nuclear materials. The training, in general, is to raise awareness and familiarise persons involved in transportation of materials about security measures to be taken during transportation to prevent any sabotage or theft of materials. The guide details "function-specific training" for people involved. This starts from recognising the category to the required packaging to emergency response steps. It wants involved parties to recognise all the prescribed documents and instructions. The guide maintains that all the training exercise should not lose the focus on the need for maintaining secrecy, which is at the core of nuclear security.

## Export/Import Regulation

Currently, India is importing, not exporting uranium. Notwithstanding the current status on import/export, India has a very comprehensive legal and regulatory framework for import and export control and for the same purpose, the provisions of Atomic Energy Act of 1962 are available and extremely important. The Foreign Trade (Development and Regulation) Amendment Act, 2010, The Weapons of Mass Destruction and Their Delivery Systems (Prohibition of Unlawful Activities) Act, 2005 and the Customs Act, 1962 are other important acts which provide statutory authority for nuclear exports and import. When India decides to export uranium, it will have a legal, regulatory and institutional system in place for the task.

As discussed earlier, uranium is one of the prescribed substances defined to be regulated under the provisions of the Act. Sections 14(b), 16, and 30 (g) of the Atomic Energy Act of 1962 explicitly entrust the central government to make rules for export and import for nuclear exports. This applies to its exports and imports too. Without the authorisation of the Government of India, no export or import of uranium can take place.

The Weapons of Mass Destruction (WMD) Act, 2005 is one of the new entries in the Indian legal framework. This law implements India's Commitment to the United Nations Security Council Resolution (UNSCR) 1540. One of the principal objectives of the Act was to prevent non-state actors from acquiring sensitive technology, which may be used for developing WMD. The September 11, 2001 incidents have already alerted the world about the danger of WMD terrorism in general and nuclear terrorism in particular.

The WMD Act introduced almost all of the global export control practices to the Indian export control system. The catch all control, which entered into the western system after the 1990 Gulf War, found its way in the Indian export control regime through this Act. However, the phrase catch-all control has not been used. Section 11 of the Act lays down, "No person shall export any material, equipment or technology knowing that such material, equipment or technology is intended to be used in the design or manufacture of a biological weapon, chemical weapon, nuclear weapon or other nuclear explosive device, or in their missile delivery systems." Under the catch-all control, the licensing authority of the supplier country may control or deny an item to a recipient if it is presumed or established that the particular item is going for development of WMD and their delivery vehicles.

The same 2005 Act incorporated deemed export and intangible controls. Deemed export refers to transfer of knowledge to a foreigner residing in the supplier country. This rule, in principle, is relevant to all commercial, research and educational institutions to prevent transfer of knowledge useful for building WMD. Intangible control is basically referred to control of specific information and know-how which is required for development, production or use of any goods. Training and technical services are generally included in intangible control. On the other hand, the forms such as blueprints and prototypes are normally covered under tangible form of control of technology. The 2005 WMD Act also authorised control related to brokerage, transit, transhipment and retransfer. The surfacing of proliferation network made the world realise the significance of brokerage control more than before. The Act further strengthened the end-user requirements.

The DAE maintains that for export and import of uranium Atomic Energy (Working of Mines, Minerals and Handling of Prescribed Substances) rules, 1984, Atomic Energy(Radiation Protection) rules, 2004, Prescribed equipment (Control of Export) Order, 1995 guidelines, guidelines for Nuclear Transfers (Exports), 2006 and 2010 guidelines for co-operation with other countries regarding peaceful uses for atomic energy, which was amended in 2013, are relevant regulatory tools, of these, the most significant are the 2006 and 2010 guidelines.

The 2006 guidelines impose a blanket ban that any nuclear material should not lead to manufacturing of nuclear explosives. They also favour special control of an item which may contribute to nuclear bomb making outside India. The guidelines seek an assurance from the government of the importing country that it will provide physical protection of materials supplied to an entity of that country. Any nuclear material exported or imported will be under the IAEA safeguards. Besides, any material exported to outside may have an extra conditionality from the Indian Government. Similarly, uranium coming in the country will be subject to third-party control.

The 2010 guidelines for implementation of arrangements for cooperation concerning peaceful use of atomic countries with other countries are also relevant for uranium import and export control. They allow export of uranium to a country which is interested in civil nuclear cooperation and trade with India. For transfer, all the conditions of the 2006 rules are to be followed. The 2010 guidelines look for more assurances and require that an application for export of nuclear materials like uranium in the format provided in its schedule-II is made and "authorisation" of an officer of additional secretary is taken for export. The guidelines also underline the possibility of additional information, need for reporting requirements and scope of verification.

On March 31, 1995, India issued a notification whereby it published a list of controlled items. This list was called Special Materials, Equipment and Technology (SMET) list. The SMET list was regularly updated at that time, but on April 1, 2001 was replaced through another notification. The new list is known as Special Chemicals, Materials, Equipment and Technology (SCOMET) and is also updated regularly. The SCOMET list included the items listed on the MTCR and NSG annexes, though these may not be in the same order as the U.S. and other participant countries of the two multilateral export control regimes have.

India has evolved a system for pre-licence screening. It ensures that the supplier is denied licence for violating laws such as Foreign Exchange Regulation Act and Foreign Exchange Management Act or placed on the caution list of Reserve Bank of India. As an end-user undertaking is required, the supplier is also expected to submit the purchase order from the foreign buyer, consignee and end-user along with the technical specification of the item for which a licence is sought. A number of factors resembling the U.S. red flag and "know your customer" are also taken into account before the authority grants the licence. Any nuclear item is to be supplied under safeguards. A supplier is  to specify "port of discharge and route" and the route cannot be changed after the licence is issued.

The Indian Trade Classification (Harmonised System) helps transactions of goods. Technology and service exporters will merely have Importer-Exporter Code. This code may be withdrawn, suspended and cancelled if an exporter violates the condition of licence or relevant Indian laws. Government officials may search, inspect and seize goods, documents, things and conveyances. However, the entire exercise is to be undertaken with certain safeguards and a supplier has the right to appeal against any activity. If a supplier is found violating an act, rules, or an order, a fine of up to five times the price of item may be levied.

The WMD Act along with other acts provides a multi-layered punishment system. A person may be sent to prison depending on the nature of violation of the act. The period may vary from five years to life imprisonment. A supplier may be fined in addition to the imprisonment. The severe punishment will be meted out for the involvement in terrorist activities. The WMD Act has given description of the nature of violation and the punishment and penalty for it.

Import of uranium and its concentrate needs authorisation from Directorate General of Foreign Trade (DGFT).[101] To implement and enforce its export control laws, India has evolved an impressive institutional framework. The DGFT is the nodal agency for implementation of the export controls system and the licensing of goods controlled under SCOMET. SCOMET items are to be divided under eight categories, starting from the Category zero to seven. The Categories zero and four are nuclear items. The items listed under the Category zero are licensed by the DAE. For instance, uranium is a SCOMET item; therefore, its licence, in principle, will be granted by the DAE. However, licence applications are to be submitted at the DGFT.

Any application for the supply of SCOMET items is cleared by an Inter-Ministerial Working Group (IMWG). The Additional director general of foreign trade chairs meetings of the IMWG. The representatives from the Ministry of External Affairs, the Ministry of Defence, the Defence Research and Development Organisation, the Department of Defence Production, the Department of Atomic Energy, the Department of Space, the Indian Space Research Organisation, National Authority of the Chemical Weapons Convention, the Department of Chemicals, the Department of Chemical & Petrochemicals and intelligence agencies participate in the IMWG.

The IMWG has some permanent invitee departments or ministries and others are invited depending on the item for which a licensing judgment is to be made. Each application is cleared on the basis of its merit. For nuclear items, approval comes

[101] Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3715, "Import of Uranium", March 20, 2013, at http://dae.nic.in/writereaddata/parl/bud2013/lsus3715.pdf

from the DAE, while for other items; the approval is given by the IMWG on a consensus basis. It is a standing body that meets every month. A No Objection Certificate is necessary from the relevant members of the IMWG. Licensing authorities are supposed to get back to the company after the IMWG meeting. Licence is granted, denied or marked: "no licence is required." If the information provided in the application is found as not enough, the licensing authorities may ask for additional information.

India's Customs Department has a large staff base and a fully automated system required for enforcing export controls. The Customs Department, and other border control agencies, just need an orientation through training and international interactions to enforce these export controls. The Customs Risk Management System effectively engages challenges of export controls of sensitive items.

## Conclusion

India has a regulatory system is place, where uranium is categorised differently as a prescribed material according to the Atomic Energy Act. On one hand it is treated with great care and sensitivity, considered as a highly relevant strategic material. At another level, uranium is indicated as the source of safeguard material as per international understanding. For safety and security, being treated as a LSA-1, however, in relation to other materials; it has less stringent safety and security procedures for operation.

Less stringent does not mean no or relaxed method of security and safety, but rather the regulatory framework has put adequate best practices and appropriate safety and security practices for uranium governance. The system uses improvised international standards drawing principally from the codes and documents prepared at the IAEA. However, guidelines developed in other international organisations are also consulted and if found appropriate are incorporated. Safeguards, Safety and Security are supposed to run in harmony in the Indian system. The approach is pronounced in the uranium facilities and activities. Indian safeguards have given due place to security in the agreements India has so far signed with the IAEA. Transportation of uranium, a global concern too has been addressed in the Indian system. The code and guidelines are improvised and claims to have zero tolerance for security and safety.

Under no circumstances, uranium procured from outside can be used for strategic purposes. This will be placed under safeguards. Unlike nuclear power plants, India's uranium mines are not separated into civil and strategic categories. All the mines are dual in nature. It may send domestic uranium for bomb or for civil nuclear energy. Importantly, in theory, the India's nuclear weapon programme may also receive support from the increasing domestic uranium base. As India or its mining company UCIL takes economic feasibility as one of the criteria for mining explored mines, so, in principle, India may continue to mine economically profitable facilities for nuclear energy purposes and economically not-so-feasible sites for security purposes; security is less price-sensitive than purely economic activities.

However, considering India's policy enshrined in its nuclear doctrine and the current global nuclear arms control trends, India may not go for an endless pursuit of nuclear weapons. It will calibrate its decision to the emerging nuclear world order and its security. As noted in the past too, India had curtailed its uranium production when it did not see its requirement. In fact, it had made some economic losses because of that decision. Significantly, the decision to curtail uranium production was taken when India had just begun the bomb-making process. However, India may continue with its decision of not making its indigenously mined or produced uranium stockpile public.

India, a producer and consumer of uranium, appears to remain a consumer in the near future because of its nuclear expansion plan, which continues despite the Fukushima incident and the anti-nuclear protests. The uranium shortage forced it to conclude the agreements with several foreign countries after the 2008 India-specific exemptions in the NSG. The shortage for its existing, under construction and planned nuclear power plants also pushed it to explore more uranium sites and open new mines. Soon it will have new mining and conversion facilities in addition to the Jaduguda cluster.

As a result, it has acquired an impressive Indian uranium production base. There is a possibility of the impressive production base combined with the outside uranium procurement further propelling India's nuclear energy quest to meet its energy demands. In principle, India could be an exporter of uranium if its reserve or pool of uranium is of no use for nuclear energy generation. However, this scenario appears to be a remote reality. By its own admission, the DAE will take at least three decades to fructify the closed cycle by planning all the phases of India's ambitious three-stage nuclear energy development. The requirement of uranium for its ever-increasing nuclear reactors does not appear to be diminishing.

Interestingly, even if India does not have a policy of exporting uranium, it has regulatory mechanisms to control uranium exports. Again for export control purposes, India has a more stringent treatment for uranium. It has placed it in the category 0 of the SCOMET. The category 0 items of the SCOMET are licensed by the DAE and they need to undergo rigorous scrutiny.

The DAE has an overarching presence for uranium activities in India. However, it performs the task through a web of organisations. The AERB is the key organisation not only for safety but also for security. In addition, other organisations of the DAE also help in accomplishing its work. Some of the non-nuclear related safety issues are handled by the organisations and departments outside DAE. Uranium security also needs assistance of outside departments and police and paramilitary forces.

The central government cooperates with the state governments in several security areas. Similarly, export and import of materials involves DGFT.

India values international cooperation in uranium supply to its regulation. It continues to interact with the international community bilaterally and multilaterally. Its policy and internal documents today are formed and influenced by several treaties, agreements, statements and understandings. The IAEA and other multilateral organisations have helped the formulation of the Indian codes and guidelines for uranium. In different specialised bodies, India participates and is benefitted by the exchange of ideas. It shares its own experience with the world, at the same time it has to shape its own system with lessons learnt from different countries. India is revising its safety code, which may be relevant for uranium safety. India has pronounced that its safety and security culture does not give any room for complacency. This culture must continue and any regulatory gap would need to be filled in the future.

# Appendices

## Appendix 1.

| *State* | *Name of the Deposit (Location)* | *Uranium Resources Established (In Metric Tonnes U3O8)* |
|---|---|---|
| Andhra Pradesh | Lambapur | 1450 |
| | Peddagattu | 7585 |
| | Tummalapalle-Rachakuntapalle | 63269 |
| | Koppunuru | 2761 |
| | Chitrial | 8473 |
| | *Sub-total* | *83538* |
| Chhattisgarh | Bodal | 1530 |
| | Jajawal | 1438 |
| | Dhumath-Dhabi | 500 |
| | Bhandaritola | 518 |
| | *Sub-total* | *3986* |
| Himachal Pradesh | Rajpura | 364 |
| | Kasha-Kaladi | 200 |
| | Tileli | 220 |
| | *Sub-total* | *784* |
| Jharkhand | Jaduguda | 5100 |
| | Jaduguda Extension | 1600 |
| | Bhatin | 1150 |
| | Narwapahar | 10700 |
| | Narwapahar Extension | 1080 |
| | Turamdih | 3750 |
| | Banduhuran | 5460 |
| | Bagjata | 1860 |
| | Mohuldih | 1700 |
| | Mohuldih Extension | 1630 |

| | | |
|---|---|---|
| | Turamdih (South ) | 4850 |
| | Garadih | 1270 |
| | Kanyaluka | 1970 |
| | Nimdih | 815 |
| | Rajgaon | 1200 |
| | Nandup | 2910 |
| | Central Keruadungri | 1029 |
| | Singridungri-Banadungri | 1764 |
| | Bangurdih | 1140 |
| | *Sub-total* | *50978* |
| Karnataka | Gogi | 4267 |
| | Walkunji-Yellakki | 415 |
| | *Sub-total* | *4682* |
| Maharashtra | Mogarra | 355 |
| | *Sub-total* | *355* |
| Meghalaya | Wahkyn | 5381 |
| | Gomaghat-Phlangdiloin | 1000 |
| | Tyrnai | 600 |
| | Lostoin | 771 |
| | Wahkut | 1161 |
| | Umthongkut | 753 |
| | *Sub-total* | *19738* |
| Rajasthan | Rohil | 5566 |
| | Umra | 1160 |
| | *Sub-total* | *6726* |
| Uttar Pradesh | Naktu | 785 |
| | *Sub-total* | *785* |
| Uttarakhand | Pokhri-Tunji | 100 |
| | *Sub-total* | *100* |
| | *Grand Total* | *171,672* |

*Table Reproduced from:* Government of India, Department of Atomic Energy, Lok Sabha, Unstarred Question No 3601, “Uranium Reserves”, August 24, 2011, http://dae.nic.in/writereaddata/3601_lsus240811.pdf

## Appendix 2. Conditions of Licence

1. This licence may be suspended or cancelled, if any declaration made or information given in the application therefor is found to be false or if any undertaking given in such application is not carried out.
2. No operations shall be carried out for purposes other than those specified under item 9 of the application form.
3. Prescribed substances will not be moved from the authorised installation without prior approval of the Licensing Authority.
4. Prescribed substances shall be transported only in accordance with the relevant safety regulations.
5. Full facilities shall be accorded to any authorised representative of the Licensing Authority to inspect the installation at any time.
6. The prescribed substances shall not be sold, rented or transferred to any other person, without prior approval of the Licensing Authority.
7. Duly qualified/experienced Safety Officer and Radiological Safety Officer shall be appointed before the commencement of the operations.
8. Any changes in the personnel listed in this application shall be intimated forthwith to the Licensing Authority.
9. No modifications in the installation shall be made without prior approval of the Licensing Authority.
10. Medical and radiation surveillance shall be provided for the employees.
11. The Radiological Safety Officer and the Safety Officer shall be provided with requisite facilities to discharge their duties and functions.
12. Information on unusual incidents and accidents shall be sent to the Licensing Authority forthwith.
13. Appropriate records of operations, inventory of prescribed substances and of routine surveillance and disposal of wastes shall be maintained.
14. Information pertaining to operations of mining, milling or otherwise handling of prescribed substances shall not be transferred to any unauthorised person.
15. The technical specifications and the operating conditions as described in the application, shall be maintained under all normal conditions.
16. The conditions attached to this licence as attachments No.1 to No.____ shall be binding on the licensee.
17. A licence shall be valid for a period of three years from the date of issue of the licence.

*Source:* Government of India, Department of Atomic Energy, "Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984", April 1984, http://dae.nic.in/writereaddata/AE(WMMPS)%201984.pdf