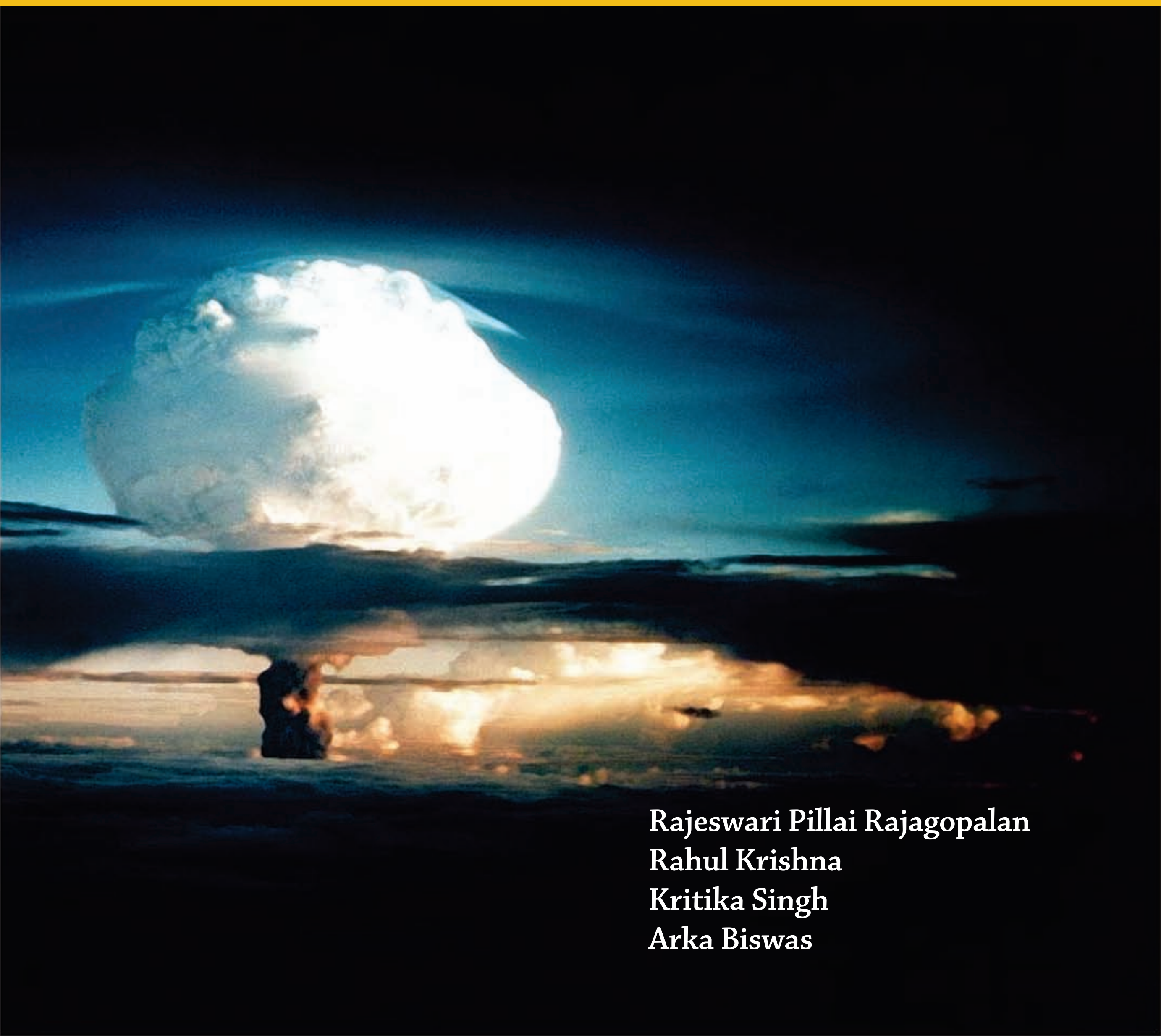
Nuclear Security in India

Second Edition



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Preface

Observer Research Foundation (ORF) published a special report on India's nuclear security, titled *Nuclear Security in India*, in January 2015. The report was one of the first comprehensive examinations of India's nuclear security policies, including an appraisal of how India has fared in implementing them. The report undertook an assessment of threats and challenges that India has continued to encounter both from within and outside. It presented a detailed analysis of the strengths and weaknesses of India's nuclear security policies and practices. This included an overview of the legal and institutional architecture and also a critical review of the policies in practice. The report also included an examination of nuclear security undertaken by the UK, France and Japan, with the objective of capturing some of the international best practices in the domain. This helped in providing a fair comparison of nuclear security measures followed by India with those by some of the established nuclear powers.

The report benefitted immensely from the extensive field visits conducted both within India and in the three aforementioned countries. Discussions with the security and the atomic energy agencies were particularly useful in developing a nuanced understanding of the subject. A highlight of the report was the set of 20 recommendations laid out in the final chapter. While some of those focused on measures which India could adopt in order to further strengthen its nuclear security, others were informed by the global best practices that could be usefully adapted to the Indian context.

The US has remained one of the critical pillars in the area of nuclear security and it has important lessons to offer in the domain. It is with this understanding that the ORF team undertook a field visit to the US, which included extensive discussions with key stakeholders, including officials from the US government and nuclear laboratories. A few site visits were also conducted, which allowed for a deeper assessment of US nuclear security practices.

ORF is publishing the second edition of the report incorporating key findings from the US field visit. The report has also undertaken a fresh review of the threat perception in the light of the recent terrorist attacks in India, including in Pathankot, and in South Asia in general. Furthermore, this edition incorporates an update on India's domestic nuclear security policies and regulations, including the proposed Nuclear Safety Regulatory Authority (NSRA) Bill and the commitments India has undertaken at the Nuclear Security Summit, 2016. Based on the findings from the US field visit, this edition includes an additional four recommendations that could be suitably modified to apply to the Indian context.

ORF is thankful to the Nuclear Threat Initiative (NTI) for funding and its team for facilitating the US field visit, which forms a critical addition in the second edition of the report. However, the report has been entirely prepared by scholars from the ORF. It must be clearly noted that the views expressed in this report are entirely the authors' own and not those of the Nuclear Threat Initiative.

Abbreviations

ACPSR	Advisory Committee for Project Safety Review
ACS	Advisory Committee on Security
AEC	Atomic Energy Commission
AERB	Atomic Energy Regulatory Board (India)
ANRE	Agency for Natural Resources and Energy (Japan)
ASN	Nuclear Safety Authority (France)
BARC	Bhabha Atomic Research Centre
CBRN	Chemical, Biological, Radiological and Nuclear
CCA	Civil Contingencies Act (United Kingdom)
CEA	Atomic Energy Commission (France)
CFR	Code of Federal Regulations (US)
CIC	Inter-ministerial Crisis Cell (France)
CISF	Central Industrial Security Force
CMG	Crisis Management Group
CNC	Civil Nuclear Constabulary
CNS	Council of Nuclear Safety
CPPNM	Convention on Physical Protection of Nuclear Material
CRCEH	Centre for Radiation, Chemical and Environmental Hazards
CRSANF	Committee for Reviewing Security Aspects of Nuclear Facility
DBT	Design Basis Threat
DEA	Department of Atomic Energy (India)
DECC	Department of Energy and Climate Change (United Kingdom)
DEN	Directorate of Nuclear Energy (France)
DEPZ	Detailed Emergency Planning Zone

DOE	Department of Energy (US)
DOT	Department of Transportation (US)
DP&S	Directorate of Purchase and Stores
DRDO	Defence Research and Development Organisation
DU	Delhi University
EDF	Électricité de France
EPZ	Emergency Planning Zone
ESL	Environmental Survey Laboratory
EU	European Union
FCO	Foreign and Commonwealth Office (UK)
FEMA	Federal Emergency Management Agency (US)
FERC	Federal Energy Regulatory Commission (US)
GAO	Government Accountability Office (US)
GCNEP	Global Centre for Nuclear Energy Partnership
GICNT	Global Initiative to Combat Nuclear Terrorism
GIGN	National Gendarmerie Intervention Group
GOI	Government of India
HSE	Health and Safety Executive (United Kingdom)
HSWA	Health and Safety at Work Act (United Kingdom)
HWB	Heavy Water Board
IAEA	International Atomic Energy Agency
IB	Intelligence Bureau (India)
ICSANT	International Convention for the Suppression of Acts of Nuclear Terrorism
INB	Basic Nuclear Installations (France)
IPPAS	International Physical Protection Advisory Service
IRD	Improvised Radiological Device
IRRS	International Regulatory Review Service
IRSN	Institut de radioprotection et de sûreté nucléaire (Institute for Radiological Protection and Nuclear Safety, France)
ITDB	Incident and Trafficking Database
JAEA	Japan Atomic Energy Agency
JAERI	Japan Atomic Energy Research Institute
JNC	Japan Nuclear Cycle Development Institute

KAPS	Kakrapar Atomic Power Station
MEDDE	Ministry of Ecology, Sustainable Development and Energy
METI	Ministry of Economy, Trade and Industry (Japan)
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MHA	Ministry of Home Affairs (India)
MLIT	Ministry of Land, Infrastructure and Transport (Japan)
NCPW	Nuclear Controls and Planning Wing
NDMA	National Disaster Management Authority
NDRF	National Disaster Relief Force
NEPDC	Nuclear Emergency Planning Delivery Committee
NERC	North American Electric Reliability Corporation
NHS	National Health Service
NISA	National Industrial Security Academy
NISR	Nuclear Industry Security Regulation
NIT	Nuclear Incident Team (US)
NNSA	National Nuclear Security Administration (US)
NORAD	North American Aerospace Defense Command
NORMS	National Objectives, Requirements and Model Standards
NPCIL	Nuclear Power Corporation of India Ltd
NRA	Nuclear Regulatory Authority (Japan)
NRC	Nuclear Regulatory Commission (US)
NSC	Nuclear Safety Commission
NSG	Nuclear Suppliers Group
NSRA	Nuclear Safety Regulatory Authority
NSS	Nuclear Security Summit
NSSG	Nuclear Safety and Security Group
NSSP	Nuclear Site Security Plan
NTI	Nuclear Threat Initiative
ONR	Office of Nuclear Regulation (United Kingdom)
ONTS	Office of Nuclear Threat Science (NNSA, US)
ORF	Observer Research Foundation
OSRAT	Operational Review Team
PHE	Public Health England

PHC	Public Health Code
PSPG	Specialized Platoons Protection Police (France)
RAPS	Rajasthan Atomic Power Station
RDD	Radiological Dispersion Device
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations
RRSP	Regional Radiological Security Partnership
RSO	Radiological Safety Officer
SAART	School for Studies on Applications of Radioisotopes and Radiation Technologies
SANESS	School of Advanced Nuclear Energy System Studies
SARCAR	Safety Review Committee for Application of Radiation
SARCOP	Safety Review Committee for Operating Plants
SGDSN	General Secretariat for Defence and National Security (France)
SIB	State Intelligence Bureau
SNMCS	School of Nuclear Material Characterization Studies
SNSS	School of Nuclear Security Studies
SOP	Standard Operating Procedure
STA	Science and Technology Agency (Japan)
TRF	Tactical Response Force (NNSA, US)
TSN	Nuclear Transparency and Safety Act (France)
UCIL	Uranium Corporation of India Ltd
UGC	University Grants Commission (India)
UK	United Kingdom
US	United States of America
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association
WINS	World Institute of Nuclear Security
WMD	Weapons of Mass Destruction

Executive Summary

The security of nuclear and radiological materials has been a global concern since the end of the Cold War and the disintegration of the Soviet Union in 1991.The threat gained greater traction after 9/11 because of fears that terrorists might acquire such material.The International Atomic Energy Agency (IAEA)'s Incident and Trafficking Database (ITDB) states that between January 1993 and December 2015, there were a total of 2,889 incidents of theft and other unauthorised activities involving nuclear and radioactive material notified to the Agency. Thus, there is a renewed effort to strengthen old international rules and regimes on nuclear security as well as to establish new ones. Four summits held so far on the subject is recognition of this renewed importance.

India has for long been a victim of terrorism—from left-wing extremism to separatist insurgency and state-sponsored, cross-border terrorism. The Mumbai attacks of 2008 offer sufficient evidence of the inclination and capacity of terrorist groups to carry out commando-style attacks on key targets within Indian territory. With support from Rawalpindi, a terrorist attack on an Indian nuclear installation remains a clear and present danger.

This report presents a comprehensive threat analysis of the nuclear security situation in India, an examination of the strengths and weaknesses of measures adopted by the country's nuclear and security establishments in response, and an overview of global best practices that will help gauge India's efforts.The study focuses on potential incidents involving the detonation of a nuclear explosive or use of weaponised nuclear devices, radiological dispersal device (dirty bomb), and acts of sabotage as well as insider threats to sensitive facilities. The safety of India's nuclear and radiological materials and institutions is also taken into account, considering the existing synergy between the safety and the security practices in the nuclear context.

The following are the key findings of the study:

- India, like other nuclear powers, faces serious threats in the realm of nuclear security. Terrorist organisations operating out of Pakistan, for example, have declared interest in acquiring nuclear capabilities; the threat of nuclear terrorism, including detonation of a radiological dispersal device or an aerial attack on a nuclear facility, cannot be ruled out.

- Threat perceptions among security agencies in India's various states present a mixed picture. Even when some states are aware of such vulnerabilities, that does not translate into streamlined policies or proper financial and human resource allocation because other more immediate concerns get in the way. Agencies in Andhra Pradesh, for instance, appear quite aware of such threats but seem to be overwhelmed by more immediate concerns related to the Maoist insurgency in the state.

- Cyber attacks may be as important a threat to India's nuclear facilities as a direct physical assault.The use of cyber networks to attack a nuclear facility could render ineffective many current safety and security mechanisms. Indian agencies need to pay more attention to new technical innovations that are available to tackle vulnerabilities in the cyber realm.

- On-site security and safety measures, including during the disposal of nuclear and radiological materials at the end of their life cycles, have been made more stringent. The use of technology to minimise human element both to avoid possible errors as well as to deal with insider threats has been increased.

- Unlike other recent evaluations, this analysis deems India's nuclear security measures to be comparable to best practices globally. Two concepts that stand out in particular are the personnel reliability programme (PRP) and the 'defence in depth' principle applied in India's nuclear facilities. Stringent background checks undertaken as part of PRP are critical in mitigating the insider threat. Indian nuclear plants have also inculcated the principle of 'defence in depth' which includes a layered system of security, thus strengthening physical protection systems. The layered security system also requires an adversary to overcome or circumvent multiple obstacles that help delay in penetration and complement access control.

- One of the challenges facing India's agencies tasked with nuclear security will be their ability to respond quickly and effectively and in a coordinated manner during emergencies. Though not unique to India, the population density in India's urban centres increases the vulnerabilities and the possible casualty levels in the event of an attack. The DAE is beginning to realise the need for integrated drill involving both security within the perimeter and outside, operating in unison. Already, the number of such drills has increased and is expected to further rise in frequency and number.

- As India attempts to integrate with the global nuclear community, international cooperation is key, both with individual countries and multilateral organisations. This would entail more openness and transparency in India's nuclear security regime. A more controlled-transparency approach and a more proactive engagement outlining India's broad strategy in the area of nuclear security can have multiple benefits for India.

Chapter – I

Nuclear Security: A Primer

Introduction

Following the end of Cold War, the security of nuclear materials became a major issue of concern. This included not only the fear of theft of nuclear material but also of the unauthorised transfers of nuclear know-how by scientists of the erstwhile Soviet Union.[1] The issue gained further traction after the terrorist attacks of September 11, 2001. Fresh assessments were made to understand the security of nuclear materials in many of the countries that possessed them, with the aim of addressing potential scenarios where these materials might fall into the hands of terrorists or any other hostile elements. Although such serious incidents have not occurred so far, these threats remain and governments know better than to take them lightly. The Nuclear Security Summit, instituted in 2010, is an indicator of this global attention. It is estimated that there are approximately 2,000 metric tonnes of weapon-usable/ weapons-grade nuclear material available globally; of these, at least some are reported to be not well-secured.[2] The International Atomic Energy Agency (IAEA)'s Incident and Trafficking Database (ITDB) states that between January 1993 and December 2015, there were a total of 2,889 incidents of theft and other unauthorised activities involving nuclear and radioactive material notified to the agency. In 2013 alone, there were 146 confirmed incidents in the IAEA database.[3]

In the Indian context, the threat around nuclear and radiological materials has become acute as well, particularly against the backdrop of the terrorist attacks in Mumbai on November 26, 2008. New Delhi is concerned that some of the terrorist groups in the region, particularly those based in Pakistan, may attempt to attack Indian nuclear facilities and/or acquire Indian nuclear material. Thus, the security of nuclear materials is a priority for the Indian government, and testament to this is the Indian Prime Minister's attendance at three of the four Nuclear Security Summits, in 2010, 2012 and 2016. Accordingly, India is engaged in serious efforts, both at the national and global levels, to establish tighter controls on civilian nuclear materials. These materials include uranium ore concentrate, low and high enriched uranium, uranium fuel, plutonium used in power and research reactors, spent fuel from reactors, and any other material that can be used for nuclear or radiological purposes. However, there are those who view the subject of nuclear terrorism as confined to the academic sphere—a threat too far into the future. In the theoretical realm, it is commonly believed that it is unlikely for terrorist groups to acquire such weapons, notwithstanding its potential impact. And even if terrorists were indeed to get hold of nuclear or radioactive material, there are several steps before this can be converted into an actual weapon for use: acquiring requisite scientific and technical knowledge and skills, the appropriate manpower, tools for conversion, and vehicles for transportation of such sensitive material.[4]

Overall, the security cover around nuclear establishments is tight and the acquisition of nuclear materials or capabilities is no easy matter. But India would rather take these threats seriously. Even while there is scepticism about India's policies and practices, it must be highlighted that New Delhi has established institutions and processes that are comparable with the best in the world. While many of these Indian institutions and practices were established in the 1960s and 1970s, they have been updated periodically in light of the changing security scenario, especially in India's neighbourhood. These measures have been further tightened in the aftermath of the 26/11 attacks in Mumbai, which raised fears of a commando-style attack or sabotage by

Pakistan-based terrorist groups like the Lashkar-e-Toiba (LeT). Thus, while India has been battling terrorism of various kinds for close to three decades, these groups have also evolved—gaining more sophistication and higher calibre—and New Delhi must consider this as it develops response and contingency mechanisms. Another threat that is not as nearly debated enough is an air assault on a nuclear facility. This is a remote contingency, and it should also be noted that most of India's reactors have double containment and can withstand the impact of an air crash.

9/11 and Nuclear Security Threat Perception

The 2001 September 11 terrorist attacks in the US played a significant role in changing the threat perception of nuclear terrorism, particularly in Western policy circles. As mentioned earlier, the West was initially afraid of a scenario of Soviet weapons falling into the wrong hands after the fall of the Soviet Union. But after 9/11, the focus shifted to the possibility of terrorist groups, such as al-Qaeda and Taliban, gaining access to these materials and devices. US government documents released by the US National Security Archives reveal that Osama Bin Laden was interested in acquiring uranium.[5] In fact, he declared that it was his 'Islamic duty' to acquire and use these weapons of mass destruction (WMD). He repeated this message in a video released in 2007.[6] Scenario-building exercises involving a wide range of activities—from the detonation of a nuclear weapon to that of a dirty bomb or a Radiological Dispersal Device (RDD)—have been carried out to assess the preparedness levels.

At the beginning of the Washington Nuclear Security Summit in 2010, US President Barack Obama warned, "We know that organisations like al-Qaeda are in the process of trying to secure nuclear weapons or other weapons of mass destruction, and would have no compunction at using them."[7] At the same summit, US Presidential Adviser, John Brennan said, "Al Qaeda is especially notable for its longstanding interest in weapons [of] useable nuclear material and the requisite expertise that would allow it to develop a yield-producing improvised nuclear device."[8] Speaking at the International Conference on Nuclear Security in Vienna in July 2013, Yukiya Amano, the Director General of the International Atomic Energy Agency (IAEA), warned the global community of terrorists and criminal organisations trying to exploit the existing loopholes and vulnerabilities in the global security systems.[9] The threat of terrorist groups getting hold of nuclear devices has been described by various state leaders as the single biggest threat to mankind.[10]

Thus, current global efforts, aimed at reducing threats of nuclear terrorism and vulnerabilities, are focused on tackling the source of the problem: understanding the vulnerabilities that might exist in the storage, control and transport of nuclear weapons and materials.[11] While the West has been tightening the grip on these materials, both on and off site, emphasis has been given to the security of fissile materials in countries such as Pakistan, which is home to a lethal brew of nuclear weapons and terrorism. There is also Pakistan's notorious history to contend with: evidence exist that a part of its security establishment has supported terrorist enterprises. Following repeated terrorist attacks on Pakistan's military bases (Sargodha air base in Punjab, November 2007; ordnance factories in Wah, August 2008; Army's General Headquarters in Rawalpindi, October 2009; Minhas airbase at Kamra in Punjab, December 2010; and Mehran naval base in Karachi, May 2011), Islamabad has come under renewed pressure to secure its nuclear arsenals. Both India and the West have been worried about these developments. While US officials have expressed their confidence regarding the security of Pakistan's fissile materials,[12] recent disclosures based on documents released by the former US intelligence contractor, Edward Snowden, reveal that the US had stepped up its surveillance of Pakistan's nuclear arms.[13]

Nuclear Terrorism: A Typology

Nuclear terrorism could manifest in three distinct ways. One mode is by using a full-scale nuclear weapon, wherein the attack will prove to be catastrophic.

However, the execution of such an attack requires a high level of expertise and purchasing a nuclear device off the shelf is not a feasible option, either. Thus, the probability of this form of nuclear terrorism is low, given that no known terrorist group is in possession of such expertise or material. Still, lessons from the AQ Khan network should suggest that the possibility cannot be ruled out completely.

A second form of nuclear terrorism is through nuclear sabotage—and the impact of a sabotage of a nuclear facility would be nothing less than catastrophic, too. This, however, is not easy for a terrorist group to execute and the probability of this type of attack remains low. The possibility, however, is of such an attack being carried out via air, in a manner similar to the 9/11 incident. Most countries are unprepared for such an event as they brace for ground-based offensives.

A third approach, and possibly the easiest to accomplish, is the production and detonation of what is called a 'dirty bomb,' essentially packing a conventional device with nuclear or radiological material. Materials needed to make a 'dirty bomb' are available in equipment used by hospitals, industry and educational institutions all over the world. While the explosion may result in a few deaths, if any, it will inflict huge damage in terms of the disruption it creates and the costs of restoration. There will also be a second-order impact of such an attack on the economy and the credibility of the incumbent government in protecting its citizens, and increasing regional tensions. Furthermore, such an attack will also have a psychological impact among the public. The next section surveys this project's key definitions, scope conditions, and research methodology.

Scope Conditions

This study has three key purposes, the first of which is to provide an overview of the current nuclear and radiological security practices followed within India, with focus on key institutions and laws. It also compares India's approach with the best practices adopted by a few key nations, and three, it highlights the strengths and weaknesses of India's nuclear security policy and practice.

While the study focuses on the security aspect, the safety of India's nuclear and radiological materials and facilities is also taken into consideration as there are overlaps between the safety and security practices in the nuclear context. While nuclear security" is 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," nuclear safety " is the achievement of proper operating conditions, prevention of accidents and mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards."[14] This study focuses on the safety and security of these materials used across civil nuclear power plants as well as research institutions and hospitals in India, including the practices adopted for storage, transportation and disposal of materials at the end of their use. Less focus is given on a full-fledged nuclear attack involving detonation of a weaponised nuclear device.

Research Methodology

The study examines published work, including both primary and secondary sources, and supplements it with fieldwork. The primary sources include various domestic and international legislation related to security of nuclear and radiological materials, as well as guidelines issued by relevant agencies in India such as the Atomic Energy Regulatory Board (AERB) and the National Disaster Management Authority (NDMA). Secondary sources include journal articles and books published on nuclear and radiological security, as well as databases available at various universities, research organisations and government websites. Since there is little data on nuclear and radiological incidents in India, the authors have collated the data based on Indian sources. The third part of the methodology involves interviews given by key personnel involved in the management of the Indian nuclear programme. A number of senior administrators from the Indian nuclear and security sectors were interviewed, something never before attempted in a study on Indian nuclear safety and security. Because of the sensitivity of their administrative positions, the report will be unable to specify the identity of the interviewed personnel.

In India, the team from the Observer Research Foundation (ORF) held interactions with officials from the country's nuclear establishment including the Department of Atomic Energy (DAE), the AERB, Defence Research and Development Organisation (DRDO) and its partner institutions, Central Industrial Security Force (CISF), NDMA, and the police. Interviews were conducted in the states of Delhi, Maharashtra, Gujarat, and Rajasthan. To gain a broader international perspective and understand best practices in nuclear safety and security, field visits were conducted in the US, UK, France and Japan. The interviewees included experts from academic and research institutions, officials from the government and the regulatory bodies of these countries, and representatives from their nuclear industry. Also, expert group and stakeholder meetings were held in Delhi and Jodhpur (Rajasthan) where an interim report was presented to receive their feedback.

For the field research conducted as a part of the study, a questionnaire (see Annexure) was presented to the experts and stakeholders responsible for security as well as safety of nuclear materials. The questions covered various issues such as threat perceptions, incident reporting structure and processes, training and guidelines, prevention and response policies and practices, and regulations that are followed by agencies and industries, both in India and abroad. The activities, from a security perspective, included theft of nuclear material and incidents involving nuclear material including accidents. The emphasis of the enquiry was on security aspects, including insider threats.

Definitions of Key Terms

Definitions of key terms have been drawn from existing terminology provided by the AERB and the IAEA.Elsewhere, definitions pertaining to security and threats have been defined specifically for the study in order to keep the parameters as broad as possible.

Access Delay: Access delay is wherein a layered security system of a facility is intended to delay a perpetrator's time to access the core of a facility by increasing the access time to entry and/or exit. Access delay is ensured through use of technology such as erection of physical barriers as well as employment of personnel to guard facilities.

Central Alarm System: A system that provides for complete and continuous alarm monitoring and assessment of the facility and communications with guards, facility management and a response force.

Certification (of Personnel): The formal process of certifying personnel by an authority for performing various activities in the nuclear and radiation facilities.

Defence in Depth: Defence in depth is a principle of security that uses multiple layers of measures for ensuring safety of workers, the public or/and the environment. A concept used to design physical protection systems that require an adversary to overcome or circumvent multiple obstacles that helps delay penetration and complements access control.

Design Basis Threat: Design Basis Threat evaluates the potential threat, both an insider threat as well as an external source and accordingly physical protection systems are erected from the stage of design itself.

Emergency Planning Zone: The zone defined around the plant for up to 16 km radius providing a basic geographic framework for decision making on implementing measures as part of a graded response in the event of an off-site emergency.

Fail Safe Design: A concept in which, if a system or a component fails, then the plant/component/ system will pass into a safe state without the requirement to initiate any operator action.

Insider Threat: This relates to one or more individuals who have authorised access to facilities/materials/activities/sensitive information who could perpetrate a malicious act or who could help an external source in committing such an act.

Nuclear and Radiological Materials: In common parlance, 'nuclear material' refers to any material that is fissionable which include isotopes of uranium, thorium, and plutonium. Radiological materials are those that are less potent, used in a variety of applications in the civilian domain including for medical purposes. These materials include cobalt and caesium, among others. From an Indian perspective and for the sake of this study, all civilian nuclear materials, such as uranium ore concentrate, low enriched and high enriched uranium, uranium fuel, plutonium used in power and research reactors, spent fuel from reactors, and any other material that can be used for fission purposes are categorised as nuclear and radiological materials.

Nuclear Fuel Cycle: Includes all operations associated with production of nuclear energy, including mining, milling, processing of uranium or thorium; enrichment of uranium; manufacture of nuclear fuel; operation of reactors; reprocessing of nuclear fuel; decommissioning; radioactive waste management and any research or development activity related to any of these activities/ processes.

Safety (Nuclear): The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of site personnel, the public and the environment from undue radiation hazards.

Sealed Source: Radioactive and nuclear materials that are sealed in a capsule form permanently or that is in a solid state and is closely bounded, as per the safety standards set by the competent authority.

Security: As per the AERB definition, nuclear security means all preventive measures taken to minimise 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.

Threats: This study focuses on assessing the threat to population and property within India posed by the illegal or unauthorised breach of nuclear and radiological material control by non-state actors including terrorist and insurgent groups as well as any anti-social element that has hostile intent towards the state. The study does not cover the accidental release of nuclear and radiological materials due to natural hazards such as damage to sites and equipment resulting from earthquakes or flooding. However, it is recognised that there is a need to ensure that safety and security policies need to be fully integrated, and that strengthening one is almost certainly likely to strengthen the other given the understanding that safety and security are two sides of the same coin. The study does consider threats such as an insider threat, sabotage and armed attack on sites using nuclear and radiological materials.

Chapter – II

Threat Analysis

On 13 April 2005, the UN General Assembly adopted the International Convention for the Suppression of Acts of Nuclear Terrorism (Convention on Nuclear Terrorism, or CNT). It was successful in defining nuclear terrorism as a crime under international law. In a nutshell, the convention stated that a person commits the unlawful act of nuclear terrorism if he or she acquires nuclear materials unlawfully, damages a nuclear facility, or participates in the planning or execution of such acts.[15] India is a signatory to the convention and abides by it.

Keeping in mind the internationally accepted definition of nuclear terrorism, and the volumes of research that have been undertaken on the subject around the globe, nuclear terrorism can be categorised into three different forms. The first, which is the least likely yet potentially the most devastating, is that terrorists would build and detonate a nuclear bomb in a major city. The second and most likely scenario is the development of a "dirty bomb" (also known as Radiological Dispersal Device or RDD). Finally, the third possibility lies somewhere between these two poles—it includes potential insider collusion or sabotage of a nuclear facility.[16]

Nuclear Terrorism in India: A Background

In India's case, an assessment of its threat scenario requires a two-fold approach: the external and internal threats. External threats can be defined as those coming from outside India including from terrorist organisations and their capacity to infiltrate the country's security systems (or those of its neighbours) and conduct a nuclear/radiological attack on Indian soil. The internal threat arises from homegrown terrorists, such as the Indian Mujahideen, radical left-wing Naxals or any of the other Indian insurgent groups. Insider collusion or sabotage is another possibility. The following sections will analyse these threats in detail, both the current perceptions and future trends.

Nuclear security is a priority for New Delhi given that India is geographically adjacent to Pakistan, the regional hub of terrorism and Bangladesh, a country with a growing Islamist threat with ties to ISIS. Owing to this security milieu, there has been significant concern expressed in public by the Indian strategic community regarding the risk of nuclear terrorism and vulnerabilities that exist in its nuclear security domain (and that of its neighbours). At the same time, as in many other countries, Indian security officials are of the view that nuclear terrorism remains a remote possibility. Yet even as the possibility of an outright nuclear attack may be considered low, the risk remains. Terrorist attacks such as 26/11 in Mumbai, the Pathankot attack in January 2016 and Uri attack in September 2016 demonstrate that India remains under constant threat from terrorist organisations. In the current geo-political scenario, the importance of assessing the threat of nuclear terrorism cannot be over emphasised. Terror outfits are planning and executing startlingly audacious attacks—from 9/11 to Paris and Brussels—proving themselves more brazen each time. Indeed, the success of an attack is often measured by its impact on the media: any form of nuclear or radiological attack would, therefore, hit the jackpot.

Gaining access to nuclear weapons or even materials is not easy in India, as is the case in many other countries. The very nature of the material suggests that it is closely guarded by trusted and capable individuals, and effective mechanisms are established in order to ensure its safety and security. In India, the nuclear weapons, for instance, are stored in de-mated and unarmed state.

They are further safeguarded with electronic codes in order to prohibit any unauthorised use or accidental detonation. Additionally, the nuclear cores, other warhead components and delivery vehicles are stored separately, thus establishing several steps involving multiple agencies before these weapons could be armed.[17]

India additionally has 22 reactors that generate power, some of which produce weapons-grade nuclear material, large amounts of radioactive nuclear waste (spent fuel) stored in special containers, and over 7,000 institutions that use radiological devices, particularly hospitals, for both diagnosis (X-rays) and treatment (cancer). While most of them are well secured by agencies tasked with monitoring and safeguarding the movement of nuclear material in the country, there are growing concerns that terrorists are employing increasingly sophisticated means to infiltrate these institutions and facilities. Nevertheless, it is reassuring to note that it would be incredibly difficult for terrorists in India either to steal a nuclear weapon or to carry significant amounts of weapons-grade nuclear material from the Department of Atomic Energy (DAE) complexes and use it to build a bomb.[18]

Even as there is tight security around nuclear installations, threats and challenges in India's neighbourhood are changing rapidly and India must remain vigilant. While it is difficult to predict with any certainty how the threat of nuclear terrorism might play out, nevertheless, India will need to be primarily concerned with two types: nuclear sabotage and/or the use of radiological dispersal device (RDD). There is no evidence to suggest that home-grown terror groups have either the knowledge base or the skill to develop a functional nuclear explosive device.[19] But India has to be mindful of the possibilities of assistance that any of the terrorist groups may receive from across the border.

The Mumbai terrorist attacks in November 2008, for instance, demonstrated both the desire and capacity of terrorist groups to carry out commando-style attacks on key targets within Indian territory. Even so, it was concluded that it would not be easy for terrorist groups to penetrate the defences and cause damage to a nuclear facility. With continued assistance from Rawalpindi, an attack on nuclear installations cannot be ruled out. For this reason, India has beefed up security at all its critical infrastructures, fully aware that they have become prime targets.[20] Therefore, India has to work on the assumption that such an attack is possible, even if the likelihood of success remains low.

While there has been so far no attack on a nuclear facility, the strike on the Indian Air Force Base in Pathankot on new year's eve of 2016 and the Indian Army base in Uri in September 2016 should be a wake-up call. The attack was a reflection of two things: one, the urgency with which India needs to secure its military bases, and, two, that modern terrorists are aware of the huge impact—including psychological—that any attack on a supposedly secure facility would have. Sabotaging a nuclear facility would, from this perspective, appear enticing.

A second and more direct nuclear threat comes from the use of dirty bombs or RDD. A dirty bomb is defined as an explosive, containing radioactive isotopes, in the form of powder or tiny pellets that, when exploded, disperse the nuclear material and contaminate the exposed area. The main damage from a dirty bomb comes from the blast itself; the contamination from its radioactive material to people and the environment is secondary and limited.[21] Considering the population density of Indian urban centres, the damage and destruction caused by an RDD will be huge. The adverse impact will be severe in terms of public morale. These attacks could also create a long-term negative impact on India's economic growth story, by distracting foreign investments and tourism, exacerbating tensions between religious communities, and diminishing public support for nuclear energy.

Another serious threat that India faces is the 'insider threat'. That all contemporary nuclear thefts or losses have involved an employee who committed the crime or who helped someone else commit the crime raises the salience of the insider threat. Similarly, sabotage by disgruntled employees has also caused anxiety.[22] Worldwide, there have been a number of incidents that have highlighted these vulnerabilities. For instance, one of the most disturbing incidents occurred at the Koeberg nuclear power plant in South Africa when "an insider placed explosives directly on the steel pressure vessel head of a nuclear reactor and then detonated them" in 1982, even before the plant went operational.[23] To counter such threats, extensive background checks are performed on personnel. However, these are not fool-proof measures as they cannot guarantee against the possibility of an occasional breach. It is true that India is yet to face a serious insider threat in its decades-long experience of running civil nuclear plants. However, as its nuclear energy programme expands, the potential for dissatisfied employees becoming an insider threat increases as well.

In addition to the fears of nuclear terrorism including dirty bombs and the insider threat, like all other countries, India also has to worry about attacks on its nuclear facilities and the appropriate response measures. The Indian nuclear industry experts and the scientific establishment assure that there are no real vulnerabilities and that Indian nuclear facilities are designed to withstand terrorist attacks.[24] Also, newer reactors have used double containment structures to withstand attacks. India has simultaneously used newer technologies and processes that safeguard the reactors against accidents.[25] Additionally, designers have relied on the concept of 'defence in depth' which uses a multiple layered system (barriers) to provide increased protection against accidents.

The closed fuel cycle utilised by the Indian nuclear establishment further enhances the safety and security of nuclear material. This is based on the concept of 'reprocess-to-reuse' that enables better control over fissile material.[26] Even though the roots of India's closed fuel cycle predate concerns about nuclear security, there is little doubt that it significantly contributes to nuclear security in India. Since fissile materials in Indian power plants are reused, it reduces the amount of surplus or usable material. India has also been in the process of developing an Advanced Heavy Water Reactor based on low enriched uranium and thorium with new safety and proliferation-resistant features, thereby reducing the threat potential.[27] The efficiency of proliferation-resistant systems depends on both intrinsic technical features and external barriers. These include technology-induced barriers as well as technology-driven detection measures, all of which reduce the risks of proliferation.

Current Threats to India[28]

Much of the concerns expressed in the discourse around nuclear security in India, particularly as it relates to the threat of terrorism emanating from Pakistan, come from the Indian strategic community. Though India shares a long border with Pakistan, a country that has remained a hotbed for terrorism and which has had a direct role in attacks like 26/11, Indian intelligence and security agencies do not perceive any credible threat to its nuclear infrastructure from Pakistan-based terrorist groups at present.[29] They do not rule out either.

India's left-wing extremists also pose a threat. The general perception is that Naxals fight on the basis of ideology and that they are not interested in acquiring nuclear devices but an attack on an Indian nuclear facility cannot entirely be ruled out, even if it is unlikely. There have been some reported indications about the Naxalite intentions to attack India's nuclear installations, though it is unclear how credible such reports are.[30] There have also been rumours of Naxals and jihadists colluding with one another under the umbrella of an 'anti-India' movement.[31] Security analysts explain, however, that they represent a remote threat to India's nuclear arsenal.[32] This is mainly due to the fact nuclear attacks do not seem to fit their *modus operandi* as they normally use small, mobile conventional weapons.[33] More importantly, extremist groups operating in India including the Naxalites have thus far lacked the sophistication to carry out such an attack on a nuclear facility. Of course, further down the spectrum, making nuclear explosives requires greater technical expertise than what indigenous terrorist groups like the Indian Mujahideen (IM) and Naxalites so far possess.

This should not, however, suggest that such groups will never be able to obtain the requisite knowledge base or skill. Foreign terrorist organisations, such as al-Qaeda, have already stated their intentions to acquire nuclear weapons. Recent reports also suggest that the IM has been considering the use of nuclear weapons/devices sourced from Pakistan.[34]

Likewise, Indian security establishment needs to be alive to the threat posed by Pakistan-based terrorist groups such as Lashkar-e-Toiba (LeT). LeT generally recruits terrorists from more affluent backgrounds with more technical education, which increases the likelihood of it recruiting young nuclear technicians and scientists.[35]

Nevertheless, one of the more probable threats to Indian nuclear facilities could come in the form of cyber attacks. The capacity of terrorist groups to use cyber tools to attack a nuclear installation is far higher as compared to other attacks. A cyber attack could render many of the safety and security mechanisms built into the design of nuclear plants/ facilities ineffective. As more and more systems rely on computer networks, cyber attacks have grown to be a major threat to India's nuclear installations.[36]

Threat in the Indian Neighbourhood

When considering the potential for a large-scale nuclear attack, India also needs to bear in mind its neighbours and their nuclear capabilities. It must be acknowledged that two of the country's neighbours (Pakistan and Bangladesh) have a growing number of radical individuals, who could aspire to harm India.[37] As ISIS spreads its propaganda around the world, India becomes increasingly vulnerable both to home-grown extremists and those that live in the neighbouring states. While no ISIS-affiliated attack has yet been carried out in

India, the probability nevertheless remains. On May 20, 2016, ISIS released a video of an Indian recruit calling for jihad against the state of India. As a nation now officially on the radar of the terror outfit, it is important for India to assess ISIS' activities both internationally and in the neighbourhood. ISIS has claimed that it will send its fighters from Pakistan and Bangladesh to attack India. The group boasted that it was currently training fighters in Bangladesh and Pakistan to launch attacks on India, and that it is seeking the help of the local mujahideen in the country.[38] These claims made by ISIS cohere directly with a revelation concerning the Indian Mujahideen, a banned terror outfit. It was discovered in December 2013 that they were planning a nuclear attack on Surat.[39]

Closer to home, Pakistan has been called the most dangerous nuclear state in the world by various Western security analysts. Islamabad firmly rejects these negative assessments of its nuclear program. A study conducted by Harvard in 2010 stated that, "despite extensive security measures, there is a very real possibility that sympathetic insiders might carry out or assist in a nuclear theft, or that a sophisticated outsider attack (possibly with insider help) could overwhelm the defences."[40]

Another threat arises from Hizbut-Tahrir (HuT) that has advocated using Pakistan's nuclear arsenal for the benefits of the wider Umma. The organisation is accused of working with al-Qaeda, and has the aim of establishing a major caliphate. The HuT does not conduct acts of terrorism in Pakistan, but is often seen as the most insidious of the jihadist groups because of its recruitment efforts within the officer corps and among well educated professionals.[41] In a recent report by the CTX Journal, it was noted that "HuT (Hizbut-Tahrir or the Party of Liberation) is quietly building a global infrastructure of radicalized youth and deep-pocketed Arab support in preparation for the global Khilafat."[42] It was reported in April 2016 that the HuT was attempting to establish its presence in India, recruit students from New Delhi and radicalise them.[43]

One can further assess the capabilities of these terrorists to conduct such attacks by observing Pakistan. Terrorists across the border have conducted brazen and successful attacks against military bases. On November 01, 2007, for example, a suicide bomber attacked a bus at Sargodha air base in Punjab, resulting in 11 deaths, including seven officers. On August 21, 2008, two Tehrik-e-Taliban Pakistan (TTP) militants conducted a suicide attack at the gate of the ordnance factories at the military city of Wah, killing 70 workers. On October 10, 2009, terrorists using automatic weapons, grenades and rocket launchers attacked the Army's General Headquarters in Rawalpindi, holding 42 hostages for 18 hours and killing a brigadier-general, among others.[44] On December 10, 2010, a suicide bomber struck an air force school bus outside the fence of the aerospace complex at Minhas airbase at Kamra in Punjab, injuring seven. The May 2011 attack on Karachi's Mehran naval base is the closest example to how an attack on a nuclear facility might go; the attackers, who may have numbered up to 20, clearly had insider help. They "scaled the perimeter fence and continued to the main base by exploiting a blind spot in surveillance camera coverage, suggesting detailed knowledge of the base layout."[45]

In contrast to al-Qaeda and TTP, which target the Pakistani state, (LeT) operates primarily against India and is thus seen by many of its compatriots as 'good' jihadis. In January 2011, LeT leader Hafiz Saeed said it would be "no problem" if fighting over Kashmir led to nuclear war between India and Pakistan.[46] Obviously, such attitudes are worrying.

Next, there are also several improbable and unlikely situations but Indian security officials need to be alert to these threats as well. The next section looks at the larger canvas of threats posed by groups such as ISIS. While ISIS may not portray itself as a direct and immediate threat, the threat manifesting through its linkages in Pakistan cannot be ruled out.

Nuclear Terror: Improbable Scenarios

A lot has been written recently about the growing strength of "Islamic State of Iraq and the Levant" (ISIL/ISIS) or "Daesh". Alarm bells went off when, on February 18, 2016 reports surfaced that the perpetrators of the November 13, 2015 Paris attacks were planning to attack Belgium's nuclear facility. A suspect linked to ISIS was found with 10 hours of surveillance footage of a high-ranking Belgian nuclear official.[47] Furthermore, two days after the Brussels bombing in early 2016, it came to the attention of Belgian authorities that a security guard who worked at their nuclear medical research facility had been murdered and that his pass was missing, presumed stolen.[48] The British Defence Secretary, Michael Fallon was recently quoted as saying that ISIS obtaining a nuclear weapon "was a new and emerging threat."[49]

ISIS has attracted many hundreds of foreign fighters from Western countries to join its ranks, some of whom come with significant academic backgrounds and intellectual ability.[50] Equally concerning is the fact that ISIS fighters or supporters have stolen over 40 kg of low enriched uranium from scientific institutions at the Mosul University in Iraq. Though the material is of limited toxicity, and cannot be used to create a complete nuclear warhead, it does have the capacity to 'spread panic' and 'inflict serious harm'.[51]

One must therefore acknowledge the possibility, however low, of ISIS creating its own nuclear weapon. The chance of them getting access to an already existing weapon is not entirely impossible, either. It has certainly been considered by the members of the group; in a recent issue of their propaganda magazine, *Dabiq*, it was claimed that the financial fortunes of ISIS were flourishing to the level that they were in a position to purchase a nuclear bomb.[52] The article reads: "The Islamic State has billions of dollars in the bank, so they call on their *wilayah* in Pakistan to purchase a nuclear device through weapons dealers with links to corrupt officials in the region".[53] The scenario is far-fetched and unlikely, but the group's narrative and aspirations do need to be taken into consideration.

In the end, it can be concluded that the possibility of nuclear terrorism today has increased in comparison to even a couple of years ago, and it is thus important for India to continue to guard against nuclear terrorism as it formulates its security policy.

Future Threats to India

Nuclear power currently contributes to 3.6 percent of India's total electricity generation.[54] The share of nuclear in the electricity production stands at 5780 MW which is around 1.91 percent of the total energy mix.[55] India has a total capacity of 5780 MW at six sites which operate more than 20 reactors in total.[56] By 2017, India is likely to increase production to 10080 MW once the ongoing projects are completed.[57] In line with India's aims to expand its dependence on nuclear energy in the future, current estimates indicate that India will be generating 60,000 MW of electricity by 2030, using nuclear energy.[58] India plans to achieve this ambitious goal by using indigenous Pressurised Heavy Water Reactors (PHWRs), foreign sourced Light Water Reactors (LWRs) and indigenously developed Fast Breeder Reactors (FBRs).These suggest a vast expansion in the number of reactors and materials in India.

As mentioned earlier, though no terrorist group has so far demonstrated the capacity to threaten India with nuclear devices or attack on its nuclear facilities, Indian officials should not assume that these conditions will not change. Indian security managers must consider such possibilities for the future. Responding to a question raised in the Indian Parliament on threats to India's Kudankulam Nuclear power plant (KNPP), the Minister of State for Personnel, Public Grievances and Pensions and Prime Minister's Office, Mr. V Narayanasamy stated that "though there is no specific security threat to KNPP at present, Department of Atomic Energy installations and its residential colonies continue to remain potential targets of outfits and elements inimical to the interest of India."[59] The nuclear security establishment has to always remain alive to such threats because a lapse can result in huge damage. The recent ISIS statements on India should also bring in caution on the Indian approach.

Most recently, Indian Prime Minister Narendra Modi stated that he would push the issue of nuclear terrorism at the Nuclear Security Summit 2016, and "would deliberate on the crucial issue of threat to nuclear security caused by nuclear terrorism."[60] During the Summit, Modi acknowledged the potential for nuclear terrorism in India and stated that the country was countering the smuggling of nuclear materials and strengthening the national detection architecture for nuclear and radioactive materials as a way of mitigating the threat and for this a counter-nuclear smuggling team had been set up.[61]

As of now, the role of India's private sector in nuclear power generation remains limited to manufacturing and supply of equipment such as reactor components, systems and services such as construction, fabrication and erection of equipment, instrumentation, logistics, among others.[62] But private sector participation in the civil nuclear sector is likely to increase in the future. While private sector participation must be encouraged, it must also be ensured that the culture of nuclear security gets ingrained in the organisational culture of these private sector actors. In the eagerness to create business opportunities, security must not be compromised. This brings to focus the functioning of regulatory bodies, which will be discussed in detail in the subsequent chapters. Guidelines by the AERB and NDMA, among others, need to be complied with. The NDMA Guidelines for Management of Nuclear and Radiological Emergencies, for example, states that "even while we have an enviable and impeccable record of safety and virtually fail-safe arrangements in all our nuclear establishments, the possibility, however, remote it may be, of human error, systems failure, sabotage, earthquake and terrorist attacks leading to the release of radioactive matter in the public domain, cannot be entirely ruled out."[63] It is one thing to have guidelines and procedures, and another to strictly enforce them.

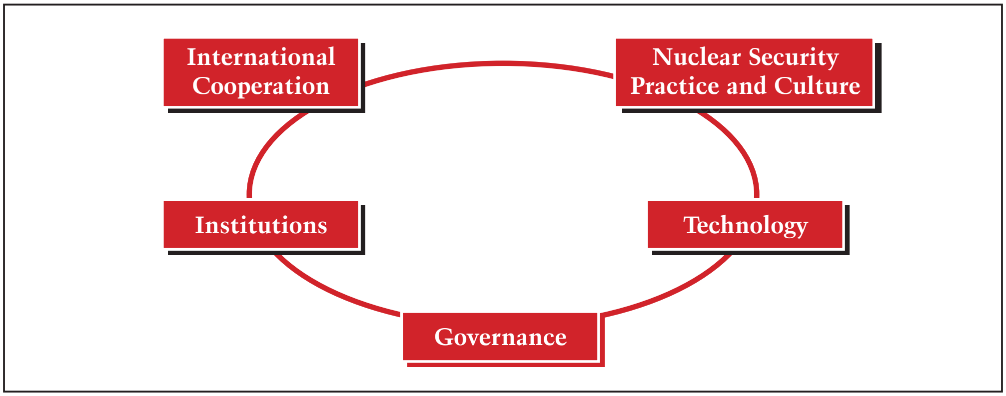
Chapter – III

Strengths and Weaknesses in India's Nuclear Security

As noted earlier, the focus of this study is on the security of nuclear and radiological materials and facilities in India. However, an examination is also made of certain safety-related aspects that overlap with security issues. The first edition of this study published in January 2015 was the first study to solely focus on these aspects in detail.

A slim brochure released in 2014 by the Ministry of External Affairs (MEA) is one of the few publicly available documents which provide an insight into India's nuclear security architecture.[64] According to the document, India's nuclear security approach is driven by five key components: Governance; Nuclear Security Practice and Culture; Institutions; Technology; and International Cooperation. These components represent a good set of criteria for judging the state of safety and security of India's nuclear materials and facilities, though there are possibly other ways of dividing the categories for analysis. The following sections will examine these five components and outline their respective strengths and weaknesses.

India's Approach to Nuclear Security



Source: Ministry of External Affairs, Government of India, "Nuclear Security in India," March 2014.

Governance and Regulations

Governance in the nuclear realm is ensured through a set of regulations and institutions established in the 1960s and 1970s, which are detailed below. Since then, there have been structural changes and amendments brought about in order to reflect the new realities of threat perceptions and technological advancements.

The umbrella legislation that encompasses the security of India's nuclear and radiological materials and facilities is the Indian Atomic Energy Act of 1962.[65] This Act provides the legal basis for the development, control and use of nuclear energy in India. This legislation also authorises the Central government to establish rules and regulations as well as release notifications to execute the provisions of this Act. Since its implementation, the Act has undergone amendments to strengthen the legal basis for nuclear security measures. There have also been a number of legislations pertaining to environmental issues – among others – that are critical in determining the location and operation of nuclear power plants, including: the Environment (Protection) Act, 1986; the Atomic Energy (Factories) Rules, 1996; and the Electricity Act 2003. The DAE also formulated the Guidelines for Nuclear Transfers (Exports) in 2006.

Key legislations introduced under the Atomic Energy Act include the Atomic Energy (Radiation Protection) Rules 1971 (further revised in 2004); the Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules 1984; and the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules 1987. The Atomic Energy (Radiation Protection) Rules sanction activities for nuclear fuel cycle facilities as well as radiation use in the arena of industry, medicine and research.[66] The Rules, after revision in 2004, have been made more comprehensive, clearly setting out roles and responsibilities of different parties including the employers, Radiological Safety Officers (RSOs), and others, in the area of protection against radiation. These rules also spell out the powers of the AERB in the following ways: detailing requirements regarding safety, health surveillance of workers, radiation surveillance and records to be maintained; issuing directives; inspections; and enforcement actions.[67] The Radiological Safety Division of the AERB is responsible for ensuring the compliance of the 2004 Radiation Protection Rules as well as the 1987 Atomic Energy (Safe Disposal of Radioactive Wastes) Rules which establish the parameters for the decommissioning and disposal of radioactive wastes.[68] The provisions contained in the 1987 Rules put the onus on the AERB to ensure that the licensees carry through their responsibilities on the safe disposal of radioactive wastes. The Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984, meanwhile, are meant to regulate activities in the area of mining, processing and/ or handling of prescribed substances.[69]

Atomic Energy Act, Rules and Notifications

The Atomic Energy Act, 1962

Provides the overarching rules for the conduct of all civilian nuclear-related activities in the country. It replaced the Atomic Energy Act of 1948. Supplemented by other laws and regulations on particular narrower issues.

Atomic Energy (Working of the mines, minerals and handling of prescribed substances) Rules, 1984

In exercise of the powers conferred by the Atomic Energy Act, 1962, the Central Government made this set of rules for the license issue for mining, milling, processing and/handling prescribed substances, site inspection, duties and responsibilities of the licensee, radiological safety officer and safety officer, cancellation/suspension of license and appeal procedures.

Atomic Energy (Safe disposal of radioactive wastes) Rules, 1987

Outlines rules for disposal of waste, application of authorisation to dispose of or transfer radioactive waste, in locations and in quantities not exceeding those specified in the authorisation. AERB is the competent authority for issuance/ suspension/ amendment of the authorisation for these wastes from an installation or their transfer to any waste management agency.

Radiation Protection Rules, 1971 (2004)

These two sets of rules cover license issues, validity, cancellation/ suspension conditions, offences and penalties, restrictions on the use of radioactive material, maintenance of records of workers, duties and responsibilities of radiological safety officer and radiation surveillance.

Prescribed Substances, Prescribed Equipment and Technology under Atomic Energy Act, 1962 (January 20, 2006)

Notification listing the materials that are classified under categories such as prescribed material, source material, special fissionable material and so on as well as lists of prescribed equipment and technology.

Guidelines for Nuclear Transfers (Exports) (February 1, 2006)

Guidelines for export of prescribed substances, prescribed equipment or transfer of related technology to any country.

Strengthening further India's resolve around nuclear security and nuclear non-proliferation, the Indian Parliament enacted the Weapons of Mass Destruction and their Delivery Systems (Prohibition of Unlawful Activities) Act in June 2005.[70] India has also continuously updated the control lists and related regulations as part of an ongoing process, and is an adherent to the guidelines laid down by the Nuclear Suppliers Group (NSG). New Delhi has also shown keen interest in joining the NSG and other international export control regimes such as the Wassenaar Arrangement and the Australia Group.[71]

In order to further improve its domestic regulations, the Government of India introduced the Nuclear Safety Regulatory Authority (NSRA) Bill in September 2011. The Bill, pertaining to nuclear regulator, seeks to replace the Atomic Energy Regulatory Board (AERB) with the National Safety Regulatory Authority (NSRA). The Bill calls for the establishment of a Council of Nuclear Safety (CNS), which will fall under the stewardship of the Prime Minister.[72] The NSRA Bill will allow India to establish a legally independent nuclear regulator, bringing it at par with countries such as France, the UK and the US.

While the NSRA is a significant progress from the current AERB, it nevertheless came under attack on several grounds.One of the criticisms was that the independence and autonomy of the proposed NSRA did not come out clearly in the proposed Bill.[73] Questions were also raised on the independence of other members of the NSRA given that the Chairperson of the NSRA would have been in the member-search committee.[74] With the change in government in 2014, the 2011 NSRA Bill lapsed.[75]

The new government under the leadership of Narendra Modi invited a team from the IAEA to undertake an Integrated Regulatory Review Services (IRRS) mission on the AERB from March 16 to 27, 2015.[76] Such a review happened for the first time and it was hailed as an important transparency measure undertaken by the Indian government on nuclear safety and security. The mission published a report which noted that the AERB functions independently without any interference from other nuclear entities of the country.[77] The report, however, recommended that the "de facto" independence of the regulator should be cemented in a law "de jure."[78]

The new government, thereafter, held a series of inter-ministerial consultations to draft a new NSRA Bill which it was planning to table in 2015.[79] The revised Bill is supposed to address the issues flagged with the 2011 Bill, but is yet to be introduced in the parliament at the time of writing this report.

India has put in place many of the requisites of an effective nuclear security regime including its regulatory apparatus, but it has done a poor job of publicising this. As India seeks greater engagement with the global nuclear community, it might benefit from greater openness about its achievements.

Nuclear Security Culture and Practices

One can possess the best technology and the legal architecture but it is finally up to the individual to play accordingly, which requires a culture where rules regarding safety and security are taken seriously. The tendency within industries and technological establishments is often to approach security through technology, and as experts argue, once "the right systems and procedures are in place, employees will follow the procedures and everything will be fine."[80] However, as the former US Department of Energy security czar, Eugene Habiger, put it, "good security is 20% equipment and 80% people."[81] The human factor is often overlooked even among the most advanced nuclear powers. Also, regulatory agencies largely focus more on instituting rules and monitoring industry compliance rather than on developing such cultures of safety and security, which is left to the industry itself.

While India has always had a culture of nuclear security, this is slowly being refined in line with international trends, at the same time maintaining cultural sensitivity. There is no one rule to fit all and in keeping with that, the security culture is evolving to suit the peculiarities of Indian sensibilities. In this regard, India has rightly started emphasising appropriate security culture as an important element of its nuclear security agenda. According to a report prepared after a workshop on the technical aspects of civilian nuclear security, "Every person, from a custodian to a technician to a scientist to a guard in the protective force, needs to believe in and support the nuclear security program for it to succeed. This is nuclear security culture."[82] This approach encompasses a multitude of measures that are put in place to ensure nuclear safety and security.

Globally, security culture has tended to vary across countries and regions. There are various local factors that determine policies and practices in the realm of nuclear security. For instance, the Personnel Reliability Programme (PRP) that is seen as an integral part of nuclear security is not employed by even some of the advanced nuclear powers, owing to their respective local cultures. In Japan, for example, where privacy is a virtue that is valued dearly, personnel vetting is seen as an intrusion by the security establishment and could cause disgruntlement among employees and thus prove counter-productive.[83] It is believed that insider threat may actually increase as a result of such intrusive vetting practices.

Designing in Safety and Security - The nuclear installations in India are designed in a way that keeps security and safety features at the fore front. As the

Ministry of External Affairs report describes it, "India has a Design Basis Threat (DBT) document and each facility has to devise its own DBT document based on national DBT for designing physical protection system at its facility."[84]

A few basic questions need to be posed in order to arrive at an effective DBT mechanism."How many outsiders? How many insiders? How many teams? How well trained? What kind of vehicles? What motivation? Willing to die?[85] These questions are pertinent because there have already been several incidents depicting general security vulnerabilities of state agencies to coordinated (but non-nuclear) attacks by terrorist groups. Examples of such coordinated attacks abound but there are a few that have demonstrated well-coordinated multiple teams working in a coherent manner: the Pathankot attack (2016), Mumbai attack (2008), and the attack on a Moscow theatre in October 2002 which involved 40 heavily armed and well-trained terrorists from outside. Answering the above questions is thus necessary for the ideal design of high-risk facilities.

In the case of India, nuclear facilities have a multi-layered security setup with the outer periphery protected by the state police, and the inner layer by the CISF (This setup is detailed in subsequent sections).[86] The plant design also incorporates access control mechanisms both physical—such as spike strips and cement/ steel barriers—and technology-aided ones like biometric systems. These measures, while delaying access to the core of the facility, provide additional time for the security guards to become aware of an intrusion, respond to it, and call for reinforcement.[87] The AERB also examines threats and motivations for carrying out malicious activities against a particular site and appropriate measures are put in place. The facilities are designed in such a way "that even in the event of a physical attack, the structural barriers prevent the release of any radioactivity outside the plant area itself and hence the public are not likely to be exposed to radiation."[88] Moreover, the involvement of personnel in actual operational sites is reduced to the minimum, with much of the operation controlled digitally through a command and control centre.[89] Also, numerous measures such as fail safe shutdown systems, active and passive cooling systems and robust containment features are incorporated while constructing each nuclear power plant. The plants are also designed to withstand earthquakes, floods and tsunamis. These mechanisms are reviewed periodically and in the wake of any serious incident, manmade or otherwise.[90] All nuclear plants in India are also located in geographically stable regions.[91]

Nuclear audits conducted by the AERB form an integral part of India's nuclear safety and security regime. Safety audits and regulatory inspections (at least two per year) are carried out by the AERB at nuclear power plants to verify compliance.[92] During the renewal of a plant's licence, consolidated safety assessments are also carried out by the AERB. Following the Fukushima incident in Japan in 2011, all of India's nuclear power plants went through comprehensive safety audits which were carried out by the AERB and the NPCIL.[93]

Environmental Survey Laboratories (ESLs), installed at all nuclear power plants before they are commissioned, are responsible for carrying out pre-operational surveys to detect baseline radioactivity levels at the sites. Periodic analyses of samples from air, water, soil, vegetables, among others, is conducted using instruments and infrastructure available with the ESLs to detect any increase in radioactivity.[94]

While these measures have been put in place, the Indian political leadership as well as the agencies responsible for safety and security acknowledge that these need to be constantly updated in accordance with the changing domestic and global developments.[95] Highlighting this, former Minister of State for Personnel, Public Grievances & Pensions and Prime Minister's Office, Mr. V Narayanasamy, in a statement in the Lok Sabha said, “Safety is a moving target in nuclear power plants and is continuously evolving based on the reviews by utilities and Atomic Energy Regulatory Board (AERB) besides internationally evolving standards. A framework to periodically review safety issues in context of national as well as global nuclear industry events and incorporate necessary measures to strengthen the safety, as required, is in place."[96] For instance, a major security upgrade took place after the Pathankot attack in early 2016. Review meetings were also held, looking into the security lapses that led to the attack; these meetings in turn fed into the review of the DBTs.[97]

Availability of Materials – All radiological and nuclear materials in India are controlled and accounted for by the AERB. Any institution which requires such material has to follow a set protocol which includes possession of a valid license and purpose of the material request.[98] Usually, research and medical institutions use small quantities of radiological and nuclear materials which have a low shelflife and are generally less potent. Scientifically speaking, these materials, given the quantity and quality, cannot be used to develop even a dirty bomb.[99] Secondly, to address the issue of pilferage of materials, the system of procurement is designed in a manner that any attempt at pilferage can be detected easily. The officers in charge of procurement at facilities have a direct line of contact with the AERB in case of emergencies. Moreover, the procurement officers are accountable for the loss of materials and are liable for prosecution in case of negligence.

Rules around the availability of materials were strengthened after the Mayapuri incident in March 2010. By the beginning of May 2010, there was an awareness camp organised for the Mayapuri scrap dealers broadly on safety, but also on the legal and regulatory aspects to be complied with in the handling and disposal of radioactive materials.[100] The incident involved the violation of regulations for the decommissioning of the gamma unit at the University of Delhi, which resulted in the material landing in the hands of a scrap dealer in West Delhi. The incident resulted in the death of one person and a few others were reportedly affected by radiation injuries. The affected persons were treated at the All India Institute of Medical Sciences (AIIMS), New Delhi. According to subsequent reports, "all five patients suffered from the haematological form of the acute radiation syndrome and local cutaneous radiation injury as well. While four patients exposed to doses between 0.6 and 2.8 Gy survived with intensive or supportive treatment, the patient with the highest exposure of 3.1 Gy died due to acute respiratory distress syndrome and multi-organ failure on Day 16 after hospitalisation."[101] Clearly, in this case, Delhi University had not complied with due procedures mandated by the AERB and the cost for that laxity was severe.

Even as this incident was a lapse on the safety front, the security implications of such an occurrence are significant. As mentioned earlier, it is true that the material handled by educational and research institutions have a low shelf life and therefore the chances of it landing in the hands of hostile elements are generally low. However, care must be taken to ensure that such incidents do not happen with more potent materials. Since the Mayapuri incident, there has been further tightening of rules ensuring that all materials are accounted for in the AERB inventory. Also, the higher education body, the University Grants Commission (UGC), has been brought into the loop as a means to ensure greater accountability in this domain.

During the interviews conducted for this study, it was evident that the AERB has tightened the implementation of its regulations and guidelines with regard to hospitals and research institutions in light of the Mayapuri incident.[102] Comprehensive regulations on the use of radioactive material by universities have been notified by the UGC after discussions with the AERB. The regulations have also tightened the security around category II sources according to the AERB categorisation. Also, the AERB's new directive for security of radioactive sources was issued, according to which details including location and inventory of radioactive materials were sought. The new guidelines mandate educational institutions to get a no-objection certificate for all radioactive materials and related equipment, including X-ray machines, from the AERB, which has the authority to undertake periodic inspections to further tighten the security processes. The guidelines also require that these institutions have a proper disposal mechanism for radioactive materials and maintain in its roster, trained personnel such as Radiological Safety Officers.[103] The licensing process was also tightened after this new directive. Since then, various sensitisation programs have also been conducted, including radiological sensitisation of the police force, RSOs and also scrap dealers in places like Mayapuri. BARC has paid special attention to the health sector and focused on the need to sensitise health care in this regard.

Transportation – Nuclear materials are transported with a heavy security cover provided by multiple agencies. There are also coordinated patrolling by these different security agencies. Real-time tracking and monitoring technologies are used to ensure security of materials during transit, and standardised protocols are adhered to in order to ensure the security of materials that are being transported. From a safety point of view, in order to avoid leakage and exposure of material, specially designed vehicles are used for transportation of radiological materials. Agencies also use other measures to ensure security. For example, altering routes is an essential part of the guidelines for transportation of nuclear and radiological materials. This is important as terrorists can identify predictable, regular routes and timings to plan ambushes along those routes.[104]

While the safety and security of nuclear materials during transportation is given high priority, security standards vary, and rightly so, during transportation of materials or equipment used in smaller research institutions. However, materials used by research institutions are of low radioactivity and are transported in small quantities so that they do not pose a serious threat.[105] Therefore, as mentioned earlier, the possibility of these materials being sought by groups or individuals with malicious intent remains highly unlikely.

Human Resources and Insider Threat – Employees working at nuclear installations and the security personnel deployed at such sites are specially trained to handle untoward incidents. Training programmes on numerous procedures including Emergency Operating Procedures (EOP) are conducted in batches to prepare the staff for all emergencies including floods, tsunamis, cyclonic storms, earthquakes and fire.[106] While the broad approach within the nuclear establishment, particularly the disaster management network, is to prepare for a post-disaster scenario, more efforts could be made towards the prevention of such incidents. Even as there is a direct linkage between safety and security, the approach with safety as the overriding principle needs to change and this is already evident.

Station	**Number of training programmes on natural disasters like earthquake/ tsunami, year-wise**			
	2013	**2014**	**2015**	**2016 (Upto July)**
TAPS-1&2	15	20	16	19
TAPS-3&4	26	12	41	6
RAPS-1&2	13	18	22	20
RAPS-3&4	18	18	27	20
RAPS-5&6	13	19	17	22
MAPS	32	24	26	13
NAPS	33	10	14	9
KAPS	21	12	34	17
KGS-1to 4	61	24	48	37
KKNPP	8	2	16	12
Total	**240**	**159**	**261**	**175**

TAPS – Tarapur Atomic Power Station, Tarapur, Maharashtra
RAPS – Rajasthan Atomic Power Station, Rawatbhata, Rajasthan
MAPS – Madras Atomic Power Station, Kalpakkam, Tamil Nadu
NAPS – Narora Atomic Power Station, Narora, Uttar Pradesh
KAPS – Kakrapar Atomic Power Station, Kakrapar, Gujarat
KGS – Kaiga Generating Station, Kaiga, Karnataka
KKNPP – Kudankulam Nuclear Power Project, Kudankulam, Tamil Nadu

This is not to suggest that security is not animportant aspect of the thinking within the nuclear establishment. In fact, the Personnel Reliability Programmes (PRP) undertaken by the DAE is a testament to the fact that security is of utmost importance to India.[107] This study found the Indian PRP to be well-planned and executed. These programmes are used to mitigate the chances of an insider threat and are inclusive and extensive in nature—extending to all employees and staff working at a particular nuclear facility, including those in charge of command and control, technicians, maintenance staff, and any other personnel who may have special access to nuclear facilities. Prior to induction, India's security agencies undertake thorough vetting and verification, including of the employee's identity, family and criminal history, and general reputation. They are also screened against alcoholism and other serious medical conditions, which could inadvertently lead to dangers. There are also periodic reviews being undertaken in order to study the behavioural pattern of employees such as their out-of office activities and interactions like meetings with foreigners, among others. The employees thereafter go through more verification measures when they are being shifted to a more sensitive facility or when they are cleared for higher security access.[108] This programme has thereby ensured a constant watch on an employee and there has been no incident so far to suggest that "the integrity of the personnel reliability program in the Indian nuclear establishment has ever been compromised."[109]

However, during the course of the interviews conducted for this study, some police officials suggested that short-term labourers employed through contractors may not be as carefully vetted.[110] During the field visit, the ORF team found, among others, that: hiring and employment periods of the short-term labourers were extremely erratic, complicating any information gathering exercises by the same; these temporary workers were restricted to the outer periphery; and the physical security measures excluded the ability to carry any surveillance or communication materials by these workers even into the outer periphery. Even though the short-term labourers do not have access to the core of the facilities, the loophole must be plugged.

Despite having the most stringent measures in place, there have been instances that warrant attention, though this is not unique to India.[111] In the recent past, there have been instances where employees have carried out damaging activities within a nuclear facility. For instance, in 2009, a disgruntled employee at the Kaiga Atomic Power Station in Karnataka was reportedly responsible for contaminating the drinking water supply with heavy water from the plant; 45 employees were poisoned.[112] Similarly, there are unconfirmed media reports that there have been about 25 intrusions at the BARC in the last two years, although the intruders reportedly did not access critical infrastructure and materials.[113] If these incidents did take place, then BARC's multi-layered security probably helped to contain these intrusions.

Decommissioning and Disposal of Nuclear Waste

While the ORF team was not given access to the actual waste disposal measures, government statements to this effect were corroborated by those interviewed.[114] India's approach to decommissioning and disposal of nuclear waste was set out in great detail by V. Narayanasamy, Minister of State (junior minister) in the Prime Minister's Office in February 2014. According to him, handling nuclear waste in India is based on the procedures and guidelines issued by the AERB. These approaches are based on several kinds of waste which is generated during operation of nuclear power plants in India – low and intermediate level radioactive waste; high level waste; and spent fuel. "The low and intermediate level radioactive waste generated during operation and maintenance of nuclear power plants is segregated, its volume reduced using various technologies and solidified. This solid/solidified waste is packaged in suitable containers to facilitate handling, transport and disposal."[115] Disposal of these wastes "is carried out in specially constructed structures such as stone lined trenches, reinforced concrete trenches and tile holes. These disposal structures are located both above and underground in access-controlled areas."[116] Locations where disposal takes place "are kept under constant surveillance with the help of bore-wells laid out in a planned manner."[117] Other techniques are used to handle the gaseous and liquid wastes.

High-level waste is handled differently. When spent fuel is reprocessed, two-three percent turns into waste and the rest is recycled. The two-three percent of waste, known as high-level waste, is managed through vitrification, stored and cooled in vaults for 30-40 years, and finally disposed thereafter at Geological Disposal Facilities specially designed for the purpose.[118] Vitrification plants are located in Trombay, Tarapur and Kalpakkam.

While the AERB has issued guidelines, codes and safety manuals on decommissioning of materials, these are more like suggestions and recommendations. These could be made mandatory. Also from the time when a facility is constructed, a plan for decommissioning has to be identified and notified to the regulatory agencies, something that has been strengthened since the Mayapuri incident although strict monitoring and compliance need to be ensured.

Reporting of Incidents – There are standard protocols set for reporting of incidents at nuclear facilities, both large and small. In large installations, matters related to security such as theft or any such criminal activity is reported to the CISF and the state police located at a nuclear power plant, and depending on the nature of the incident, the case is transferred to the designated authority. For instance, matters of petty crimes are handled primarily by the state police and the CISF, who are stationed at the facilities. For incidents of greater magnitude, the NDMA and the NDRF are brought into play, with the immediate objective of containing any possible radiation exposure to the larger public. The district administration authorities are called in at this stage who also maintain disaster management plans, which include evacuation of public from affected areas, provision of food and water supply (since the water supply is likely to be contaminated following a disaster).[119] Prior to an incident, the district authorities have the responsibility of ensuring motorable roads along identified evacuation routes, identifying possible emergency shelter and camping facilities for a large number of people, among others.[120] In case of incidents that may involve a major terrorist attack on a facility, the NSG will be called into action. In all of these scenarios, the AERB is kept in the loop, which will closely monitor the developments following such incidents.

In addition, to detect radiation, the Government of India has decided "to install mobile radiation detection systems in Police vehicles of selected police stations of major cities (more than 800 police stations in the country) with technical support from Bhabha Atomic Research Centre (BARC)."[121] But the NDMA has not been able to identify appropriate vendors who could supply such equipment yet, though funding has been sanctioned. This is something that must be attended to on a priority basis.[122]

To detect illicit material, India has deployed indigenously developed detectors at airports, seaports and border posts.[123] Currently, there are 300 detectors installed across India.[124]

Institutions

India has established various institutions to ensure the safety and security of materials as well as facilities across the country. These include the Atomic Energy Commission (AEC), the DAE, AERB, Nuclear Controls and Planning Wing (NCPW) and BARC among others. While the AERB is primarily responsible for overseeing the civilian nuclear sector, the DAE and BARC also contribute on matters related to India's strategic nuclear programs.

In September 2011, following the Fukushima crisis, the GOI introduced a new bill in parliament called the Nuclear Safety Regulatory Authority (NSRA) Bill (the deficiencies of the proposed bill has been addressed in an earlier section on regulations). The bill aims at constituting a Council of Nuclear Safety (CNS), under the leadership of the Prime Minister. When the bill is passed, the CNS will become the body which will oversee and review policies around radiation/ nuclear safety in India. The bill also includes a list of offences which are punishable under the Code of Criminal Procedure, 1898.[125]

Atomic Energy Commission

The Atomic Energy Commission, essentially a governing body, was set up in 1948, initially under the Department of Scientific Research. In 1958, after passing a government resolution, the AEC was established in the Department of Atomic Energy. The members of the Commission are appointed by the Prime Minister of India every year based on the recommendations of the Secretary to the GOI in the DAE. The AEC enjoys executive and financial powers and is responsible for formulation of policies of the DAE. The AEC also prepares the budget of the DAE, with full executive and financial powers vested in it. The actual execution is carried out by the DAE.[126]

Department of Atomic Energy (DAE)

The DAE, set up in 1954, is tasked with development of nuclear power technology, applications of radiation technologies in various fields including agriculture, industry and scientific research. The DAE's vision statement outlines the wide-spectrum mandate of the organisation. It states that the DAE seeks "to empower India through technology, creation of more wealth and providing better quality of life to its citizen. This is to be achieved by making India energy independent, contributing to provision of sufficient, safe and nutritious food and better healthcare to our people through development and deployment of nuclear and radiation technologies and their applications."[127]

Primarily, the DAE is responsible for the design, construction and operation of nuclear power and research reactors and the supporting nuclear fuel cycle technologies. The DAE oversees the deployment of indigenous and other proven technologies, development of fast breeder and thorium reactors. It is also responsible for building and operating research reactors for radioisotopes production and radiation technology application in medicine, agriculture and industry. Certain advanced technologies such as accelerators, lasers, supercomputers, instrumentation are also being developed by the DAE. These technologies are developed also with an aim to empower the industry through technology transfer. The DAE also makes a significant contribution to India's national security.[128]

Given the broad mandate of the DAE, there are several different boards/ committees and departments dealing with nuclear research aspects. From a nuclear security perspective, it would be important to highlight the role of Crisis Management Group (CMG). The Crisis Management Group within the DAE has as members, senior officials of other DAE units such as the NPCIL, BARC, the Heavy Water Board (HWB) and the Directorate of Purchase and Stores (DP&S), and one senior official from the AERB. There are different emergency scenarios being developed and for which appropriate response plans have also been drawn, all of which emphasise the role of the local district administration, the CMG (of the DAE) and the National Crisis Management Committee (a decision-making body and gives directions to the Crisis Management Group).[129] During an emergency, the DAE is expected to coordinate its response using its CMG, which in turn coordinates with the local authorities in the concerned area to provide technical inputs.[130]

Furthering nuclear security, India has established a Counter Nuclear Smuggling Team (CNST) at the national level in order to develop "effective and coordinated response to threats involving the acquisition of nuclear and radioactive materials for malicious purposes."[131] The CNST has so far held three meetings although the third meeting held in July 2016 was said to be most effective both from an operational perspective and in terms of the representation of agencies.[132] The meeting that began with a classroom discussion went on to scenario building and table top exercises about potential threats and how to handle them.[133] The meeting was also significant as it involved all the different security agencies including the border guarding ones that were previously absent.

Lastly, in its effort to instil greater confidence in nuclear energy among the public, the DAE also conducts workshops and seminars on nuclear safety.[134] From a nuclear security perspective, it is important to take note of the fact that safety and security are two sides of the same coin. Therefore, if safety measures are adhered to, any vulnerability that may exist in the security domain may already be addressed.

Atomic Energy Regulatory Board

The AERB was formed in 1983 to carry out regulatory and safety-related functions. These include ensuring that "ionising radiation and nuclear energy does not cause unacceptable impact on workers, members of the public and to the environment."[135] The AERB has many committees under its umbrella to discharge its duties. The Safety Review Committee for Operating Plants (SARCOP) and the Safety Review Committee for Applications of Radiation

(SARCAR) are the main committees responsible for safety review. SARCOP, established in June 1988, makes assessment of and enforces nuclear, radiological and industrial safety in all operating plants under the DAE.[136] The SARCAR is responsible for streamlining the implementation of Radiation Protection Rules in all its processes and institutions that use radioisotopes and radiation materials in medical, industrial and research institutes.[137]

The AERB maintains records and tracks nuclear and radiological material movement and management throughout the country within the civilian nuclear domain.[138] AERB conducts security and safety audits of the nuclear installations and other research institutions that fall under its purview. Moreover, the AERB "has powers to not only license the operation of a facility but also to order partial or full shut down of any facility that violates its guidelines. It ensures that while the beneficial aspects of a nuclear programme and use of ionising radiation are fully exploited, their use does not cause undue risk to public health and the environment."[139] AERB licences nuclear power plants for a period of five years during which regulatory surveillance and monitoring of safety-related performance is carried out.[140]

As per the Atomic Energy (Radiation Protection) Rules, 2004, AERB is the licensing authority for equipment used in hospitals and research institutions. Such equipment include those that emit ionising radiation and are used for the purpose of radiography, fluoroscopy, and interventional radiology. Before the license is granted, a compliance review is undertaken to ensure that the licensee meets the regulatory requirements. Inspections are also carried out to ensure that these institutions are complying with the regulatory requirements. As a followup, inspection reports are issued which contain actions required to be taken by the institution. In case of a failure on compliance-related issues, punitive actions are also taken.[141]

Security regulations and inspections are carried out with the same underlying philosophy as nuclear safety regulations and inspections. The AERB conducts planned, unplanned and surprise inspections for operating plants and during various development stages of ongoing projects. The planned inspection usually happens once a year for the operating plants. The inspection team (usually of four members) comprises the members of the Committee for Reviewing Security Aspects of Nuclear Facility (CRSANF) who are trained and experienced in the nuclear security aspects. The inspection team and the team leader (lead inspector) are authorised by the AERB. Inspections usually take three to four days, depending upon the number of Operating Islands to be inspected.

The inspections are based on the AERB documents, checklist for Regulatory Inspections (RIs), AERB recommendations for modifications/ upgradations, follow-up of previous RIs and security events reported earlier.

The AERB has three tiers of review on nuclear security aspects:

- **First Tier Review:**
  - Committee for Reviewing Security aspects of Nuclear Facility (CRSANF)
  - Committee for review of Nuclear Security aspects of radiation facilities and for transport of Radioactive Materials
  - Advisory Committee on Security (ACS) – Advises on all nuclear security aspects

- **Second Tier Review:**
  - Safety Security Interface maintained at AERB level by review of reports of first tier by Safety Review Committee for Operating Plants (SARCOP) for Plants
  - The respective Advisory Committee for Project Safety Review (ACPSR) for Projects
  - Safety Review Committee for Application of Radiation (SARCAR) for Radioactive Material

- **Third Tier Review:**
    - Atomic Energy Regulatory Board

Even as these security-related regulations continue to be important aspects of the AERB functioning, there have been questions about the credibility of the AERB in functioning as an autonomous entity because the AERB receives administrative and financial support from the DAE.While this might be an issue, this study has not found any specific instance where this has acted as a constraint on the AERB's functioning.

Nuclear Controls and Planning Wing (NCPW)

The National Progress Report of India presented at the Nuclear Security Summit 2014 highlighted a new institutional initiative known as the Nuclear Controls and Planning Wing (NCPW), which was set up in the DAE in 2013. This body is supposed to "assist in the implementation of India's commitments related to nuclear safeguards, export controls and nuclear safety and security."[142] For example, the head of the NCPW led the Indian delegation to the Sixth US-India Civil Nuclear Energy Working Group, held at the Idaho National Laboratory in July 2014.[143]

Global Centre for Nuclear Energy Partnership (GCNEP)

India approved the establishment of Global Centre for Nuclear Energy Partnership (GCNEP), which was set up in September 2010. Under the GCNEP, India has agreements of cooperation with the US, Russia, France and the IAEA. The GCNEP has a major role in capacity building in the areas of technology, education and training, and R&D, with an objective of developing enhanced nuclear safeguards, promoting the development of advanced, more proliferation resistant nuclear power reactors, establishing accreditation facilities for radiation monitoring and training of manpower in the field of nuclear security and radiological safety, among others. The Centre has five specialised schools: School of Advanced Nuclear Energy System Studies (SANESS), School of Nuclear Security Studies (SNSS), School on Radiological Safety Studies (SRSS), School of Nuclear Material Characterization Studies (SNMCS), and School for Studies on Applications of Radioisotopes and Radiation Technologies (SARRT).

Bhabha Atomic Research Centre (BARC)

The BARC is responsible for carrying out research and development activities in the field of atomic energy, which vary from basic laboratory research to plant level operations.

Apart from research in the civilian sector, the BARC makes substantial contributions towards India's national security. For instance, research conducted by BARC has been critical in developing India's indigenous nuclear powered submarine – the Arihant.[144] The BARC is also responsible for education and training of most of the staff employed at nuclear installations in India. Additionally, it has trained and deployed emergency response teams for all nuclear installations in India. It also trains radiological safety officers (RSOs) for civilian installations and institutions which use small quantities of nuclear or radiological material.

Nuclear Power Corporation of India Limited (NPCIL)

The NPCIL is a public sector undertaking under the DAE responsible for operating the nuclear power stations in India. The company is managed by a Board of Directors appointed by the President of India. NPCIL is responsible for "develop[ing] nuclear power technology and to produce nuclear power as a safe, environmentally benign and an economically viable source of electrical energy to meet the increasing electricity needs of the country."[145] The NPCIL functions with guidance and supervision from the DAE, the AERB, the BARC and the CISF. The NPCIL maintains safety teams, and has developed its own SOPs and manuals to deal with contingencies.

In order to allay fears about nuclear power and increase awareness among local communities, the NPCIL conducts public awareness programmes near its nuclear power plant sites.[146]

Central Industrial Security Force (CISF)

The CISF is tasked with providing security to nuclear installations in India. It is responsible for ensuring access control and monitoring the movement of staff and personnel inside the installations. It is also one of the multiple agencies responsible for providing security during transportation of nuclear material. The personnel of the CISF are specially trained to handle situations of emergencies at nuclear installations including radiation leaks and terrorist attacks. The personnel guarding nuclear installations are equipped with radiation detection and protection equipment. The CISF also participates in disaster management mock drills and exercises conducted with the NPCIL staff, state police, fire service, and other state administration institutions. The CISF also runs a training institute, the National Industrial Security Academy (NISA), located in Hyderabad, Andhra Pradesh, which is focused on CBRN security and is considered one of the premier officer training institutions on the subject.

State Police

The state police is responsible for maintaining security at the outer periphery of nuclear installations as per guidelines issued by the Ministry of Home Affairs (MHA). Law and order issues such as theft and other crimes are handled by the state police. They are also involved in carrying out security audits and regular mock drills in collaboration with other stakeholders. The state police's intelligence wing also keeps vigil around the nuclear facility to detect unusual activities. State police is also responsible for conducting security audits in the outer peripheral areas of a nuclear facility. During transportation of materials, the state police, along with other agencies, is responsible for providing armed escorts. They maintain a database of incidents that is supposed to be updated regularly. SOPs and bluebooks are also maintained by the state police to deal with contingencies.

Intelligence Agencies

Central and State Intelligence Bureaus actively monitor movements around nuclear facilities. They play a critical role in ensuring the security and providing intelligence on facilities and material security. These agencies are also likely to be in a position to identify, in advance, if a non-state group is showing signs of attacking or disrupting activities of a particular site. Accordingly, warnings and alerts are issued to the relevant departments. Additionally, these agencies take part in the security audits and suggest recommendations for enhancing physical security of installations. These agencies have a critical role in conducting the personnel reliability programme, as explained in the previous sections.

The Intelligence Bureau (IB) along with representatives of the state intelligence bureau (SIB) and the state police carry out periodic security audits of critical nuclear installations. The audit also verifies the steps taken by the site staff and the AERB in securing the facility. Recommendations are made at the end of these audits to enhance security or to fill any gaps that may have been found.

NDMA/ NDRF

The National Disaster Management Authority (NDMA) is the agency responsible for disaster mitigation and relief in India. Falling under the Ministry of Home Affairs, the NDMA was set up as per the National Disaster Management Act of 2005. The NDMA is equipped with its own National Disaster Relief Force (NDRF) which is positioned strategically across the country to respond to a wide range of natural and man-made disasters including nuclear and radiological emergencies.[147] Currently there are four battalions of NDRF personnel (about 1000 persons per battalion) trained in tackling CBRN incidents.[148]

The NDMA has issued guidelines on Management of Nuclear and Radiological Emergencies to strengthen the existing frameworks for the prevention and mitigation of incidents. While focused largely on post-disaster scenarios, the guidelines aim "to institutionalise a holistic and integrated approach to the management of disasters at all levels and covering all components of the disaster continuum—prevention, mitigation, preparedness, response, relief, rehabilitation, reconstruction, recovery, etc."[149]

The "[G]uidelines recommend a series of actions on the part of the various stakeholders at different levels of administration that would (i) mitigate the accident at source;(ii) prevent deterministic health effects on individuals and limit the probability of stochastic effects in the population; (iii) provide first aid and treatment of injuries; (iv) reduce the psychological impact on the population; and (v) protect the environment and property, all under the constraint of available resources."[150]

Although the NDMA and the NDRF are trained to handle nuclear and radiological incidents, their role is primarily associated with providing post-disaster response. Moreover, given that India is prone to numerous natural disasters which are more likely to impact the nation than man-made security breaches in the nuclear and radiological areas, the orientation of the disaster management institutions is largely focused on dealing with natural disasters. Therefore, it is possible that man-made nuclear security matters may receive less attention.

There is a need for the policy planners to give more attention to issues regarding man-made incidents in the nuclear and radiological arena. Moreover, the NDMA's knowledge and expertise in this area can be utilised further. The NDMA can be involved on a larger scale when conducting mock drills and exercises in and around nuclear installations. Also, the state-level disaster management agencies need to be given a more visible role in the prevention, management, mitigation, and post-disaster response functions. A few states such as Delhi and Gujarat have proven their pro-active participation in all of these functions, and this can be a model for other states.

Armed Forces

India's armed forces play a limited role in the security of civilian nuclear power plants, despite the fact that they are better trained than most Indian police forces in handling contingencies. All army personnel undergo periodic training on Chemical, Biological, Radiological, and Nuclear (CBRN) security. The deployment of the military services to deal with nuclear security contingencies is considered a last option, to be used only if all other measures have failed, mirroring the traditional use of the military 'in aid of civil authorities' which usually happens only if other arms of the government have failed, whether it is a natural disaster or an armed attack.

Technology

Technology enables India to achieve nuclear security in different ways. The first way is technological choices that reduce the risks of proliferation.[151] For example, India uses a closed fuel cycle, which Indian nuclear scientists insist, carries less proliferation risks.[152]

Technology is also used to track materials in real time while in transit. Thermal cameras are also used to enable accurate video analytics. Sensors and access control barriers are also used to protect nuclear installations. These technologies are designed and developed indigenously by institutions such as the BARC.[153]

As technology rightly assumes an important role in securing the country's nuclear facilities, it must be noted that they also present new vulnerabilities because the same technology is available to everyone, including non-state actors and terrorist groups. In that sense, Indian security establishments need to do more to be in line with the global technology trends and be more innovative in developing indigenous technologies.

Cybersecurity is also a crucial component in ensuring safety and security at nuclear facilities. The Stuxnet cyber attack, for instance, reportedly impacted the Iranian nuclear programme adversely. The Iranian nuclear programme had been set back by a couple of years due to the attack. The event demonstrated how a cyber attack can impact a nuclear installation. Moreover, a report by global cybersecurity giant Symantec highlighted that the attackers had to access the site's systems physically in order to infect it. The report said, "To infect their target, Stuxnet would need to be introduced into the target environment. This may have occurred by infecting a willing or unknowing third party, such as a contractor who perhaps had access to the facility, or an insider. The original infection may have been introduced by removable drive."[154] This physical access, through the use of a USB or a similar device, could have only been possible through an insider, with or without their knowledge. This highlights the importance of promoting a culture of cybersecurity wherein all personnel at sensitive sites have a general awareness about cyber-related matters.

The Indian nuclear establishment including the nuclear power plants are live to the threat of cyber vulnerabilities. In Indian civilian nuclear facilities, such threats are being addressed by the Computer Information and Security Advisory Group (CISAG). The CISAG is responsible for conducting audits of information systems, framing guidelines and plans to mitigate cyber attacks and its effects. More importantly, there is an effort to instil a culture of cyber security and accordingly, use of USB or any such external drives is forbidden, and there is limited internet connectivity, usually limited to one in the entire facility.[155] However, smartphones are increasingly becoming more capable and their use within facilities could potentially compromise security.

Thus, even as India's nuclear security establishment is alive to the threat posed by cyber technologies, there should be no room for laxity. Indian security agencies need to continuously monitor emerging nuclear security threats and come up with defensive measures. This is important since India has been one of the favourite targets of cyber hackers from around the world.

International Cooperation

Previous reports on Indian nuclear security and safety do not appear to have taken into consideration India's involvement in international efforts in this area. The Indian government has always been keen to join all international initiatives enhancing nuclear material security in a bid to combat the threat of nuclear terrorism. The eagerness is to a large extent driven by India's concerns regarding its neighbour – which has a history of nuclear proliferation and terrorism. Indian Prime Ministers' presence at three of the four nuclear security summits in 2010, 2012 and 2016 is an indication of India's support for global initiatives to secure and safeguard nuclear materials.[156] Although not party to the Nuclear Non-Proliferation Treaty (NPT), India has been an ardent supporter of developing an effective nuclear non-proliferation regime. Similarly, India is not a full-fledged member of the Proliferation Security Initiative (PSI) but it has taken part in many of the exercises as an observer.[157]

Furthering its commitments to international cooperation, in 2002, India joined the Convention on the Physical Protection of Nuclear Material (CPPNM), which was drawn up in 1979. India is also one of the few countries to ratify the July 2005 Amendments which were made to plug some of the loopholes in the original legislation. This is the only legally binding treaty for the physical protection of civil nuclear energy facilities. India "support(s) the fifth revision of the recommendations contained in INFCIRC/225."[158]

India is also party to the International Convention for the Suppression of Acts of Nuclear Terrorism, which seeks to facilitate cooperation among member states to combat nuclear terrorism. The convention was mandated by a 1996 United Nations General Assembly (UNGA) Resolution and was subsequently adopted by the UNGA in 2005. India signed and ratified this convention in 2006.[159]

India has expressed its support to the Code of Conduct on the Safety and Security of Radioactive Sources, and has thereby voluntarily adopted the provisions enshrined within. India is also part of IAEA's Illicit Trafficking Database (ITDB) established in 1995. The database is used to disseminate information on illicit trafficking and other unauthorised activities and events involving nuclear and radioactive materials. In fact, India has argued for the IAEA to be given a central role in strengthening nuclear security and fostering meaningful international cooperation.[160] India is also a member of the IAEA Commission on Nuclear Safety Standards and the Advisory Group on Nuclear Security, and has been an active participant of the IAEA's Action Plan on Nuclear Security. Furthermore, India has been a part of the IAEA-US Regional Radiological Security Partnership (RRSP), and has organised international training courses in India. New Delhi has used the IAEA as a platform to offer assistance in search and recovery of orphaned radioactive materials, and has commended the Agency's efforts to develop a Nuclear Security Information Portal.[161]

India's efforts at the international arena have not been restricted to the IAEA. Since 2002, India has shepherded a resolution in the UN General Assembly on measures to prevent terrorists from gaining access to Weapons of Mass Destruction (WMD). Moreover, India is a party to the Global Initiative to Combat Nuclear Terrorism, participating in working groups on nuclear detection, nuclear forensics and response and mitigation. India is also a cooperative partner in Interpol's Radiological and Nuclear Terrorism Prevention Unit, and the World Customs Organization.

With regard to safety, India had invited the IAEA's Operational Safety Review Team (OSART) to review the Rajasthan Atomic Power Station (RAPS) Units 3&4 in November 2012. The OSART, after the review, identified certain good practices, which were shared with the IAEA and the global nuclear industry. At the same time, the recommendations made by the OSART for India were also noted for implementation. International peer reviews by experts from the World Association of Nuclear Operators (WANO) were also carried out. Most recently, India signed and ratified the IAEA's Additional Protocol.

India's initiative to establish the Global Centre for Nuclear Energy Partnership (GCNEP) is a testament to its credentials as an active global partner in furthering nuclear security. The key objectives of the GCNEP are "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" on areas including nuclear security and safety.[163] India has also contributed to the upgrade of the IAEA's Seibersdorf Laboratory under the ReNuAl project in 2015 and also a contribution of U.S. $1 million to the IAEA Nuclear Security Fund in 2016.[164]

India has been an active participant at the four Nuclear Security Summits (NSS) held in Washington DC in 2010, Seoul in 2012, The Hague in 2014, and Washington DC in 2016. The decision to set up the GCNEP and conclude practical arrangements with IAEA was announced at the NSS 2012. At the latest and final NSS held in Washington DC in March-April 2016, India made significant commitments, few of which are highlighted here.

Firstly, India joined the initiative on strengthening nuclear security implementation, based on the joint statement issued by the co-chairs of the NSS 2010, 2012 and 2014. This joint statement, formally published by the IAEA as INFCIRC/869, has the agenda for "instituting an effective and sustainable international nuclear security regime, based on national commitments and action plans to strengthen the effectiveness of nuclear security measures in general."[165] India also agreed to join 'gift baskets', including those on counter nuclear smuggling, sharing best practices through GCNEP and NSS-follow up through contact group in Vienna. Gift basket is an approach that is used to circumvent lack of consensus, allowing those who are willing to join the initiative to continue.[166] India also plans on convening a meeting for the Global Initiative to Combat Nuclear Terrorism in 2017. Furthering the goals of reducing the use of Highly Enriched Uranium (HEU), which has been one of the global goals in the area of nuclear security, India announced in its national report card that the only reactor in India that was using HEU "has been shut down and the planned replacement reactor will not use HEU."[167]

Conclusion

For a country like India which is situated in a particularly difficult neighbourhood, nuclear security is of immense importance. Even as it considers nuclear incidents highly unlikely, the dangerous consequences, should there be one, explain the anxieties of the nuclear establishment and the political leadership. Therefore, the government has taken every step to strengthen its policies and practices in line with new threats and vulnerabilities.

While there are five key principles that drive the Indian approach to nuclear security – governance, institutions, security practice and culture, technology, and international cooperation – India could do better in publicising its efforts and achievements. Governance in this domain, for instance, is ensured through a well-established legal and institutional infrastructure, though some commentators have raised questions about the independent nature of the regulatory body.

Similarly, the 'defence in depth' principle that is at the core of the physical protection of facilities is a significant measure, lessening the potential for any intruders to attack the core of a nuclear facility. This principle is further applied at multiple levels including individual, institutional, behavioural and design aspects of a facility. In fact, it is this principle that is enshrined in the physical protection measures including access control mechanisms such as spike strips, physical and metal barriers as also technology-aided systems such as biometric recordings. These have proven to be effective and India has avoided any case of intrusion into its facilities.

As far as its security culture and practices are concerned, it can boast of having some of the best practices comparable to several other advanced nuclear powers. For instance, the Personnel Reliability Programme (PRP) that India has instituted is among the best anywhere in the world. Here too, however, this study has noted that it could be expanded to include temporary labourers.

Lastly, while India has some of the best policies and practices in place, both in its institutional and legal framework, there is scope for improvement in terms of its outreach and publicity. In today's world, when international cooperation has become an integral part of the development of nuclear programmes, it is not sufficient that India adheres to global best practices; it must also be seen doing so by the international community. This requires India to publicise its efforts and achievements more aggressively.

Chapter – IV

Best Practices – US, UK, Japan, France

The previous chapter examined the state of the play in India's nuclear security policy and practice, bringing out the strengths and weaknesses. Even as India has instituted a tight network of regulations and institutions, there is always scope for strengthening them further and thus it is important to study some of the good practices from other countries that have been operating in this domain. There are important similarities and differences between countries in the manner in which safety and security issues relating to nuclear material are handled. There are countries such as the Czech Republic, for instance, that have integrated both functions under one ministry – the State Office for Nuclear Security – that is responsible for performing safety and security audits. But in most countries, safety and security aspects of nuclear materials are handled by separate agencies.

The focus of this study is on the security aspects of nuclear materials and facilities, but safety issues have begun to loom larger in the wake of the Fukushima crisis in March 2011.The crisis highlighted the importance of approaching both safety and security in a holistic manner in order to be able to effectively respond to situations, both man-made and natural. Because the consequences of the impact of the Fukushima crisis was felt on both safety and security aspects, organisations such as the International Atomic Energy Agency (IAEA) and the World Institute of Nuclear Security (WINS) began studying the relationship between the two. Among the outcome documents of such deliberations was *Time for an Integrated Approach to Nuclear Risk Management, Governance and Security/ Safety/ Emergency Arrangements*, by the WINS. Though this document primarily reviews security practices, it also takes a brief look at some safety practices, especially where it overlaps security.

There is a wealth of information on good practices on nuclear security from around the world, though it may not be feasible for India to adapt every such practice for various reasons. Local conditions, including socio-cultural practices and resource allocation are important factors that might constrain India from adopting certain practices. Nevertheless, it is useful to review these practices and, for the same, this chapter examines the policies and practices in the area of nuclear security in the US, the UK, Japan, and France. The section on the US is larger than the other country studies partly because of the far more extensive domestic legislation that covers this area. This exercise will also help India compare, contrast and gauge its own practices.

Nuclear Security in the US

The United States has been one of the frontrunners in nuclear technology since the Manhattan Project gave the US its first atomic bomb in the early 1940s. Since then, however, nuclear technology has found its utility in enhancing the civilian and peaceful applications – nuclear energy contributes to almost one-fifth of the US' energy needs.[168] Greater reliance also has brought in certain vulnerabilities. Safety of nuclear materials, reactors and facilities has been an issue for long but in recent years, the bigger concern is about the security of these materials. Acknowledging the possibility and dangers of these materials falling into the wrong hands, including terrorist groups and criminal groups, governments around the world including the US have instituted measures to tighten the security around nuclear materials and facilities. Even though nuclear security has been gaining importance since the end of the Cold War, the issue gained greater salience in the post-9/11 context with fears of terrorists getting hold of nuclear materials. Hence, post-9/11, there has been a particular transformation of strategy that is based on the security and protection of nuclear material and reactors both in the military as well as civilian sectors. The following sections examine the various regulations put in place by the United States to secure their vast civilian nuclear energy sector and how well they have been implemented.

Legislative Mechanisms

In recent years, there has been a renewed call for developing legislations specifically focused on the issue of nuclear security and nuclear terrorism in the United States. Up until 2001, the US relied on generalised anti-terror and cyber security legislation to address the issue of nuclear security. In the past decade, however, the US has recognised the importance of formulating specific laws in compliance with international standards to cover the issue.

The American civil nuclear program was initiated by the Atomic Energy Act of 1954 which was signed by the Eisenhower Administration. The Price Anderson Nuclear Industries Indemnity Act of 1957 was another legislation passed during this period, shaping the civil nuclear sector and holding relevance even today. The Act limits the liability of private corporations for nuclear accidents and establishes a cap on the compensation that is required to be paid by corporations in case of an accident. It establishes a fund under the Federal Government which is to be used to ensure full compensation pay-out to the victim.[169] This Act was renewed by the Energy Policy Act of 2005 and applies to all reactors built up to 2026.[170] The intention behind the Price Anderson Act was to encourage corporations to invest in nuclear power generation at a time when safety mechanisms were still at a rudimentary stage. However, considering that the nuclear power sector has expanded tremendously and that private sector is now at a stronger and competitive position, there have been questions raised on why the liability in nuclear accidents still remains with the Federal Government.[171] The law is being debated again, especially following the Fukushima disaster, as several critics believe that corporations should take greater, if not full, responsibility for any accidents that may occur in their jurisdiction.[172]

The Energy Reorganisation Act of 1974 created the Nuclear Regulatory Commission (NRC) and laid down its responsibilities and mandate. It divided responsibilities of the erstwhile Atomic Energy Commission between the newly created NRC and the Department of Energy. The Energy Policy Act of 2005, apart from renewing the Price Anderson Act, lays the groundwork for legislation in the field of nuclear security regulations in the US. It mandated various regulatory provisions under the banner of the Nuclear Regulatory Commission such as formulating Design Based Threats, conducting Force-on Force mock drills and, in a first, allowing the licensees to maintain their own security teams and arm their personnel.[173]

The National Defense Authorization Act was passed by the US Congress with one of its objectives being to strengthen nuclear security frameworks.[174] The act established the National Nuclear Security Administration under the Department of Energy (DOE) with the mandate of making advancements in technology and international cooperation on topics of non-proliferation, nuclear security, protection of nuclear weapons in countries like Russia and establishing intelligence and counter intelligence initiatives for non-proliferation.[175]

The effort to develop a comprehensive legislation on nuclear security, however, has been fairly recent with the 9/11 terror attacks serving as a wakeup call to the US to secure its civilian nuclear facilities. The US, prior to 2015 had not ratified either of the two major international conventions on nuclear security, i.e., the 2005 Amendment to the Convention of the Physical Protection of Nuclear Materials (CPPNM) and the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT). The primary reason for this was the fact that both these conventions required countries to develop domestic law, criminalising acts of nuclear terrorism, on which the US Congress had failed to reach a consensus. However, in June 2015, the White House passed the Bill criminalising Nuclear Terrorism after bi-partisan support from Congress and thereafter submitted their instruments of ratification of the 2005 Amendment to the CPPNM and ICSANT.[176]

It is to be noted however, that the legislation that has finally been passed, is quite comprehensive and makes the US one of the few countries to include legislation on theft of radioactive material and sabotage of nuclear facilities in its domestic legal framework. Notably, the US Congress decided not to impose the death penalty under acts of nuclear terrorism in the US Criminal Code[177] even when it resulted in the deaths of civilians, which was proposed in the original bill introduced in Congress but was removed due to objections by Democrats within the Congress.[178]

In a major step, lawmakers decided to include sabotage of nuclear facilities and usage of radioactive material for terrorist activities under the definition of International Terrorism under the Patriot Act.[179] This gives enforcement agencies access to several provisions including wiretapping and detainment which can be used in cases of suspected nuclear terrorism.

The US is one of the few countries which has designed and implemented specific legislation aimed at cyber security in the nuclear security arena. Interestingly, the law which has been passed under the Code of Federal Regulations has placed the onus of maintaining cyber security and analysing cyber threats to nuclear power plants on the licensees/operators of the power plant.[180] The Federal Government has chosen to have minimum involvement in this matter and has appointed the Nuclear Regulatory Commission to conduct checks on cyber security mechanisms as part of their licensing procedure.[181]

There have been several other acts passed in the US which govern areas of nuclear security and safety. The Nuclear Non-Proliferation Act establishes export control regulations on nuclear exports and enlists NRC as the licensing body for licensing nuclear exports.[182] The National Environment Policy Act also covers certain areas of nuclear safety from an environmental perspective which has shaped nuclear safety policy.

To conclude, while legislation on areas relating to nuclear security has taken a long time to achieve consensus on Capitol Hill, the law that eventually got passed has been quite comprehensive and gives teeth to enforcement agencies for effective implementation.

Regulatory Mechanisms

Two bodies share the responsibility for regulation of nuclear sites. The 1974 Energy Reorganization Act gives the Nuclear Regulatory Commission (NRC) the mandate to regulate all commercial sites including power plants and mines, while the Department of Energy (DOE) has the mandate to regulate Research & Development laboratories.

The DOE set up the National Nuclear Security Administration (NNSA) which has the mandate to innovate in the area of nuclear security. NNSA undertakes a whole host of steps, including tailoring exercises for various government and private facilities, allowing them to test their own security. It also engages with other countries and international organisations to promote global efforts on nuclear security.

The operation, regulation and oversight of military nuclear facilities fall directly under the ambit of the Department of Defense. The Pentagon establishes full control including the establishment of standard operating procedures (SOPs) and security of facilities under the US military.[183]

Licensing for civilian nuclear sites is done by the NRC after reviewing the proposed design and site for the reactor. The NRC also holds a public hearing before the final license is awarded so as to increase public participation in the regulation of the sector.[184]

The NRC uses the concept of Design Basis Threat (DBT) to certify designs of reactors. The DBT describes general levels of threat that nuclear plants must be prepared to defend against. It describes various kinds of adversaries, their numbers, weaponry used and even mode of transport in a document called General Adversary Characteristics which the plant needs to protect against by design to obtain certification. These regulations are also specified under the Code of Federal Regulations.[185] It is to be noted that the DBT until 2009 did not consider a number of eventualities, including a crash of a commercial aircraft on the nuclear facility. Having assessed the probability of such incidents as high, the NRC on June 12, 2009 published rules that required "all new nuclear power plants to incorporate design features that would ensure that, in the event of a crash by a large commercial aircraft, the reactor core would remain cooled or the reactor containment would remain intact, and radioactive releases would not occur from spent fuel storage pools."[186] The NRC has also made it necessary for existing nuclear power plants to implement these measures.[187]

Threat Assessment

The 9/11 Commission, in its report, assessed that nuclear reactors and fuel cycle facilities were potential targets considered by terrorists for the 9/11 attacks.[188] So far, nuclear reactors were designed and secured with the purpose of avoiding nuclear accidents including from natural disasters. However, in the past few years, the threat of non-state actors on nuclear facilities has become very real. Threats include theft of radioactive material, from both reactors and spent fuel pools, sabotage of an active nuclear plant, through internal as well as external factors, and although improbable, also the possibility of a full-scale ground assault on nuclear facilities.

The NRC conducts threat assessment for all nuclear facilities licensed under it and produces the *Annual Threat Environment Report* which outlines the risks and vulnerabilities faced by nuclear plants. The NRC has set up Liaison offices in all major security and intelligence agencies in the US, including Department of Defence, Directorate of National Intelligence and Department of Homeland Security, to ensure an effective threat assessment mechanism. This is coordinated by the recently set up Office on Nuclear Security and Incident Response under the NRC.[189]

The NNSA has also made successful strides in the area of threat assessment. It has set up the Office of Nuclear Threat Science (ONTS) which analyses the threat of nuclear terrorism not only within the US but overseas as well. The ONTS manages the Nuclear Counterterrorism Program, "an NNSA program that sustains specialized expertise and integrates and executes key activities to advise and enable technical aspects of U.S. Government nuclear counterterrorism and counter proliferation missions."[190] Through the Nuclear Counterterrorism Program, ONTS provides state-of-the-art training, operational support, technical advice, and expert policy recommendations in nuclear threat identification, weapons of mass destruction and improvised nuclear device defeat and render safe science and technology activities, and selected post-detonation nuclear forensics supporting attribution.[191]

NNSA has also set up a robust "over-the-horizon" initiative which conducts strategic studies in the fields of non-proliferation and nuclear security in conflict regions such as the Middle East.[192] Furthermore, it makes recommendations to other governments and private operators, for instance on threat assessment. NNSA is also the one of the few organisations to have made forays in nuclear forensic analysis.[193]

Forms of Threat

i. Ground attack

Threat

In recent years, the probability of a commando-style ground attack has become greater with major terrorist groups showing capabilities for executing well-planned attacks which suggest threat to nuclear facilities. The Department of Homeland Security has stepped in and taken up the responsibility of addressing security against such an attack outside the reactor complex whereas the licensee is responsible for the security inside. Even though active nuclear plants are under considerable protection, recently decommissioned plants have minimal levels of protection and do hold radioactive material that can be used to make a Radiological Dispersion Device (RDD).

Furthermore, the incident of 2012 when a nun and two others broke into one of the most "secured" nuclear sites in the US – the Y-12, where highly enriched uranium is stored, exposed the vulnerabilities that remain in place.[194] Assessment of the incident revealed that it was a lapse in security culture that allowed the three peace activists to reach the main complex of the facility, despite being captured in all detection systems deployed at the periphery.[195] This clearly brings into focus the issue of complacency despite the best measures in place.

Regulation

The NRC has issued specific regulations for physical protection of facilities against the threat of theft and sabotage, under the Code of Federal Regulations (CFR).[196] As per the defence-in-depth principle, protection from a ground attack is to be done by establishing four areas with varying levels of security, both in terms of physical barriers and human patrolling.[197] The CFR also provide for mechanisms to protect against coordinated attacks by multiple teams using different entry points, attack by suicide bombers either entering by foot or through a vehicle which may be designed to explode, attackers coming via sea route as well as rocket propelled explosives. According to the guidelines, protection mechanisms should be designed with the objective of delaying entry of attacking forces into the reactor complex so that government forces have additional time to intervene. Guidelines also mandate periodic Force-On-Force exercises to test the effectiveness of the protection systems.[198]

The NNSA has aided the NRC in this endeavour, by tailoring table-top exercises in both threat prevention and consequence management for various nuclear facilities, both government and private.[199]

Implementation

In order to address the threat from a ground attack, the US has employed an integrated approach for physical protection and nuclear material accounting and control, which is based on a strong security culture with trustworthy employees.[200] The physical protection systems have three key functions – Detection, Delay and Response.[201] The first key function is Detection – discovering an adversarial action being undertaken at the nuclear power plant. For this function, various technologies are employed such as an intrusion detection sensor. The second key function is Delay – slowing down adversary's progress. This includes a mixture of human and technological measures, such as active and passive barriers, locks and protective forces. Third and the final key function of the physical protection system is Response – actions undertaken by protective forces once they are alerted that an attack is underway.

For the function of Response, the NRC gives the broad guidelines but the industries take on the task of implementing them on the ground by conducting mock drills. These drills involve scenarios where an adversary makes an attempt at penetrating the outer periphery to enter the core area of the facility and effect damage to critical target areas. The adversary force in Force-On-Force exercises is developed by the industry itself. These exercises are conducted at least once every three years. Notably, express notification of the exercise being conducted is given to the operator in advance, which raises some questions on the effectiveness of these exercises. The NRC conducted 23 Force-On-Force exercises in 2012 and 11 of the plants were found to be deficient in their levels of security.[202]

There are also other questions relating to implementation and effectiveness. For instance, the Government Accountability Office (GAO) raised questions on the force being used. The GAO in its September 14, 2004 report noted that the "NRC is considering the use of a force provided by a company that the nuclear power industry selected; this company provides security guards for about half the facilities to be tested. This relationship with the industry raises questions about the force's independence."[203] Responding to these concerns, the NRC now claims that US Special Forces personnel are also part of these exercises to provide an independent evaluation of the quality of protection at nuclear plants.[204]

The NNSA hires its own team of armed security personnel to protect its own facilities and provides recommendations for private operators as well.[205] It has endeavoured to transform its force into a Tactical Response Force (TRF) with increased survival capabilities and the ability to engage threats at longer distances.[206] The NNSA also provides teams of first responders to various nuclear plants in case of an incident and has a Nuclear Incident Team (NIT) to aid missions for nuclear security.[207] The NIT is to coordinate NNSA assets for deployment as well as keep NNSA abreast of an evolving situation where there has been a deployment of NIT.

ii. Air-Based attack

Threat

In the aftermath of 9/11, questions were raised regarding the vulnerability of nuclear plants to attacks by hijacked commercial jetliners as what had just then happened. A jetliner, for instance, can be crashed directly into a reactor, into the surrounding cooling and control mechanism and also into the spent fuel pools in the reactor complex. However, former NRC Director Nils Diaz has reportedly claimed that "the likelihood of both damaging the reactor core and releasing radioactivity that could affect public health and safety is low."[208] Nevertheless, even as the threat of an airplane piercing through the container of a reactor core is questionable, the explosion caused by the same in surrounding areas could cause cooling mechanisms to fail in reactors that are not built according to new guidelines.[209] This could very well result in a Fukushima-style nuclear disaster.

Regulation

Post-9/11, the NRC released new requirements for the construction of reactors to protect them against a potential jetliner crash. As has been noted earlier, the NRC in 2009 made it mandatory for the new reactors to incorporate designs which could withstand large aircraft crashes under the Design Basis Threat requirements for construction. The NRC now requires license applicants to "perform a design-specific assessment of the effects on the facility of the impact of a large, commercial aircraft" and "identify and incorporate into the design those design features and functional capabilities."[210] NRC has also made it necessary for reactors operational before 2009 to implement measures that would counter the otherwise detrimental effects of a large aircraft crash.[211]

The NRC has coordinated with federal agencies such as the Federal Aviation Administration and the North American Aerospace Defense Command (NORAD) to minimise and eliminate threats from commercial jetliners.

Implementation

Based on recommendations given by the NRC, operators submitted design changes for approval. For instance, it is reported that "Westinghouse submitted changes in the certified design of its AP1000 reactor to NRC on May 29, 2007, proposing to line the inside and outside of the reactor's concrete shield building with steel plates to increase resistance to aircraft penetration."[212] To the relief of private operators, the NRC had announced in January 2007 that the protection of nuclear power plants from large aircraft crash was primarily the responsibility of the US military.[213] Operators were instead asked to focus "on preventing radiation from escaping in case of such an attack and to improve evacuation plans to protect public health and safety."[214]

iii. Insider Threat

Threat Assessment

The intelligence community has been particularly wary of vulnerabilities from insider threat for nuclear security. The argument is that it is difficult for any organised ground attack to take place on a facility without insider help. This threat does hold credence as most plants have elaborate defence-in-depth systems in place, which might cause delay to any ground force trying to penetrate it; however, with an accomplice on the inside who has knowledge of these procedures, it may be possible to defeat the security measures that are in place.

A threat that most security agencies have not considered though, is one of an insider operating alone, or a lone wolf. A report by the Division of Safeguards in the NRC suggests "the combined motivations of psychological problems, disgruntlement and revenge accounted for 54% of the identified motivations" for insiders to commit sabotage.[215] This led on to the assertion that "A clearance cannot be expected to provide full assurance of future trustworthiness because any number of factors can impair employee stability and reliability after hire."[216]

Thus even though conventional background and security clearance checks conducted by organisations might ensure that criminals, terrorists and mentally unstable persons are not hired, they do not account for behavioural changes that might prompt a lone-wolf sabotage attempt or even possible collusion with an outsider. And as organisations are heavily reliant on these background checks for hiring, they become virtually blind to the possibility mentioned above.

Regulation

The ability to grant access authorisation to employees of a plant lies with the licensee operating the plant. The NRC has requirements which the licensee must comply with when enabling access authorisation for employees, including background checks through the prospective employee's Social Security Number, credit history, personal history, employment history and criminal record. A psychological assessment which includes clinical interviews is also mandatory before hiring an employee.[217] It is to be noted that in the regulations enlisted by the NRC, access to nuclear power plants may be granted to foreign nationals. US citizens with a criminal history too may get access authorisation if they are assessed as suitable by the plant operator.[218] Along with other details of criminal investigations, criminal record is considered by the operator in deciding whether or not to give unescorted access to a nuclear power plant.

Implementation

A nuclear power plant operator is required to develop, implement, and maintain an Access Authorization (AA) programme to protect against an insider threat at the plant. Rules from the NRC security plan, 10 CFR Part 73 (Physical Protection Requirements), NRC Security Order EA-02-261 (Compensatory Measures for Access Authorization), and 10 CFR Part 26 (Fitness for Duty) govern the establishment and implementation of the AA programme.[219] Accordingly, the licensee is required to perform thorough reviews and screenings of each person granted unescorted access to an NRC-licensed facility, including "employment history review (including all periods of unemployment), military history review, criminal history review, credit history review, education history review, interviews with provided references, initial drug and alcohol screening, and initial psychological screening."[220]

To further mitigate insider threat post AA, the US conducts a trustworthiness programme. As has been noted earlier, the physical protection system employed by the US at nuclear power plants has a heavy emphasis on the role of trustworthy employees. For the same, the US has established and implemented a "standardised personnel screening process" that includes "periodic background checks and investigations; periodic psychological and medical evaluations; regular file review and re-investigation; and adjudication mechanisms for handling disputes."[221]

Furthermore, the US has employed preventive and protective measures against insider threat. Preventive measures include identity verification, document verification, trustworthiness assessment, limited authorised access, compartmentalising access to physical areas, roles and duties, periodic reassessment of trustworthiness, cyber security, security awareness and training, employee satisfaction programs, and sanctions and prosecution.[222] Protective measures, meanwhile, include physical protection system with key functions of detect, delay and response. Significant importance is also given to a robust nuclear security culture which is key to an effective physical protection system.[223]

Introduction of biometric security systems at facilities is another important feature. Similarly, introduction of accounting and audit mechanisms for materials to prevent their theft is noteworthy. Tamper protection systems and alarms are also being used to ensure the physical integrity of containers that hold nuclear material.

iv. Cyber-attacks

Threat

As reactors switch from analogue controls to digital controls, they open themselves up to the threat of a variety of cyber-attacks including worms, hacks and phishing. In the modern day, even reactors that are analogues, now have digital support systems which leave them vulnerable as well. In the US, "critical digital assets" that perform a variety of functions integral to the operation, safety and security of the plant are thoroughly isolated from the internet to protect them. However, recent reports suggest that perpetrators of the attack on Korea Hydro and Nuclear Power Co Ltd, a South Korean nuclear power generator, managed to gather vital information that was then released on various internet platforms. This shows that cyber-attacks may not just occur on the digital systems of the plant, but may occur on the systems of the licensee as well, giving non-state actors access to vital, confidential information about a plant.[224] It is yet to be seen whether digital attacks have the ability to directly sabotage a reactor. The current threat evaluation is that the attack can disable various defence-in-depth mechanisms and can pose a grave security threat.

Regulation

The NRC, in January 2010, published a Regulatory Guide on cyber security and design which lay down measures that licensees need to be undertaken in order to enhance cyber security at nuclear power plants. This guide incorporates best practices from various international bodies such as the International Society of Automation and the Institute for Electrical and Electronics Engineers (IEEE).[225]

Regulatory requirements for cyber security are listed under the Code of Federal Regulations (CFR) which enlist three major objectives for licensees: safeguarding of confidential data, denying access to systems, and adversely impact the operation of plants and all of these have also been listed under the Design Basis Threat model.[226]

The "balance of plant" systems at plant, which do not directly participate in plant operation, do not come under the NRC regulations but are regulated by Federal Energy Regulatory Commission (FERC) to comply with standards issued by the North American Electric Reliability Corporation (NERC).[227]

Implementation

The NRC began the Cyber Security Oversight Program from January 2013 and it submits an annual report to Congress every year titled, "Report to Congress on the Security Inspection Program for Commercial Power Reactors and Category I Fuel Cycle Facilities". The report for 2014 states, "Most inspections revealed several very low security significance violations of cyber security plan requirements. Industry is increasing its ability to identify problems and working with the NRC on remediation solutions. No significant violations were identified. Because the cyber security requirements are new, and licensees have demonstrated a good-faith attempt to implement the requirements, the NRC has used enforcement discretion for these violations."[228] The NRC and the NNSA have improved safety and security mechanisms drastically over the past few years and have actively pursued a better security culture. There are, however, minor loopholes as described above, including in the Design Basis Threat mechanism, which need to be addressed.

Nuclear Safety

Nuclear safety has been an important agenda in policymaking since the conception of the civil nuclear program. The Fukushima disaster has made US policymakers rethink their nuclear safety policy. Existing standards have been put under scrutiny both by regulatory bodies as well as the media and public.

The IAEA defined one of the most fundamental principles of safety in 1988 thus: "The ultimate responsibility for the safety of a nuclear power plant rests with the operating organization. This is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors and regulators."[229] The NRC also follows this principle and safety of plants is primarily the responsibility of the plant licensee, while NRC publishes regulatory requirements and has oversight functions.

The US civil nuclear programme also follows the defence-in-depth principle for nuclear safety and has a Design Basis Threat mechanism for protection against nuclear accidents. The CFR has established comprehensive mechanisms for Nuclear Safety with regulations such as "Standards for Protection against Radiation"[230] and "Design objectives for equipment to control releases of radioactive material in effluents - nuclear power reactors".[231] The CFR also outlines regulations for the level of radioactivity in effluent from nuclear plants as well as solid waste.[232]

Following the Fukushima disaster, the NRC established a task force to understand and apply lessons from the disaster to the US civil nuclear program. The NRC then came out with a new set of guidelines to create mechanisms in order to maintain cooling and containment structure integrity during events such as floods and earthquakes that were more severe than anticipated by the plants' designs.[233] The NRC also came out with new safety regulations specifically aimed at plants that had similar designs to those at Fukushima.[234]

Transportation

Transportation of radioactive material as well as spent nuclear fuel is a potential vulnerability for any nation. The NRC and the Department of Transportation (DOT) regulate the transport of these materials in the US. The DOT lays out specific regulations on route selection, vehicle placarding and driver training that are applicable to transport of radioactive material.[235]

The licensees have to obtain a shipping license from the NRC called the Certificate of Compliance. The security of the nuclear material is the responsibility of the licensee. The licensee is required to use an armed guard in heavily populated areas and also needs to coordinate with local and state law enforcement agencies which help protect the material during transportation.[236] Aside from regulatory aspects, the Federal Government has very little involvement in the transportation of these materials.

The US complies with most international texts giving advisory regulations for transportation security of radioactive material and has implemented the IAEA guidelines on the subject.[237] The CPPNM is also implemented in the form of domestic policies in ensuring the security of radioactive material in transit.

Disaster Preparedness

Emergency Preparedness is the responsibility of two bodies in the US. The NRC is responsible for emergency preparedness mechanisms on site whereas the Federal Emergency Management Agency (FEMA) is responsible for emergency preparedness in the surroundings.

The NRC has established extensive guidelines outlining emergency protocols in eventualities caused both by natural as well as man-made disasters. NRC's emergency protocols follow the principle of establishing an Emergency Planning Zone (EPZ) which is scientifically calculated by estimating the spread of radioactive material in a disaster. The NRC conducts mock drills once every two years at all plants across the country, to test the preparedness in dealing with emergencies. These drills are also supervised by FEMA.[238]

In the event of a disaster, the licensee first informs the relevant state agencies for an immediate response and then alerts the NRC. The NRC coordinates a federal response with the involvement of various agencies such as the Department of Energy, the Environment Protection Agency and the Department of Health and Human Services. Given that the State agencies, as first responders, operate under broad NRC guidelines, their effectiveness as an emergency responder is reasonable.[239]

The NNSA also maintains an Office of Emergency Operations which is the US government's "primary capability for radiological and nuclear emergency response and for providing security to the nation from the threat of nuclear terrorism."[240] The three primary responsibilities of the Office of Emergency Operations are "Radiological search – NNSA deploys teams to look for and identify radiological material; Render safe – this is a specialized activity of making sure a nuclear device is safe if such a device is found; and Consequence management – this is the characterization of the spread of radiological material if some type of terrorist event or natural occurring event or accident."[241]

International Cooperation

The US has played an active role in forming international partnerships for nuclear security. US ideology on this subject is highlighted by the National Strategy to Combat Weapons of Mass Destruction which acknowledges the fact that the US needs to take a proactive step to secure nuclear material all across the globe and prevent proliferation of the same to non-state actors and "hostile states".[242]

The US has signed and ratified ICSANT and the 2005 Amendment to the CPPNM. It was, in fact, integral in pushing the 2005 amendment to the CPPNM which led to the inclusion of nuclear plants in the ambit of the Convention. As part of multilateral initiatives, in 2006, then President George W Bush established the Global Initiative to Combat Nuclear Terrorism (GICNT) with Russia. This initiative set up information sharing on nuclear terrorism threats and also helped nations cooperate in the area of capacity building.[243] The US leadership in the area of nuclear security resulted in the Nuclear Security Summit process, which has come to an end after the 4th Summit held in Washington DC. The summit process was a useful exercise in bringing together a large number of countries to think about and make commitments in the area of nuclear security. It is not clear whether the next US president after Barack Obama will be inclined to take these initiatives forward.

There are also other multilateral initiatives which the US has been involved in. One of the most integral multilateral coalitions set up on the subject is the G-7 Global Partnership through which nations allocate funds for nuclear security projects all across the globe. This was started as the G-8 Global Partnership to focus on the security of nuclear weapons in former Soviet countries and transport them to Russia, however, this relationship with Russia broke down after Russia's annexation of Crimea.[244]

The US also maintains an important bilateral partnership with China in order to secure civilian nuclear power plants through technology sharing. They have together committed to further efforts in the field in Ghana and Nigeria through the IAEA.[245]

Even as the US has pursued a few bilateral initiatives such as the one with Russia and China, nuclear security is too critical an area to be left to bilateral or regional engagements. Nuclear security has to be dealt with at the global level and the US leadership is a key for success.

Nuclear Security in the UK

Like India, the UK has also been the subject of homegrown terrorism, mostly from the IRA, but the nature and face of terrorism has undergone a major change since 9/11. A 2004 report from the UK Parliamentary Office of Science and Technology noted that "the events of September 11th 2001 heightened concerns over the potential for terrorist attacks on nuclear facilities."[246] Even though the 7/7 terrorist attacks in London were not directed against nuclear or other WMD sites, it has been considered as the worst attack in the UK since the 1988 bombing in Lockerbie in Scotland.

Given these threat perceptions, particularly of WMD terrorism, the UK has signed and ratified the UN Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT). In a statement at the UN High Level Meeting on Countering Nuclear Terrorism in September 2012, Baroness Warsi said the UK's signing of the Convention is a demonstration of its "commitment to maintaining the highest possible international standards in countering the threat from nuclear terrorism."[247] In March 2010, the UK, in its updated

National Security Strategy, said that "the UK does face nuclear threats now" and that there was "the possibility that nuclear weapons or nuclear material [could] fall into the hands of rogue states or terrorist groups."[248] The concern was that the terrorist groups in Afghanistan may have already developed the knowledge base to build a dirty bomb and that now they may try to get one into the UK. Security agencies believe London, Bristol, Liverpool, Newcastle, Glasgow, and Belfast remain vulnerable to such a terror attack. In yet another report, outlining its strategy against chemical, biological, radiological and nuclear terrorism, the UK government categorised the al-Qaeda as the "first trans-national organisation to support the use of CBRN weapons against civilian targets and to try to acquire them."[249] The report also highlighted the shortfall in the security around the storage sites of decommissioned material, citing that as a major vulnerability.

One of the major distinctions between the UK and India (as well as other nuclear powers) is that the UK has set up a special branch of the police, the Civil Nuclear Constabulary (CNC), to guard nuclear materials and facilities other than those with the armed forces. In fact the UK has had such a special force since 1955, originally called the UK Atomic Energy Authority Constabulary, which became the CNC in 2004.The following sections detail how the UK has developed its legal and institutional framework in order to strengthen nuclear security.

Legislative Mechanism

Following the Fukushima crisis, the UK has adopted an integrated approach combining both safety and security aspects in the nuclear arena. The Office for Nuclear Regulation, an agency of the UK's Health and Safety Executive aims "To regulate security in the UK's civil nuclear industry in order to prevent theft or sabotage of nuclear material and/or the sabotage of nuclear facilities, including in transit and sensitive nuclear information."[250] Some of the recent key legislations that drive the UK's legislative framework include: The Energy Act 2004, The Nuclear Industry Security Regulations (NISR), the Anti

Terrorism Crime and Security Act 2003 and Nuclear Industries (Security) Fees Regulations 2005.

The Health and Safety at Work Act 1974 (HSWA) and the Nuclear Installations Act 1965 provide the legislative framework for the safety of the nuclear industry in the UK. The HSWA puts the onus on "all employers, including those in the nuclear industry, to look after the health and safety of both their employees and the public."[251] Additionally, the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) is responsible for establishing emergency preparedness framework which ensures that the public is well informed of and prepared for what must be done in case of a radiation emergency. The REPPIR places responsibilities on operators in whose premises there is radiation involved including in hospitals, factories, ports, nuclear installations, as well as on those responsible for transporting radioactive materials "through a public place" thus excluding those that are considered standard modes of transport such as road, rail, inland waterway, sea, air, or through a pipeline. The REPPIR also requires all local authorities and those employers who have a direct role in a radiation emergency, such as the emergency services, to have an off-site emergency plan.[252] While the REPPIR does not alter the existing nuclear license conditions as noted in the 1965 Nuclear Installations Act, all operators are required to put in place arrangements that reflect their compliance with the REPPIR to the HSE (as the regulator).[253]

Similarly, there are specific laws that deal with security of the civilian nuclear industry in the UK. The Nuclear Industries Security Regulations 2003 (NISR) puts the legal obligation on operators of civil nuclear facilities to establish physical security of facilities, materials and information. The legislation also covers aspects related to security during national and international transportation of materials and vetting of staff including contractors, apart from mandating the operators to have a Nuclear Site Security Plan (NSSP).

Regulatory Mechanism

The Office for Nuclear Regulation (ONR), an agency of the HSE, is responsible for regulating safety and security of nuclear industries in the UK. Nuclear security regulation is approached on an integrated basis with 3S's – security, safety and safeguards – and 3 Ps – purpose (protection of people and society from hazards of nuclear industry), principles and processes (for effective regulation).[254]

While the ONR was formed as an agency of the HSE, it is likely to become an independent statutory corporation. The ONR is responsible for regulation of nuclear sites though the legal responsibility rests with the operator. Even as nuclear security policy is established through legislation, the standards and regulatory decisions are made by the ONR. The ONR's regulations require operators of civil nuclear facilities to have a site security plan (SSP) and these plans need to be approved by the ONR. The SSP must also detail "the standards, procedures and arrangements that enable duty holders to maintain acceptable security arrangements at civil licensed nuclear sites and other nuclear premises."[255] These SSPs are constantly reviewed by the operators and a formal review is undertaken by the operators annually, which again needs to be approved by the ONR. The ONR also undertakes site inspections in order to ensure compliance with the prescribed measures.[256] The ONR is also responsible for regulating transportation of nuclear and radioactive materials, decommissioning of nuclear sites and cooperation with international regulators on safety and security related matters.[256]

The defence nuclear sector in the UK is divided into licensed and non-licensed sites. While the licensed sites fall under the domain of civilian regulations, the non-licensed sites operate under the regulatory framework laid down by the Ministry of Defence (MoD). However, certain safety-related aspects are regulated by the ONR even at these sites.

Safety

The safety of nuclear installations in the UK is ensured by combining the following factors: Design of the plant; an operating regime with peer checking, self-assessment, training accreditation and internal oversight; a regulatory group within the licensee's organisation; external peer review of licensee by organisations such as the World Association of Nuclear Operators (WANO) and the Institute of Nuclear Power Operations; and lastly, oversight by an independent external regulator – ONR (the ONR's performance is monitored through international peer review by institutions such as the IAEA).

The ONR's role is primarily one of goal-setting with regard to safety and security, without prescribing how these goals are to be reached. Therefore, the ONR charts out the regulatory expectations, leaving the licensees to determine and justify the ways and means to achieve them. The ONR's approach gives certain amount of autonomy to the operators "to be innovative and to achieve the required high levels of nuclear safety by adopting practices that meet its particular circumstances."[258] To achieve this goal, the ONR has set 36 conditions for each nuclear site licence within which the operators have to operate. The ONR combines its assessment and inspection functions to ensure that operators function with risks as low as reasonably practicable.

A number of variables enable the ONR to assess whether the practices in place are satisfactory. These include an assessment of safety cases, periodic reviews of safety, on-site compliance inspections, inspections by plant insurers, and incidents and events investigation reports. Intelligence gathered from the operators including members of senior management and internal regulators and emergency drill demonstrations also enable the ONR to make a judgement about the safety standards that are being followed.[259] Monitoring the performance of the licensee's internal regulator is also an important aspect of the ONR's safety assessment. In case it is assessed that the operators' standards are not up to the mark, then the ONR initiates a response based on the "degree of shortfall." In extreme cases, the ONR is also mandated to undertake criminal prosecutions against the operator.

Security

For nuclear security, the UK follows the principle of defence-in-depth, putting in place multiple layers of barriers. As noted earlier, the duty to ensure physical security of sites, material (even while transportation) and information lies with the operator. However, the ONR, being the regulatory agency for safety and security of the civil nuclear sector, has the power to compel improvements in the security arrangements of operators if necessary. The operator has to meet the requirements set out by the ONR in its National Objectives, Requirements and Model Standards (NORMS) which follows a goal-setting and outcome-based approach.[260] In order to ensure compliance, the ONR conducts planned as well as surprise inspections at sites.

The Department of Climate Change and Energy (DECC) is responsible for the effective functioning of the nuclear security system. The DECC checks for assurance on safety and security from the regulator – ONR. It also commands the Civil Nuclear Constabulary (CNC) which is responsible for "protection for civil nuclear licensed sites and safe-guarding nuclear materials, nuclear site operators, policing and nuclear regulators as well interlinking with home office forces."[261] The CNC also provides the security cover during transportation of nuclear materials.[262] Security of smaller institutions is handled by private security agencies that are approved by the ONR.[263] Moreover, the UK Cabinet Office is also involved in the process through its Nuclear Security Team.[264]

The radioactive sources that are not licensed under the nuclear category are managed and regulated by environment agencies with support from police counter-terrorism security advisers. The role of the police is also extended to conducting visits and reviewing the security mechanisms in such places.

During the interviews conducted by this study's authors in the UK, it was noted that while the UK maintains a good security culture with regard to information security, cyber security was pointed out as an area where improvements are required, and immediately.

Transportation

Similar to India's AERB, the ONR is responsible for the transportation of all radioactive material in the UK. These include "flasks carrying spent nuclear fuel from operating and decommissioning nuclear reactors, radiopharmaceuticals needed for hospitals, sealed radioactive sources needed in the construction industry and, for instance, the non-destructive testing of North Sea oil rigs."[265] Quality controls for vehicles for the safe transport as well as storage of highly hazardous materials are ensured by the ONR.[266] Materials used in hospitals and industry also fall under ONR's ambit. While incidents and accidents are to be reported to the ONR, it also conducts inspections to gauge compliance.[267] The transport prescriptions are also in line with international requirements set forth by international organisations such as the IAEA.

Disaster Preparedness

The ONR enforces emergency planning and preparedness related regulations in the UK. The DECC through its Nuclear Emergency Planning Delivery Committee (NEPDC) is tasked with coordinating the response at the time of a crisis. The NEPDC is constituted with representation from first responders, such as fire service, police, local emergency planning officers, the ONR and other relevant agencies.[268] The emergency Guidance of the DECC looks at preparedness under different heads including off-site emergencies, during the first phase of an emergency when urgent action needs to be initiated and post-incident recovery situation. As noted earlier, emergency response measures of nuclear sites are formulated through the REPPIR 2001. Most recently, the Civil Contingencies Act (CCA) 2004 was enacted, replacing the earlier legislations such as the Civil Defence Act 1948 and the Civil Defence Act (Northern Ireland) 1950. The CCA establishes a comprehensive emergency planning and response framework, from the local to the national level. The REPPIR Regulations have precedence over CCA in nuclear emergency preparedness and response though CCA measures will apply in areas that are not covered by the REPPIR Regulations or in cases where they complement the REPPIR Regulations.[269]

According to a recent ONR report, the emergency plans prepared by the operator in consultation with all the relevant stakeholders are tested by holding exercises under three different levels:

- **Level 1 exercises** are held at each nuclear site once a year and concentrate primarily on the operator's actions on and off the site.
- **Level 2 exercises** are aimed primarily at demonstrating the adequacy of the arrangements made by the local authority to deal with the off-site aspects of the emergency.
- **Level 3 exercises** rehearse the wider involvement of central government.[270]

While designing countermeasures, the ONR works closely with the Centre for Radiation, Chemical and Environmental Hazards (CRCEH), which falls under Public Health England (PHE).The CRCEH is responsible for providing guidance on response plans for public protection. Depending on the nature of operations, the radiation most likely to be released due to an accident, the ONR determines the area which is to be covered by a site's Detailed Emergency Planning Zone (DEPZ). Also, the UK National Health Service (NHS) has stationed emergency coordinators across the country. These coordinators maintain regular contact and exercises with other stakeholders such as the police and fire services, among others, who will be handling the response at the time of an emergency.[271]

International Cooperation

The UK participates in a wide range of international activities to strengthen the international as well as domestic systems in place for nuclear security and safety. The ONR, being the nodal agency for nuclear security and safety in the civilian sector, provides "technical expertise to support the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management."[272] Apart from its engagement with the IAEA on nuclear safety and security, the ONR also engages with a variety of forums such as the European Nuclear Safety Regulators group, the International Regulatory Review Service (IRRS), the Organisation for Economic Co-operation and Development/Nuclear Energy Agency, Western European Nuclear Regulators Association (WENRA), and G8 Nuclear Safety and Security Group (NSSG). With regard to nuclear security, the ONR maintains close relations with the IAEA's Office of Nuclear Security, International Physical Protection Advisory Service and the European Civil Nuclear Security Regulators' Forum.[273]

The Foreign and Commonwealth Office's (FCO) CBRN team is responsible for supporting multilateral institutions when required and supports processes like the Nuclear Security Summit. The FCO CBRN team also coordinates training with agencies responsible for nuclear matters as and when requested directly or through the IAEA.[274]

Nuclear Security in Japan

Japan has a well-established nuclear programme, with nuclear energy making up to about 26 percent of its total power generation, prior to the Fukushima crisis of 2011. Following the crisis, the share of nuclear energy dropped to seven percent of the country's total energy consumption.[275] While Japan is faced with nuclear threats from North Korean nuclear weapons, it has also faced similar dangers from natural disasters such as what happened at Fukushima. This has placed huge emphasis on the safety aspects, though a sizeable number of this study's interviewees from Japan underlined the threats that emanate from North Korea as an important consideration.[276]

Legislative Framework

Because of Japan's relatively long history of operating nuclear power plants, it has a well-established legal framework, which has been occasionally reviewed and modified. The most fundamental and overarching legislation pertaining to nuclear activities is the Atomic Energy Basic Law established in 1955. With the basic objective of meeting Japan's energy security requirements and to further the research, development and use of nuclear energy for peaceful purposes, the Basic Law establishes "a framework for the regulation of nuclear activities, specific aspects of which are to be dealt with in subsequent, separate acts."[277] Subsequent sections deal with specific activities, processes and procedures. While these set out the basic underlying elements, they have been followed with further specific legislations including the Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (June 1957, as amended); the Law concerning Prevention from Radiation Hazards due to Radioisotopes etc. (June 1957, as amended); and the Law on Compensation for Nuclear Damage (June 1961, as amended).There is also the Law on Final Disposal of High-Level Radioactive Waste (June 2000), which provides a legal framework regarding the underground disposal of high-level radioactive waste in Japan.[278]

The Nuclear Reactors Regulation Law also has an important role in Japan's nuclear legal sphere.[279] The Regulation Law stipulates, for instance, that State agencies undertaking nuclear activities (refining, manufacture, reactor operation, storage of spent fuel, reprocessing, waste disposal, and use of nuclear fuel material) are mandated to establish rules for the physical protection aspects of nuclear materials in their installations. These rules must in turn be compliant with the specific requirements of other relevant ministries. For instance, MEXT lays down clear directions for a framework for research reactors that are not utilised in power generation. Similarly, METI is responsible for power reactors, refining, manufacture, reprocessing and waste disposal, and the Ministry of Land, Infrastructure and Transport (MILT) is responsible for nuclear shipment.[280] The Regulations Law was amended in 2005 to institute a regular inspection system, in order to comply with the revised IAEA guidelines for physical protection. An operator of nuclear facility establishes the physical protection regime but any modification needs to be approved by the concerned minister. The operator is also mandated to employ a physical protection supervisor who will ensure compliance with the relevant rules.

The Special Law on Emergency Preparedness for Nuclear Disaster (December 1999) is an important one in the nuclear security domain. It mandates the nuclear operator to take appropriate measures to "prevent nuclear emergencies, prepare an Emergency Plan, in consultation with mayors and prefectural governors, and establish a Nuclear Disaster Prevention Organisation. This organisation is responsible for taking necessary measures to prevent or mitigate nuclear emergencies."[281]

Institutional Architecture

The responsibility for the regulation of nuclear activities in Japan falls under the Ministry of Economy, Trade and Industry (METI), the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and MLIT, depending on the type of activities under consideration. The Atomic Energy Commission (AEC), formed within the Cabinet Office (formerly the Prime Minister's Office), was formed under the aegis of the Atomic Energy Basic Law of 1955, tasked with developing national policies on the research, development and use of nuclear energy and technology. The AEC was then divided to create the Nuclear Safety Commission (NSC), also under the Cabinet Office, with the focus of dealing with safety aspects of Japan's nuclear activities. These are detailed in the following paragraphs.

Ministry of Economy, Trade and Industry

The METI has jurisdiction over a broad policy area encompassing Japan's industrial and trade policies, energy security and control of arms exports. Specifically, METI is responsible for safety regulation and licensing of nuclear energy utilisation, namely milling and refining, nuclear fuel fabrication, nuclear power generation, spent fuel reprocessing and storage, and radioactive waste disposal.

In 1973, the Agency for Natural Resources and Energy (ANRE) was established within the METI, assigned to ensure a stable and efficient supply of energy, and to ensure industrial safety. The agency is thereafter sub-divided into several groups, each of which is made responsible for nuclear energy technology development, improvement and co-ordination of nuclear radioactive waste management and nuclear facility identification, among others.

During the reorganisation of the government in January 2001, a Nuclear and Industrial Safety Agency (NISA) was established within the ANRE, which was to be responsible for regulating both nuclear and industrial safety. As the regulatory authority, the NISA was made responsible for supervising nuclear power plants, nuclear fuel processing plants, and spent fuel reprocessing facilities. The drafting of safety regulations and the licensing of milling and refining, nuclear power reactors, nuclear fuel fabrication, spent nuclear fuel reprocessing and storage, and radioactive waste disposal are also undertaken by the NISA.[282] However, questions have been raised about the independence of the NISA as a regulator, also being the promoter of nuclear energy. In fact, a Japanese government report to the IAEA noted that it was the "NISA's lack of independence from the trade ministry, which promotes the use of atomic power," that dampened the response effort after disaster struck at the Dai-ichi plant in Fukushima.[283] The same report, quoting *Asahi* news, said the government was going to merge the NISA with the Nuclear Safety Commission to establish a new nuclear safety agency under the environment agency by April 2012. Thus, the Nuclear Regulation Authority (NRA) came into existence on September 19, 2012 under the Ministry of Environment. The Authority will be responsible for nuclear safety, security, safeguards, radiation monitoring, and radioisotopes regulation.

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

MEXT is responsible for the science and technology aspects of nuclear energy, including policy making, development of nuclear technologies, rules governing research reactors, safeguards against radiation hazards, and the transportation of nuclear materials. The Ministry comprises a Secretariat, seven bureaus, and a Director General for International Affairs. Nuclear regulations are administered by the Science and Technology Policy Bureau. MEXT is also mandated to issue licenses for research reactors, reactors that are not used for electricity generation, including those at the research and development stage, and facilities using nuclear fuel.[284]

Atomic Energy Commission (AEC)

The AEC was established by the Atomic Energy Basic Law with the purpose of developing policies on all matters related to the research, development and utilisation of atomic energy. The AEC operates under the terms of its own legislation, the Law for the Establishment of the Atomic Energy Commission (December 1955).While the AEC is more of an advisory body, it has the power to make recommendations through the Prime Minister or to other ministries and departments that might have a role in the regulation of this sector. Additionally, these ministries and departments are mandated "to consult with the AEC in the course of carrying out their own licensing and regulatory activities."[285]

Nuclear Safety Commission (NSC)

The NSC was established in 1978, which was a fallout of a decision that nuclear safety should no longer be handled by the AEC (which was also responsible for the promotion of nuclear energy), but by an independent agency. That would ensure a clear separation of interests and responsibilities, which would in turn help ensure long-term nuclear security.

Following the Tokai-mura criticality accident in 1999, the Secretariat of the NSC was transferred on 1 April 2000 from the Science and Technology Agency (STA) to the Cabinet Office, principally for instilling greater independence and autonomy. NSA's key mandate include: defining regulatory guidelines for the safe use of nuclear energy, issuance of guidelines for the safety of nuclear reactors, issuance of guidelines for the prevention of radiation hazards.[286] On matters such as their licensing procedures, the licensing authorities are mandated to have prior consultation with the NSC on safety and radiation protection matters.

Japan Atomic Energy Agency (JAEA)

The Japan Atomic Energy Agency, established under the 2004 Japan Atomic Energy Agency Law, came into existence as a result of merging two national nuclear R&D organisations – the Japan Atomic Energy Research Institute (JAERI) and the Japan Nuclear Cycle Development Institute (JNC). The respective roles and responsibilities of both these organisations have been handed over to the JAEA, apart from those that have been taken over by RIKEN (a research institute in the field of science and technology) and also certain other activities that are considered not required for the fulfilment of the JAEA's objectives.

Nuclear Security in France

Like the UK, France too has been battling various forms of violence within the country. Terrorism figured as a major area of concern in the discussions held by this study's authors with security officials and experts in Paris as part of this project. France is also seeing stronger anti-nuclear activism from groups such as Greenpeace. Despite all these internal disturbances, France has managed to avoid any major nuclear security incidents; this is commendable, given that France remains the second largest producer of nuclear power after the US, running 58 nuclear reactors across the country. However, a new bill introduced in the French Parliament in June 2014 proposes to bring the nuclear share from the current 75 percent to 50 percent by 2025 and increase the share of renewables from 15 percent to 40 percent by 2030.[287]

Legislative Mechanism

With three key objectives – promotion of the responsible development of civil nuclear energy, combating of nuclear proliferation, and prevention of nuclear and radiological terrorism – France has instituted a well-established legislative framework, with its first law on the protection and control of nuclear materials enacted in 1980, well before these issues assumed global importance. The 1980 legislation delves into details of the protection of vital installations, including nuclear ones. The legislation also seeks to define a clear security plan, detailed protection measures and a government-established external protection plan. The specific legislations around safeguarding of nuclear material and activities have key principles such as "governmental approval to import, export, develop, hold, transfer, use and transport nuclear material; controlling authorized activities and measures taken to combat the theft, diversion or misuse of nuclear material." The law states that if these regulations are breached, a prison sentence of up to ten years can be imposed.[288]

The Public Health Code (PHC) is the broad legislative and regulatory framework that governs the French use of radioactive materials, both natural and artificial. The Public Health Code issues:

> general rules for licensing or notification for all nuclear activities, defined as activities involving a risk of exposure to people to ionising radiation emanating either from an artificial source, whether substances or devices, or from a natural source

> in cases where natural radionuclides are processed in view of their radioactive, fissile or fertile properties, and for interventions to prevent or reduce a radiological risk following an accident or contamination of the environment; specific provisions regulating exposure to ionising radiation from natural sources; the conditions governing the acquisition, distribution, import, export, transfer, taking back and disposal of radioactive sources; and the procedures for the protection of persons exposed to ionising radiation for medical or medico-legal purposes.[289]

The PHC also lays down specific rules governing radioactive sources. In addition, specific legal regulations have been put in place with provisions to deal with certain substances, activities and institutions.[290] The French rules also mandate operators to follow rules regarding physical protection, safe disposal and monitoring of nuclear material and accounting of the material as per existing international instruments such as the EURATOM Treaty and IAEA recommendations. In addition, there are specific measures supplemented through antiterrorism laws and a proven prevention policy.[291]

More recently, in June 2006, France enacted the Nuclear Safety and Transparency (TSN) Act which is considered one of its most comprehensive legislations yet, providing for the Nuclear Safety Authority (ASN) to become an independent authority as also detailing the legal provisions for basic nuclear installations (INB) (for instance, regulating each life cycle phase, monitoring, sanctions).[292] Prior to this, the French nuclear legislation was largely uncoordinated. The TSN Act is thus seen as a landmark legislation, attending to the issues of nuclear transparency in a holistic manner as defined in section 1 (1) thus: "nuclear safety, radiation protection, the prevention of malicious acts and measures to combat them, and measures to protect the public in the event of an accident."[293]

Regulatory Institutions

A number of institutions deal with various aspects of nuclear security and safety in France. These include: Ministry of Ecology, Sustainable Development and Energy (MEDDE), Alternative Energies and Atomic Energy Commission (CEA), Nuclear Safety Authority (ASN), Institut de radioprotection et de sûreté nucléaire (IRSN), General Secretariat for Defence and National Security (SGDSN), and the French military.

Ministry of Ecology, Sustainable Development and Energy (MEDDE)

The MEDDE is the nodal agency for issuing licenses and control of nuclear materials. It is also responsible for conducting inspections of sites under its purview and is mandated to apply sanctions in case standards are not met. It operates through its Department of Nuclear Security (DSN) and the French Institute for Radiological Protection and Nuclear Safety (IRSN). The IRSN, which is under the DSN, is responsible for authorisation of national level transportation of materials.[294]

High level of attention is paid to the decisionmaking process. Trends in the field of nuclear security are periodically identified and are then followed up at various levels. In case certain action is recommended, the DSN has the authority to take punitive actions such as de-authorisation of licenses if certain standards are violated or if recommended actions are not complied with.

DSN also inspects smaller installations periodically. These institutions have to demonstrate to the DSN that their security standards and practices are uptodate and effective. In case the standards are found to be weak, the DSN prescribes modifications.

With regard to tracking of material, category 1, 2 and 3 materials[295] are monitored round the clock but other nuclear materials are identified but not tracked. For materials falling under Category 1 and 2, the threat assessments are conducted by the DSN with assistance from the intelligence agencies.

Alternative Energies and Atomic Energy Commission (CEA)

Established in October 1945, the CEA is an extensive research organisation, with two key objectives: to become the leading technological research organization in Europe and to ensure that its nuclear deterrent remains effective in the future. The Commission focuses on four areas: low-carbon energies, defence and security, information technologies and health technologies. In each of these fields, the CEA maintains a cross-disciplinary culture with engineers and researchers from different fields, building on the synergies between fundamental and technological research. Within the CEA, the Directorate of Nuclear Energy (DEN) maintains expertise and innovation in nuclear energy production systems, which is passed onto public authorities and industries so as to develop sustainable, safe, and economically competitive nuclear energy technology.

Nuclear Safety Authority (ASN)

Established through the June 13, 2006 Nuclear Security and Transparency Act, ASN is an independent authority with the mandate to regulate civil nuclear activities in France. It has responsibility towards informing the public and the stakeholders (Local Information Committees, environment protection commissions among others) of its activities and the state of nuclear safety and radiation protection. During emergencies, the ASN "monitors the steps taken by the licensee to make the facility safe." It also assists the government by sending to the competent authorities its recommendations about civil nuclear security measures to be taken.[296] The ASN fulfils its functions by monitoring and regulating nuclear power plants, radioactive waste management, nuclear fuel shipments, packages of radioactive substances, medical facilities, research laboratories, and industrial activities. On behalf of the government, the ASN undertakes regulation of nuclear safety and radiation protection that keep the workers safe and prevent the environment from being affected by hazardous effects from nuclear activities.[297] In addition, the ASN is mandated to validate safety equipment including the containers that are used for transporting sensitive material.[298] The ASN is also responsible for managing radiological emergencies.

The Operator

Under the French model, a bulk of the responsibility relating to the security of civil nuclear facilities and materials rests with the operator. The operator, by law, has to maintain a nuclear security plan in order to ensure that materials or facilities remain out of reach from terrorists. It is the duty of the operator to assess, design and implement measures for nuclear security including physical protection measures.[299] Accounting of material, training of staff and maintaining a security culture is also part of the operator's responsibility. However, there are minimum standards that are to be followed by the operator while putting these measures in place.

Institut de radioprotection et de sûreté nucléaire (IRSN)

The Institute for Radiological Protection and Nuclear Safety (IRSN) is the French national public agency that provides the expertise in assessing nuclear and radiological risks. As a research and expert appraisal organization, IRSN contributes to the implementation of public policies concerning nuclear safety and security, health and environmental protection against ionizing radiation. The Institute is under the joint authority of the Ministries of Defence, the Environment, Industry, Research, and Health. Its areas of specialisation include the environment and radiological emergency response, human radiation protection in medical and professional capacity, and in both normal and post-accident situations. Its responsibilities include nuclear reactor safety as well as safety in plants and laboratories, transport and waste treatment and the prevention of major accidents. The IRSN interacts with all parties concerned by these risks including nuclear safety and security authorities, local authorities, companies, research organisations, and stakeholders' associations.

General Secretariat for Defence and National Security (SGDSN)

The SGDSN, functioning under the Prime Minister's Office is the key agency responsible for handling national level emergencies including those falling within the nuclear domain. It is positioned in a way to provide direct inputs to the Prime Minister, who maintains direct communication with the President in case of national level crisis. The General Secretariat for Defence and National Security (SGDSN) is responsible for:

- secretarial support for high-level inter-ministerial meetings chaired by the Head of State, the Prime Minister or their chief collaborators;
- undertaking certain more central tasks entrusted to departments of the Prime Minister because of their inter-ministerial nature or because of institutional changes.

The SGDSN is akin to the National Security Council in other countries such as the US, in-charge of coordinating between different ministries and departments.

Security Forces

Although the operator provides for the security of facilities and materials, this is done through the utilisation of state forces such as the Specialized Platoons Protection Police (PSPG) and Gendarmerie Nationale. The PSPG is trained by the Gendarmerie Nationale which also trains its special operation forces – GIGN. This unified command and training structure ensures high levels of interoperability between these forces in the time of a crisis.

At the site level, the PSPG, which is under the command of the Gendarmerie National Police, is responsible for providing security. As the operator pays for the deployment of the PSPG, it becomes the first response force of the operator in case the site faces an attack or security-related incident. The PSPG, since it is under the national Gendarmerie, also becomes the first responder of the state in case of a crisis. The Gendarmerie also has special intervention forces called the GIGN under its command who receive similar training as given to the PSPG. Different types of exercises are held with a focus on developing organisational interface and a shared culture. Exercises among these agencies are held every four months. Following the IPPAS mission held towards the end of 2011, the members noted "The advantage and the suitability of this model," as it allows for "flexible coordination between the operator's resources and those of the state."[300]

GIGN, the intervention group of the National Police, is a special unit of the police for management of emergency situations requiring the commitment of specially trained and equipped personnel and/or implementation of technical or special measures. The GIGN acts primarily under the following scenarios: flight-hijack (PIRATAIR); ship-hijack/attack (Piratmer); nuclear attack (Piratome); chemical or biological attack (Piratox); hostage situation of French nationals abroad (Piratext).

The GIGN also prepares its response to scenarios based on some key parameters: Anticipation; Prevention; Detection; Intervention; and Protection. These forces, at the operational level, also have access to air support. Given that these nuclear security threats from non-state actors and terrorists do not have a precedent, the research and development in this regard is given due importance. For instance, the GIGN conducts R&D in collaboration with the IRSN and industry representatives from the EDF and AREVA.

While the French military has no direct stakes in the civilian nuclear sector, its services are utilised when needed. For instance, international transfers of nuclear materials are done under the security provided by the French military forces.

Nuclear Security Culture in France[301]

Security is a shared responsibility between the State and the Operator. There are both prescriptive as well as performance-based measures in France. While the operator is encouraged to come up with their own standards for security of materials which is assessed by the regulator, minimum protection standards are prescribed, which have to be adhered to.[302] The operator is also responsible for sending out alerts to the relevant agencies when an incident or attack takes place.

France appears to have a strong security culture and follows the concept of defence-in-depth, which aims at preventing an intruder from accessing key facilities by putting in layered restrictive measures. The CEA is responsible for putting physical barriers and other access control mechanisms in place. Additionally, the CEA has developed a software known as Eva, which is capable of collating access and other security-related data and thereby noting trends in the security arena. This facilitates framing of preventive responses when needed. This software has also been shared with the IAEA and other major nuclear powers such as the US. The CEA has a physical protection laboratory which is used to test security devices, exchange best practices, thus enhancing knowledge of performance as well as vulnerabilities of security equipment.[303] The testing is also done in collaboration with other agencies.

As a general principle, the desk officers handling various components of nuclear security are encouraged to work in an interactive environment with their counterparts in other divisions so as to avoid working in silos. This helps in getting acquainted with the multiple and overlapping areas in nuclear security.

With regard to cyber security, the CEA has put a policy in place. There is also a charter prescribing cyber-related rules to be followed. Punitive actions are taken when matters of non-compliance are noted. However, the role of the individual and awareness of the potential threats at the individual level were highlighted as one of the most important aspects during the interviews conducted for the study.

Transportation

There are separate laws that deal with the transportation of nuclear material. The Ministry of Foreign Affairs, Ministry of Ecology, Sustainable Development and Energy (MEDDE) is responsible for different kinds of transportation, in compliance with international agreements signed by France. The IRSN is responsible for authorisation of national level transportation of materials. The DSN is also responsible for providing authorisation when international transfers are made.

Detailed regulations are made available to the transporter. Each transporter is checked and inspected before the clearance for transportation is provided. The transporter has to assure the agencies that their security is tight. Periodic exercises are also conducted to keep response mechanisms efficient. From the safety point of view, the Nuclear Safety Authority (ASN) is responsible for validating safety equipment such as containers that are used in transportation. From a security point of view, it is the transporters' responsibility to adhere to all the security and safety regulations. The transporter must also respect the regulations laid down for the transportation of dangerous materials. Moreover, the French National Police and the Gendarmerie Nationale are utilised to secure the materials and provide armed escort when necessary. The French military is also used to provide security cover when materials are transported outside France.

Crisis Management

Crisis management in France is a shared responsibility of all the different stakeholders. The plans are implemented at two levels – national (through the SGDSN) and the district level through the Ministry of Interior. The PM is in charge of crisis management of major crises; the PM keeps the President informed about the developments. Other ministries are also involved depending on the scale of the crisis and its impact at the national level.[304] There is also the Inter-ministerial Crisis Cell (CIC), which is headed by the minister in charge of the particular ministry that is affected by the crisis. The CIC is responsible for preparing details for the Prime Minister. The CIC remains in touch with the crisis management cells of other ministries and operators. The decision is taken collectively by the all the stakeholders such as the SGDSN, the MEDDE, the Ministry of Foreign Affairs and the Ministry of Interior, among others.

Broadly speaking, the response mechanism put into place for emergencies including natural disasters is also oriented to tackle nuclear emergencies. Risk analysis is done on a broad spectrum and involves all stakeholder ministries. Risk in the nuclear domain is categorised as accidents or threats, depending on the level of the crisis. The analysis is done in a European context so that other EU members can also benefit from the assessment.

With regard to CBRN terrorism, the French government has put in place a specific intervention plan, which is strengthened by holding regular exercises to test the effectiveness of these plans. The exercises relating to nuclear and radiological terrorism are held every two years. These include scenarios such as use of Improvised Radiological Devices (IRD) as well as physical attacks on a nuclear facility by terrorists.

Conclusion

The four case studies present interesting similarities and contrasts to India's nuclear security practices. While some of the institutional and legal frameworks are quite similar to that of the UK, key principles such as the Personnel Reliability Programme adopted by India and France are noteworthy. However, policies and programmes will depend on the socio-cultural milieu of each country or region. For instance, Japan has not adopted this programme as it is seen as potentially violating privacy, which the Japanese regard highly.

However, there are some practices that these countries have adopted that might be usefully considered in India. For example, India could consider developing a separate force for the protection of its nuclear establishment. It could also mull the creation of a more independent regulatory mechanism and more thorough multi-agency exercises to deal with nuclear safety and security contingencies.

Chapter – V

Conclusions

India puts a strong emphasis on nuclear safety and security measures not least because of its troubled relationship with Pakistan, which supports terrorism against India as a strategic policy. More than two decades of terrorist violence against political leaders, population centres and symbols of state power have made internal security a prominent feature of India's national security concern. This has extended to nuclear security – India has utilised policy, governance, and technology to counter terrorist threat in the nuclear realm. A nuclear attack might be a remote possibility but it is a high-impact one and cannot be taken lightly. It is this concern that has motivated this study, which looked at both safety and security issues, in India as well as in four major nuclear powers – the US, the UK, France and Japan. The study examined the nuclear safety and security practices of these countries in order to understand which of them might usefully be adopted by India.

Several conclusions can be drawn from this study, the first of which is that India's nuclear security measures are fairly robust. Thus, this study's authors disagree with previous studies – in particular, the NTI Nuclear Security Index – which have ranked India fairly low in global comparisons. There may be a couple of reasons for that. One is that these earlier studies have taken a quantitative approach that did not examine in-depth Indian nuclear security practices. This present study, on the other hand, is almost entirely on the Indian case (save one chapter that probed the best practices of the US, UK, France and Japan) and the authors were able to examine Indian practices in-depth and speak to senior officials from both the Indian atomic energy establishment and security services. Second, the NTI study, as a comparative one, used quantitative markers to rank several dozen countries on their nuclear security practices. While such studies have their value, they cannot be expected to be accurate about individual cases.

A second major conclusion is that India needs to be more proactive in publicising its achievements. The Indian reticence in this regard is particularly surprising, considering that it has a strong case to make. For a variety of historical and institutional reasons, the Indian nuclear establishment has developed highly robust safety and security norms, much before these issues became an international concern in the post-9/11 era. Sadly, India's reluctance to highlight these aspects has resulted in international concerns, which equated this lack of transparency with poor procedures and weak standards. The assumption appears to have been that India was not transparent because its nuclear safety and security measures were below par; this is far from the case.

The third conclusion that can be drawn, especially on the basis of cross-country comparisons, is the influence of cultural factors on nuclear safety and security. Even well-known international procedures such as the Personnel Reliability Programme (PRP) appear problematic in certain cultural contexts. Though this study was not intended to critically examine the nuclear safety and security in other countries, it does appear that on some measures such as in PRP, India does a lot better than countries such as Japan.

The fourth conclusion is that though Indian nuclear safety and security practices are vigorous, India can also learn from best practices elsewhere. A list of 24 recommendations is outlined here. For example, India could attempt to create a separate police force.While the CISF, which currently handles the task of securing nuclear facilities, has done a good job so far, its mandate is vast.With the Indian nuclear establishment set to expand, it might be preferable to have a separate force dedicated to the security of nuclear facilities.

Similarly, another recommendation would be to increase the autonomy of the nuclear regulators. Finally, it is also recommended that regular exercises be conducted at all levels. While the Indian nuclear establishment and security services do conduct some security exercises, it is not clear that they are frequent enough, or are multi-agency. Because coordination between different agencies is a particularly difficult problem, India needs to stress multi-agency exercises much more than it does so currently.

Chapter – VI

Enhancing Nuclear Security in India: Recommendations

India's nuclear establishment is constantly reviewing and updating its security policies and practices. As it does so, India can benefit from the best practices that have been adopted by other nuclear powers.

While there has been considerable transparency and openness around nuclear *safety* issues, India has not done the same on those dealing with nuclear *security*. This might be understandable as a way of ensuring that undesirable elements and terrorists do not get information that they can then use to defeat security measures, but it also harms nuclear security by preventing legitimate assessments and criticisms that can facilitate improvements. This different response between safety and security might be because Indian atomic energy personnel are generally proud of their technological developments on the safety front but tend to be cautious or unwilling to respond when it comes to security issues. India has to be able to appreciate the advantages of being open in the security domain as much as they are on issues of safety. No one is arguing for total transparency, but there is merit in spelling out its nuclear security policy in broad terms and the measures taken to address some of the vulnerabilities. The excellence of some mechanisms such as Personnel Reliability Programme (PRP) that India practices is not well known in the global nuclear community. For instance, France, which has a close partnership with India on nuclear safety issues, was unaware that India followed a PRP as part of its nuclear security regime.

While appreciating the strengths of India's nuclear security policy and practice, it is equally important that the deficiencies are highlighted in order to remove any vulnerability that may exist on this score. Thus, this report makes several recommendations for further strengthening nuclear security in India.

Recommendations

1. Ensuring personnel reliability at all levels: It has been seen that extensive background verification measures are put in place for all the employees including the contractors in nuclear power plants and other nuclear installations. But there have been drawbacks in India's PRP as it does not extend to temporary labourers who may be attached to an installation on short-term basis. These labourers undergo normal police verification and they do not have access to the core of a facility, which does mean that the risk is low. Nevertheless, India should mandate stringent background verification even for these short-term labourers, thus avoiding even these minimal risks.

2. Maintaining proper documentation of old and new contractors: Keeping a database of all the previous contractors is an important tool in tracking the movement of people who have access to sensitive information or detailed knowledge about a nuclear installation. There have been cases where disgruntled former employees and contractors have caused security incidents.

3. Accounting of nuclear materials: Despite the fact that the AERB maintains an inventory of all nuclear and radiological materials, there have been lapses as seen in the Mayapuri incident in 2010. According to AERB officials, the incident occurred probably because of the fact

that this material originated from a foreign source before the AERB was even established. Moreover, it was also the responsibility of the Delhi University (DU) to report the possession of radioactive material to the AERB.That failure was not the only one on the part of DU: DU also did not follow the procedures for the disposal of the material at the end of its life cycle. Therefore, accounting of materials should be made more stringent by ensuring better compliance from educational institutions and hospitals that handle these materials.

4. Tightening of the licensing process: Following the Mayapuri incident in 2010, intense discussions between the AERB and the UGC led to the UGC issuing comprehensive regulations on usage of radioactive material by universities and colleges. Also a new directive for security of radioactive sources was issued by the AERB, according to which details including location and inventory of radioactive materials were sought. The licensing process, determining who can handle such materials, has been tightened after this new directive, but review of such licensing procedure needs to be undertaken periodically.

5. Force-on-force exercises and inspections must be implemented: Periodic force-on-force exercises and inspections are useful in the assessment of vulnerability in the security of a nuclear power plant. These drills can be designed for every nuclear plant in the DBT itself, which should be reviewed on a periodic basis. A periodic review of DBTs can bring on certain rigour and clarity on the threat perceptions and vulnerabilities, and accordingly, appropriate response mechanisms can be developed. Here, it is critical that the force-on-force involves all the different agencies including the CISF, state police and NDRF.

6. Security culture must be ingrained: Security culture is a key factor to any efficient physical protection system. Be it addressing cyber threats or insider threats, trustworthiness of employees play a crucial role in ensuring nuclear security. Imparting security culture is a slow and

gradual process that requires concerted efforts at every level – be it a facility janitor, a lab researcher, a technician, control room operators or security guards, the idea of security culture needs to permeate. This needs to be reinforced at nuclear power plants on a regular basis through training programmes and modules. These trustworthiness programmes must be reviewed periodically in order to understand their effectiveness. Efforts to study failures must be undertaken and come up with rectifying measures. India could also explore options for collaboration with its international partners in developing such security culture modules.

7. Graded access should be instituted: Access within a particular facility needs to be done on a calibrated basis. There has to be clear requirements and eligibility criteria established to determine who should be given access at what level. These could be codified through key regulatory and legal mechanisms in order to institutionalise the processes. Introduction of "need to know" basis is significant in order to limit the vulnerabilities.

8. Radiation detection systems must be beefed up: In order to detect illegal movement of nuclear or radioactive material across the country, the government should increase the number of Mobile Detection System (MDS). These systems complement the existing hand-held detection systems that are already operational at major borders and sites across the country. But MDSs are much more significant as they appear as regular vehicles and can thus deceive smugglers or terrorists carrying nuclear or radiological, which fixed and hand-held detection systems cannot.

9. Technological advances are creating new risks. Today's smartphones can do as much as a computer could do a few years back and thus have the potential to compromise nuclear security. Therefore, use of smartphones in nuclear establishments should be strictly prohibited,

which currently is not.

10. Cyber security measures need to be strengthened: Efforts should be made to develop software for the specific purpose of nuclear installations and establishments. Exclusivity in this field will ensure protection and a lower probability of breach. Using common software should be discouraged.

11. Establish a separate nuclear constabulary for securing India's nuclear facilities: Instead of the CISF that currently safeguards India's nuclear installations as one of its many responsibilities India should establish a separate police force, similar to that of the UK Civil Nuclear Constabulary, whose sole responsibility is to protect nuclear materials and facilities. This is particularly important in the context of India's plans to expand its nuclear power sector significantly.

12. All transportation vehicles, even those used for supplying lower half-life radiological and nuclear materials should be equipped with GPS and real-time tracking facility, in order to have real-time knowledge on the material being transported, should there be an incident en route.

13. NDMA guidelines for radiological and nuclear emergencies should be mandatory: While the issuance of the nuclear-specific guidelines has been a positive step, these become more meaningful with full adherence. Adherence will be reached in full measure only if these are mandatory through administrative and legal means.

14. An independent regulatory board should be set up. There has to be clear separation of roles and functions between the nuclear establishment and its regulator to avoid even the slightest appearance of a conflict of interest. This is important for independent and autonomous functioning as an independent regulator, but particularly because of widespread opinion that India's regulatory functions as subjugated to other agencies within the nuclear establishment.

15. Security should be a shared responsibility between the State and the Operator. The operator could suggest its own standards for security of materials but the State should ensure that a minimum protection standard is met. This practice will enable the important stakeholders to have a say in devising their own security mechanisms and ensure that the security is double checked.

16. Interaction between nuclear site operators and state disaster management authorities should be increased. Currently, these take place as part of the inter-agency coordination meetings but the interactions between the two are important in reviewing the security, given that these are both local bodies.

17. Strengthen the capacities at the local level: Local police units, fire services and hospitals in the vicinity of a nuclear installation should be equipped with radiation detection and protective equipment and gear. The capacity to deter, respond and recover must be enhanced because local agencies are the first line of response in any emergency situation.

18. Undertake risk analysis on a more regular basis: An efficient response system will depend on having a sound understanding and appreciation of the challenges and risks on a regular basis.

19. While intra-agency exercises and mock drills are done fairly frequently, there are less large-scale exercises involving all the different security agencies. Table-top exercises involving all the security agencies must be undertaken. Even countries that do these large-scale exercises on a regular basis will find it a challenge in the event of an incident. Also, uniform guidelines and manuals could be prepared precisely on how these drills must be executed so that all the agencies are on the same page.

20. Exercises involving the NDMA and NDRF battalions should be conducted periodically to ensure efficiency during actual contingency situations. Local community agencies must be formed and given basic training to deal with contingency scenarios.

21. All units of nuclear installations including the accommodation of staff working at nuclear installations such as a power plant should fall under the same district jurisdiction. In the case of Kakrapar Atomic Power Station, the plant and the residential units fall under two different district jurisdictions. This will hamper the response efforts in the event of an incident.

22. Robust attempts should be made to promote awareness about nuclear safety and security especially among the public living around civil nuclear plants. Dispelling myths and addressing doubts about nuclear energy should be given priority and should form an important component of the development and outreach efforts of the nuclear establishment.

23. International cooperation in sharing nuclear security best practices could be considered. This could potentially be undertaken under the aegis of the GCNEP, which has a School on Nuclear Security Studies.

24. Make nuclear security an integral part of the annual report and regular feature in other prominent GOI publications (of the Department of Atomic Energy and the Ministry of External Affairs).

Annexures

1. Public Sector and Industrial Units under DAE
2. Regulatory Inspections in the Nuclear Security Realm in India
3. Sample Questionnaire
4. Interviewees for the Study

Annexure – 1

Public Sector and Industrial Units under DAE

Nuclear Power Corporation India Limited

In Operation

Plant	Type	Capacity (MWe)
Tarapur Atomic Power Station (TAPS), Maharashtra	BWR	160
Tarapur Atomic Power Station (TAPS), Maharashtra	BWR	160
Tarapur Atomic Power Station (TAPS), Maharashtra	PHWR	540
Tarapur Atomic Power Station (TAPS), Maharashtra	PHWR	540
Rajasthan Atomic Power Station (RAPS), Rajasthan	PHWR	100
Rajasthan Atomic Power Station (RAPS), Rajasthan	PHWR	200
Rajasthan Atomic Power Station (RAPS), Rajasthan	PHWR	220
Rajasthan Atomic Power Station (RAPS), Rajasthan	PHWR	220
Rajasthan Atomic Power Station (RAPS), Rajasthan	PHWR	220
Rajasthan Atomic Power Station (RAPS), Rajasthan	PHWR	220
Madras Atomic Power Station (MAPS), Tamil Nadu	PHWR	220
Madras Atomic Power Station (MAPS), Tamil Nadu	PHWR	220
Kaiga Generating Station (KGS), Karnataka	PHWR	220
Kaiga Generating Station (KGS), Karnataka	PHWR	220
Kaiga Generating Station (KGS), Karnataka	PHWR	220
Kaiga Generating Station (KGS), Karnataka	PHWR	220
Narora Atomic Power Station (NAPS), Uttar Pradesh	PHWR	220
Narora Atomic Power Station (NAPS), Uttar Pradesh	PHWR	220
Kakrapar Atomic Power Station (KAPS), Gujarat	PHWR	220
Kakrapar Atomic Power Station (KAPS), Gujarat	PHWR	220

Under Construction

Project	Capacity (MWe)	Expected Commercial Operation
Kudankulam Atomic Power Project	2x1000	Unit 1– August 2014 Unit 2 – Mar-2015 (Date is Under Review)
Rajasthan Atomic Power Project	2 x 700	Unit 7 – Jun-2016 Unit 8 – Dec-2016
Kakrapar Atomic Power Project	2 x 700	Unit 3 – Jun-2015 Unit 4 – Dec-2015

Indian Rare Earths Limited

- IREL produces/sells six heavy minerals, namely ilmenite, rutile, zircon, monazite, sillimanite and garnet, as well as various value-added products.
- IREL has five units, namely:
  - Chavara Mineral Division
  - Manavalakurichi (mk) Mineral Division
  - Orissa Sands Complex (oscom)
  - Rare Earths Division (red) Aluva
  - Indian Rare Earth Research Centre (IRERC)
- Strategic Value Addition of IREL:
  - Recovery from thorium value Chemical processing of monazite to separate the contained thorium value (~8% ThO_2) in the form of thorium hydroxide concentrate happens to be the most fundamental value addition activity of the company carried out for the last 50 years or so.
  - A small part of the purified thorium nitrate is converted to nuclear grade thorium oxide powder to meet the requirement of Bhabha Atomic Research Centre (BARC) and Nuclear Fuel Complex (NFC) for developing thorium based fuel for nuclear reactors.
- Recovery of Uranium value:
  - In recent time IREL has got engaged through its Rare Earths Division, in activity involving recovery of uranium value present in Indian monazite in the form of Nuclear grade ammonium diuranate (ADU) to supplement the indigenous supply scenario for uranium as required in the Indian Nuclear Power programme.
  - In addition to monazite, RED has developed facilities for recovering uranium value from other secondary resource as well.

Uranium Corporation of India Limited

- The UCIL is at the forefront of the Nuclear Power cycle. Fulfilling the requirement of uranium for the Pressurised Heavy Water Reactors, UCIL plays a very significant role in India's nuclear power generation programme.
- The UCIL operation sites:
  - Jharkhand:
    - Jaduguda Mine
    - Bhatin Mine
    - Turamdih Mine
    - Bagjata Mine
    - Narwapahar Mine
    - Banduhurang Mine
    - Jaduguda Mill
    - Turamdih Mill
    - Mohuldih Mine
  - Other States:
    - KPM Project, Meghalaya
    - Tummallapalle Uranium Project, Andhra Pradesh
    - Lambapur Uranium Project, Andhra Pradesh

Bharatiya Nabhikiya Vidyut Nigam Limited

- Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI) is a Public Limited Company under the companies act, 1956 with the objective of constructing and commissioning the first 500 MWe Fast Breeder Reactor (FBR) at Kalpakkam in Tamil Nadu and to pursue construction, commissioning, operation and maintenance of subsequent Fast Breeder Reactors for generation of electricity in pursuance of the schemes and programmes of Government of India under the provisions of the Atomic Energy Act, 1962.

- BHAVINI is currently constructing a 500MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, 70 Kms away from Chennai. The PFBR is the forerunner of the future Fast Breeder Reactors and is expected to provide energy security to the country. The PFBR is being built with the design and technology developed at the Indira Gandhi Centre for Atomic Research (IGCAR) located at Kalpakkam.

Heavy Water Board

- The board is primarily responsible for production of Heavy Water (Deuterium Oxide-D2O) which is used as a 'moderator' and 'Coolant' in the nuclear power as well as research reactors.
- India is one of the largest manufacturers of heavy water in the world and is meeting the heavy water requirements of the Indian Nuclear Power Programme.

Nuclear Fuel Complex

- Nuclear Fuel Complex, Hyderabad, caters to the fuel and zirconium requirements of the Nuclear Power programme in India.
- Their products include reactor fuel, reactor grade materials and reactor core components and structures.

Annexure – 2

Regulatory Inspections in the Nuclear Security Realm in India

The Atomic Energy Regulatory Board (AERB) of India, which reviews the safety aspects of the civilian nuclear projects, enumerates the following nuclear security requirements for Plants and Projects:

- Main Plant Boundary (MPB)
  - Watchtower
  - Patrollable Road
  - Access control for Personnel, Material & Vehicles
  - Detection
  - Delay elements
  - Radiation monitors

- Operating Island (OI)
  - Isolation Zone with detectors
  - Access control for personnel, Vehicle and Materials
  - No Parking
  - Unloading of consumables from outside
  - Location for storing, handling & disposal of hazardous material
- Distance between MPB & OI
- Central alarm station/Alternate central alarm station
- Vital areas & its requirements

- ❖ New fuel storage areas
- ❖ Communication systems
- ❖ Power supplies
- ❖ Configuration controls
- ❖ Security organisations
- ❖ Maintenance of Physical Protection System (PPS)
- ❖ Modification /upgradation of PPS
- ❖ Safety Security Interface
- ❖ Security Event Reporting
- ❖ Security Requirements for operating plants due to construction of new projects
- ❖ SOPs & Contingency Plans
- ❖ Quality assurance & audits
- ❖ Training, retraining & licensing
- ❖ Regulatory Inspection
- ❖ Documents

The documents prepared by AERB covering nuclear security aspects are: Nuclear security requirements for NPPs; Guidelines for Reporting of Nuclear security events; 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; two documents under preparation are Security requirements for Heavy Water Plants; and Security requirements for Nuclear Fuel Processing Facilities.

The AERB has three tiers of review on nuclear security aspects:

- ❖ First Tier Review:
  - ◆ Committee for Reviewing Security Aspects of Nuclear Facility (CRSANF)
  - ◆ Committee for Review of Nuclear Security aspects of radiation facilities and for transport of Radioactive Materials

- Advisory Committee on Security (ACS)-Advises on all nuclear security aspects

❖ Second Tier Review:
- Safety Security Interface maintained at AERB level by review of reports of first tier by Safety Review Committee for Operating Plants (SARCOP) for Plants
- The respective Advisory Committee for Project Safety Review (ACPSR) for Projects
- Safety Review Committee for Application of Radiation (SARCAR) for Radioactive Material.

❖ Third Tier Review:
- Atomic Energy Regulatory Board

Security regulations and inspections are carried out with the same underlying philosophy as nuclear safety regulations and inspections. The AERB conducts planned, unplanned and surprise inspections for operating plants and during various development stages of ongoing projects. The planned inspection usually happens once a year for the operating plants of which the schedule needs an approval by the AERB. The inspection team (usually 4-membered) comprises the members of the Committee for Reviewing Security aspects of Nuclear Facility (CRSANF) who are trained and experienced in the nuclear security aspects. The inspection team and the team leader (lead inspector) are authorised by the AERB. Inspections usually take around 3-4 days depending upon the number of Operating Islands to be inspected.

The inspections are based on the AERB documents, checklist for Regulatory Inspections, AERB recommendations for modifications/upgradations, follow-up of previous RIs and security events reported earlier.
There are three stages in the inspection:

1. Field checks
2. Document Verification

3. Interviews/competency checks

Field checks:

Checks at different layers: Main Plant Boundary (MPB), Operating Island (OI) and Vital Area (VA) and Inner Area (IA) for the effectiveness of methods followed/technology used for:

- Detection
- Delays
- Assessment
- Access control for personnel, Vehicle and Materials
- Functioning of various Gadgets
- Power supplies
- Communication
- Alarms
- Central Alarm Station/Alternate Alarm Station
- Illumination
- Water body

Evaluation of the impact of new projects under construction near operating plants (by operating plant authorities).

- Segregation between project and operating plant
- Access control for construction personnel, vehicle and materials to project
- Location of construction labour camp
- Location of contractors workshop

Inspecting the fulfilment of nuclear Security requirements for different stages of project (by project authorities):

- Siting
- Excavation
- First pour of concrete
- Erection of major equipment
- Identification of critical area during different stages of the projects and provision for monitoring and control
- Commissioning of PPS for New Fuel storage Building before arrival of fuel
- Commissioning of all PPS before Initial Fuel Loading
- Segregation of first unit for which IFL is to be done from the other units under construction or commissioning
- Requirements for operations

Document Verification:

The documents that are verified by the inspection team include:

- List of Vital Areas/Inner Areas
- Procedures for:
  - Access controls of personnel- Visitors & Contractors
  - Vehicle & Material Movements
- Surveillance & Audit (Internal & external)
- Maintenance of PPS gadgets
- Standard Operating Procedures
- Reporting and Evaluation
- Contingency plans
- Records of Exercise, deficiencies and corrective actions
- Non availability of gadgets and alternate measures
- Modifications & Upgradation of PPS
- Station & Site Security committee constitution orders and their minutes of meeting along with records of follow-up actions
- Interfaces:
  - Safety and Security
  - Plant Management and Security organisation

  - Site security organisation with external agencies
- Training syllabus and its records
- Configuration Control
- Internal Audit Records
- Security Organisation

Interview and Exit Meeting:

Interviews/competency checks are held with:

- Plant Management
- Central Alarm Station (CAS) operators
- Main Guard House (MGH) Security Personnel
- Operational & Maintenance staff

As the last step, an Exit Meeting is held by the inspection team in which a briefing of observations & deficiencies is done and immediate corrective actions are discussed and recommended.

The regulatory inspection report is issued within one week of the inspection and is maintained in strict confidentiality. Important and repeat observations are specially highlighted in the report. Response to RI reports, and follow ups are also mentioned in the RI report.

The reports are then reviewed in security committees. The report along with responses is reviewed in the first tier - CRSANF. The recommendations of the first tier based on their review are reviewed in the second tier - SARCOP, ACPSR, SARCAR.

The reviewed reports are considered while the AERB grants clearances for the various stages. The reports are then maintained in the Database for the follow-up of recommendations.

Annexure – 3

Sample Questionnaire

Safety and Security of Radioactive and Nuclear Materials in the Indian Context

Common Questions

1. How do you assess the danger of radioactive and nuclear materials being used by non-state actors?

2. How likely is the possibility of radioactive and nuclear materials being used in India by non-state actors in the future?

3. What do you have to say about the existing radioactive and nuclear safety and security laws? How sufficient are they to ensure safety and security of radioactive and nuclear materials?

4. What are the onsite and offsite security measures in place to ensure that radioactive and nuclear materials do not fall into hands of terrorist organisations or someone with malicious intent?

5. Have you come across any incident such as theft of radioactive and nuclear materials in the past? What is the reporting pattern followed

during incidents? How likely is it that such incidents could go unreported?

Industry

1. What are the steps that you have taken, either due to the need to comply to certain laws or by your own initiative to ensure safety and security onsite?

2. How safe and secure are these materials offsite–during transport particularly?

3. What kind of training and equipment do you provide to your employees who deal with such radioactive and nuclear materials?

4. How do you ensure that persons employed in your company do not have a criminal history?

5. What is the level of coordination with government agencies? Do the State agencies responsible for disaster management and providing security interact with you frequently?

6. In case of theft of material, do you report it to the police? Have there been any incidents of this sort? If so, how has this been handled?

7. In case of accidents, what is the Standard Operating Procedure?

Preventive Agencies (Police, CISF and Intelligence Agencies)

1. How would you prioritise the threat from radioactive and nuclear materials, even in the larger context of CBRN? What appears to be more likely, today and in the future?

2. Is there a centralised database for incidents – classified or unclassified?

3. What is your level of interaction with other agencies that could be involved in a potential incident relating to radioactive and nuclear materials such as NDMA or NDRF?

4. What kind of specialised manpower and equipment do you possess to detect or respond to radioactive and nuclear threats? Are they adequate?If they are not, what are the weak areas?

5. How much portion of your total funding goes under the radioactive and nuclear/ CBRN head? Do you feel this would increase or decrease in the future?

6. Do you feel the private security agencies working at certain companies are capable enough to deal with radioactive and nuclear issues? If not, what could be done to improve the situation?

7. Have penalty-driven measures worked to bring about greater compliance? If not, have the authorities considered revoking their licenses and such stringent measures?

Incident Responders (NDMA, NDRF, Fire Service, Armed Forces etc.)

1. What sort of training do you undergo to face radioactive and nuclear related situations?

2. Do you impart basic training to community, factory workers and private security guards?

3. Do you feel that you get adequate funding to prepare for radioactive and nuclear related threats?

4. What are the activities you undertake to improve preparedness and awareness?

Regulatory Bodies

1. Do industries follow the existing rules and regulations for handling of radioactive and nuclear materials uniformly? Do you feel that existing checks and balances are sufficient to prevent misuse of or accident involving radioactive and nuclear materials?

2. How do you ensure that rules are being adhered to? Have penalty-driven measures worked to bring about greater compliance?If not, have the authorities considered revoking their licenses and such stringent measures?

3. What do you think could be done to improve the situation of safety and security?

4. Should penalty-driven measures be there in order to ensure compliance?

5. How can large industries play a role in improving the safety and security situation in the small-scale industries?

Diplomats and Arms Control Analysts

1. Are there global export control regime-related regulations that are to be implemented at the national level?

2. Can India's attempt to gain membership in various export control mechanisms bring about more stringent measures in India's nuclear security?

3. Could India's participation by way of cooperation with international agencies and other partners bring about more streamlined institutions and practices in the domestic context?

Annexure – 4

Interviewees for the Study

India

Within India, interviews were conducted in Maharashtra (Mumbai and Pune), Gujarat (Ahmadabad and Surat), Rajasthan (Jaipur and Jodhpur), and Delhi. Details of institutions visited for the purpose are given below.

Delhi

1. DRDO, New Delhi
2. Institute of Nuclear Medicine & Allied Sciences
3. Army Headquarters, New Delhi
4. Regulatory guy in ITO
5. Delhi Fire Service
6. All India Institute of Medical Sciences (AIIMS), Delhi

Gujarat

1. State Police, Ahmadabad
2. State Police, Surat
3. Kakrapar Atomic Power Station, Surat
4. CISF, Kakrapar Atomic Power Station, Surat
5. Institute for Plasma Research (IPR), Gandhinagar

Maharashtra

1. Department of Atomic Energy, Mumbai
2. Atomic Energy Regulatory Board (AERB), Mumbai
3. Mumbai Police, Mumbai
4. Mumbai Fire Service, Mumbai
5. CISF, Mumbai
6. College of Military Engineering (Indian Army), Pune
7. NDRF Headquarters, Pune

Rajasthan

1. State Police, Jaipur
2. State Police, Jodhpur
3. Defence Research and Development Laboratory (DRDL), Jodhpur
4. All India Institute of Medical Sciences (AIIMS), Jodhpur
5. Sardar Patel Police University, Jodhpur

As part of the international field study, interviews were conducted in the US, UK, France and Japan. This list gives the names of officials and experts met during the visits.

The US

1. **Joan Rohlfing**
   President and Chief Operating Officer
   Nuclear Threat Initiative

2. **Page O. Stoutland**
   Vice President, Scientific and Technical Affairs
   Nuclear Threat Initiative

3. **Samantha Pitts-Kiefer**
   Senior Program Officer
   Nuclear Threat Initiative

4. **Leon Ratz**
   Program Officer
   Material Security and Minimization
   Nuclear Threat Initiative

5. **Joseph D. Rivers**
   Senior Level Advisor on Security
   U.S. Nuclear Regulatory Commission

6. **Maia Gemmill**
   Scientific Advisor
   Brookhaven National Laboratory

7. **Amy Whitworth**
   Senior Advisor

Office of Defense Nuclear Security
National Nuclear Security Administration

8. **Rodney K. Wilson**
Director
Center for Global Security and Cooperation
Sandia National Laboratories

9. **Geoffrey E. Forden**
Principal Member of Staff
Cooperative Monitoring Center
Sandia National Laboratories

10. **Mancel Jordan Parks**
Physical Security Analyst
International Nuclear Security Engineering
Sandia National Laboratories

11. **Adriane C. Littlefield**
Regional Security, Multilateral Affairs
Cooperative Monitoring Center
Sandia National Laboratories

12. **Sarah Frazer**
Manager
Policy Engagement and Training Account
Pacific Northwest National Laboratory

13. **Jana Fankhauser**
Technical Group Manager/ Senior Advisor
Global Security Technology and Policy
Pacific Northwest National Laboratory

14. **Randy Hudson**
Project Manager
National Security Directorate
Pacific Northwest National Laboratory

15. **Doug MacDonald**
Senior Security Engineer
National Security Directorate
Pacific Northwest National Laboratory

16. **Brian M. Parker**
Project Manager
Nonproliferation Systems Integration
Pacific Northwest National Laboratory

17. **Eric Hirschi**
MPC&A Program Manager
Nonproliferation Systems Integration
Pacific Northwest National Laboratory

18. **David Donnelly**
Legislative & Regulatory Affairs Specialist
Global Security Technology and Policy
Pacific Northwest National Laboratory

19. **Rachel Weise**
Legislative & Regulatory Affairs Specialist
Global Security and Technology
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20. **Jaime Wise**
Project Coordinator
Office of Radiological Security
Pacific Northwest National Laboratory

21. **Hans M. Kristensen**
Director, Nuclear Information Project
Federation of American Scientists

22. **Jeremy Taylor**
Desk Officer, Asia-Pacific International Operations
Office of Global Strategies
Transportation Security Administration
U.S. Department of Homeland Security

23. **Matthew Bunn**
Professor of the Practice of Public Policy
Belfer Center for Science and International Affairs
Co-Principal Investigator, Project on Managing the Atom
Harvard Kennedy School

24. **Eugene B. Kogan**
Director
American Secretaries of State Project
Belfer Center for Science and International Affairs
Harvard Universityl

25. **Vipin Narang**
Associate Professor of Political Science
Massachusetts Institute of Technology

26. **Nickolas Roth**
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Harvard University

27. **William H. Tobey**
Senior Fellow

Belfer Center for Science and International Affairs
Harvard University

28. **Charles D Ferguson**
President, Federation of American Scientists

29. **Martin Malin**
Executive Director, Project on Managing the Atom
Belfer Center for Science and International Affairs
Harvard University

The UK

1. **Matthew Clarke**
Head of Civil Nuclear Security and Safety Assurance
Department of Energy and Climate Change

2. **Richard Hardiman**
Head of Programme
Global Threat Reduction Programme
Department of Energy and Climate Change

3. **Joanna Dally**
Head, CBRN Security Team
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Directorate for Defence and International Security
Foreign and Commonwealth Office

4. **Matthew Phillips**
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7. **Patricia Lewis**
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6. **Ms. Shoko Iso**
Nuclear Material Control Center
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7. **Mr. Naoki Miyamoto**
Nuclear Material Control Center
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8. **Dr. Ichimasa**
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9. **Dr. Marie Izuyama**
National Institute of Defense Studies (NIDS)
Tokyo

10. **Shunichi TANAKA**
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Nuclear Regulatory Authority
Roppongi, Tokyo

11. **Dr. Syouji TSUMITA,**
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Nuclear Regulatory Authority
Roppongi

12. **Dr. Seiichiro Takagi**
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Tokyo

13. **Dr. Yasuyuki Ishida**
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14. **Dr. Akira Shimotiro**
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15. **Prof. Nobumasa Akiyama**
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16. **Prof. Yusuke Kuno**
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17. **Prof. Horimoto**
Retd. Professor in International Relations

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Kyoto University

18. **Dr. Masaaki Nakatsu**
Japan International Cooperation Agency (JICA)
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France

1. **General (2s) Christian RIAC**
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5. **Edwige Bonnevie**
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25. Based on interviews with senior DAE and AERB officials in Mumbai, February 18 and 19, 2014 respectively.

26. Based on interviews with senior DAE officials in Mumbai, February 18, 2014.

27. Supra note Prime Minister's Office.

28. This section is developed on the basis of interviews with senior intelligence and police officials conducted for this study between September 2013 and July 2014, and earlier interviews conducted for a study on CBR security between September 2011 and June 2012.

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India, like other nuclear powers, faces acute threats in the realm of nuclear security. Even as the country's nuclear security measures may be comparable to best practices globally, they are constantly reviewed and tightened, especially in the aftermath of the 26/11 attacks in Mumbai which raised fears of a commando-style attack or an act of sabotage by Pakistan-based terrorist groups like the Lashkar-e-Taiba (LeT). While India has been battling terrorism of various kinds for close to three decades, these groups have also evolved, gaining more sophistication and becoming more brazen—this must be considered by New Delhi as it develops its battery of response and contingency mechanisms.

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