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Nuclear Security Governance in India: Institutions, Instruments, and Culture

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Abstract

Nuclear security has gained a great deal of prominence in the recent past thanks to high-level international political attention − especially during the Nuclear Security Summit (NSS) process. India has been an enthusiastic participant in the NSS initiative and is currently in the process of adopting measures to strengthen and enhance its nuclear security governance structures.

India's nuclear security culture is based on the beliefs that a credible threat exists and that nuclear security is important; and that the various recent global initiatives on nuclear security are also in India's own interest. The imperatives of ensuring greater nuclear security in India lies, first of all, in the fact that the country has embarked on an ambitious civil nuclear expansion plan. Secondly, it has a fairly large, dispersed countrywide, nuclear infrastructure that needs to be secured adequately. Thirdly, radiological materials are used in many sectors and chances of their misuse or misappropriation cannot be completely ruled out. Above all, India is situated in a volatile region, and hence, vulnerable to nuclear terrorism.

Therefore, this study takes a comprehensive look at India's approach to nuclear security, in general, and critically examines the physical security measures that the country has put in place. Particular focus is placed on the evolution and strengths, as well as weaknesses, of the country's nuclear security institutions, instruments, practices, and culture. Given that the strengthening of India's nuclear security governance is an ongoing endeavour, the paper also puts forward a number of policy recommendations.

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The views expressed in this paper are those of the authors and do not necessarily reflect on the position of their respective institutions or Sandia National Laboratories.

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NOMENCLATURE

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AERB	Atomic Energy Regulatory Board
AHWR	Advanced Heavy Water Reactor
BARC	Bhabha Atomic Research Centre
BHAVINI	Bharatiya Nabhikiya Vidyut Nigam Ltd.
BSF	Border Security Force
CAG	Comptroller and Auditor General of India
CII	Critical Information Infrastructure
CISAG	Computer Information and Security Advisory Group
CISF	Central Industrial Security Force
CPPNM	Convention on the Physical Protection of Nuclear Material
CSI	Container Security Initiative
CTBT	Comprehensive Test Ban Treaty
DAE	Department of Atomic Energy
DBT	Design Basis Threat
DCI	Department of Commerce and Industry
DFGT	Directorate General of Foreign Trade
DFSL	Directorate of Forensic Science Laboratories
DGCA	Director General of Civil Aviation
DRP	Directorate of Radiation Protection
ENR	Enrichment and Reprocessing
EWA	Early Work Agreement
FBR	Fast Breeder Reactor
FBTR	Fast Breeder Test Reactor
FRFCF	Fast Reactor Fuel Cycle Facility
FTA	Foreign Trade (Development and Regulation) Act
GCNEP	Global Centre for Nuclear Energy Partnership
GICNT	Initiative to Combat Nuclear Terrorism
HEU	Highly Enriched Uranium
HRD	Human Resource Development
IAEA	International Atomic Energy Agency
ICSANT	International Convention for the Suppression of Acts of Nuclear Terrorism
IGCAR	Indira Gandhi for Atomic Research
IGP	Inspector General of Police
IPFM	International Panel on Fissile Materials
IPR	Institute of Plasma Research
IRRS	Integrated Regulatory Review Service
ITDB	International Trafficking Data Base
JNPP	Jaitapur Nuclear Power Plant
JNPT	Jawaharlal Nehru Port Trust
KNPP	Kudankulam Nuclear Power Plant
KRIBHCO	Krishak Bharati Cooperative Ltd.

L&T	Larson & Toubro
LWR	Light Water Reactor
MEA	Ministry of External Affairs
MRDS	Mobile Radiation Detection Systems
MTCR	Missile Technology Control Regime
MUs	Million Units (or Unit) is a gigawatt hour
MWBC	Mobile Whole Body Counter
NALCO	National Aluminum Corporation
NC&PW	Nuclear Control & Planning Wing
NCA	Nuclear Command Authority
NPCIL	Nuclear Power Corporation of India Ltd.
NPPs	Nuclear Power Plants
NPT	Nuclear Non-proliferation Treaty
NSG	Nuclear Suppliers Group
NSRA	Nuclear Safety Regulatory Authority
NSS	Nuclear Security Summit
NTI	Nuclear Threat Initiative
NTRO	National Technical Research Organization
NUMAC	Nuclear Material Accounting
ONGC	Oil and Natural Gas Corporation
OSART	Operational Safety Review Team
PAC	Public Accounts Committee
PFBR	Prototype Fast Breeder Reactor
PHWR	Pressurized Heavy Water Reactor
PPS	Physical Protection System
PRP	Personnel Reliability Program
PSUs	Public Sector Undertakings
PWR	Pressurized Water Reactor
RMP	Rare Materials Plant
SAIL	Steel Authority of India Limited
SASA	Strategic Armament Safety Authority
SCOMET	Special Chemicals, Organisms, Materials, Equipment and Technology
SDV	Screen Distance Value
SFC	Strategic Forces Command
SOPs	Standard Operative Procedures
UCIL	Uranium Corporation of India Ltd.
UGC	University Grant Commission
WANO	World Association of Nuclear Operators
WMD	Weapons of Mass Destruction

EXECUTIVE SUMMARY

Nuclear terrorism and clandestine proliferation continue to pose a serious threat to international security. India fully shares the continuing global concern on possible breaches of nuclear security.

Plenary Statement by External Affairs Minister Salman Khurshid at the Nuclear Security Summit 2014.

India has significant reasons to ensure stringent safe-keeping of its nuclear infrastructure. The worsening regional security environment, clandestine proliferation, and thriving terror and smuggling networks in the neighbourhood, and above all, the unique nature of its nuclear program necessitates nuclear security in India to be a priority. India is conscious of the fact that credible threats to nuclear infrastructure exist; consequently, in coordination with international agencies and stakeholders, it has undertaken several security measures to strengthen its nuclear security system. Over the years, India has nurtured a comprehensive security arrangement in and around its nuclear infrastructure. However, there exists ample scope for further improvements in all aspects relating to nuclear security governance in the county.

In retrospect, India has had a checkered history with the international nuclear order. Initially, it was engaged in nuclear disarmament activism, proposing an end to nuclear testing, and was instrumental in the setting up of the International Atomic Energy Agency (IAEA). Subsequently, as a result of its 1974 nuclear test, a nuclear embargo was imposed, whereby India was denied nuclear technology and material for more than three decades. The end of this moratorium came in 2005, when President Bush and Indian Prime Minister Manmohan Singh began a sustained nuclear dialogue, culminating in an agreement facilitating nuclear cooperation. Today, India is well on its way to becoming an integral part of the international nuclear order. The Indo-US nuclear deal signed in October 2008 virtually ended India's isolation in the global nuclear order. In 2008, the Nuclear Suppliers Group (NSG), which normally prohibits its members from nuclear commerce with states which have not signed the Nuclear Non-proliferation Treaty (NPT), agreed on a special waiver in the case of India.

As of now, India has 21 operational reactors, 6 are under construction, and 16 more are planned based on cooperation with Russia, France, and the US. India is pursuing development of nuclear power plants by using a mix of indigenous Pressurized Heavy Water Reactors (PHWRs), Fast Breeder Reactors (FBRs), and Light Water Reactor (LWRs) based on foreign technical cooperation and fuelled by imported enriched uranium. Beyond 2030, large expansion based on FBRs, and later thorium-based reactors are planned as part of India's closed fuel cycle approach. The three-stage nuclear power program, based on 'reprocess to reuse' strategy, strives to extract the maximum energy from the limited uranium resources, provide (arguably) "inherent proliferation resistance," and ensure long-term energy security.

Besides energy production, India is pursuing comprehensive programs in radiation and isotope technologies for societal benefit in the areas of food preservation, development of superior mutant varieties of seed/crops, nuclear medicine for diagnostics and radiation therapy, industrial radiography, sewage and waste management, etc. These areas have registered phenomenal growth. A large number of radioactive consignments (nearly 80,000 per year) containing radioactive materials are being transported within, and many more also transit through the country. Besides the civilian application of nuclear resources, India has a strategic nuclear program based on the doctrinal posture of 'no-first-use' and 'second-strike' capability.

Owing to the past practice of mixing civil and strategic nuclear programs, nuclear security structure and arrangement in India seem to have been intertwined. With the separation of India's civilian nuclear installations from the strategic programme, India's nuclear security architecture has been streamlined. India's approach towards nuclear security constitutes broadly five elements: institutions; technology; nuclear security practice and culture; governance; and international cooperation. Though India's nuclear organizational structure is well laid out, the relation between the promoting agency (DAE) and the regulatory agency (AERB) requires a fresh look.

In India, security of nuclear facilities and material is the responsibility of the individual operator; the AERB specifies the safety requirements through codes and guides, in which it lays down the necessary requirements. The primary responsibility for the safety of nuclear installations and material, and their transport and disposal lies with the user/facilities. The AERB periodically issues and updates safety and security related documents for the concerned agencies to adhere to.

As the domains of nuclear security and nuclear safety in India have traditionally been considered as two sides of the same coin, the legislative framework and institutional architecture that were responsible for nuclear safety also catered to nuclear security considerations. Various rules were established under the 1962 Atomic Energy Act such as: Atomic Energy (Working of Mines, Minerals and Handling of Prescribed Substance) Rules, 1984; Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987; Atomic Energy (Factories) Rules, 1996; Atomic Energy (Control of Irradiation of Food) Rules, 1996; and Atomic Energy (Radiation Protection) Rules, 2004; the WMD Act 2005 – all in different ways address security related issues of India's nuclear programme. Meanwhile, India has clearly been steadfast in its adherence to the instruments and norms stipulated by the global nuclear security regime.

The Indian nuclear security architecture is based mainly on five pillars: 1) national legal provisions in consonance with IAEA guidelines; 2) oversight agency (AERB) that stipulates the SOPs; 3) the security (and intelligence) agencies in charge of threat assessment and physical protection; 4) the human element (personnel) with the responsibility of oversight or observance; and 5) surveillance and detection technology for detection, delay, and response approach.

The physical protection system around Indian nuclear facilities is designed on the basis of their nuclear threat assessment, taking into account the Design Basis Threat (DBT) and Beyond DBT (BDBT) to create a layered protective envelope – consisting of inbuilt reactor security, material security, perimeter security, personnel reliability, material protection and accounting, transportation security, air and water front defense, emergency preparedness, legal provisions, and in extreme situations, the military protection, etc.

The Central Industrial Security Force (CISF) is in charge of providing security to nuclear facilities in the country. Each nuclear facility is guided by a CISF team headed by a Commandant. At many sites, the CISF team is supplemented by a Special Task Force. A Departmental Committee headed by an Inspector General of Police (IGP) at the Secretariat oversees the physical security at the sites. The CISF has developed the necessary ability to deploy specially-trained First Responders in case of a nuclear emergency. However, the CISF is not in charge of all nuclear related installations in the country.

India has put in place a comprehensive material protection control and accounting programme comprised of three basic elements: (1) the legislative and regulatory framework; (2) an integrated physical protection programme for facilities and materials; and (3) a comprehensive "Nuclear Material Accounting and Control System" (NUMAC). A Nuclear Control & Planning Wing (NC&PW) was created in the DAE as of in 2013 to take "the lead on international cooperation on nuclear security" by integrating DAE's safeguards, export controls, and nuclear security related activities. However, questions have been raised regarding the physical protection at the sites where radiological sources, materials, devices, and instruments are used. Also, smuggling of radioactive materials in and around India is often reported.

One can find that though security concerns are not overlooked, there is the absence of an overarching security apparatus. For instance, the physical security of nuclear installations is provided by multiple organizations such as the CISF, the local police, and sometimes even private security organizations. On the other hand, material accounting is done by the DAE, and the review of security practices is the responsibility of the AERB. Thus, there are multiple organizations in charge of the various aspects of nuclear security in the country, resulting in non-uniform nuclear security culture, norms, and standard operating procedures.

This study has identified a number of areas where much more needs to be accomplished in order to improve the nuclear security culture and architecture in India. First, India should demonstrate more confidence and clarity in the essential elements of its nuclear security practices, and make "transparency" a key feature of its nuclear security culture. In this pursuit, complete autonomy of the regulatory body from the promoting agency should be ensured. In pursuit of controlling the movement of radioactive materials it is suggested that all major Indian seaports should be equipped with technology similar to Container Security Initiative (CSI). Meanwhile, the international community must help mainstream India in the global nuclear order. It would be in everyone's interest to facilitate India's entry into the export control organizations. India can be

invited to observe nuclear security training, practices, simulation exercises, etc. in other nuclear states and vice versa. India and the NSS process should also consider convening Regional Nuclear Security Summits.

In the end, the study also outlines a set of steps that may be undertaken within a specific timeframe to amplify India's nuclear security culture.

1. INTRODUCTION

A nuclear renaissance is on the anvil in India given the widespread belief in the country that nuclear energy is perhaps a credible option in ensuring the availability of great amounts of energy in a relatively short span. This optimism about nuclear energy in India necessitates a debate on the security of the country's nuclear material and facilities. However, in addition to its ambitious plans for nuclear energy expansion, India has other significant reasons to ensure stringent safe-keeping of its nuclear infrastructure. The worsening regional security environment, thriving terror and smuggling networks in the neighbourhood, prevalent domestic dissident groups, and above all, the unique nature of its nuclear program and the exceptions it has bargained for itself over the years imply that nuclear security in India is not just a mere requirement for compliance with the International Atomic Energy Agency (IAEA) recommended guidelines: nuclear security for India is fundamental and indispensable, and it is clearly in its own interests to be more forthcoming about the steps it has taken in this regard. Given India's enthusiastic participation and official statements during the various Nuclear Security Summits (NSS), in 2010, 2012, and 2014, acknowledging the importance of nuclear security, one could say that India is conscious of the fact that credible threats to its nuclear infrastructure do exist. Because of its commitment to the NSS and its own endeavor to secure its nuclear infrastructure, India, in coordination with international agencies and stakeholders, has undertaken several security measures to strengthen its nuclear security system. Since security threats are dynamic in nature, and the global nuclear security regime is still evolving, constant review of the threat and consequent national measures to meet the unfolding challenge are needed.

This study offers a critical examination of India's nuclear security governance – the strengths and weaknesses of the security system in place, taking into account several allegations advanced by a variety of institutions/actors both inside and outside the country. In doing so, an attempt is made to describe the nature and current status of India's nuclear program, India's contemplation of the concept of nuclear security, and its integration with the global nuclear security regime. This study, relying purely on open sources, also scrutinizes the physical protection system (PPS) in place in and around India's civilian nuclear installations. The major conclusion reached by this study is that although India has nurtured a comprehensive security arrangement, there exists ample scope for further improvement in all aspects relating to nuclear security governance in the county.

During the last seven decades of India's involvement with nuclear technology, no major nuclear disaster is known to have occurred with the exception of sporadic misconducts, industrial anomalies, and negligence. Indeed, India claims to have the distinction of over 379 "reactor

years" of safe operation.[1] However, reported smuggling of radioactive materials, terrorists' interest in nuclear assets, and expanding usage of radiological materials in various industrial sectors make it important for India to address the weak links in its nuclear security governance to ensure that there is absolutely no slippage of nuclear technology and material into the wrong hands.

It is pertinent to inquire why India is ranked low in the nuclear security index created by the Washington D.C.-based Nuclear Threat Initiative (NTI), especially since India has a robust non-proliferation record and a long history of dealing with nuclear material. As India regards 'secrecy' as a vital element of its counter strategy to any threat in the nuclear field, it is difficult to get a clear picture from the outside on the security measures in place. Often, unavailability of information is mistaken for the absence of measures. Moreover, the historical complementarities between India's civil and strategic nuclear programs have added to the difficulty in distinguishing the line that separates the related organizations from the safety and security measures in place. Finally, the tradition of secrecy seems to have manifested in a culture of 'insularity' and devotion to 'sticking with the program' as it is. With the Indo-US nuclear deal, followed by the Nuclear Suppliers Group (NSG) waiver, and the India-specific IAEA safeguards agreement, India has been able to widen its civil nuclear network involving various supplier countries and industrial houses. This has heralded the process of India's reengagement with the global nuclear order and, at the same time, a thorough rearrangement of its nuclear safety-security systems.

While aspiring for NSG membership and massive expansion of the nuclear energy program, India has to manage the dual challenge of maintaining its 'responsible state' status at the global level, while promoting greater acceptance of new nuclear energy projects at home with the domestic public. Therefore, this study, while mapping the contours of India's nuclear security architecture in place, recommends that India develop confidence in its nuclear status to nurture 'transparency' as a major factor in its nuclear security culture; nuclear information management through calibrated academic curricula; and graduated autonomy of the regulatory system, including adoption of international best practices across the board.

Owing to unavailability of information and sensitivities involved in the steps India takes to prioritize nuclear weapons security, this study focuses mainly on the civilian nuclear facilities and program. The effort is to bring to the fore the major aspects of the nuclear security architecture in India, which is largely understudied, and highlight the scope for improvement in various domains related to nuclear security management.

[1] Statement by Ratan Kumar Sinha, Chairman of the Atomic Energy Commission and Leader of the Indian Delegation to the 57th General Conference, Viena, 18 September 2013. Available at http://dae.nic.in/writereaddata/gc2013_stmt.pdf, p. 2.

2. INDIA AND THE GLOBAL NUCLEAR ORDER

India has had a checkered history with the international nuclear order. It has engaged in anti-nuclear activism, proposed an end to nuclear testing in 1954 after the United States (US) nuclear testing in Bikini Atoll[2], and signed the Partial Nuclear Test Ban Treaty (PTBT) in 1963. India played a major role in the discussions to establish the IAEA and actively participated in the negotiations on the Nuclear Non-proliferation Treaty (NPT), but decided not to sign when it became clear that it would become an unequal treaty. As Scott Sagan points out, "In the actual negotiations creating the NPT text, Sweden and India proposed to include a commitment to a number of 'tangible steps,' including security assurances for non-nuclear-weapons states, an end to nuclear testing, and a freeze on the production of nuclear weapons in the treaty. The US and the Soviet Union refused to allow such specific measures to be included in the final text of the NPT."[3] India, although not a party to the NPT, voluntarily made subject six of its nuclear reactors to IAEA inspections even though it was under no obligation to do so. The Indian nuclear tests of 1974 prompted a number of NPT countries to set up the NSG, in order to govern the supply of nuclear materials and technology.

As a result of the 1974 nuclear tests, a nuclear embargo was imposed on India whereby India was denied nuclear technology and material, such as nuclear fuel and uranium. This prevented the Indian scientists from getting adequate exposure to international nuclear research and institutions, and unfortunately, early indoctrination into a culture of safety and security. This also, in a sense, led to an unhealthy tradition of secrecy regarding nuclear matters in India, as the Indian nuclear establishment had to keep the developments in the country's nuclear program under wraps so that it was not interrupted by external actors.

2.1 India's Integration with the Global Nuclear Order

Despite its past, today, India is well on its way to becoming an integral part of the international nuclear order, both in its strategic and civilian nuclear programs. Sustained nuclear dialogue with the United States began in 2005, when President Bush and Indian Prime Minister Manmohan Singh began discussing nuclear cooperation. This engagement led to a new Indo-US partnership, which, in turn, redefined the Indian engagement with the international nuclear order. After years of sustained negotiations, India and the US announced an Indo-US nuclear deal in 2005, and eventually signed it in October 2008, virtually ending the Indian isolation in the global nuclear order. The bargain the two countries had struck was a useful compromise: New Delhi didn't have

[2] Indian Prime Minister Jawaharlal Nehru asked the two superpowers to reach a 'Standstill Agreement' on nuclear weapon testing. Text of Nehru's demand is available at: http://www.pugwashindia.org/Issue_Brief_Details.aspx?Nid=73

[3] Scott D. Sagan, "Convenient Consensus and Serious Debate about Disarmament," Discussion Paper Presented to the Working Group on an Expanded Non-Proliferation System, Washington, DC, June 8-9, 2010. Available at http://www.nti.org/media/pdfs/ConvenientConcensusDebateDisarmament-ScottSagan-060610_2.pdf?_=1326132026

to give up its nuclear weapons to be part of the international nuclear order; and the NPT did not have to be rewritten to accommodate India.

In 2008, after considerable negotiations, the NSG, which normally prohibits its members from nuclear commerce with states which have not signed the NPT, agreed on a special waiver in the case of India.[4] However, there is a certain lack of clarity as to whether India will be able to benefit from enrichment and reprocessing (ENR) technology transfer, for which the NSG is now framing new rules. In amending its guidelines in 2011, the NSG stressed it would restrict ENR commerce to parties to the NPT. However, the US, France, and Russia have said that they will continue with the clean exemption the NSG gave India in 2008, meaning the future NSG guidelines would not adversely affect their ENR trade with India.[5]

India has played an active role in the IAEA since its inception and has always emphasized the importance of the latter's role in promoting the peaceful uses of nuclear science and technology, as well as extended support to its safety-security-safeguards related responsibilities. India has been participating in IAEA's Advisory Groups and Technical Committees and contributes to its activities by providing experts, organizing training programs and workshops, and providing equipment. India is one of the founding members of the IAEA's International Project on Innovative Reactors and Fuel Cycles (INPRO). It also contributes $50,000 annually towards the program.[6]

On February 02, 2009, India and the IAEA signed an Agreement for Application of Safeguards to Civilian Nuclear facilities in India that entered into force on May 11, 2009. As part of the Agreement, India pledged to place 14 civilian reactors under the IAEA inspection regime.[7] India is implementing a separation plan for civilian and military reactors/facilities so that there is no cross-feeding of nuclear material from one to the other. As of March 2014, India has placed 20 nuclear facilities under the IAEA safeguards.[8]

2.2 India and the International Export Control Regime

Other than the major treaty commitment of the NPT, one of the major features of the contemporary nuclear order is the existence of international nuclear cartels. These export control

[4] Wade Boese, "NSG, Congress Approve Nuclear Trade with India," *Arms Control Today*, October 2008. Available at https://www.armscontrol.org/act/2008_10/NSGapprove

[5] SiddharthVaradarajan, "Challenges ahead for India's nuclear diplomacy," *The Hindu*, November 01, 2011. Available at http://www.thehindu.com/todays-paper/tp-opinion/challenges-ahead-for-indias-nuclear-diplomacy/article2586970.ece

[6] "India and the IAEA," Indian Embassy (Vienna), Government of India. Available at http://www.indianembassy.at/pages.php?id=64

[7] "India notifies separation plan to IAEA," *Economic Times*, October 16, 2009. Available at http://articles.economictimes.indiatimes.com/2009-10-16/news/27657210_1_separation-plan-iaea-board-safeguards-agreements

[8] "Agreement between the Government of India and the International Atomic Energy Agency for the Application of Safeguards to Civil Nuclear Facilities," INFCIRC/754/Add.5. 28 March 2014. Available at http://www.iaea.org/Publications/Documents/Infcircs/2014/infcirc754a5.pdf, pp. 1-2.

organizations have traditionally sought to isolate India. However, post-2008, New Delhi has also been in negotiations to gain membership of various international export control regimes: the NSG, which 'governs the export of items that are especially designed or prepared for nuclear use;'[9] the Missile Technology Control Regime (MTCR), which aims to control the 'non-proliferation of unmanned delivery systems capable of delivering weapons of mass destruction, and which seeks to coordinate national export licensing efforts aimed at preventing their proliferation;'[10] the Australia Group (AG), which 'seeks to ensure that exports do not contribute to the development of chemical or biological weapons;'[11] and the Wassenaar Arrangement (WA), which aims to promote 'transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies, thus preventing destabilizing accumulations.'[12] Of the four, the NSG, which deals directly with nuclear issues, is the most significant in regard to the civilian reactors in India. While New Delhi formerly viewed these informal arrangements as technology-denial regimes, today it feels the need to engage them in a mutually beneficial manner.

Although India has not been admitted to any of these strategic associations, membership remains a possibility since India fulfills most of the criteria for inclusion in these groups. According to Rajiv Nayan, "India fulfills all the membership criteria of the MTCR and the Australia Group. Similarly, it also fulfills all the criteria for the NSG, except on the counts of NPT adherence and some existing nuclear free zone treaties. Equally, India fulfills the adherence criteria for the Wassenaar Arrangement, except in the NPT."[13] Even as New Delhi would prefer the membership of NSG to that of the others, it is the membership of NSG that is the most difficult to obtain.

India has also revised its domestic export control regime to align it with the control lists stipulated by the various international export control organizations. Rajiv Nayan writes: "The Special Chemicals, Organisms, Materials, Equipment and Technology (SCOMET) list is the principal regulatory mechanism for Indian export controls. It is regularly updated and expanded frequently, depending on the pace of technology… The Indian export control system was revamped in keeping with the guidelines and technology control lists of the NSG and the MTCR as per the July 18, 2005 joint statement."[14]

India has been an enthusiastic participant in the NSS process started in 2010. It supported the Washington Summit Communiqué and Work Plan of the first NSS in 2010, and announced that it would establish a Global Centre for Nuclear Energy Partnership, which has since been formed. India hosted a NSS 'Sherpa' preparatory meeting in New Delhi on January16-17, 2012. At the

[9] For more on NGS see http://www.nuclearsuppliersgroup.org/Leng/02-guide.htm
[10] For more on MTCR see http://www.mtcr.info/english/
[11] For more on the Australia Group see http://www.australiagroup.net/en/index.html
[12] For more on the Wassenaar Arrangement see http://www.wassenaar.org/introduction/index.html
[13] Rajiv Nayan, "Integrating India with the Global Export control Systems: Challenges Ahead," *Strategic Analysis*, 35: 3, 2011, p. 443.
[14] Ibid, p. 441.

second NSS in 2012, India pledged $1 million towards the IAEA's Nuclear Security Fund for 2012–13. Many view that "the summits failed to convince New Delhi to increase transparency" and "have proved unable to break through India's penchant for secrecy on what it considers to be matters of national security…."[15] India was also an enthusiastic participant at the NSS 2014.[16] In the Plenary Statement, the leader of India's delegation, External Affairs Minister Shri Salman Khurshid, underlined that "India had not wavered in its commitment to global efforts to prevent the proliferation of weapons of mass destruction and their means of delivery."[17] India has also declared its intention to establish an independent Nuclear Safety Regulatory Authority (NSRA) to enhance oversight of nuclear security and strengthen synergy between safety and security.[18] The legislation to establish the Authority was tabled in the Indian Parliament, but the bill has since lapsed, as the last session of the 15th Lok Sabha could not pass the bill before the general elections in April 2014.[19] The new government is likely to reintroduce the bill in the parliament soon.

[15] P. R. Chari, "India's Role in the Hague Nuclear Security Summit", *Proliferation Analysis*, March 18, 2014. Available at http://carnegieendowment.org/2014/03/18/india-s-role-in-hague-nuclear-security-summit/h4iw

[16] Nuclear Security Summit 2014, "National Progress Report – India,"https://www.nss2014.com/sites/default/files/documents/india.pdf ;P.R. Chari, "India's Role in the Hague Nuclear Security Summit," *Proliferation Analysis*, Carnegie Endowment. March 18, 2014. Available at http://carnegieendowment.org/2014/03/18/india-s-role-in-hague-nuclear-security-summit/h4iw

[17] Statement by Bhaswati Mukherjee, "3rd Nuclear Security Summit The Hague, Netherlands (March 24-25, 2014)."Available at http://mea.gov.in/in-focus-article.htm?23194/3rd+Nuclear+Security+Summit+The+Hague+Netherlands+2425+March+2014, 09 April 2014.

[18] "Nuclear Security Summit National Progress Report," India, March 27, 2012. Available athttp://www.mea.gov.in/bilateral-documents.htm?dtl/19074/. For more details on the Indian participation at the 2012 NSS meeting see, http://www.mea.gov.in/global-issue-detail.htm?85/Nuclear+Security+Summit+2012

[19] "The Nuclear Safety Regulatory Authority Bill, 2011." Available at http://www.prsindia.org/uploads/media/Nuclear%20Safety/Nuclear%20Safety%20Regulatory%20Authority%20Bill%202011.pdf

3. STATE OF INDIA'S NUCLEAR PROGRAM

The 'Integrated Energy Policy of India' considers the role of nuclear power, among other options, as "the most potent means to long-term energy security," and therefore prescribes "accelerated development of nuclear source for sustainable development of the country."[20] The Nuclear Power Corporation of India Ltd. (NPCIL) has planned to launch 16 more reactors – eight 700 MW Pressurized Heavy Water Reactors (PHWRs) and eight Light Water Reactors (LWRs), based on cooperation with Russia, France, and the US – at an outlay of Rs 230,000 crore (approximately $3.8 billion USD (September 2014 rates) during the 12th Five Year Plan period (FYP) (2012-17).[21] The total installed capacity is scheduled to reach 9,980 MWe during this planning period which will help India in "building strategic stockpile of nuclear fuel to counter the risk of disruption of international fuel supply".[22]

Today, nuclear energy constitutes around 3% of the total electricity produced in the country and the vision is "to have 14,600 MWe nuclear capacity on line by 2020;" in the long-term, India aims "to supply 25% of electricity from nuclear power by 2050."[23] With the civil nuclear agreement with the US, the India-specific safeguards agreement with IAEA, and the NSG waiver in 2008, India has initiated civil nuclear cooperation with around two dozen countries and three dozen industrial houses.[24] Currently, 21 nuclear power reactors are in operation in six states producing around 5000 MW. Six reactors under construction are expected to generate an additional 4,800 MW, while another 33 are planned.[25]

Nuclear power output has increased by over 80% (i.e., from 18,634 million units (MUs)[26] in 2006-07 to 35,333 million units during 2013-14).[27] Uranium supplies from Canada, France, Kazakhstan, and Russia have helped Indian reactors to operate with high capacity. The capacity factor rose to 79% in 2011-12 from 71% in 2010-11. Nine reactors recorded an unprecedented 97% capacity factor during 2011-12, and with imported uranium from France, the Kakrapar reactors recorded 99% capacity factor during 2011-12.[28] The target of nuclear energy generation in the 11thFive Year Plan (2007-2012) was 163,395 MUs, which was revised to 124,608 MUs.

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[20] Government of India, "Integrated Energy Policy: Report of the Expert Committee," 2006, Planning Commission, New Delhi, p. xxii.
[21] "Nuclear Power Corporation of India to Launch 16 New Nuclear Reactors," *The Economic Times*, June 01, 2012.
[22] Press Information Bureau, Government of India, "Integrated Energy Policy." Available at http://www.pib.nic.in/newsite/erelease.aspx?relid=46172, December 26, 2008.
[23] "Nuclear Power in India", http://world-nuclear.org/info/Country-Profiles/Countries-G-N/India/?, September 2014.
[24] Sitakanta Mishra, "India's Civil Nuclear Network," *Air Power Journal*, Vol. 5, No. 4, (October-December 2010), pp. 107-32.
[25] Nuclear Power Corporation of India Ltd., "Nuclear Power Generation (2006-07 to 2014-15)," http://www.npcil.nic.in/main/AllProjectOperationDisplay.aspx; "Status of Projects Under Construction," http://www.npcil.nic.in/main/ProjectConstructionStatus.aspx
[26] 1 MU = 1 Gigawatt-hour
[27] NPCIL, "Nuclear Power Generation (2006-07 to 2014-15)." Available at http://www.npcil.nic.in/main/allprojectoperationdisplay.aspx
[28] Namrata V Lotia, et al, "Development of Framework for the Evolution of Alternative Energies Supply and Demand: A Review," *IOSR Journal of Mechanical and Civil Engineering*. Available at http://iosrjournals.org/iosr-jmce/papers/ICAET-2014/me/volume-6/13.pdf?id=7622, p. 58.

But, "the actual generation in the 11th Five Year Plan was 109,642 MUs".[29] Reportedly, this "target could not be achieved because of non-availability of uranium."[30] The Unit 1 reactor at Kudankulam Nuclear Power Plant (KNPP) attained its full power status on June 07, 2014.[31] On April 19, 2014, India and Russia signed a framework agreement for building the third and fourth units of the KNPP.[32] A Memorandum of Understanding (MoU) has been signed for an Early Work Agreement (EWA) between NPCIL and Westinghouse for the Mithivirdi plant in Gujarat.[33] Meanwhile, India and France have reportedly agreed on the cost of power that will be generated by Jaitapur Nuclear Power Plant (JNPP) in Maharastra.[34] During his July 2014 visit to Bhabha Atomic Research Centre (BARC), Prime Minister Narendra Modi said "the DAE should strive to meet the target of increasing nuclear capacity threefold from the present level of 5,780 MW by 2023-24, within the projected cost."[35]

3.1 The Three-Stage Program

In a quest to leverage its nuclear industry, India is pursuing development of nuclear power plants using a mix of indigenous PHWRs, Fast Breeder Reactors (FBRs), and LWRs based on foreign technical cooperation and fuelled by imported enriched uranium. In addition, these plants are planned to be under IAEA Safeguards. Presently, 15 PHWRs, totaling around 3,800 MWe capacity, are in operation. Among the other designs, sixteen more PHWRs of 700 MWe at five different inland sites are planned.[36] Today, the PHWRs comprise over 80% of India's installed nuclear reactors, and are claimed to have some safety and operational advantages over the PWRs "such as not requiring refueling outages, as well as greater fuel cycle flexibility…can more easily utilize lower enriched uranium, reprocessed fuel, and potentially thorium."[37] Beyond 2030, large expansion based on FBRs, and later thorium-based reactors are planned as part of

[29] "Uranium Shortage Hit Nuclear Power Generation Target in 11th Plan,", *Firstpost.com*, 23 July 2014. Available at http://www.firstpost.com/india/uranium-shortage-hit-nuclear-power-generation-target-11th-plan-1631071.html
[30] Ibid.
[31] PallavaBagla, "Kundankulam Nuclear Plant Attains Full Power Status for First Time,", *NDTV.com*, June 07, 2014. http://www.ndtv.com/article/india/kundankulam-nuclear-plant-attains-full-power-status-for-first-time-537695?pfrom=home-lateststories.
[32] Alexander Korablinov, "Rosatom Chief Confirms Kudankulam 3 & 4 Agreement Signing," *Russia & India Report*, 23 May 2014. Available at http://in.rbth.com/economics/2014/05/23/rosatom_chief_confirms_kudankulam_3_and_4_agreement_signing_35451.html
[33] "Westinghouse Signs MoU for Building N-Plants in India,, *Zeenews.india.com*, June 13, 2012. Available at http://zeenews.india.com/news/nation/westinghouse-signs-mou-for-building-n-plants-in-india_781702.html.
[34] "India, France Agree on Cost of Power Generated by Jaitapur Nuclear Power Plant," *The Economic Times*, March 09, 2014.
[35] "India's Nuclear Capacity could Jump Threefold by 2023-24: Modi," *Business Standard*, July 22, 2014. Available at http://www.business-standard.com/article/current-affairs/india-s-nuclear-capacity-could-jump-threefold-by-2023-24-modi-114072101107_1.html.
[36] Sinha, n. 1, p. 3.
[37] Bill Linton, "Market Overview: The Outlook for Nuclear Power in India", April 16, 2014. Available at http://www.power-eng.com/articles/npi/print/volume-7/issue-2/nucleus/market-overview-the-outlook-for-nuclear-power-in-india.html.

India's closed fuel cycle approach[38] – this three-stage nuclear power program strives to extract the maximum energy from the limited uranium resources, provide (arguably) "inherent proliferation resistance,"[39] and ensure long-term energy security.

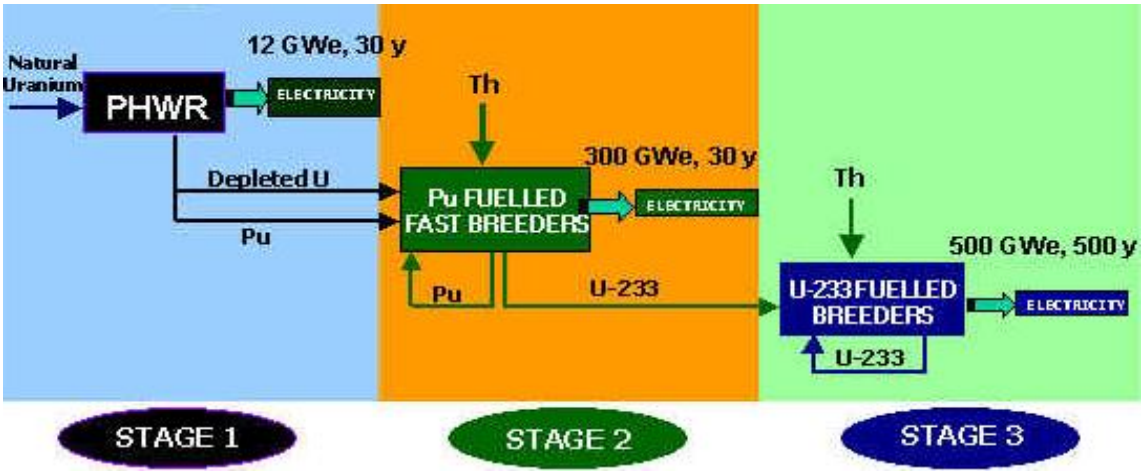

Figure 1: India's Three-Stage Nuclear Power Program

Source: http://www.barc.gov.in/reactor/tfc_3sinpp.html

The three-stage Indian nuclear power program, according to India's nuclear establishment, is devised to utilize the available resources efficiently and in a sustainable manner. The essence of the 'reprocess to reuse' nuclear strategy is that it avoids both the buildup of stockpiles as well as the need to store large amounts of spent fuel that could be prone to malefactors. The first stage, which mainly comprises the PHWRs, uses the domestic natural uranium as fuel to generate electricity. In this stage, natural uranium (U235, 0.72%) undergoes fission and a portion of the remaining U238 gets converted to Pu239; the spent fuel generated from this stage will be "reprocessed to recover" the Pu239 to be utilized as fuel in the FBRs in the second stage.[40] These reactors, besides using Pu239 as fuel, will also make use of thorium as blanket in the reactor core. The thorium (Th232) will undergo nuclear mutation in the reactor core to produce U233. Therefore, the second stage constitutes the FBRs along with reprocessing plants and plutonium-based fuel fabrication plants. The U233 produced in the second stage, along with thorium, will be used as fuel in the third stage of reactors, thus "to make optimum use of our vast thorium reserves for sustained power generation to cater to the long-term needs of the nation."[41]

[38] BARC, "Indian Programme on Reprocessing." Available at http://www.barc.gov.in/publications/eb/golden/nfc/toc/Chapter%206/6.pdf
[39] Ibid.
[40] Ramendra Gupta, "Nuclear Energy Scenario of India." Available at http://www.ucil.gov.in/web/nu_energy_of_india.pdf
[41] Interview with *IEEMA Journal*, Dr S K Jain, CMD, NPCIL, *Face2Face*. Available at http://npcil.nic.in/pdf/ten_06feb2012_01.pdf, p. 48.

Currently, India is entering into the second stage of the three-stage program and has established three reprocessing plants to extract plutonium.[42]

According to AEC Chairman R.K. Sinha, "The construction of the 500 MWe Prototype FBR (PFBR) is nearing completion at Kalpakkam" and expected to achieve criticality this year.[43] A co-located Fast Reactor Fuel Cycle Facility (FRFCF) to reprocess and re-fabricate the fuel from PFBR is also being built at Kalpakkam with the cost of 9,600 crore (roughly $1.5 billion based on November 2014 exchange rates).[44] A Fast Breeder Test Reactor (FBTR), fuelled with unique mixed carbide fuel, located at the Indira Gandhi Centre for Atomic Research (IGCAR), has "performed well,"[45] providing valuable operating experience and technical inputs. An Advanced Heavy Water Reactor (AHWR) is under development by BARC "to expedite the transition to thorium based systems." [46] The successful running of the KAMINI research reactor at Kalpakkam, based on uranium-233 fuel derived from thorium marks the beginning of the third stage of operation.[47] It is viewed that "this mammoth program has the potential to provide energy security to the country for about 400 years supplementing the potential of other resources."[48]

For expediting its ambitious nuclear industry, India imports about 40% of its uranium requirements.[49] While reaching out to potential uranium suppliers across the globe, India also plans for optimal utilization of the country's scarce uranium resources. In four States, 13 uranium mining projects are currently in different stages of exploration.[50] The two Processing Plants at Jaduguda and Turamdih prepare yellow cake and send it to the Nuclear Fuel Complex at Hyderabad for further processing into UO2 pellets. The plant at Jaduguda has the capacity to process 2500 tonnes of ore per day.[51] India has continued to make progress in finding new uranium resources in the country through extensive exploration work, using multiple technologies. In 2012, with the use of advanced techniques, India has been able to identify new sources of uranium and reserves have registered an increase of about five percent.[52] During 2012-13, the "performance of all operating units of UCIL has been quite satisfactory, recording

[42] Gupta, "Nuclear Energy Scenario of India."
[43] "DAE Aims to Produce More Fuel this Year, Assures Sinha", October 01, 2014. Available at http://freepressjournal.in/dae-aims-to-produce-more-fuel-this-year-assures-sinha/
[44] "Rs 9,600-crore Nuclear Fuel Facility to Come up at Kalpakkam," July 20, 2013. Available at http://www.dnaindia.com/india/report-rs9600-crore-nuclear-fuel-facility-to-come-up-at-kalpakkam-1863491
[45] "IGC Annual Report 2012." Available at http://www.igcar.ernet.in/igc2004/igcanr2012.pdf, p. 12.
[46] S.V. Kumar, "Reprocessing In India: Development, Demonstration And Deployment." Available at http://www.barc.gov.in/presentations/svkspeach.html
[47] "Ramtanu Maitra", Thorium: Preferred Nuclear Fuel of the Future. Available at http://www.21stcenturysciencetech.com/Articles%202005/Thorium_nuclear.pdf, p. 46.
[48] ibid
[49] "Nuclear Power in India," World Nuclear Association, 30 July 2014. Available at http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/India/.
[50] Uranium Corporation of India Ltd., "Uranium Occurrence and Production Centres in India." Available at http://www.ucil.gov.in/web/operetions_of_ucil.html
[51] Gupta, p. 7.
[52] Statement by Ratan Kumat Sinha, Chairman of the Atomic Energy Commission and Leader of the Indian Delegation to the 57th General Conference, Vienna, 18 September 2013. p. 4.

highest ever mineral production as well as ore processed and dispatch to Nuclear Fuel Complex."[53] The monitoring of the recovery process of uranium and by-products from the ore is undertaken by the UCIL Control Research & Development Department.[54]

To achieve the target and judicious mobilization of expertise and resources, India has put in place an integral and coordinated framework involving specialized agencies, academic institutions, public sector undertakings, and private industrial houses. By mobilizing both domestic and international stakeholders, India plans to strengthen its technological and human resource base and acquire more uranium and technology. Assuming India receives NSG membership, India aspires to participate in international nuclear commerce as a supplier. As a long-term strategy, India has plans to diversify its nuclear industry, involving both domestic and international private industrial houses such as Larson & Toubro (L&T), Tata, Relience, Punj Lloyd, Westinghouse, Areva, GE, Sandpit, etc. In order to reduce the burden of the two Public Sector Undertakings (PSUs) in charge of nuclear-related activities – NPCIL and BHAVINI – India is planning to diversify the operational and management responsibilities of nuclear plants among other PSU. The National Aluminum Corporation (NALCO), Indian Oil Corporation, Indian Railways, Oil and Natural Gas Corporation (ONGC), Steel Authority of India Limited (SAIL), and NTPC have also expressed interest in such projects.[55] However, diversification of the nuclear energy program, though warranted, will equally pose additional safety-security challenges.

3.2 Use of Radiological Material

Besides energy production, India is pursuing comprehensive programs in radiation and isotope technologies for societal benefit in the areas of food preservation, development of superior mutant varieties of seed/crops, nuclear medicine for diagnostics and radiation therapy, industrial radiography, sewage and waste management, etc. These areas have registered phenomenal growth. In the medical sector alone, more than 57,443 medical X-ray units are in operation in various parts of the country.[56] According to a 2008 Atomic Energy Regulatory Board (AERB) estimate, radioactive materials used in India for industrial and medical applications are estimated at over 12,000 devices, which include 300 telecobalt therapy units, 100 accelerators, over 2,000

[53] Uranium Corporation of India Ltd., *46th Annual Report 2012–2013*. Available at http://www.ucil.gov.in/web/Annual%20Report%20-%20English%20-2012-13.pdf, p. 9.
[54] "Control Research and Development." Available at www.ucil.gov.in/web/control_research_&_development.html
[55] "Nuclear Power in India," World Nuclear Association, July 30, 2014. Available at http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/India/, p. 12-14.
[56] "Report of the Comptroller and Auditor General of Indian on Activities of Atomic Energy Regulatory Board for the Year Ended March 2012," Report No. 9 of 2012-13. Available at http://www.indiaenvironmentportal.org.in/files/file/Performance%20audit%20on%20activities%20of%20Atomic%20Energy%20Regulatory%20Board.pdf

computed tomography scan units, 150 nuclear medicine centers, 1400 industrial radiography cameras, 8000 nucleonic gauges, and 14 gamma radiation processing plants (Fig. 2).[57]

TYPE OF MACHINES	NUMBERS
Medical X-ray Units	57,443
Telecobalt Therapy Units	300
Accelerators	100
Computed Tomography Scan Units	2000
Nuclear Medicine Centres	150
Industrial Radiography Cameras	1400
Nucleonic Gauges	8000
Gamma Radiation Processing Plants	14

Figure 2: Number of Radiological Units in the Country

Source: Compiled from CAG Report, March 2012.

A large number of radioactive consignments (nearly 80,000 per year) containing radioactive materials are being transported within, and many more also transit through the country.[58] Given the surging economic development and demand in various sectors of economy, application of radiological material in the country is bound to increase.

3.3 The Strategic Program

Besides the civilian application of nuclear resources, India has a strategic nuclear program based on the doctrinal posture of 'no-first-use' and 'second-strike' capability with "punitive retaliation…to inflict damage unacceptable to the aggressor."[59] India is also preparing its third leg of the nuclear triad – INS Arihant, the first 6,000-ton submarine with a 83MW pressurized light-water reactor onboard, is being readied for extensive sea-trials.

Although no exact number on India's nuclear weapons inventory is available, it is speculated that New Delhi roughly possesses enough weapon-usable plutonium to build between 100 and 130 nuclear bombs, and these numbers are expected to grow in the coming years.[60] No public

[57] A.R. Sundararajan, K.S. Parthasarathy, and S. Sinha, "Application of Radiation in Medicine, Industry and Research," in *Atomic Energy Regulatory Board: 25 Years of Safety Regulation* November 2008. Available at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/SJBook.pdf, p. 146.
[58] Ibid, p. 137.
[59] "Draft Report of National Security Advisory Board on Indian Nuclear Doctrine," August 17, 1999. Available at http://www.mea.gov.in/in-focus-article.htm?18916/Draft+Report+of+National+Security+Advisory+Board+on+Indian+Nuclear+Doctrine
[60] "Not All Indian Fissile Material Being Used for Bombs: Analysts," July 25, 2012, Nuclear Threat Initiative. Available at http://www.nti.org/gsn/article/not-all-indian-fissile-material-being-used-bombs-analysts/.

information is available on the holding of unirradiated civilian plutonium, but India is believed to have several tons of unirradiated reactor grade material, i.e., weapon-usable plutonium that it plans to use in its breeder reactor program. According the International Panel on Fissile Materials (IPFM), "India's stockpile of fissile materials is estimated to include 2.4±0.9 tonnes of Highly Enriched Uranium (HEU) (0.8±0.3 tonnes of 90% HEU equivalent), 0.54±0.18 tonnes of weapon-grade plutonium, and 4.9±0.4 tonnes of reactor-grade plutonium, that includes 4.7±0.4 of material considered strategic reserve and 0.24 tonnes of safeguarded plutonium."[61] And, the total amount of HEU produced through enrichment route by India is "estimated to be 2.4±0.9 tonnes, with enrichment of about 30%, which corresponds to 0.8±0.3 tonnes of 90% HEU equivalent."[62] Currently, the Trombay reprocessing plant reprocesses the spent fuel from research reactors with the capacity of 60 tonnes per year.[63] The plants at Tarapur and Kalpakkam, each with an operating capacity of 100 tonnes per year, process off-site fuels from PHWRs. Moreover, additional reprocessing facilities are being set up with the active participation of the Indian industry to accelerate the programme.[64]

[61] International Panel on Fissile Materials,, "Global Fissile Material Report 2013,"http://fissilematerials.org/library/gfmr13.pdf, p. 79; "Countries: India," http://fissilematerials.org/countries/india.html, February 04, 2013.
[62] Ibid.
[63] Rajeev Sharma, "Coming to India's Aid on KNPP's Spent Nuclear Fuel, *India & Russia Report*, May 13, 2013. Available at http://in.rbth.com/economics/2013/05/13/coming_to_indias_aid_on_knpps_spent_nuclear_fuel_24903.html
[64] Indian Programme on Reprocessing," BARC.gov.in. Available at http://barc.gov.in/publications/eb/golden/nfc/toc/Chapter%206/6.pdf

4. NUCLEAR SECURITY GOVERNANCE IN INDIA

The Ministry of External Affairs (MEA) media briefing on the eve of the third NSS (2014) categorically claims that "India is no stranger to nuclear security. At the dawn of India's nuclear power programme, Prime Minister Nehru minuted that source materials for nuclear energy was not an ordinary commodity and needed to be handled with care."[65] It further claims that "there has been no breach of nuclear technology security of the kind that allowed AQ Khan to access and proliferate sensitive nuclear technology and materials." Even more pertinently, "India's efforts to secure its nuclear materials, facilities and activities did not begin with the recent rise in international awareness about the dangers of nuclear terrorism."[66] The NSS process that brought momentum to "national action and responsibility for securing nuclear and radiological materials, has, according to an Indian commentator, universalised a threat that India was fighting a lonely battle against" for the last few decades.[67] Owing to the past practice of mixing civil and strategic nuclear programs, nuclear security structure and arrangement in India seem to have intertwined.

Prior to the NSS process, the AERB Safety Code of October 2009, described 'nuclear security' as "all preventive measures taken to minimize the residual risk of unauthorised transfer of nuclear material and/or sabotage, which could lead to release of radioactivity and/or adverse impact on the safety of the plant, plant personnel, public and environment."[68] In its 2014 media briefing, the MEA described the concept of nuclear security as "prevention and detection of, and response to unauthorized removal, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear or radiological material or their associated facilities."[69] Both definitions largely parallel the definition used by IAEA since 2003: "The prevention and detection of and response to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities."[70] Suffice to say that the idea of nuclear security perception in India is in line with the global concern. The former Prime Minister Manmohan Singh's acknowledgement at the 2010 NSS that "nuclear security is one of the foremost challenges we face today" and that the Summit process is in India's own interest, acknowledges the fact that the threat to nuclear infrastructure is credible and India is conscious of the issue. Given this recognition of the threat to nuclear security, India has been an enthusiastic partner of the NSS process to explore innovative approaches and best practices for nuclear security.

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[65] Ministry of External Affairs (MEA), "Nuclear Security in India." Available at http://www.human.ula.ve/catedralibreindia/documentos/india_nuclear.pdf

[66] Ibid.

[67] Manpreet Sethi, "Fighting Nuke Threat is No Joke," *The New Indian Express*, May 01, 2014.

[68] Atomic Energy Regulatory Board, "Glossary of Terms for Nuclear and Radiation Safety," Guide NO. AERB/SG/GLO, March 2005. p. 43.

[69] MEA, "Nuclear Security in India."

[70] IAEA, *Nuclear Security Plan 2010-2013*, document GOV/2009/54-GC(53)/18(17 August 2009), pp. 1-2. Available at http://www.iaea.org/About/Policy/GC/GC53/GC53Documents/English/gc53-18_en.pdf

However, analysts have argued that "for years, neither the Indian strategic community nor the Indian government paid serious attention to the problem of nuclear terrorism" publicly. Rather, the Indian government joined almost all the international initiatives without any major debate on it domestically.[71] Information regarding India's approach towards nuclear security was largely confined to the nuclear establishment and government officials. The Indian strategic community first became aware of India's nuclear security strategy only in 2010, when the country's foreign policy establishment briefed the media and the Prime Minister Singh made his statement at the NSS in Washington, DC. The MEA media briefing in the eve of the 2014 NSS broadly described five elements of India's approach to nuclear security: institutions; technology; nuclear security practice and culture; governance; and international cooperation (Fig. 3).

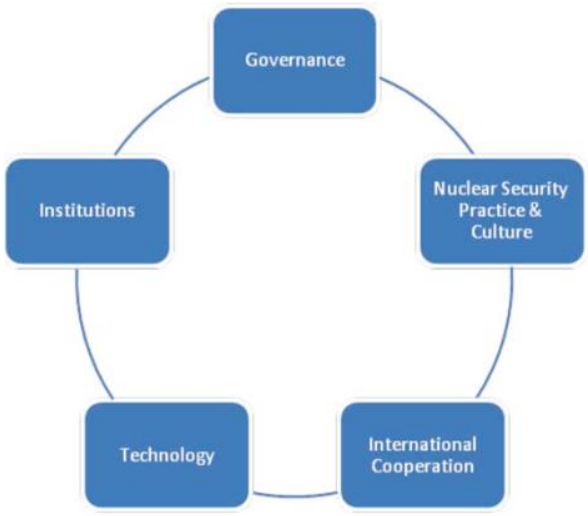

Figure 3: Five Elements of India's Approach to Nuclear Security
Source: http://www.mea.gov.in/Images/pdf/Brochure.pdf

4.1 Institutions: Roles and Responsibilities

India's Atomic Energy Commission (AEC) was established in August 1948 within the Department of Scientific Research, which was set up in June 1948. The Department of Atomic Energy (DAE) came into existence in August 1954 through a Presidential Order. Thereafter, a Government Resolution in1958 transferred the DAE within the AEC. The Secretary to the Government of India in the DAE is the ex-officio Chairman of the AEC. The other Members of the AEC are appointed on the recommendation of the Chairman of the AEC.[72] The AERB of India, which is the country's civilian nuclear regulatory authority, was established in 1983 by the Government of India. The primary authority of the institution comes from the Atomic Energy

[71] Rajiv Nayan, "India's Nuclear Security Policy," *IDSA Comment*, 05 January 2012. Available at http://idsa.in/idsacomments/IndiasNuclearSecurityPolicy_rnayan_050112.html
[72] Government of India, "Atomic Energy Commission." Available at http://dae.nic.in/?q=node/394

Act of 1962. Figure 4 shows the institutional structure and organizational chart of India's atomic energy establishment.

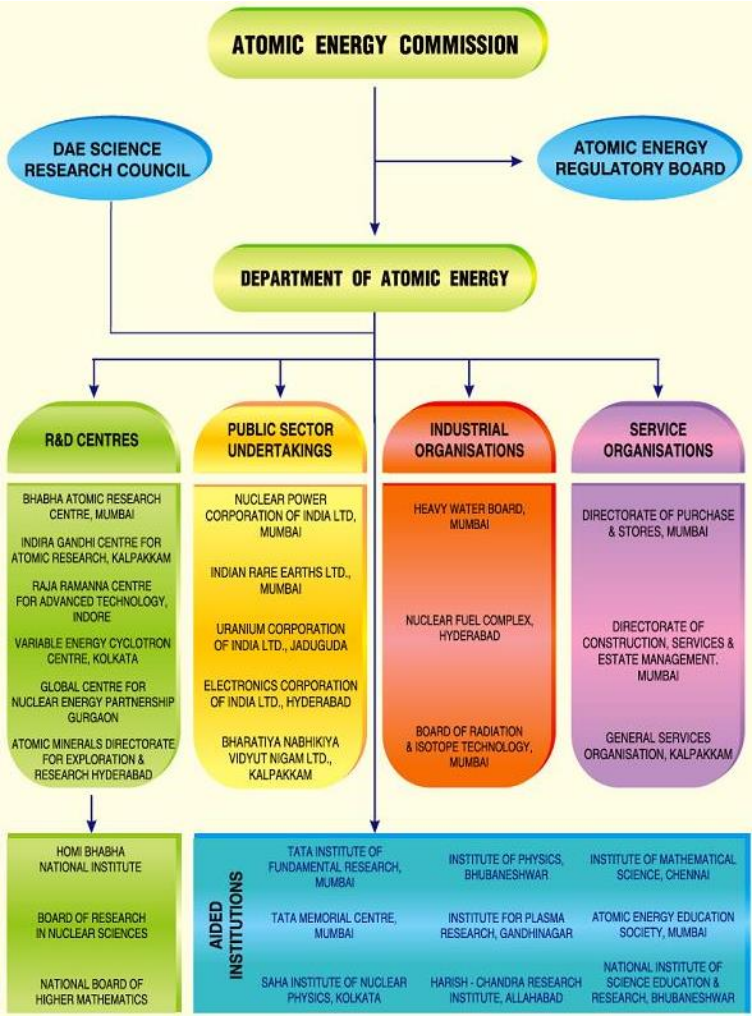

Figure 4: Organizational Structure of India's Nuclear Establishment

Source: DAE, Government of India, (http://dae.nic.in/?q=node/634)

4.2 The Regulatory Framework

The AERB reviews the safety and security of the country's Operating Nuclear Power Plants, Nuclear Power Projects, Fuel Cycle Facilities, and Other Nuclear/Radiation Facilities and Radiation Facilities.[73]As far as the unusable radioactive material is concerned, "any imported source, after the useful life-time is over, is sent back to the supplier abroad for safe disposal."[74]

[73] Ibid.
[74] Ibid.

"Such sources are exported back to the supplier only after completing all the regulatory procedures ensuring that the source is safe for transport. The user is required to intimate to AERB once the export of the disused source is complete… However, in some cases, particularly for sources imported long ago, the user is not able to export the source for safe disposal. In such cases, AERB helps the user to dispose of the disused sources at any authorized waste management agency in the country after completing all the regulatory formalities".[75] The rule with regard to the unusable radioactive material from domestic sources is that "once a disused source is known to be lying in the facility, the user is advised to arrange transport of the source for safe disposal to the domestic supplier. Such transport for safe disposal to the domestic supplier is done after completing the required regulatory procedures. Once the disused source is safely received by the domestic supplier for safe disposal, intimation is sent to AERB."[76]

Safety and security of nuclear facilities and material is the responsibility of the individual operator; the AERB specifies the safety requirements through codes and guides, in which it lays down the necessary requirements. The primary responsibility for the safety of nuclear installations and material, and their transport and disposal lies with the user/facilities.[77] Indeed, it has issued a number of guides for both safety and security of nuclear facilities and material. It also ensures compliance to safety standards, as it controls the licensing process of setting up a nuclear facility and running it. The AERB also conducts occasional reviews of the safety and security standards of nuclear power plants. More importantly, since license is given to nuclear power plants for a maximum of five years, the renewal of a license requires a safety review of the plants. AERB conducts monthly inspections of nuclear projects under construction, quarterly inspections for nuclear power projects, bi-annual inspections for operating plants, and yearly inspections for high-hazard radiation facilities.[78]

The AERB has been periodically issuing and updating safety and security related documents such as the "Nuclear Security Requirements for Nuclear Power Plants," the "Security of Radioactive Sources in Radiation Facilities," and the "Security of Radioactive Material During Transport."

The following are some of the key documents that have been prepared by the AERB on nuclear security related aspects:[79]

- Nuclear Security Requirements for Nuclear Power Plants (NPPs)
- Guidelines for Reporting of Nuclear Security Events

[75] Government of India, Department of Atomic Energy, "Lok Sabha Starred Question No.404 Due on 25.8.2010 by Shri Abdul Rahman Regarding Radioactive Material." Available at http://dae.nic.in/writereaddata/lssq404_250810.pdf
[76] Ibid.
[77] Ibid.
[78] R. Bhattacharya, "Nuclear Regulatory Framework in India." Available at http://www.abdan.org.br/download/encontro/india.pdf
[79] Fredric Lall, "Regulatory Inspection on Nuclear Security Aspects of Civilian Nuclear Power Plants/Projects," December 2012. Available at www.nrcsecurityconference.org/slides/Dec5/India.pdf

- Checklist for Regulatory Inspection of Nuclear Power Plants (NPPs)
- Checklist for Regulatory Inspection of Nuclear Power Projects
- Procedure for Identification of Vital Areas
- Security of Radioactive Sources in Radiation Facilities
- Security of Radioactive Material during Transport
- Other documents under preparation
    - Security requirements for Heavy Water Plants
    - Security requirements for Nuclear Fuel Processing Facilities

4.2.1 Concerns about Regulatory Framework

One of the major concerns regarding any nuclear regulatory framework is the lack of autonomy of the regulator from the nuclear energy establishment. The nuclear regulator, AERB, is not an independent entity, as it depends on the government for funding and expertise, and reports to the Atomic Energy Commission, of which the Chairperson is the Secretary of the Central Government's Department of Atomic Energy. The government also appoints the regulatory body's head. As A. Gopalakrishnan, former head of the AERB, points out, "[S]imilarly, we have almost all AERB Advisory Committees stacked with vast majority of Ex-DAE personnel, who all jointly skew their opinion mostly in the DAE's favour."[80]

Indeed, these long-standing concerns have found a prominent place in recent reports by India's Comptroller and Auditor General of India (CAG) and the Parliament of India's Public Accounts Committee. Both reports highlighted a number of institutional, safety, performance, and other related issues regarding nuclear regulation in India. Most of the concerns raised by these reports have direct or indirect implications for the larger issue of nuclear security. The CAG report of 2012-13 submitted to the President of India reported the following problems with the functioning of the AERB:[81]

- "The legal status of AERB continued to be that of an authority subordinate to the Central Government, with powers delegated to it by the latter.
- AERB did not have the authority for framing or revising the rules relating to nuclear and radiation safety.
- The maximum amounts of fines were too low to serve as deterrents against offences/contraventions related to nuclear and radiation facilities, which involve substantial risks. Further, AERB had no role in deciding the quantum of penalties and no powers with regard to imposition of the same.

[80] A Gopalakrishnana, "Nuclear safety regulator: The US model," December 13, 2011. Available at http://www.dnaindia.com/analysis/column-nuclear-safety-regulator-the-us-model-1624980

[81] "Executive Summary," Report No. 9, 2012-13. Available at http://saiindia.gov.in/english/home/Our_Products/Audit_report/Government_Wise/union_audit/recent_reports/union_performance/2012_2013/SD/Report_9/Exe_Summ.pdf

- The consenting process and system for monitoring and renewal were found to be weak in respect to radiation facilities. This led to a substantial number of radiation facilities operating without valid licenses.
- On-site emergency preparedness plans were being put in place by the Plant Management of NPPs, and nuclear fuel cycle facilities were being tested by them. Though actual periodic exercises prescribed (based on various types of emergencies) were conducted by them, AERB only reviewed the reports of these exercises and did not directly associate itself in these exercises, even as observers. Off-site emergency exercises carried out, highlighted inadequate emergency preparedness. Further, AERB was not empowered to secure compliance of the corrective measure suggested by it.
- Although AERB maintained liaisons with international nuclear organisations, it was slow in adopting international benchmarks and good practices in the areas of nuclear and radiation operation. AERB had not yet availed of the opportunity of the peer review and appraisal services of IAEA to get its regulatory framework and its effectiveness reviewed by them."

Following up on the CAG report, which was clearly critical of the nuclear governance structures in India, the Public Accounts Committee of the Indian Parliament (2013-2014) carried out a sustained inquiry into the activities of the AERB and submitted a report entitled "Activities of the Atomic Energy Regulatory Board" to the Parliament in November 2013. The report reaches conclusions that are very similar to those of the CAG report. The following are some of its conclusions:[82]

- "The Committee observe that the failure to have an autonomous and independent regulator is clearly fraught with grave risks.
- Regarding the proposed Nuclear Security Regulatory Bill that is currently pending in the Parliament – The Committee recommends that the DAE should seriously re-examine the provisions of the Bill and take necessary steps urgently so as to ensure that the nuclear regulator becomes an independent and credible body at par with similar regulators in other Countries.[83]
- The Committee are concerned to note that AERB did not have any authority for framing rules relating to nuclear and radiation safety as the rule-making power under Section 30 of the AE Act, 1962 vests with the Central Government, that is, with the DAE and the AERB is involved in the consultative process.[84]

[82] "Activities of Atomic Energy Regulatory Board" Public Accounts Committee 2013-2014, Ninetieth Report." December 2013. Available at http://164.100.47.134/lsscommittee/Public%20Accounts/15_Public_Accounts_90.pdf, p. 47.
[83] Ibid, p. 48.
[84] Ibid., p. 49.

- The Committee note that even after nearly three decades of its existence, AERB is yet to formulate a nuclear and radiation safety policy for the Country in spite of a specific mandate in its Constitution Order of 1983.[85]
- The Committee are concerned to note that there is an acute shortage of Radiological Safety Officers, who are required to be designated for all radiation units in accordance with the provisions in Rule 22 of RPR, 2004 and Rule 13 of Safe Disposal of Radioactive Waste Rules, 1987…the Committee observe that effectiveness of safety procedures remains deeply compromised due to their acute shortage. The Committee are concerned to find that there was acute shortage of not only RSOs but also of trained manpower in general in AERB.[86]
- The Committee note with profound concern that off-site emergency exercises carried out highlighted inadequate emergency preparedness even for situations where the radiological effects of an emergency originating from NPP are likely to extend beyond the site and affect the people around."[87]

The Committee concluded its report with the following stinging remarks:

> In fact, the Committee's examination revealed inter-alia, diminished legal status of AERB which remained a mere subordinate authority lacking due autonomy of an empowered and independent regulator as existent in many other Countries; failure of AERB to develop safety policy, standards, codes and guides; weak consenting process and monitoring system resulting insubstantial number of radiation facilities units operating without valid licenses as evident by the non-registration of 91 per cent of medical x-ray facilities in the country which therefore, remained out of the ambit of the regulating control of AERB; absence of rules to prescribe fees for recovery of the cost of services for regulating and consenting process; failure to enforce safety provisions and compliance to frequency of regulatory inspections for both industrial radiography and radiotherapy units and shortfall of over 97 per cent inspection in case of diagnostic radiology facilities; absence of a detailed inventory of all radiation sources to ensure effective compliance of regulation for safe disposal of disused sources; inadequate emergency preparedness for nuclear and radiation facilities; absence of a legislative framework for decommissioning of Nuclear Power Plants; and total absence of peer review and appraisal service of IAEA.[88]

4.2.2 The Nuclear Safety Regulatory Authority (NSRA) Bill

As pointed out earlier, the Indian government is currently in the process of bringing about a new law to set up a more empowered nuclear regulatory authority in the country with far more

[85] Ibid., p. 50.
[86] Ibid., p. 55.
[87] Ibid., p. 56.
[88] Ibid., pp. 57-8.

autonomy.[89] But questions remain on how autonomous even the new body will be. The demand for making the regulatory body autonomous has been a long-standing one. In 1997, the Raja Ramanna Committee report had recommended that the Atomic Energy Act (1962) should be amended to enhance the effectiveness of the nuclear regulatory system in the country. Thereafter, in 2000, the government had directed the DAE to suggest the necessary amendments to the 1962 Act. However, it was only after the Mayapuri radiation accident (New Delhi) in 2010 and the Fukushima disaster (Japan) of 2011 that the government became serious about taking a relook at the nuclear regulatory system in the country.

The above-mentioned Parliamentary standing committee also conveyed to the DAE that the proposed law in its current form may lack full autonomy and has recommended that "the DAE should seriously re-examine the provisions of the Bill and take necessary steps urgently so as to ensure that the nuclear regulator becomes an independent and credible body at par with similar regulators in other Countries."[90] Among other issues, the Bill also suffers from the fact that it is dependent on the government for funding and appointment of staff. Moreover, "The Council of Nuclear Safety to be established by the NSRA Bill — with the Prime Minister as the Chair and mostly government representatives as members — will be a very powerful body with the power to appoint the chairperson and members of the new regulatory body. This will diminish the powers of the regulator since it will be subordinate to the Council chaired by the Prime Minister. We will, as a result, end up having a government-controlled regulator all over again." The NSRA Bill is explicit on the ability of the government to control the regulator: "the Central Government may, by notification, supersede the Authority for such period, not exceeding six months, as may be specified in the notification."[91]

The NSRA, at least in its current form, does not elaborate on which facilities would be put under the new authority – currently, the AERB can only oversee the civilian facilities.[92] If that continues under the new law, it is uncertain who will oversee the safety and security of the strategic facilities and programs. The Bill mentions that new regulatory bodies can be created to regulate the strategic programs (clause 25, Sub-clause (2) of the Bill). However, there has been no movement to do so as of now. The previous government has laid the NSRA Bill in the Indian Parliament to be legislated into law. However, now that the term of the 15thLok Sabha has ended, the Bill has lapsed. The new Lok Sabha and a new government will now have to restart the process all over again. After the Bill was introduced in the Parliament in 2011, the Parliamentary Standing Committee had given its recommendations on the Bill, some of which were incorporated by the DAE, but not all. Talking about the Bill, the Minister in the Prime Minister's

[89] For a copy of the Bill see, http://www.prsindia.org/uploads/media/Nuclear%20Safety/Nuclear%20Safety%20Regulatory%20Authority%20Bill%202011.pdf

[90] "Activities of Atomic Energy Regulatory Board," p. 48.

[91] Happymon Jacob, "Regulating India's nuclear estate," *The Hindu*, August 29, 2014. Available at http://www.thehindu.com/opinion/lead/regulating-indias-nuclear-estate/article6360984.ece

[92] A. Gopalakrishnan, "Transparency in Nuclear Safety Regulation," February 02, 2012. Available at http://www.dnaindia.com/analysis/comment-transparency-in-nuclear-safety-regulation-1644896India

Office, Mr. Narayanaswamy had said in 2013 that "the government adopted majority of the recommendations given by the committee and it has now come to the Lok Sabha."[93]

This is not to argue that the NSRA Bill is not an improvement from the existing AERB. Indeed, there are significant differences between the two. For one, while the AERB was set up by a government order, the new regulator under NSRA will be established by an Act of the Parliament, making it more powerful. Moreover, while the AERB was bound to report to AEC and indirectly to the DAE, the new authority will not report to the AEC and will submit its report to the Parliament. However, the council of nuclear safety to be established by the Bill – chaired by the Prime Minister and comprised mostly of government representatives − will be a very powerful body, including the power to appoint the chairperson and members of the regulatory body. This is likely to diminish the powers of the regulator.[94] Besides, "the Chairperson of the NSRA will be on the search committee for other members. This may affect the independence of other members."[95] According to the latest reports, the new government headed by Prime Minister Narendra Modi has already taken steps to legislate on the NSRA. [96]

4.3 The Legal Framework

In India, nuclear security and nuclear safety have traditionally been considered as two sides of the same coin, and hence, the legislative framework and institutional architecture that were responsible for nuclear safety also catered to nuclear security considerations. The country's legislative framework for nuclear matters flows from the 1962 Atomic Energy Act, passed by the Indian Parliament. As per the 1962 Act, the AEC is the sole authority in the country that deals with nuclear energy matters. The regulatory body, AERB, was not set up by the Atomic Energy Act of 1962, but by a gazette notification by the government of India in 1983. The AERB is responsible for both the safety and security aspects of nuclear facilities and material. Prior to the establishment of the AERB, self-regulation by each facility was the norm in the 1950s, and safety monitoring and surveillance was taken care of by the Health Physics Division and Directorate of Radiation Protection at the BARC in the 1960s.[97] In 1972, the Safety Review Committee was set up in the DAE − the government department that deals with nuclear energy matters and reporting to the Prime Minister of the country.[98]

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[93] "Nuclear Safety Bill to be Taken up in Next Session: Minister," www.zeenews.india.com, September 06, 2013. Available at http://zeenews.india.com/news/nation/nuclear-safety-bill-to-be-taken-up-in-next-session-minister_874653.html

[94] Happymon Jacob, "Regulating India's Nuclear Estate," *The Hindu*, August 29, 2014.

[95] "The Nuclear Safety Regulatory Authority Bill 2011: Highlights of the Bill.". Available at http://www.prsindia.org/billtrack/the-nuclear-safety-regulatory-authority-bill-2011-1980/

[96] Indrani Bagchi and Sanjay Dutta, " Soon, a PM-led council for nuclear safety", *Times of India*, October 18, 2014. Available at http://timesofindia.indiatimes.com/india/Soon-a-PM-led-council-for-nuclear-safety/articleshow/44863604.cms

[97] R. Bhattacharya, "Nuclear Regulatory Framework in India," November 2012. Available at http://www.abdan.org.br/download/encontro/india.pdf

[98] Ibid.

Various rules were established under the 1962 Atomic Energy Act such as: 1) Atomic Energy (Working of Mines, Minerals and Handling of Prescribed Substance) Rules, 1984; 2) Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987; 3) Atomic Energy (Factories) Rules, 1996; 4) Atomic Energy (Control of Irradiation of Food) Rules, 1996; and 5) Atomic Energy (Radiation Protection) Rules, 2004. The AERB is legally empowered to enforce these rules.[99] In addition, the Manufacture, Storage and Import of Hazardous Chemical Rules (1989), under the Environmental Protection Act, 1986, also names "AERB as the authority to enforce directions and procedures as per Atomic Energy Act with respect to radioactive substances." [100] Furthermore, India enacted The Weapons of Mass Destruction and Their Delivery Systems (Prohibition of Unlawful Activities) Act in 2005.

4.4 India and the Global Nuclear Security Regime

India has been an active participant in the global nuclear security regime. To start with, New Delhi is clearly committed to fighting terrorism in all its forms, and hence, it is party to "all the 13 universal instruments accepted as benchmarks for a State's commitment to combat international terrorism," including the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT).[101] India has ratified the Convention on the Physical Protection of Nuclear Material (CPPNM) as well as its 2005 Amendment. It has also expressed its support for the 5th revision of IAEA's INFCIRC/225. India adheres to the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and the NSG guidelines on nuclear transfers.[102] With regard to the safety review of India's nuclear facilities, India has recently been more forthcoming, especially after the 2008 India-IAEA agreement. India's civilian nuclear power plants were reviewed by the Operational Safety Review Team (OSART) of the IAEA and the World Association of Nuclear Operators (WANO). While the Indian nuclear reactors have been under WANO peer review for some time (NPCIL is a member of WANO), they were reviewed for the first time in 2012 by OSART.[103] India has also now requested the Integrated Regulatory Review Service (IRRS), the Peer Review Mission of IAEA, to conduct a review of the nuclear power plants in India, which is likely to take place later this year or in early 2015.[104] The IRRS peer review usually looks at both safety and security aspects.[105] However, it is unclear whether

[99] Ibid.
[100] AERB, "The Rules." Available at http://www.aerb.gov.in/AERBPortal/pages/English/Constitution/Rules_jsp.action
[101] MEA, "Nuclear Security in India."
[102] Ibid.
[103] "IAEA experts to begin review of nuclear plants in Rajasthan tomorrow," *The Times of India*, October 29, 2012. Available at http://timesofindia.indiatimes.com/india/IAEA-experts-to-begin-review-of-nuclear-plants-in-Rajasthan-tomorrow/articleshow/17003100.cms
[104] "Indian atomic energy regulator readying for IAEA review," March 04, 2014. Available at http://www.dnaindia.com/india/report-indian-atomic-energy-regulator-readying-for-iaea-review-1966844
[105] IAEA, "Integrated Regulatory Review Service." Available at http://www-ns.iaea.org/reviews/rs-reviews.asp

the peer review will include security aspects in the Indian case. In addition, India has been cooperating with Interpol's Radiological and Nuclear Terrorism Prevention Unit.[106]

India has clearly been steadfast in its adherence to the instruments and norms stipulated by the global nuclear security regime. India has not only adopted the UN Security Council Resolution 1540 (as well as its extension Resolution 1977), but has taken measures to implement its recommendations. Regarding some of the other measures that makes India a part of the global nuclear security regime, an exhaustive report of the Ministry of External Affairs states that

> "India participates in the IAEA's Illicit Trafficking Database (ITDB), which was established in 1995 and disseminates information on confirmed reports about illicit trafficking and other unauthorized activities and events involving nuclear radioactive materials to the States. Since 2007, India is a party to the Global Initiative to Combat Nuclear Terrorism and has participated in its working groups on nuclear detection, nuclear forensics and response and mitigation. India also cooperates with the Interpol's Radiological and Nuclear Terrorism Prevention Unit and the World Customs Organization on nuclear trafficking issues."[107]

In fulfilling the promise made by India at the inaugural Nuclear Security Summit, it has established the 'Global Centre for Nuclear Energy Partnership' with a view to "help in capacity building, in association with the interested countries and the IAEA, involving technology, human resource development, education & training and giving a momentum to R&D in enlisted areas."[108] Established in 2010, the Centre currently has five schools, including one on Nuclear Security studies. India, as a "partner to the IAEA-US Regional Radiological Security Partnership (RRSP) has been organizing international training courses in India under the aegis of the IAEA."[109] India has also been hosting international conferences on nuclear security including one in November 2012, in collaboration with the United Nations Office of Disarmament Affairs. Moreover, "India has also conducted 9 regional training seminars on nuclear security in cooperation with the IAEA."[110] India is a participant in IAEA's Illicit Trafficking Database (ITDB)[111] and the Global Initiative to Combat Nuclear Terrorism (GICNT),[112] even though it is not a member of the 'Megaports Initiative' or the Proliferation Security Initiative (PSI). New Delhi has not ruled out joining the PSI and the Container Security Initiative (CSI).

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[106] "Nuclear Security Summit National Progress Report India,", Press Information Bureau, Government of India, March 27, 2012. Available at http://pib.nic.in/newsite/PrintRelease.aspx?relid=81755
[107] MEA, "Nuclear Security in India."
[108] "Global Centre for Nuclear Energy Partnership," Government of India. Available at http://www.gcnep.gov.in/about/about.html
[109] "National Progress Report: India," Nuclear Security Summit, Seoul, March 26-27, 2012. Available at http://nuclearsecuritymatters.belfercenter.org/files/nuclearmatters/files/india_-_national_report.pdf
[110] Ibid.
[111] "India and the IAEA." Embassy of India, Vienna. Available at http://www.indianembassy.at/pages.php?id=64
[112] NTI, "Global Initiative to Combat Nuclear Terrorism." Available at http://www.nti.org/treaties-and-regimes/global-initiative-combat-nuclear-terrorism-gicnt/

India has also been attempting to adjust the country's domestic laws to match the legal provisions, practices, and expectations of the international nuclear order. India passed the Chemical Weapons Convention Act in 2000 and subsequently amended it in 2010. The law was enacted "to give effect to the convention on the prohibition of the development, production, stockpiling and use of chemical weapons and on their destruction. India had signed the convention on January 14, 1993."[113] The country enacted The Weapons of Mass Destruction and Their Delivery Systems (Prohibition of Unlawful Activities) Act in 2005[114] "to fulfill India's obligations under the United Nations Security Council Resolution 1540 of April 28, 2004."[115]

Further, the Foreign Trade Development and Regulation (FTDR) Act No. 22 of 1992 (amended in 2010) provides the legal basis for India's strategic trade control system. The FTDR "empowers the Directorate General of Foreign Trade (DGFT), situated within the Department of Commerce and Industry (DCI), to license the export and import of items on the Indian Tariff Classification (Harmonized System) or ITC (HS) list."[116] This legal instrument was further strengthened with the passage of the Weapons of Mass Destruction (WMD) Act in 2005, which "authorizes the GOI to regulate the export, re-transfer, re-export, transit, and transshipment of any items related to the development, production, handling, operation, maintenance, storage, or dissemination of a WMD or missile delivery device. It also established a catch-all control that restricts exports of non-listed items destined for a WMD end-use, and it provided a rudimentary legal basis to regulate technology transfers."[117]

4.5 The Physical Protection System (PPS)

India shares the global concerns on nuclear security and strives to follow a 'cradle to grave' principle of security for nuclear materials and associated facilities. Keeping in mind the allegation that India's nuclear security and control measures are "average" and below those of Pakistan, the sections of this report delve into the physical security system in place in India's nuclear installations.

At the outset, the physical security system in India's nuclear infrastructure has many dimensions: the nature of the nuclear programme itself – their unique closed fuel cycle, which is argued to be inherently secure; the technological dimension where India is known to have made many technological advances to respond to any such contingency if it ever arises; the human dimension where the country maintains an impeccable record; the facility-specific physical security systems

[113] "Lok Sabha passes chemical weapons, AIIMS bills," *Ndtv.com*, August 30, 2012. Available at http://www.ndtv.com/article/india/lok-sabha-passes-chemical-weapons-aiims-bills-260977
[114] "The Weapons of Mass Destruction and their Delivery Systems (Prohibition of Unlawful Activities) Act, 2005," MEA, Government of India. Available at http://www.mea.gov.in/Uploads/PublicationDocs/148_The-Weapons-Mass-destruction-And-Delivery-Systems-Act-2005.pdf
[115] R. Ramachandran, "A Bill and nuclear hopes," *Frontline*, Vol. 22, Issue 12, Jun 04-17, 2005. Available at http://www.frontline.in/navigation/?type=static&page=flonnet&rdurl=fl2212/stories/20050617003102900.htm
[116] "India's Export Controls: Current Status and Possible Changes on the Horizon," *SECURUS Strategic Trade Solutions*, 2011. Available at http://securustrade.com/Indias_Export_Controls_Article_July_2011_FINAL.pdf
[117] Ibid.

that it has developed in and around its nuclear installations, India's experience in managing terrorism given the regional security environment; and most importantly, the safe-keeping of its nuclear arsenals.

The nuclear security architecture of India's nuclear infrastructure is based mainly on five pillars:

1) National legal provisions in consonance with IAEA guidelines;
2) Oversight agency (AERB) that stipulates the SOPs;
3) The security (and intelligence) agencies in charge of threat assessment and physical protection;
4) The human element (personnel) with the responsibility of oversight or observance; and
5) Surveillance and detection technology for detection, delay, and response approach.

As an oversight agency, the AERB has prescribed the technical basis to establish security levels – a graded approach of security[118] – for ensuring the safety of radioactive materials during all stages of their handling in its guidelines on "Security of Radioactive Sources in Radiation Facilities."[119] In India's case, safety and security aspects of radioactive/nuclear materials are intimately linked and many of the measures designed to address safety would also address security. Normally the physical protection system around Indian nuclear facilities is designed on the basis of their nuclear *threat assessment,*[120] taking into account the Design Basis Threat (DBT) and Beyond DBT (BDBT) to create a layered protective envelope – consisting of inbuilt reactor security, perimeter security, personnel reliability, material protection and accounting, transportation security, air and water front defense, emergency preparedness, legal provisions, and in extreme situations, military protection.

[118] The Graded Approach to Security is based on the vulnerability analysis for a specific source, facility, or activity such as transportation. Assessment is made of the level of risk involved. Depending on the degree or level of risk involved the security measures required to protect the source is determined. The higher the risk, the more capable security systems are required. Based on the security threat associated with radioactive sources, four security levels - A, B, C and D have been defined. It must be emphasized that these security levels do not themselves lay down the security guidelines or measures.

[119] AERB, "Security of Radioactive Sources in Radiation Facilities," Safety Guide No. AERB/RF-RS/SG-1. Available at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/SG-RF-RS-01.pdf

[120] Design basis threat assessment is normally done by government agencies such as Ministry of Home, Intelligence Bureau, Ministry of External Affairs, Law Enforcement Agencies, Cost Guards and Customs, Regulatory Authorities and other agencies with security related responsibilities.

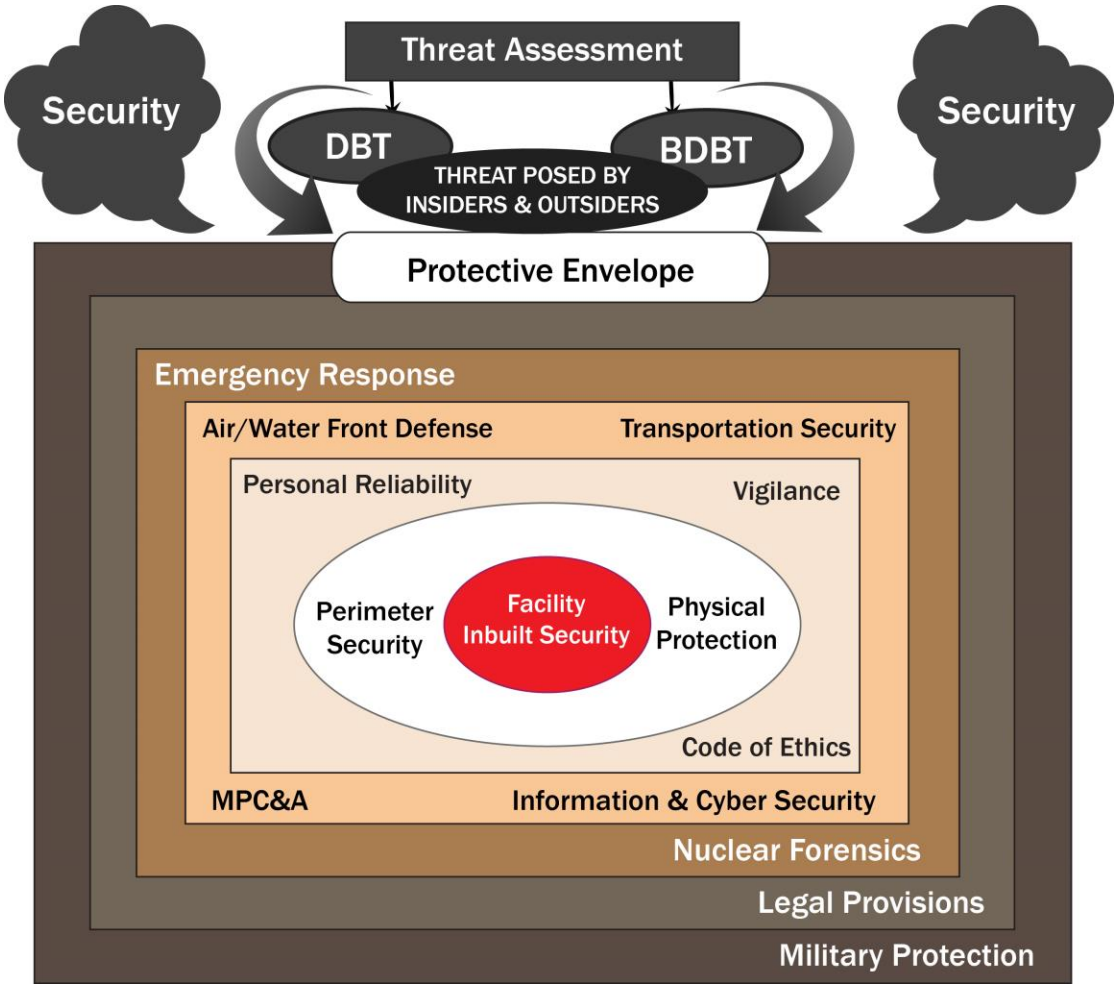

Figure 5: The Security Envelope

Source: Sitakanta Mishra, "Contours of India's Nuclear Safety," *Air Power*, Apr-June 2011 (Adapted and updated).

4.5.1 Inbuilt Security

Indian nuclear plants are characterised by a high level of built-in safety-security features, which make them relatively less vulnerable to sabotage.[121] According to Rajesh Basrur and Friedrich Steinhäusler,"[T]he large-volume, low-pressure, low-temperature moderator surrounding the pressure tubes keeps the risk of a fuel meltdown low. The steam generators are positioned well above the core, which promotes natural thermosyphoning (heat movement) in case shutdown cooling is lost. In addition, the CANDU plants are enclosed by heavy concrete walls, including a reactor vault of a minimum four feet thickness surrounding the nuclear core itself."[122] Reactors like the Kaiga-1 and 2, Rajasthan-3 and 4, and Tarapur-3 and 4 are housed in double containment domes. The domes are made of "the microsilica-based high performance concrete;" they also

[121] Rajesh M. Basrur and Friedrich Steinhäusler, "Nuclear and Radiological Terrorism Threats for India: Risk Potential and Countermeasures." Available at http://jps.anl.gov/vol1_iss1/3-Threats_for_India.pdf, p.7.
[122] Ibid.

have other added safety features like the automatic, "quick acting poison injection system to shut down the reactor in an emergency".[123]

The primary inner containment of the reactor is "designed to withstand the 'design basis' accidents" like postulated loss of coolant leading to reactor blackout; the secondary containment envelops the inner containment, and "the annulus between the two containment walls is maintained under vacuum, with a provision of continuous monitoring for any accidental release of radioactivity".[124] For avoiding the accidents due to external missile such as aircraft impact, adequate care is taken to exclude this event with proper siting criteria and selecting a safe screen distance value (SDV). During site selection, if the site falls within SDV for different types of airfields, a "probabilistic study of aircraft crashing" on the installation (considering flight frequencies) are carried out. If this probability is not acceptably low, the site is considered unsuitable for establishing NPP.[125] According to a study conducted by Mukesh Kukreja, et. al. of the Reactor Safety Division, BARC, "on the damage evaluation of the 500 MWe PHWR's containment for aircraft impact, concludes that such an event would cause only local deformation; the double containment is capable of absorbing the full impulsive load."[126]

India's unique three-stage nuclear programme (based on the 'closed fuel cycle') is said to promote the security of nuclear materials. The 'reprocess to reuse' approach "avoids both the build-up of stockpiles, as well as the need to store large amounts of spent fuel in underground repositories that could turn into easy to access plutonium mines for malefactors in the future."[127] In order to eliminate chances of terrorists' access to high-level nuclear waste, India follows the vitrification method for nuclear waste management. In addition, India is also working on design and deployment of proliferation resistant reactor designs such as the Advanced Heavy Water Reactors (AHWRs), based on thorium and Low Enriched Uranium (LEU), which is associated with the high-energy gamma-emitter U-232, that makes access and use by unauthorised non-state actors difficult. Responding to the global concern for security of HEU in research reactors, "the enriched uranium based fuel in the APSARA nascent reactor has been placed in a "safeguarded facility." At present no research reactor in India is operating with HEU.

[123] Department of Atomic Energy, *Nuclear India*, Vol. 34, No.1-2, July-Aug 2000. Available at http://dae.nic.in/?q=node/171

[124] Mukesh Kukreja, et al., "Damage Evaluation of 500 MWe Indian Pressurized Heavy Water Reactor Nuclear Containment for Air Craft Impact," Proceedings of the 17th International Conference on Structural Mechanics in Reactor Technology (SMiRT 17) Prague, Czech Republic, August 17–22, 2003, p. 1; also see, B.N. Rao et al, "Reliability analysis of 500 MWe PHWR Inner Containment Using High-Dimensional Model Representation", *International Journal of Pressure Vessels and Piping*, vol. 87, 2010, pp. 230-238.

[125] Roshan A.D., Shylamoni P., and Sourav Acharya, *Monograph on Siting of Nuclear Power Plants*, AERB, Civil & Structural Engineering Division. Available at http://www.aerb.gov.in/t/sj/Siting.pdf, p. 13.

[126] Kukreja, "Damage Evaluation of 500 MWe Indian Pressurized Heavy Reactor Nuclear Containment for Air Craft Impact."

[127] MEA, "Nuclear Security in India."

4.5.2 Perimeter Security

Each nuclear facility is designed with three concentric circles of security zones, known as the perimeter security system (Fig. 6). Though this is designed more for efficient emergency response and relief operations, it simultaneously enhances plant security. The inner most circle (O-A) is the plant station area. The second circle (O-B) is the Exclusion Zone from the inner fence of the plant area and is directly under the control of the plant administration, with two rings of security deployed with sophisticated surveillance systems and allowing no public habitation. The Sterilized Zone (B-C) is where the growth of population is limited by administrative control. The outermost circle is the Emergency Planning Zone, where constant monitoring is undertaken for security and emergency planning purposes. (The expanse of these zones varies from facility to facility.) Close surveillance is conducted over transportation networks, means of communication, etc.

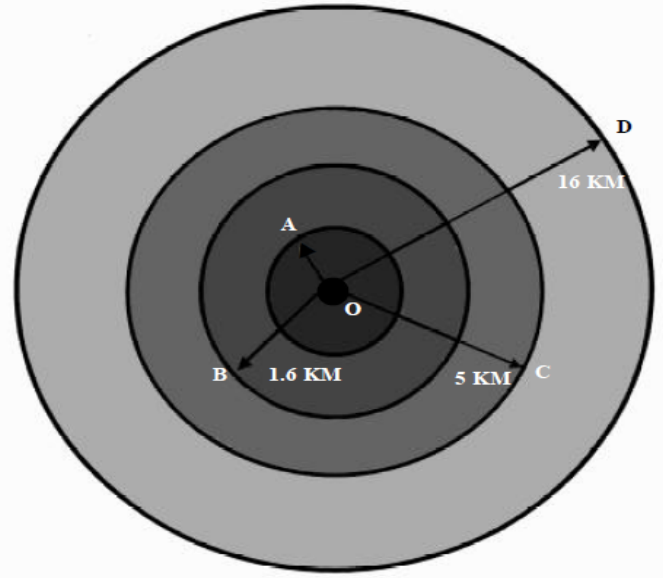

Figure 6: Perimeter Security Zoning System

Source: http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/SG-O-06.PDF, p. 29.

4.5.3 Physical Protection

The AERB, as the regulator responsible for safety as well as security, prescribes safety-security guidelines to be followed by Indian plants in accordance with IAEA guidelines. An Advisory Group of Experts help in reviewing the implementation of these guidelines. It has also been recently entrusted with the responsibility to ensure that a licensee takes adequate measures towards security.[128]

[128] SS Bajaj, "Regulatory Practices for Nuclear Power Plants in India" *Sadhan*, Vol. 38, Part 5, October 2013. Available at http://www.ias.ac.in/sadhana/Pdf2013Oct/13.pdf, pp. 1044-45.

As far as physical protection is concerned, all nuclear facilities in India are secured by a physical protection system (PPS) aiming to restrict easy access to sensitive areas. Every facility is surrounded by two fences – inner and outer – having a double-layer security structure. In order to prevent inadvertent or unauthorised access to radioactive sources or the facility, many technical measures are used. These are comprised of state-of-the-art hardware, security devices, and electronic security systems such as fences, walls, rooms/vaults, cages, transport packaging, locks and interlocks for doors with alarm systems, intrusion-resistant source-holding devices, surveillance cameras, etc.[129] For more sensitive parts of the facility, "a variety of surveillance, detection, delay, response and access control measures are in place in a graded manner over four layers."[130] Normally, access control is maintained over personnel by verifying identity cards. BARC has invented a 'Phonetic Number System' with many novel mathematical features, permitting unique identification of people with only six digits, called the Phonetic Code.[131] This System of Phonetic Identification was accepted by the Ministry of Home Affairs, Government of India, in 1986, to check infiltration across the border into India from Pakistan. The 'Need to Know' principle was adopted for information security relating to source location, specific security plans and measures, source utilization plans, date and time of source transfer, etc. The Global Centre for Nuclear Energy Partnership (GCNEP) and BARC provide a training course for concerned authorities regarding requirements, design, and evaluation of PPS.[132]

The Central Industrial Security Force (CISF), a paramilitary force, is in charge of providing security to nuclear facilities in the country. Each nuclear facility is guided by a CISF team headed by a Commandant. At many sites, the CISF team is supplemented by a Special Task Force. A Departmental Committee headed by an Inspector General of Police (IGP) at the Secretariat oversees the physical security at the sites. The CISF has developed the necessary ability to deploy specially-trained First Responders in case of a nuclear emergency. Four companies of the CISF with specialised training are deployed in four locations across the country: the Ghaziabad unit caters to Delhi and other northern areas; the Ranchi unit for the eastern areas; Kota unit for the western; and Chennai unit for the southern part.

However, the CISF is not in charge of all nuclear related installations in the country. For example, the Heavy Water Plant in Baroda is guarded by departmental security personnel with armed police support under the command of Deputy Commissioner of Police, Special Branch, Baroda City. The Heavy Water Plant in Hazira is co-located with the Krishak Bharati Cooperative Ltd. (KRIBHCO) fertilizer plant and its security is taken care of by KRIBHCO security personnel, in addition to armed police personnel from the State Police. And, the Institute

[129] AERB, "Security of Radioactive Sources in Radiation Facilities," AERB Safety Guide, AERB/RF-RS/SG-1. Available at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/SG-RF-RS-01.pdf
[130] MEA, "Nuclear Security in India."
[131] D.N. Srivastava, "Hi-Tech Computerized Security Management," Vol. 34, No.3-4, Sep-Oct 2000, Department of Atomic Energy, Government of India. Available at http://dae.nic.in/?q=node/172
[132] "National Training Course on Physical Protection of Nuclear Material and Nuclear Facilities," 18 to 22 February, 2013 Mumbai, Available at http://www.gcnep.gov.in/programs/details/NTC-PPofNMNF-Report.pdf

of Plasma Research (IPR) at Gandhi Nagar employs private security personnel.[133] Due to the dispersed and individualized approach to handling security at various nuclear facilities, it would be prudent, therefore, to suggest a unified or centralised security arrangement in all nuclear related installations for better coordination and security planning and implementation.

Besides this, DAE installations and its residential colonies continue to remain potential targets of outfits and elements inimical to the interests of India. Anonymous letters threatening bomb blasts at KKNPP and kidnapping of senior officials have been received many times.[134] Reportedly, the 26/11 Mumbai terror attacks planner, David Coleman Headley, surveyed the BARC complex for a possible terror strike.[135] At least 25 intrusions have been reported in two years and this is the result of "a lack of unified command and control, as security is handled by both AEC and CISF."[136]

Moreover, the National Disaster Relief Force (NDRF) is trained to deal with nuclear disasters, if not security. Recent newspaper reports indicate, however, that the agency is not yet fully ready to deal with nuclear disasters. A recent *Indian Express* story had this to say:

> In theory, there's back-up in place already. A nuclear emergency should set off what's called a level 3 response – involving the country's defence, paramilitary, police, and government agencies all the way from the Centre to the taluka. The National Disaster Management Agency had prepared a structured document, providing precise directions on rescue, decontamination, and evacuation, to be administered in real-time by control rooms at the Ministry of Home Affairs in New Delhi and in the states. The reality is that Maharashtra doesn't have a set of operating procedures in place, which would govern all organisations in a crisis.[137]

The SOPs of three agencies the *Indian Express* accessed showed overlaps, while the one at the state level had not been updated since 2005.

4.5.4 Personnel Reliability

India's nuclear establishment follows a personnel reliability program designed with several lines of inquiry. Generally, a background check of the employee is conducted to verify his identity, credit history, criminal history, reputation, and character. A series of psychological and medical screenings are used to evaluate the mental health and stability of the individual, taking into consideration aspects such as depression, schizophrenia, epilepsy, high/low blood pressure, and

[133] Rajya Sabha, Unstarred Question No. 2175, "Security at Units of Atomic Energy," answered on December 13, 2012. Available at http://dae.nic.in/writereaddata/rsus2175.pdf
[134] Lok Sabha Unstarred Question No. 2626, "Security Threat to Kudankulam Power Plan," March 13, 2013. Available at http://www.dae.nic.in/writereaddata/parl/bud2013/lsus2626.pdf
[135] Shoaib Ahmed, "Mumbai: BARC Security Breached 25 Times in Two Years," *IBN Live*, March 28, 2012.
[136] Ibid.
[137] Smita Nair, "Nuclear disaster: Control rooms with no bosses, hotline turned cold," *Indian Express*, October 21, 2014. Available at http://indianexpress.com/article/india/india-others/nuclear-disaster-control-rooms-with-no-bosses-htline-turned-cold/99/

other disorders. To motivate and ensure a fair working environment, the employees "are provided with excellent living conditions and career opportunities. The Scientific and Technical promotions in the Department are governed by the Merit Promotion Scheme and are not vacancy based. Compulsory health care facilities are provided covering all disciplines including mental help, social welfare services counseling and psychiatry. This covers both employees and their families. Cultural and recreational activities are also conducted regularly."[138]

Additionally, a detailed interview to verify background information and elucidate other potential concerns is conducted at the time of employment, or when any sensitive task is being assigned. With an appropriate Human Resource Development (HRD) program,[139] periodic reviews of job performance, co-worker interaction, after work activities, etc., are monitored. The AERB has developed a "formal code of professional ethical values" for all employees to adhere to.[140] In order to ensure all activities in nuclear and radiation facilities in India are conducted in compliance with the Atomic energy Act of 1962, the officials shall be guided by the principle to: (1) to maintain a high level of professional competence; (2) maintain high level of honesty and integrity, and be principled and consistent in application of regulations. All employees of the AERB have to accept a "statement of responsibility" to uphold the highest standards of professional conduct in the performance of professional duties.[141]

Similarly, the NPCIL, which operates the nuclear power plants in the country, has mandated a "Code of Ethics & Conduct" requiring "commitment for ethical professional conduct from every director and senior employee."[142] The code, formulated in the form of statements of personal commitment, bestows responsibilities on concerned personnel for the design, construction, operation, and maintenance of nuclear power projects. Also, the code asks to maintain confidentiality of information, strive to achieve the highest quality, mutual trust, and transparency and, avoid conflict of personal interest with the interest of the company at large. The other public sector undertaking, Bharatiya Nabhikiya Vidyut Nigam Ltd. (BHAVINI), has its own code of business conduct and ethics for board members and senior management.[143] More importantly, it has framed a Fraud Prevention Policy "to provide a system for prevention/detection/reporting of any fraud that is detected or suspected and fair dealing of matters on the subject."[144]

The NPCIL has also instituted a Vigilance Directorate with the objective "to eliminate or minimize factors which provide opportunity for corruption or malpractices through in-depth

[138] Lok Sabha, Question No. 6416, "Suicide Among Scientists," May 05, 2010. Available at http://dae.nic.in/writereaddata/lsus050510.pdf.
[139] NPCIL, "21st Annual Report 2007-08." Available at http://www.npcil.nic.in/pdf/annual_report07_08.pdf, p. 07.
[140] AERB, "Code of Ethics." Available at http://www.aerb.gov.in/t/publications/ethics.pdf
[141] Ibid, p. 5.
[142] NPCIL, "Code of Ethics and Conduct." Available at http://www.npcil.nic.in/main/CodeofEthics.aspx
[143] BHAVINI, "Code of Business Conduct and Ethics for Board Members and Senior Management." Available at http://www.bhavini.nic.in/attachments/Code%20of%20Business%20Conduct%20&%20Ethics.PDF
[144] BHAVINI, "Risk Management – Fraud Prevention Policy." Available at http://www.bhavini.nic.in/attachments/Risk%20management%20and%20Fraud%20Prevention%20Policy.pdf

examination … regular inspection and surprise visits," ensuring prompt observance of proper conduct and ethics relating to integrity.[145] According to the corporation, it maintains surveillance on employees who have access to sensitive parts of the plants and performs regular and surprise inspections to detect possible misconduct.[146]

However, occasional incidents of malpractice in different departments of the establishment are reported. In November 2009, some employees of a maintenance unit of the Kaiga plant were treated "for increased level of tritium after they drank water from a cooler in the operating area".[147] In a clarification then, India's Minister for Science and Technology, Prithviraj Chavan, said an insider at the plant is suspected of spiking the cooler with "heavy water."[148] In addition, questions have been raised in the Parliament regarding suicides and mysterious deaths of personnel.[149] Sekhar Basu, Director of BARC, argues that "The number of deaths due to suicide is less than 100 (69 to be precise) over a period of 20 years and over 60,000 employees work at DAE.[150] The official view is that the reasons for suicides are general; none of these unnatural deaths are connected to radiation exposure, working conditions, or official activities. Rather, safety and security measures to prevent casualties are in place at all nuclear power plants, and employees are provided with "excellent living conditions and career opportunities;" compulsory health care facilities are provided including social welfare services, mental help, counseling, psychiatry, etc.[151]

4.5.5 Material Protection Control & Accounting

India has devised a comprehensive material protection control and accounting programme comprised of three basic elements: (1) the legislative and regulatory framework; (2) an integrated physical protection programme for facilities and materials; and (3) a comprehensive "Nuclear Material Accounting and Control System" (NUMAC).[152] While all facilities are covered by a multi-layered security system, facility-specific NUMAC arrangements are in place under an

[145] "Vigilance," Nuclear Power Corporation Of India Limited. Available at http://www.npcil.nic.in/main/Vigilance.aspx
[146] "Director's Report," *Annual Report 2004-2005*, Nuclear Power Corporation of India Ltd, p. 17.
[147] "Union Minister Confirms Nuclear Sabotage", *The Times of India*, November 29, 2009.
[148] "Water Cooler at Indian Nuclear Plant Contaminated," *Voice of America*, November 29, 2009. Available at http://www.voanews.com/english/news/Water-Cooler-at-Indian-Nuclear-Plant-Contaminated-78087742.html
[149] Lok Sabha Unstarred Question No. 3362, "Deaths of Scientists in BARC," 12 February 2014. Available at http://dae.nic.in/writereaddata/parl/budget2014/lsus3362.pdf; Lok Sabha Unstarred Question No. 324, 23 February 2011, Available at http://dae.nic.in/writereaddata/324_lsus230211.pdf.
[150] Pradipti Jayaram, "Counting Suicides in India's Nuclear Family," http://www.thehindubusinessonline.com/features/counting-suicides-in-indias-nuclear-family/article6497513.ece, October 13, 2014.
[151] Lok Sabha Unstarred Question No. 6416, "Suicide Among Scientists," May 05, 2010. Available at http://dae.nic.in/writereaddata/lsus050510.pdf.
[152] Based on K. Raghuraman, from DAE, presentation in an international workshop on "Protection, Control, and Accounting of Nuclear Materials: International Challenges and National Programs" at the National Academy of Sciences, Washington, DC. Christopher Eldridge, "Domestic MPC&A Program," in *Protection Control and Accounting of Nuclear Materials*, National Academy of Sciences, Washington, DC. Available at http://books.nap.edu/openbook.php?record_id=11343&page=39, pp. 39-40.

Officer in Charge to oversee each facility. The Inventory Information and Control and Data Management Section and a control laboratory compile and preserve the information. The activities of all NUMAC facilities are coordinated through a central NUMAC group at the DAE. At the top, the Senior Coordination Committee reviews NUMAC reports to initiate actions, if needed. The responsibility of NUMAC is to identify nuclear material by type, nature, and amount; to implement accounting and control mechanisms; to ensure measurement capabilities and statistical analysis of reported data as efficient; to oversee auditing practices and implement inspection and verification practices; and to ensure the compliance of constructive measurements, periodic inspection, verification and auditing, and documentation of inventory changes and discrepancies thereof.[153]

A Nuclear Control & Planning Wing (NC&PW) was created in the DAE in 2013 to take "the lead on international cooperation on nuclear security" by integrating DAE's safeguards, export controls, and nuclear security related activities.[154]

4.5.6 Transportation Security

The AERB has stipulated a Safety Guide on security of radioactive material during transport (AERB/NRF-TS/SG-10) that prescribes the requirements for ensuring safety in the movement of radioactive material through public domain.[155] This guide specifies rules, regulations, and standard procedures to be followed in packaging and shipment, and protective measures to be arranged during the process of transportation. Security levels are specified for different materials (Category I to 5), depending upon their degree of fissile characteristics and danger involved. This includes, amongst others, prior approval for the shipment, special vehicle, security locks, appropriate training of personnel involved, additional security and escort by armed guards, secure communication support, an on-line tracking system, etc.[156]

4.5.7 Air and Water Front Defense

Within a month after the 9/11 terror attacks in the US, New Delhi promulgated no-fly zone restrictions around nuclear power plants. Reportedly, the flights over BARC were also banned because there were fears that planes flown by countries hostile towards India could perhaps crash into the reactors in suicide missions.[157] Requisition for additional anti-aircraft guns was made for deployment to the Narora Atomic Power Plant in Rajasthan and for two atomic power plants in

[153] Ibid, p. 40.
[154] "National Progress Report 2014: India." Available at https://www.nss2014.com/sites/default/files/documents/india.pdf
[155] "Security of Radioactive Material During Transport," *AERB Safety Guide No. AERB/NRF-TS/SG-10*, AERB, January 2008. Available at http://www.aerb.gov.in/T/PUBLICATIONS/CODESGUIDES/sg-10.pdf
[156] Ibid, pp. 13-16.
[157] Srinivas Laxman, ChinmayiShalya, "Ban Flight of Civilian Planes over BARC: Experts," *The Times of India*, December 04, 2008.

southern India.[158] However, no information is available on whether these facilities are adequately protected by anti-aircraft defenses.

Taking no chances with its security following the Mumbai terror attacks (November 26, 2011), security arrangements around India's key nuclear installations are given a second thought. As a step in this direction, the Director General of Civil Aviation (DGCA) has "declared a no-fly zone around the Kalpakkam nuclear plant" in Tamil Nadu,[159] BARC and Tarapur Atomic Power Station in Mumbai.[160]

In an April 27, 2011 meeting chaired by the then CISF Director-General N.R. Das and attended by top officials of 14 atomic energy plants, the DAE and CISF reviewed the security arrangements of major nuclear power plants, considering constant threat to India's sensitive installations.[161] In the meeting it was decided to strengthen the water front security of all nuclear installations and fortify these areas with the help of additional security personnel and deployment of security devices. To meet the threat that may arise from the waterfront, the Indian Coast Guard deploys additional boats off the coast of Bombay to guard BARC.

4.5.8 Security of Radiological Materials

Arguably, physical protection at the sites where radiological sources, materials, devices, and instruments are used (e.g., hospitals, research facilities, oil and gas exploration industry, road construction industry, and steel manufacture) "is rather lax, at best comparable to the protection provided at a jeweler shop (i.e., not a real logistical problem for a trained team of adversaries.)"[162] Even in a highly industrialized country like the US, with "cradle-to-grave" supervision of radioactive material, on average based on 1999 estimates, every year control is lost over about 200 such sources.[163] It can be assumed that the situation is, at best, similar, or even worse, in India.

In April 2010, the Cobalt-60 used in the irradiator of the Chemistry Department of Delhi University landed in New Delhi's Mayapuri scrap market, resulting in a radiation leak and death of one person.[164] The scrap market was not equipped with radiation detection devices and the scrap workers had no radiation-related awareness. Even the authorities in charge of the

[158] "Indian Atomic Energy Body Wants 'No Fly Zones' Over Nuke Facilities," *Deutsche Presse-Agentur*, February 5, 2002, in Lexis-Nexis Academic Universe, February 13, 2005. Available at http://www.lexis-nexis.com
[159] "India Declares Kalpakkam Nuclear Plant No-Fly Zone," December 17, 2008. Available at http://www.brahmand.com/news/India-declares-Kalpakkam-nuclear-plant-no-fly-zone/821/1/12.html Vinay Kumar, "Kalpakkam Nuclear Plant No-Fly Zone," *The Hindu*, December 17, 2008.
[160] Srinivas Laxman and Chinmayi Shalya, "Ban Flight of Civilian Planes over BARC: Experts", *The Times of India*, December 04, 2008.
[161] "DAE, CISF Review Security of Nuclear Power Plants,", *The Times of India*, April 30, 2011.
[162] Basrur and Steinhausler, "Nuclear and Radiological Terrorism Threats for India: Risk Potential and Countermeasures," p.5.
[163] Greta J. Dicus, "USA Perspectives - Safety and Security of Radioactive Sources," *IAEA Bulletin*, Vol. 41, No. 3, 1999, pp. 22-27.
[164] "Biggest radiation crisis in 4 years may shut DU labs," *Hindustan Times*, April 30, 2010.

laboratory were unaware of the radiological material inside the unused irradiator. The AERB had no inventory of radioactive materials sourced from abroad prior to its own existence. Before the AERB was set up in 1983, the Directorate of Radiation Protection (DRP) was responsible for the radiation protection program, including radiation surveillance in hospitals, industries, and research institutes. It suggests that the coordination between the DRP and AERB was absent after the former was established.[165] Another such incident of a lackadaisical act was the misplacement of a power source containing Pu-238, an alpha emitter in sealed conditions installed at Nanda Devi (Indian side of Himalayas), which could not be traced in spite of several attempts.[166] So, several gaps seem to exist at each level, starting from the suppliers' responsibility to the users' obligation, from monitoring of movement of materials to waste disposal, and finally, lack of public awareness.

Smuggling of radioactive materials in and around India is often reported. According to a report in 2001, uranium smuggled from Jaduguda mines was confiscated from smugglers in Balurghat in northern West Bengal, which was "planned to be smuggled across the Bangladeshi border".[167] Five people were arrested in Meghalaya for allegedly trying to smuggle uranium on September 10, 2008.[168] More threatening instances have been reported:

- "Uranium 235 weapons-grade material recovered from criminals in Tamil Nadu in 1998;
- The theft of more than 8 kg of natural uranium from the Indira Gandhi Centre for Atomic Research (IGCAR) in Chennai (later seized by the Central Bureau of Investigation in 1999);
- The recovery of 26 kg of uranium from illicit traffickers in Hyderabad in 2000; a gamma radiography camera containing Iridium 192 stolen during transportation" in Assam in July 2002;[169]
- An industrial ionising radiation-gauging device containing about 9.25 GBq Cs-137 source, used in a coal washery, "was found to be missing from the premises on November 16, 2006";[170]
- Seizure of around 4 kg of low-quality uranium after the Bihar police arrested a group of smugglers from the Nepal border in 2008;[171] and

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[165] Sitakanta Mishra, "Radiation Safety: How Prepared Are We?," *National Defence & Aerospace Power*, Centre for Air Power Studies, New Delhi, No. 25/10, May 15, 2010.
[166] Lok Sabha Unstarred Question No: 2194, "Missing of Nuclear Device," March 10, 2010. Available at http://dae.nic.in/writereaddata/lsus100310.pdf.
[167] Andrew Prosser, "Nuclear Trafficking Routes: Dangerous Trends in South Asia," Centre for Defence Information, November 24, 2004. Available at http://www.cdi.org/PDFs/TraffickingSmuggling.pdf, p. 9.
[168] "Five arrested for alleged 'uranium' smuggling, say police," September 11, 2008. Available at http://www.spacewar.com/reports/Five_arrested_for_alleged_uranium_smuggling_say_police_999.html
[169] Rajeswari Pillai Rajagopalan, et al., "Chemical, Biological and Radiological Materials: An Analysis of Security Risks and Terrorist Threats to India," 2012. Available at http://www.observerindia.com/cms/export/orfonline/documents/ORF-RUSI.pdf; Jennifer Cole, "An Explosion of Demand", CBRNe WORLD, August 2012,
[170] "Safety Surveillance of Radiation Facilities." Available at http://www.aerb.gov.in/AERBPortal/pages/English/t/annrpt/2006/chapter3.pdf, p. 29.

- 15 disused Cobalt-60 isotopes stolen from the SAIL Durgapur plant in January 2011.[172]

Though the authenticity of these reports can be questioned, chances of such incidents are hardly surprising given the location of South Asia, situated between two well-established drug trafficking routes – the Golden Crescent and Golden Triangle. These incidents indicate that "while elaborate security structures have been put in place to prevent radioactive material falling into the hands of malicious actors, thus far it has not proved to be completely foolproof."[173]

Increasing incidents of smuggling uranium ore in the Nepal-Bihar-Jharkhand-West Bengal conduit have been reported that raise the issue of security of uranium mining. The information regarding the security arrangement in uranium mines and mining activities is not publicly available. Moreover, smuggling of monazite sands (a beach sand mineral containing thorium) from the beaches in the states of Tamil Nadu, Kerala, and Orissa are reported. Even though DAE has not given license to any private entity except the state-run Indian Rare Earth Ltd. (IREL) to produce, process, and export monazite, a mining cartel led by a Tirunelveli firm has allegedly mined and quietly exported the material.[174] Another report reveals that around 2.1 million tonnes of monazite, equivalent to 195,300 tonnes of thorium at 9.3 per cent recovery, has disappeared from the shores of India.[175] In an answer to the question on mining of monazite in the Lok Sabha, the Minister of State for Personnel, Public Grievances & Pensions and Prime Minister's Office, Shri V. Narayansamy replied that minerals like ilmenite, rutile, leucoxene, garnet, sillimanite, and zircon are free of monazite and delisted from the prescribed substances list (DAE notification vide ref. S.O.61(E) dated January 20, 2006), hence for the handling of these minerals licensed from DAE under the Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substance) Act (AEC), 1984 is not required. Therefore, private companies are allowed to separate and export these materials from beach sands. However, license under the AEC is still required for the handling / export of monazite and Thorium, which are prescribed substances. This Department has not given any licenses for the export of beach sand as such.[176]

Conscious of the threat, Indian authorities have made attempts to address the existing loopholes through a number of policies and technological solutions. To ensure Mayapuri-type incidents are not repeated, the University Grant Commission (UGC), the national body that manages higher education in India, has issued comprehensive guidelines on the usage of radioactive material by

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[171] India Police Seize 8 lbs of Uranium from Smugglers" February 19, 2008. Available at http://www.reuters.com/article/worldNews/idUSB65928720080219?feedType=RSS&feedName=worldNews.
[172] "15 Disused Cobalt-60 Isotopes Stolen from SAIL in Jan", *The Economic Times*, March 14, 2011.
[173] Rajagopalan, "Chemical, Biological and Radiological Materials: An Analysis of Security Risks and Terrorist Threats to India," p. 15.
[174] "How India Lost Thorium as Govt Bungled." Available at http://freepressjournal.in/how-india-lost-thorium-as-govt-bungled/ October 05, 2012.
[175] Bikram Lamba, "The Great Thorium Robbery," *Cnn.com*, September 09, 2012. Available at http://ireport.cnn.com/docs/DOC-839177.
[176] Lok Sabha Question No 1531, "Mining of Monazite," Suresh Kodikunnil, November 30, 2011.

universities and colleges across the country[177] Also, BARC has prepared a comprehensive inventory of all the radioactive materials imported, used, and disposed in the country.

India's ministry of shipping has ordered the installation of Radiation Monitor Portals in all major ports in the country.[178] Monitoring devices have been installed in the major seaports of the Jawaharlal Nehru Port Trust (JNPT, Navi Mumbai), Mumbai Port, Kandla, Goa, New Mangalore, Cochin, Tuticorin, Ennore, Chennai, Visakhapatnam, Paradip, and Kolkata. At present, only the JNPT is Container Security Initiative (CSI) compliant and equipped with "automated container screening and information exchange" provisions to intercept the movement of radioactive materials.[179] This study is of the view that India should consider equipping its other major seaports with technology similar to CSI arrangements.

Mobile Radiation Detection Systems (MRDS), as part of the preparedness to handle radiological emergencies, have been initiated in major Indian cities. In 2011, the Union Home Ministry sanctioned setting up nearly 1,000 MRDS in 50 Indian cities for detecting radiation.[180]

Indian scientists have indigenously developed two types of radiation detection systems using plastic scintillators – a portal monitor for pedestrians and a camouflaged Limb/Pole monitor.[181] These have been calibrated and installed at a few facilities to detect orphan sources and unauthorized movement or illicit trafficking of radioactive materials. At the major transit points, border crossings, and airports, radiation monitoring devices have been installed to monitor the unauthorized movement of radioactive materials.[182] Devices have been positioned in 14 major airports, including Delhi, Mumbai, Chennai, Kolkata, and Amritsar. In a phased manner, the remaining airports will be covered. Similarly, in the first phase, devices have been installed at 13 integrated border check-posts including the check posts at Wagah-Attari and on either side of the India-Nepal border. The police and border security forces have been given the necessary training to identify and take action if such an event is noticed. In 2004, India's Border Security Force (BSF) formed a battalion with special skills in countering nuclear, biological, and chemical threats. With the aim to tackle danger arising out of the possibility of terrorists using WMDs, "the DRDO has developed a mobile truck mounted laboratory to screen troops in the field from the after effects of radiation and initiate remedial measures. The chamber, termed as Mobile

[177] University Grants Commission, "UGC Guidelines for Universities, Research Institutes and Colleges for Procurement, Storage, Usage and Disposal of Radioactive and other Hazardous Material/ Chemicals," January 2011. Available at http://www.ugc.ac.in/oldpdf/xiplanpdf/disposalofradioactiv.pdf
[178] "India to Install Radiation Monitors for Steel Scrap Import at All Major Port," December 16, 2011. Available at http://www.steelguru.com/indian_news/India_to_install_radiation_monitors_for_steel_scrap_import_at_all_major_port/241105.html
[179] Gurpreet S Khurana, "India and the Container Security Initiative", *IDSA COMMENT*, July 17, 2007.
[180] Vishwa Mohan, "50 Cities to Get Mobile Kit to Trace Radiation,"*The Times of India*, October 07, 2011.
[181] Harikumar M, Vaishali M Thakur, Amit Kumar Verma, Krishnamachari G., D. N Sharma, "Detection of Unauthorized Movement of Radioactive Sources in the Public Domain for Regaining Control on Orphan Sources - Systems and Feasibility," IAEA. Available at http://www.unece.org/fileadmin/DAM/trans/radiation/docs/India.pdf
[182] Y. Mallikarjun, "Seaports, Airports to Get Radiation Detection Equipment," *The Hindu*, May 04, 2012.

Whole Body Counter (MWBC) will do away with the necessity and the logistic impediment of evacuating soldiers from operational areas to rear echelons."[183]

4.5.9 Information & Cyber Security

The extensive use of information technology in various systems has given rise to concerns of potential attacks on these systems. It is alleged that India currently has neither a strong cyber law, nor effective cyber security capabilities. Many times in the past, government websites and emails have been hacked. According to media reports a few years ago, computers at the Rare Materials Plant (RMP), Rattehalli, were possibly infected by malware.[184] The authors could not find any information on India's cyber security strategy for its nuclear infrastructure. Situated in an unstable neighborhood with non-state actors, India's nuclear infrastructure is vulnerable to cyber espionage or sabotage.

One may wonder if the Indian technocrats are prepared to mitigate a Stuxnet-type threat to its nuclear installations with robust protection. The National Critical Information Infrastructure Protection Centre National Technical Research Organisation (NTRO) has prescribed Guidelines for Protection of National Critical Information Infrastructure to take all necessary measures to facilitate protection of Critical Information Infrastructure (CII) from unauthorized access, modification, use, disclosure, disruption, incapacitation, or destruction.[185] Also, the Computer Information and Security Advisory Group (CISAG) is in charge of periodic oversight of information systems. It has put in place plans and guidelines to counter cyber-attacks and mitigate any adverse effects. Specific guidelines are under preparation to deal with network related risks to control and instrumentation systems used in various installations.[186]

4.5.10 Nuclear Forensics

In a bid to tackle smuggling and illegal transportation of nuclear materials, the Directorate of Forensic Science Laboratories (DFSL), Bangalore, has drawn up a comprehensive plan and proposed establishment of a national nuclear forensic science centre. The plan is expected to take off by 2018-19, but the proposal is still pending with the state government.[187] As one of the objectives of the GCNEP is to enhance nuclear safeguards through various advanced systems (including nuclear forensics), it may coordinate and expedite the DFSL plan.

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[183] "DRDO Develops Mobile Lab to Screen Troops in Nuclear Scenario". Available at http://www.tribuneindia.com, January 06, 2015.
[184] S. Raghotham, "Cyber Attack on Key N-Facility in Mysore?"*The Asian Age*, November 02, 2011.
[185] NTRO, "Guidelines for Protection of National Critical Information Infrastructure," Version 1.0, June 2013. Available at http://www.ficciweb.info/conf-cell/Guidelines.pdf,
[186] MEA, "Nuclear Security in India."
[187] "Dirty Bomb: Forensic Lab to Take Lead in Fighting Nuclear Terrorism," March 06, 2011. Available at http://www.dnaindia.com/bangalore/report-dirty-bomb-forensic-lab-to-take-lead-in-fighting-nuclear-terrorism-1516166

4.5.11 Security of Strategic Assets

There is virtually no open information available on the steps India takes to prioritize security of its strategic assets, including nuclear weapons, components, or strategic facilities. It is believed that India's nuclear weapons are in a disassembled and dispersed state. It is important to acknowledge the fact that India adheres to a second-strike nuclear posture that relies on secrecy, and therefore has to keep internal safety and security measures away from scrutiny, mainly to ensure survivability of its arsenal. The Strategic Forces Command (SFC) has administrative control of the nuclear forces. The Strategic Armament Safety Authority (SASA) that functions directly under the Nuclear Command Authority (NCA) is responsible for all matters relating to the safety and security of India's nuclear and delivery assets at all locations.[188] It is believed that the physical security of warheads and components is provided by a specialized force drawn from the Indian Army.

After the Indo-US civil nuclear deal, India separated its civil nuclear facilities from facilities that are associated with its strategic programme. As of 2014, 20 nuclear facilities and 12 reactors are on the civilian list. Though a comprehensive physical security architecture of the civilian facilities is in place (as discussed above), nothing is known about the physical security arrangement for the strategic nuclear plants except the 2014 MEA document stating that "Separate institutions and operating procedures exist for nuclear security at India's strategic facilities."[189]

For instance, since 2000 BARC has not been under the regulatory supervision of the AERB. This is a significant move since BARC houses much of India's strategic nuclear program, including the Dhruva reactor. As of now, only the civilian nuclear reactors in the country are under the regulatory supervision of the AERB, and the strategic facilities are managed by internal safety committee structures constituted by the facility director.

Collaboratively, while the CISF is responsible for the physical security of the civilian nuclear installations in the country, the NUMAC cell within the DAE ensures that there is a proper nuclear material accounting and control system in the country. This implies that nuclear security in India is the responsibility of different organizations: physical security is with the CISF or the local police; material accounting (which has security implications) is of the responsibility of the DAE; and the review of security practices is handled by the AERB. Indeed, when it comes to physical security, there is more than the CISF that is involved.

[188] Shyam Saran, "India's Nuclear Weapons Not for National Pride," May 09, 2013. Available at http://ris.org.in/images/RIS_images/pdf/tribune-9may%202013.pdf
[189] MEA, "Nuclear Security in India."

5. NUCLEAR SECURITY CULTURE IN INDIA: AN EVALUATION

In India, nuclear security has traditionally been subsumed within the broader nuclear safety framework. The various legal and institutional frameworks in the country were instituted, keeping the safety considerations in mind. Given the intertwined nature of safety and security, one would have expected more transparency within the country's nuclear security infrastructure since a healthy safety culture, by definition, demands a certain amount of transparency. However, transparency regarding nuclear security, or even safety for that matter, in the country's nuclear establishment is hardly visible. There are a number of reasons for the lack of transparency in India's nuclear establishment. The country's distinctive nuclear past, including many years of isolation, and a mix of civilian and strategic nuclear programs, have given rise to heightened levels of caution within the country's nuclear establishment. Additionally, given that India's nuclear programme was under sanctions and isolated by the international community after the 1974 PNE, there was a culture of extreme secrecy within the establishment, ensuring that the nature of the country's nuclear programme was not disclosed to outsiders.

Secrecy can be both positive and negative as far as nuclear security is concerned. While a certain amount of secrecy and sense of threat will contribute to enhancing security measures in nuclear installations, it is also possible that extreme secrecy will reduce accountability and internal checks and balances. However, there is a new-found belief in India that it is no longer an isolated state in the global nuclear order and that it is, therefore, important that it participate in global norms and rules. For instance, IAEA has been invited by India to conduct a peer review of the Indian nuclear safety regulatory system, which is slated to take place in early 2015.[190] There is also a great sense of urgency among the Indian political leadership on nuclear security matters. This is evident from the participation of the Prime Minister and the External Affairs Minister in the Nuclear Security Summits and their statements indicating the seriousness with which India approaches nuclear security matters. The then Prime Minister, Dr. Manmohan Singh, stated at the 2010 NSS that "Nuclear security is one of the foremost challenges we face today." Likewise, the then External Affairs Minister declared in the Hague Summit that "India fully shares the continuing global concern on possible breaches of nuclear security."[191] India has been actively implementing the various undertakings that it made at the various NSS, such as not using HEU in research reactors and establishing the GCNEP.

In short, it would be appropriate to argue that India's nuclear security approach is based on the foundation and belief that "credible threat exists and that nuclear security is important." In our considered opinion, we believe that India needs to further strengthen its institutional, legal, and physical infrastructure relating to nuclear security, in order to ensure that its nuclear

[190] "IAEA Review of Indian Nuke Plants Latest by Early 2015," March 04, 2014. Available at http://m.outlookindia.com/items.aspx/?artid=831294

[191] "Khurshid: Nuclear Terrorism Serious Threat to Global Peace", *Indian Express*, March 26, 2014. Available at http://indianexpress.com/article/india/india-others/khurshid-nuclear-terrorism-serious-threat-to-global-peace/

establishment is secure. We also believe that the country does have the institutional and physical basis that can be further enhanced and strengthened.

5.1 Absence of an Overarching Security Apparatus

One of the issues that should be taken seriously by the government of India regarding nuclear security is the absence of an overarching security apparatus to safeguard the country's nuclear security installations. For instance, as mentioned earlier, the physical security of nuclear installations is provided by a mix of multiple organisations such as the CISF, the local police, and sometimes even with private security organisations. On the other hand, material accounting is done by the DAE, and the review of security practices is the responsibility of the AERB. Note that this is the situation on the civilian side alone. Thus, there are multiple organisations in charge of the various aspects of nuclear security in the country, resulting in non-uniform nuclear security culture, norms, and standard operating procedures.

5.2 Regulatory Autonomy

It may be noted that there was no regulatory mechanism prior to 1983 when the AERB was established through a gazette notification by the government of India. Prior to 1983, the security and safety regulation was carried out by an internally constituted committee in each facility. Not much has changed since 1983.

The AERB's regulatory powers are limited, as it is not a truly autonomous institution. The Public Accounts Committee of the Parliament of India in its 19th report pointed out that "the legal status of the AERB continues to be that of an authority subordinate to the Central Government, with powers delegated to it by the latter."[192] It is the government of India that appoints the head of the regulatory body and provides the necessary funding. Moreover, the head of the AERB reports to the Chairperson of the Atomic Energy Commission, who is also the Secretary in the Department of Atomic Energy, which creates the situation of the regulator reporting to the promoter of nuclear projects. This is a potential conflict-of-interest and has implications for the extent and quality of oversight by the regulatory authority. The new Bill under consideration of the Indian Parliament, the NSRA, also, in its current shape and form, does not provide for a truly autonomous regulator.

The Bill was presented to the previous Lok Sabha in September 2011 and was subsequently referred to a Department-Related Parliamentary Standing Committee on Science & Technology, Environment & Forests in the same month. The Committee gave its report in March 2012 and, according to reports,[193] the government (DAE) adopted most of the suggestions and sent it back to the Parliament. The Bill is currently lapsed and is likely that the new government will

[192] Public Accounts Committee 2013-2014, "Activities of Atomic Energy Regulatory Board," December 2013. Available at http://164.100.47.134/lsscommittee/Public%20Accounts/15_Public_Accounts_90.pdf, p. 4.
[193] "Nuclear Safety Bill to be Taken up in Next Session: Minister," September 06, 2013. Available at http://zeenews.india.com/news/nation/nuclear-safety-bill-to-be-taken-up-in-next-session-minister_874653.html

reintroduce the Bill in the newly formed Lok Sabha (it has not yet been introduced in the Rajya Sabha).

The Committee in its report[194] asked the government to ensure that the regulatory authority is made more autonomous. The PAC also made the same recommendation to the government: "The department of atomic energy should seriously re-examine provisions of the Bill and take necessary steps to ensure the nuclear regulator becomes independent and credible and at par with regulators in other nations."[195]

Analysts have also critiqued the various provisions of the Bill. For instance, Suvrat Raju and MV Ramana have argued that the clause "the decision of the central government whether a question is one of policy or not shall be final" is problematic since "if a pesky Authority questions, say, the decision to import an untested nuclear reactor, the government can silence it simply by declaring that the matter is one of 'policy.' This clause profoundly undermines the independence of the Authority."[196] According the Raju and Ramana, the appointment process is also faulty − "Another structural problem with the proposed NSRA is that all its members will be "appointed by the central government on the recommendations of the search committees." However, these committees will be constituted by the "Council of Nuclear Safety," which will comprise seven Union Ministers, the Secretary of the DAE, and the Cabinet Secretary. So, in effect, the government will have complete control over the appointment process, and can use it to appoint pliant technocrats."[197]

5.2.1 Program Confusions

There are reactors that are connected to the grid and produce electricity, yet are marked "strategic." The difference between these reactors and those that are "civilian" is the length of irradiation; but confusion remains regarding the status of the spent fuel generated out of these reactors. Yet, it is conceivable that there could be two sets of standards and different organizations involved in managing safety and security of each, simply because of this semantic (or perhaps operational) difference. This could seem problematic in the public eye from a consistency and regulatory point of view.[198]

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[194] Department-related Parliamentary Standing Committee on Science & Technology, Environment & Forests, "Two Hundred and Twenty First Report on the Nuclear Safety Regulatory Authority Bill, 2011," March 06, 2012. Available at http://www.prsindia.org/uploads/media/Nuclear%20Safety/NSRA%20Bill%202011_%20Standing%20Com%20Report.pdf

[195] Ibid, p. 48.

[196] Suvrat Raju and MV Ramana, "It's Better to be Safe than Sorry," *Hindustan Times*, February 05, 2014. Available at http://www.hindustantimes.com/comment/analysis/it-s-better-to-be-safe-than-sorry/article1-1180454.aspx

[197] Ibid.

[198] Inputs via email from Toby Dalton, Deputy Director, Nuclear Policy Program, Carnegie Endowment for International Peace, Washington D.C. July, 2014.

5.2.2 Conceptual Tensions

There are conceptual tensions at every level of nuclear security: between safety and security; between physical protection and material protection and accounting; between the use of technology and manpower; and between counter-intelligence and "need to know" system.[199] Such tensions need to be addressed to achieve a certain level of balance that would be acceptable for India. The accountability system in the country needs to be based on how these tensions are resolved. We've seen in failures in the US where internal accountability was lacking.[200]

Besides ensuring the security of nuclear materials and facilities spread throughout the country, the other major challenge that India needs to wake up to is the security of radioactive materials, sources, and devices. This is an enormous challenge given the number of facilities and amount of material and devices to be secured. Currently, the government is only beginning the task of putting in place proper accounting of these facilities and materials. There have been a number of past incidents involving radiological material, including one involving the University of Delhi (Mayapuri scrap market incident in 2010). Both the CAG and the PAC reports have raised concerns about these incidents. Given the fact that there have been accidents in the past involving radioactive material, New Delhi should create national level structures to bring the radioactive material under proper regulatory and security mechanisms.

There are also other such related concerns linked (directly or indirectly) to nuclear or radiological security in India. For instance, as previously noted, there have been a number of reports on the smuggling of radioactive material, hacking of websites of sensitive nuclear-related institutions in the past leading to fears about India's ability to withstand a cyber-attack directed against its nuclear facilities, instances of misconduct and malpractices in nuclear facilities,[201] and mysterious and unnatural deaths of nuclear scientists. Related concerns are the physical security of residential colonies attached to the nuclear facilities, and the security of thorium and uranium mining sites. There can often be conceptual tensions between issues of safety and security with implications for the everyday management of nuclear security. Therefore, there is a need to maintain a well-thought out balance between these two, sometimes competing, but equally important issues.

Finally, it is worth recalling the words of Kiyoshi Kurokawa, the Chairman of the Fukushima Nuclear Accident Independent Investigation Commission, on the Fukushima nuclear accident: "What must be admitted — very painfully — is that this was a disaster 'Made in Japan.' Its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience; our reluctance to question authority; our devotion to 'sticking with the program'; our groupism; and our insularity … nuclear power became an unstoppable force,

[199] Ibid.
[200] Ibid.
[201] "Sabotage in Kaiga: Tritium Added to Drinking Water," *Economic Times*, November 30, 2009. Available at http://articles.economictimes.indiatimes.com/2009-11-30/news/28471895_1_tritium-drinking-water-contamination

immune to scrutiny by civil society. Its regulation was entrusted to the same government bureaucracy responsible for its promotion." [202] Anyone familiar with the Indian nuclear establishment will see that much of what Kurokawa says about the Japanese nuclear safety culture could also be applicable in the case of India's nuclear safety/security culture. There is an urgent need for the government to look closely at how much these characteristics are prevalent in India's case and seek ways for them to be addressed.

[202] Kiyoshi Kurokawa, "The National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission," 2012. Available at http://ieer.org/wp/wp-content/uploads/2012/07/Fukushima_NAIIC_report_lo_res3.pdf

6. RECOMMENDATIONS FOR ENHANCING NUCLEAR SECURITY GOVERNANCE, INSTITUTIONS, INSTRUMENTS, AND CULTURE

This study has identified a number of areas where we believe much needs to be done in order to improve the nuclear security culture and architecture in India. Based on our findings, we put forward the following suggestions for debate and consideration by the government of India and the International community.

6.1 Recommendations for India

Transparency

- Demonstrate more confidence and clarity in the essential elements of the country's nuclear security practices.
- Make transparency a key feature of the country's nuclear security culture.
- Develop a comprehensive white paper on security and safety measures.

Enhance the Autonomy of the Regulatory Body

- Ensure complete autonomy of the regulatory body from the promoting agency.
- Include scientists, civilian auditors, environmentalists, etc. into the regulatory oversight body.
- Constitute a bi-partisan body to select the members of the regulatory body.

Strengthen National Nuclear Safety-Security Culture

- Reexamine organizational issues identified in the Fukushima accident investigation, including "reflexive obedience, reluctance to question authority, devotion to 'sticking with the program', and vested interest, groupism, and insularity."[203]
- Set up a high-level committee to explore how prevailing trends in India's nuclear security system can be addressed.

New Areas to Consider

- Create unified security command/structure/requirements for the civilian nuclear installations.
- Create a special division within the CISF, or even a new specialized nuclear security force, to address nuclear security.

[203] Ibid.

- Create an agency to oversee and regulate strategic nuclear facilities.
    - Consider the strategic importance of declaring thorium-bearing areas and monazite sands as exclusive zones and providing them oversight and adequate security.
- Enhance the security of radiological materials, devices, and facilities.
- Equip major Indian seaports with technology similar to CSI.

6.2 Recommendations for the International Community

- Help mainstream India in the global nuclear order.
- Invite India to observe nuclear security training, practices, simulation exercises, etc. in other nuclear states and vice versa.
- Pursue India's entry into the export control organizations.
- India and the NSS process should consider convening Regional Nuclear Security Summits.

7. NEXT STEPS

This section identifies some of the short-term, intermediate-term, and long-term steps that we think could be taken by the Indian government in order to strengthen the safety and security of India's civilian nuclear facilities and material.

Short-term (1-2 years)

- Introduce theoretical and practical aspects of nuclear security in university courses on arms control/disarmament, nuclear strategy, nuclear energy, etc.
- Conduct a comparative study on the nuclear security structures of various countries and determine what aspects are applicable in Indian conditions.
- Initiate debates in the country on the NSRA legislation through mass media.

Intermediate-term (2-5 years)

- Hold a regional preparatory workshop (formal or informal) in South Asia to explore the possibility of holding a Regional Nuclear Security Summit.
- Prepare a draft action plan, based on the practices and experiences of other countries, for securing radiological facilities in India. Necessary training may be given to the personnel in key radiological facilities in the country on nuclear security.

Long-term (ongoing)

- Promote interface and collaboration among universities, think tanks, and nuclear establishment in India to discuss and deliberate on nuclear security matters.
- Promote collaborative research on nuclear security between Indian and international think tanks and Universities.

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