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NUCLEAR SECURITY IN INDIA

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About the Author

Dr. Rajeswari Pillai Rajagopalan is Senior Fellow at the Observer Research Foundation (ORF), New Delhi. Dr. Rajagopalan joined ORF after an almost five-year stint at the National Security Council Secretariat (NSCS), Government of India (2003-2007), where she was an Assistant Director. Prior to joining the NSCS, she was Research Officer at the Institute for Defence Studies and Analyses, New Delhi. She was also a Visiting Professor at the Graduate Institute of International Politics, National Chung Tsing University, Taichung, Taiwan in early 2012. She is the author of three books: *Clashing Titans: Military Strategy and Insecurity Among Asian Great Powers; The Dragon's Fire: Chinese Military Strategy and Its Implications for Asia*; and *Uncertain Eagle: US Military Strategy in Asia. S*he has also co-authored two books. Her research articles have appeared in edited volumes, and in *India Review, Bulletin of Atomic Scientists, The National Interest, Indian Foreign Affairs Journal, Strategic Studies Quarterly, Strategic Analysis, and CLAWS Journal.* Other writings have appeared in the *Journal of Strategic Studies, Journal of Peace Research* and *Contemporary South Asia* and she has also contributed essays to newspapers such as *The Times of India, The Hindustan Times, The Economic Times* and *The Pioneer*.

Her areas of research interests include Indian and Asian foreign policy and security issues, US foreign policy, space security and other arms control issues. She has her own blog at: http://securitystrategyrajagopalan.blogspot.in/and she can be contacted at rajeswarirajagopalan@gmail.com; rpr@orfonline.org.

Acknowledgement

Completing a study on a subject like nuclear security is not easy and I accumulated many a debt as I trudged along. This study was undertaken in collaboration with the Sardar Patel University of Police, Security & Criminal Justice, Jodhpur and the National Disaster Management Authority (NDMA). A special thanks is owed to Mahendra Kumawat, Vice Chancellor of the Sardar Patel Police University for the effort he put into this project. General (Dr.) J.K. Bansal, VSM at the NDMA, not only helped us understand the intricacies of India's disaster management arrangements but put us together with others involved in this important function. There is little doubt that this project would have been much poorer but for this collaboration.

A number of other institutions and individuals also require special mention. I would like to thank the Ministry of External Affairs (MEA), the Department of Atomic Energy and the Atomic Energy Regulatory Board (AERB) for their openness and candour and for the access provided to the nuclear facilities. In the MEA, I would particularly like to thank Mr. Amandeep Singh Gill. I am also profoundly thankful to the staff of the Kakrapar Atomic Power Station for working out a site visit for the ORF team, which helped immensely in enhancing our understanding of the nuclear security practices. I also want to thank Vinod Mall, IPS, for his generous help during our field visit to Gujarat.

In addition, and in no specific order, I would like to acknowledge the following institutions and individuals whose cooperation was essential to this project. In Delhi, the Institute of Nuclear Medicine and Allied Sciences, the All India Institute of Medical Science, National Accreditation Board for Certification Bodies, Quality Council of India, the Delhi Fire Service, the Indian Army and the Defence Research and Development Organisation. In Gujarat, the Institute of Plasma Research (Gandhinagar), State Police (officials in Ahmedabad and Surat), Kakrapar Atomic Power Station (Surat), and the Central Industrial Security Force at the Kakrapar Atomic Power Station; in Maharashtra, the College of Military Engineering (Pune), the Mumbai Police, the Mumbai Fire Services, and the offices of the CISF in Mumbai, the Department of Atomic Energy in Mumbai, and the AERB in Mumbai; in Rajasthan, Rajasthan Police (officials in Jaipur and Jodhpur), the Defence Research and Development Laboratory (Jodhpur), All India Institute of Medical Sciences (Jodhpur), and the Sardar Patel University of Police, Security & Criminal Justice (Jodhpur).

A key part of the study were the field visits conducted in the UK, France and Japan. In the United Kingdom, I would like to thank the Department of Energy and Climate Change, the Foreign and Commonwealth Office, the Chatham House and the Royal United Services Institute. In France, I convey my thanks to the officials and key persons from the Ministry of Ecology, Sustainable Development and Energy, Ministry of Defense, Ministry of Foreign Affairs, Secretariat-General for National Defence and Security (SGDSN) Prime Minister's Office, CEA, University of Paris, Fondation pour la recherché stratégique(FRS) and CSFRS, another think tank in Paris that does significant amount of work on nuclear security. In Japan, I thank the officials from the Japan Atomic Energy Agency, the Nuclear Material Control Center, National Institute of Defense Studies, Nuclear Regulatory Authority, Japan Institute of International Affairs, University of Tokyo, Hitotsubashi, Kyoto University and Japan International Cooperation Agency.

I have also benefitted immensely from the contributions made by Delhi's strategic community members through this project. I must particularly thank Amb. (Dr.) Sheel Kant Sharma and Prof. R. Rajaraman, whose experiences and expertise guided me in the writing of this report.

At the ORF, I want to specially thank Mr. Sunjoy Joshi for his continued support and encouragement. Dr. Raja Mohan has been a constant source of strength and he offered a patient hearing to all my questions, be it on the subject or the process involved in studying this subject. Samir Saran shouldered many of my problems during the course of this study. I owe Arka Biswas and Kaveri Ashok for their painstaking effort in completing this report. I want to thank Arvind John and Rahul Prakash who wrote the initial versions of some of the chapters. Finally, I would be dishonest if I did not acknowledge Rajesh's help in the editing of this report.

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: Autorité de sûreté nucléaire (Nuclear Safety Authority, France)

BARC: Bhabha Atomic Research Centre

CBRN: Chemical, Biological, Radiological and Nuclear

CCA: Civil Contingencies Act (United Kingdom)

CEA: Commissariat à l´énergie atomigue et aux énergies alternatives (Atomic Energy Commission, France)

CIC: Cellule inter ministérielle de crise (Inter-ministerial Crisis Cell, France)

CISAG: Computer and Information Security Advisory Group

CISF: Central Industrial Security Force

CMG: Crisis Management Group

CNC: Civil Nuclear Constabulary (United Kingdom)

CNS: Council of Nuclear Safety

CPPNM: Convention on Physical Protection of Nuclear Material

CRCEH: Centre for Radiation, Chemical and Environmental Hazards (United Kingdom)

CRSANF: Committee for Reviewing Security Aspects of Nuclear Facility

DBT: Design Basis Threat

DAE: Department of Atomic Energy

DECC: Department of Energy and Climate Change (United Kingdom)

DEN: Direction de l´énergie nucléaire (Directorate of Nuclear Energy, France)

DP&S: Directorate of Purchase and Stores

DRDO: Defence Research and Development Organisation

DSN: Département de sûreté nucléaire (Department of Nuclear Security, France)

EDF: Électricité de France

ESL: Environmental Survey Laboratory

EU: European Union

GCNEP: Global Centre for Nuclear Energy Partnership

GIGN: Groupe d´intervention de la Gendarmerie nationale (National Gendarmerie Intervention Group, France)

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: Installations nucléaires de base (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

KAPS: Kakrapar Atomic Power Station

KNPP: Kudankulam Nuclear Power Plant

MEA: Ministry of External Affairs

MEDDE:	Ministére de l´écologie, du développement durable et de l´énergie (Ministry of Ecology, Sustainable Development and Energy, France)
METI:	Ministry of Economy, Trade and Industry (Japan)
MEXT:	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MHA:	Ministry of Home Affairs
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 (United Kingdom)
NISA:	National Industrial Security Academy (Japan)
NISR:	Nuclear Industry Security Regulation (United Kingdom)
NORMS:	National Objectives, Requirements and Model Standards (United Kingdom)
NPCIL:	Nuclear Power Corporation of India Ltd
NRA:	Nuclear Regulatory Authority (Japan)
NSC:	Nuclear Safety Commission (Japan)
NSG:	Nuclear Suppliers Group
NSRA:	Nuclear Safety Regulatory Authority
NSSG:	Nuclear Safety and Security Group
NSSP:	Nuclear Site Security Plan (United Kingdom)
NTI:	Nuclear Threat Initiative
ONR:	Office of Nuclear Regulation (United Kingdom)
OSART:	Operational Safety Review Team
PHC:	Public Health Code
PRP:	Personnel Reliability Programme
PSPG:	Pelotons spécialisés de protections de la gendarmerie (Specialized Platoons Protection Police, France)
RAPS:	Rajasthan Atomic Power Station
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: Secrétariat général de la défence et de la sécurité nationale (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

TSN: La loi de la Transparence et à la Sécurité en matière nucléaire (Nuclear Transparency and Safety Act, France)

UCIL: Uranium Corporation of India Ltd

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 the 9/11 terror attacks because of fears that terrorists might acquire such material. The International Atomic Energy Agency's Incident and Trafficking Database states that between January 1993 and December 2013, there were a total of 2,477 incidents of theft and other unauthorised activities involving nuclear and radioactive material notified to the Agency. In 2013 alone, there were 146 incidents confirmed in the IAEA database. Thus, there is a renewed effort to strengthen old international rules and regimes as well as to establish new mechanisms. Three nuclear security summits held so far, just on this issue, is recognition of this renewed importance.

India has for long been a victim of terrorism. It has suffered everything from left-wing extremism to separatist insurgency and state-sponsored cross-border terrorism. The Mumbai terror attack offers 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.

Given the context, we present a comprehensive threat analysis of the nuclear security situation in India, the measures adopted by the Indian nuclear and security establishments in response, strengths and weaknesses and an overview of the best practices around the world in order to gauge India's nuclear security efforts. The study focuses on potential incidents involving the detonation of a nuclear explosive or use of weaponised nuclear devices, radiological dispersal devices (dirty bomb), and sabotage as well as insider threats to sensitive facilities. While the study focuses largely on the security aspects, the safety of India's nuclear and radiological materials and institutions is also taken into account, considering the existing synergy between the safety and security practices in the nuclear context.

The key findings of the study are:

- India, like other nuclear powers, faces serious threats in the realm of nuclear security. Terrorist organisations operating out of Pakistan have declared interest in acquiring some kind of nuclear capabilities and 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 various states in India present a mixed picture. Even when some states are aware of threats and vulnerabilities, it 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, to give only one example, appear quite aware of such threats but seem to be overwhelmed by more immediate concerns emanating from Maoist insurgents in the state.

- Cyber attacks may be as important a threat to India's nuclear facilities as a direct physical assault. Use of cyber networks to attack a nuclear facility could render ineffective many current safety and security mechanisms. Indian agencies need to pay greater 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. 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, we assess that India's nuclear security measures are 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 helps delay penetration and complements 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 Department of Atomic Energy is beginning to realise the need for integrated drills involving both security within the perimeter and outside operating in unison. Already the number of such drills has increased and is expected to increase in frequency and number further.

- As India attempts to integrate with the international nuclear community, cooperation, both with individual countries and international organisations, is a key aspect. 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 the fear of not only 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 continue to remain alive and are not taken lightly. The Nuclear Security Summit instituted since 2010 is an indicator of this increasing global attention. It is estimated that there are approximately 2,000 metric tonnes of weapon-usable/ weapons-grade nuclear material available globally, and at least some of these 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 2013, there were a total of 2,477 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]

The threat around nuclear and radiological materials has become acute in the Indian context as well, particularly against the backdrop of the terrorist attacks in Mumbai on 26 November 2008. New Delhi has concerns 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. The fact that the Indian Prime Minister attended the first two Nuclear Security Summits is a testament to this. Accordingly, India is engaged in serious efforts, both at the national and global levels, to bring about 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 is a tendency, both in India and around the world, to see nuclear terrorism as an academic and a futuristic threat. This is still debated in the theoretical realm because of the perceived unlikelihood of terrorist groups acquiring such weapons, notwithstanding the catastrophic consequences of such a likelihood. Even if terrorists were to get hold of nuclear or radioactive material, several steps need to be followed before this can be converted into an actual weapon for use. These steps include acquiring requisite scientific and technical knowledge and skills, appropriate manpower, tools for conversion and vehicles for transportation of such sensitive material.[4] This rationalisation is not, however, unique to India.

The security cover around nuclear establishments is generally tight and acquisition of nuclear materials or capabilities is no easy matter. However, this has not led India into taking these threats lightly. Even while there is skepticism 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 global standards. While many of these 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 against the backdrop of the 26/11 attacks in Mumbai.

Following the Mumbai terrorist attacks, fears of a commando-style attack or sabotage by Pakistan-based terrorist groups, like the Lashkar-e-Toiba (LeT), has increased. Thus, while India has been battling terrorism of various kinds for close to three decades, there have been significant additions to the capabilities of these groups that India needs to factor in as it prepares its response and contingency steps. Another threat that is not debated often is an air assault on a nuclear facility. This is a remote contingency but 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 Terror Attacks and Nuclear Security Threat Perception

The 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 before, the West was initially afraid of a scenario of Soviet weapons falling into 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.[6] 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 which was released in 2007.[7] Scenario building exercises involving everything from the detonation of a nuclear weapon to that of a dirty bomb or a Radiological Dispersal Device (RDD) have been carried out in order to assess the preparedness levels.

At the beginning of the Washington Nuclear Security Summit in 2010, 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 Advisor John Brennan said that "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 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 as the single biggest threat to mankind by various leaders.[10]

Thus, today's 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 at 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, particular emphasis has been given to the security of fissile materials in countries such as Pakistan, which brews the deadly cocktail of nuclear weapons and terrorism. Also Pakistan's notorious history, of part of the security establishment supporting terrorist enterprises does not make for much reassurance. Following terrorist attacks on Pakistan's military bases in the recent years 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 weapons.[13]

Types of Nuclear Terrorism

Broadly put, nuclear terrorism could manifest itself in three distinct ways. One mode is by using a full-scale nuclear weapon, wherein the attack will prove to be catastrophic. However, execution of such an attack requires a very high level of expertise. Buying 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 terrorist groups do not possess such expertise or material. However, lessons from the A.Q. Khan network should suggest that the possibility cannot be ruled out completely.

A second form of nuclear terrorism is through nuclear sabotage. Successful sabotage of a nuclear facility would have catastrophic impact. This, however, is not easy for the terrorist groups to execute and the probability of this type of attack remains low, given the difficulty associated with it. Nevertheless, the possibility of such an attack carried out via air, in a manner similar to the 9/11 incident, is a more likely possibility. Most countries are unprepared for such an event because most agencies continue to prepare mostly against ground-based offensives.

A third approach, and possibly the easiest to accomplish, is the production and detonation of 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 very 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, the credibility of incumbent government in protecting its citizens and increasing regional tensions. Furthermore, such an attack will also have a psychological impact on the public.

The next section surveys the project's scope conditions, research methodology and key definitions.

Scope Conditions

This study has three key purposes. One, it provides a general overview of the current nuclear and radiological security practices followed within India, with focus on key institutions and laws. Two, it compares India's approach with the best practices adopted in a few key states. Three, it highlights the strengths and weaknesses of India's nuclear security policy and practice.

While the study focuses largely on the security aspect, the safety of India's nuclear and radiological materials and facilities is also taken into consideration, as the study found certain 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. Not much focus has been given to a full-fledged nuclear attack involving detonation of a weaponised nuclear device, given improbability.

Research Methodology

The study examines published work, including both primary and secondary sources, and supplements it with fieldwork. The primary source for the study 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 very little data on nuclear and radiological incidents in India, the ORF team has collated the data from 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 as well as the 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 those interviewed.

In India, the team from ORF held interactions with officials from India'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 police. Interviews were conducted in states of Delhi, Maharashtra, Gujarat and Rajasthan. For an international perspective and to understand best practices in nuclear safety and security in other countries, field visits were conducted in the 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 feedback.

For the field research conducted as part of the study, a questionnaire (see Appendix 5) was presented to the experts and stakeholders responsible for security as well as safety of nuclear materials. The questions focused on 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: 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 personnel guarding 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 the various activities in nuclear and radiation facilities.

Defence in Depth: A principle of security that uses multiple layers of measures for ensuring safety of workers, the public and/or 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: Evaluates the potential threat, both an insider threat as well as an external source, and accordingly physical protection systems are created from the stage of design itself.

Emergency Planning Zone: The zone defined around the plant up to 16 km radius provides 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, 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 with authorised access to facilities, materials, activities or sensitive information who could perpetrate a malicious act or who could help an external source in committing such an act.

Nuclear and Radiological Materials: Nuclear material in common parlance 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 cesium. 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 are in a solid state and 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 with 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. This study considers threats such as an insider threat, sabotage and armed attack on sites using nuclear and radiological materials.

Chapter – II

Threat Analysis

Nuclear Security in India – A Background

Given India's geographical proximity to Pakistan, the regional hub of terrorism, there has been significant concern expressed in public by the Indian strategic community about the risk of nuclear terrorism and vulnerabilities that may exist in its nuclear security apparatus. On the other hand, like many other countries, Indian security officials appear to consider nuclear terrorism as a remote possibility. Nevertheless, the 9/11 [and 26/11] terror attacks affected Indian thinking and influenced a review of policy towards nuclear security.[15]

Gaining access to nuclear weapons or nuclear materials is not easy. The very nature of the material (or the weapon) implies that it is very closely guarded by trusted and capable individuals, and concrete mechanisms are put in place to ensure its safety. In the Indian case, for instance, its nuclear warheads are stored in a de-mated and unarmed state. They are further safeguarded with electronic codes which prohibit any unauthorised use or accidental detonation of these weapons. The nuclear cores, other warhead components and delivery vehicles are stored separately, thus ensuring that multiple steps involving multiple agencies are required before these weapons are armed.[16]

Among the types of nuclear terrorism described in the first chapter, India will have to be primarily concerned with the latter two: nuclear sabotage and the use of radiological device. There is no evidence to suggest that home-grown terrorist organisations have the knowledge base or skill to make any functional nuclear explosive device.[17] But India does not enjoy the luxury of discounting the possibility of assistance which these terror groups may receive from across the border.

In fact, the Mumbai terrorist attacks in November 2008 confirm both the desire and capacity of terrorist groups to carry out commando-style attacks on key targets within Indian territory. 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.[18]

India also faces an even more direct threat from the use of dirty bombs. Given the density of population in Indian urban centres, the damage caused by a dirty bomb will be immense. Even if the direct impact of such an explosion is limited, the adverse effect on public morale could be severe, as explained in the previous chapter. Such attacks could derail India's economic growth story, make it a less attractive destination for foreign investments and tourists, increase tension between religious communities and simultaneously diminish 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 this type of threat. Similarly, sabotage by disgruntled employees has also caused anxiety.[19] 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.[20] To counter such threats, extensive background checks are performed. However, these are not foolproof 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 appropriate response measures. The Indian nuclear industry experts and the scientific establishment, however, have assured that there are no such vulnerabilities and that Indian nuclear facilities are designed to withstand terrorist attacks.[21] Newer reactors have also used double containment structures to withstand attacks. India has simultaneously used newer technologies and processes that safeguard the reactors against accidents.[22] 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.[23] 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.[24] 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[25]

Much of the concern expressed in the discourse on nuclear safety and security in India, especially as it relates to the threat of terrorism emanating from Pakistan, comes 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.[26] In addition, extremist groups operating in India have thus far lacked the sophistication to carry out such an attack on a nuclear facility. Further, making nuclear explosives requires greater technical expertise than what indigenous terrorist groups like the Indian Mujahideen (IM) possess, as yet.

This should not suggest that such groups will never be able to obtain the requisite knowledge base or skill. Transnational 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.[27]

Likewise, Indian security establishment needs to be alive to the threat posed by Pakistan-based terrorist groups such as 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.[28]

In recent years, some of these fears have further heightened after the two high-profile attacks by Tehrik-e-Taliban Pakistan (TTP) and Lashkar-e-Jhangvi on highly secure military bases in Pakistan. One attack took place on the General Headquarters of the Pakistan Army in Rawalpindi in October 2009[29] and the other on the naval aviation base at PNS Mehran, near Karachi in May 2011. This brought about renewed international, in particular Indian, concerns about the safety and security of Pakistan's nuclear arsenal.[30] The fact that the terrorists appear to have used classified maps of the premises in the attack on the General Headquarters also highlights the possibility of inside help in carrying out the assault. This is particularly worrying given that there are nearly "70,000 people in Pakistan who have access to, or knowledge of, some element of the Pakistani nuclear weapons production, storage, maintenance, and deployment cycle."[31] This anxiety is exacerbated by the escalation of nuclear weapons production by Pakistan[32] and the rapid expansion of its fissile material production.[33]

These high-profile attacks demonstrate Pakistani terrorist groups' ability to carry out surgical strikes on high-security installations. Threats, specifically against nuclear installations, get further compounded if instances of strikes on Pakistan's nuclear facilities by these terror groups are considered. These include an attack on the nuclear missile storage facility at Sargodha in November 2007, an attack on Pakistan's Kamra nuclear airbase by a suicide bomber in December of the same year, and the August 2008 attack when TTP suicide bombers blew up several entry points to one of the armament complexes at the Wah cantonment, which is considered to be one of the main nuclear weapons assembly sites in Pakistan. But it is also true that these incidents have been unnecessarily hyped. None of these attacks appear to have even penetrated the security perimeter. In Sargodha, for instance, a bus carrying school kids was attacked; and in Wah, the bomb killed employees.[34] Moreover, it is not clear that the attackers targeted these facilities because of their presumed connection to Pakistan's nuclear weapons rather than simply because they were military facilities. Nevertheless, these attacks should not be taken lightly, as they clearly demonstrate the intent of the terrorist groups to attack high-value targets.

It is also important to note that Pakistani terrorist groups may not actually carry out an attack without the blessing of the Pakistani establishment. This, paradoxically, makes it less likely that there would be a terrorist attack on Indian nuclear facilities by Pakistan-supported groups because Pakistani officials would be aware of the consequences of any such complicity. This could be the reason why the 26/11 terrorists chose to attack commercial sites in Mumbai rather than a nuclear installation. Moreover, with global scrutiny pinpointed on groups with an interest in acquiring nuclear weapons/material, and states that can potentially support them, the costs of international response to any such misadventure may dissuade Pakistan from encouraging such attacks.

Another threat is the risk of sabotage by home-grown left-wing extremists, or as they are called in India, Naxals. The general perception is that Naxals fight on the basis of ideology and that they are not interested in acquiring nuclear devices. 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.[35] To reiterate, even though there has not been any perceived interest from the Naxalites to seek or use a nuclear device, an attack by them on India's nuclear facilities cannot be entirely ruled out. Furthermore, there have also been rumours of Naxals and jihadists colluding with one another under the umbrella of an 'anti-India' movement.[36]

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.[37]

Future Threats to India

Currently nuclear power contributes to 3.6 percent of India's total electricity generation.[38] India has a total capacity of 4,780 MW at six sites which operate 20 reactors in total. By 2017, India is likely to increase production to 10,080 MW once the ongoing projects are completed.[39] 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.[40] 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 either the intention or capacity to threaten India with nuclear devices or attack on Indian 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."[41] The nuclear security establishment has to always remain live to such threats because a lapse can result in huge damage.

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 and logistics.[42] 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 as well. 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 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."[43] It is one thing to have guidelines and procedures but if strict adherence to these guidelines cannot be ensured, these remain useless.

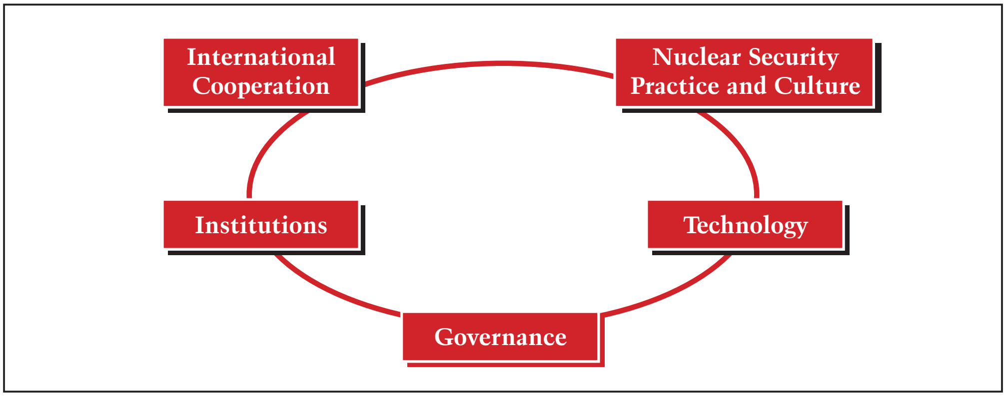
Chapter – III

Strengths and Weaknesses in India's Nuclear Security

As noted previously, the focus of this study is mainly on the security aspects of nuclear and radiological materials and facilities in India. However, some safety-related aspects that overlap with security issues have also been examined. This is the first study to solely focus on these aspects in detail.

A brief brochure released by the Indian Ministry of External Affairs (MEA) is one of the few publicly available documents which provides an insight into India's nuclear security architecture.[44] 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 criterion for judging the state of safety and security of India's nuclear materials, 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.

Indian 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.[45] 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 to release notifications to execute the provisions of this Act. The Act, since its implementation, has undergone amendments to strengthen the legal basis for nuclear security measures. In addition, there have been a number of legislations pertaining to environmental issues–among others–that are critical in determining the location and operation of nuclear power plants. These include 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 (which were 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.[46] The Rules, after revision in 2004, have been made comprehensive in the sense that they clearly set out roles and responsibilities of different parties including 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.[47] The Radiological Safety Division of the AERB is responsible for ensuring compliance with 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.[48] The provisions contained in the 1987 Rules put the onus on the AERB to ensure that the licensees carry out their responsibilities regarding the safe disposal of radioactive wastes. The Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules, 1984, are meant to regulate activities in the area of mining, processing and/or handling of prescribed substances.[49]

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 exercising 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 issue, 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.

Further strengthening 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.[50] India has also continuously updated the control lists and related regulations as part of an ongoing process. India has been an adherent of the guidelines laid down by the Nuclear Supplier's 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.[51]

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 seeks to replace the AERB with the NSRA. The Bill calls for the establishment of a Council of Nuclear Safety (CNS), which will be under the stewardship of the Prime Minister.[52] However, the Bill has come under attack on several grounds. One of the criticisms is that the independence and autonomy of the AERB/NSRA does not come out clearly in the proposed Bill. Questions have also been raised by critics about the appointment of its members.[53] Nevertheless, it must be added that the NSRA is far superior to the existing mechanism.

Still, it might be useful to consider some modifications to these rules for a couple of different reasons. First, modifying some of these rules is not very difficult and might potentially have real benefits in terms of improved safety and security. Second, as India gets more integrated into the global nuclear order, it will be beneficial in strengthening India's reputation in this area. Although India has put in place many of the requisites of an effective nuclear security regime, 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 and projection of 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 by the rules, which requires a culture where rules regarding safety and security are taken seriously. Broadly speaking, 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."[54] However, as the former US Department of Energy security czar Eugene Habiger put it, "good security is 20% equipment and 80% people."[55] The human factor is often overlooked even among the most advanced nuclear powers. Also, by and large, regulatory agencies focus more on instituting rules and monitoring industry compliance rather than on developing such cultures of safety and security. This is largely left to the industry itself.

While India has always had a nuclear security culture, this is slowly being refined in line with international trends, while at the same time remaining culturally sensitive. There is no one rule to fit all and in keeping with that, the security culture is evolving to suit unique Indian sensibilities. In this regard, India has rightly started emphasising appropriate security culture as an important element of its nuclear security. According to a report prepared after a workshop on 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 programme for it to succeed. This is nuclear security culture."[56] This approach encompasses a multitude of measures that are put in place to ensure nuclear safety and security.

Globally speaking, security culture has tended to vary from country to country and region to region. Several local factors condition the 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 in even some of the advanced nuclear states, owing to their respective local cultures. In Japan, a country that holds privacy very dearly, personnel vetting is seen as an intrusion by the security establishment and may cause disgruntlement among employees, which could be counter-productive.[57] 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 forefront. As the Ministry of External Affairs report describes it,"India has a Design Basis Threat (DBT) document and each facility has to devise their own DBT document based on national DBT for designing physical protection system at its facility."[58]

A few basic questions need to be posed in order to arrive at an effective DBT mechanism. These include: "[H]ow many outsiders?, how many insiders?, how many teams?, How well trained?, what kind of vehicles?, what motivation? Willing to die?"[59] These questions are pertinent because there have already been several incidents depicting general security vulnerabilities of state agencies to coordinated attacks by terrorist groups, though these have been non-nuclear incidents. Examples of such coordinated attacks abound but the 2008 Mumbai attack and the attack on a Moscow theatre in October 2002, which involved 40 heavily armed and well-trained terrorists from outside, in particular demonstrated well-coordinated multiple teams working in a coherent manner. Therefore, answering the above questions is necessary for arriving at an ideal design of high-risk facilities.

In India, nuclear facilities have a multi-layered security set-up with the outer periphery being protected by the state police, while the inner layer is covered by the CISF (detailed in subsequent sections).[60] The plant design also incorporates access control mechanisms both physical, such as spike strips and cement/steel barriers, and technology-aided mechanisms, such as biometric systems. These measures, while delaying access to the core of the facility, provide additional time for the security guards to become aware of intrusions and call upon other security agencies for assistance.[61] Additionally, the AERB examines threats and motivations for carrying out malicious activities against a particular site and accordingly 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."[62]

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.[63] Also, numerous measures such as fail-safe shutdown systems, active and passive cooling systems and robust containment features are incorporated while constructing a nuclear power plant. The plants are also designed to withstand earthquakes, floods and tsunamis. These mechanisms are reviewed periodically.[64] All nuclear plants in India are also located in geographically stable regions.[65]

The AERB also conducts audits on all nuclear power plants in India. Safety audits and regulatory inspections (at least two per year) are carried out by the AERB at nuclear power plants to verify compliance.[66] During the renewal of a plant's licence, consolidated safety assessments are also carried out by the AERB. After the Fukushima incident, all nuclear power plants went through comprehensive safety audits which were carried out by the AERB and the Nuclear Power Corporation of India (NPCIL).[67]

Environmental Survey Laboratories (ESLs) are installed at all nuclear power plants before they are commissioned. ESLs are responsible for carrying out pre-operational surveys to detect baseline radioactivity levels of the sites. Periodic analysis of samples from air, water, soil, vegetables, among others, is conducted using instruments and infrastructure available with ESLs to detect any increase in radioactivity.[68]

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.[69] Highlighting this, former Minister of State for Personnel, Public Grievances & Pensions and Prime Minister's Office, Mr. V. Narayanasamy, said in a statement in the Lok Sabha, "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."[70]

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 licence and purpose of the material request.[71] Usually, research and medical institutions use small quantities of radiological and nuclear materials which have a low shelf-life and are generally less potent. Scientifically speaking, these materials, given the quantity and quality, cannot be used to develop even a dirty bomb.[72] Secondly, to address the issue of pilferage of materials, the system of procurement is designed in a manner that 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 availability of materials have been strengthened after the Mayapuri incident in March 2010. In May 2010, an awareness camp was organised for the Mayapuri scrap dealers on the safety aspects, and also on the legal and regulatory aspects to be complied with in the handling and disposal of radioactive materials.[73] The incident involved violation of the regulation 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 seven 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, "[a]ll 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."[74] 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 has a low shelf-life and therefore, the danger of it landing in the hands of hostile elements is 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, 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 the light of the Mayapuri incident.[75] Comprehensive regulations on usage of radioactive material by universities have been notified by the University Grants Commission after discussions with the AERB. The regulations have also tightened the security around

Category II sources according to the AERB categorisation. The AERB's new directive for security of radioactive sources was also 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 equipments, 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 have trained manpower such as RSOs.[76] The licensing process was also tightened after this new directive. Since then, various sensitisation programmes have also been conducted, including radiological sensitisation of the police force, RSOs and also scrap dealers in places like Mayapuri. The Bhabha Atomic Research Centre (BARC) has paid special attention to the health sector and focused on the need to sensitise healthcare 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. 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.

While safety and security of nuclear materials during transportation is given high priority, security standards vary, 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 very small quantities so that it does not pose a serious threat.[77] Therefore, as mentioned earlier, the possibility of these materials being sought by groups or individuals with malicious intent remains highly unlikely. Agencies use other measures also to ensure security. For example, altering routes is an essential part of the guidelines for transportation of nuclear and radiological materials. This is significant, as there will be no set route that is predictable to any terrorist group which may be looking to identify regular routes/timings to plant ambushes along the routes.[78]

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 emergencies such as floods, tsunamis, cyclonic storms, earthquakes and fires.[79] While the broad approach in the nuclear establishment, particularly the disaster management network, is to prepare for a post-disaster scenario, more efforts could be made towards prevention of incidents. Even as there is a direct linkage between safety and security, the approach with safety as the overriding principle needs to change.

List of Training Programmes (on natural calamities) conducted from 2010-2013

Station	2010	2011	2012	2013
TAPS-1&2	5	5	7	11
TAPS-3&4	15	6	12	26
RAPS-1&2	13	41	20	9
RAPS-3&4	21	34	40	6
RAPS-5&6	6	28	20	6
MAPS	12	37	11	32
NAPS	3	11	6	33
KAPS	6	12	8	21
KGS-1to4	4	21	17	50

Source: Government of India, Department of Atomic Energy, "Training of Workers," Lok Sabha, Unstarred Question No. 2113,http://dae.nic.in/writereaddata/parl/winter2013/lsus2113.pdf.

This is not to suggest that security is not an important aspect of the thinking within the nuclear establishment. In fact, the PRPs undertaken by the DAE is a testament to the fact that security is of utmost importance to India.[80] This study found the Indian PRP to be very well done. These programmes are used to mitigate the chances of an insider threat. The PRP is inclusive and extensive in nature. The programme extends 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, there is thorough vetting and verification (including the employee's identity, family and criminal history, general reputation) being undertaken by India's security agencies. They are also screened against serious medical conditions, which could inadvertently lead to dangers. There are also periodical reviews being undertaken in order to study the behavioural pattern of employees (such as their out-of office activities) and interactions (such as meetings with foreigners, among others). The employees thereafter go through more verification measures when they are being shifted to a more sensitive facility.[81] 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 programme in the Indian nuclear establishment has ever been compromised."[82]

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.[83] During the field visit, the ORF team found 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.

Despite the most stringent measures, there have been instances that warrant attention, though this is not unique to India.[84] 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 drinking water supply with heavy water from the plant which led to poisoning of 45 employees.[85] Similarly, there have been unconfirmed media reports that there have been about 25 intrusions at BARC in the last two years, although the intruders reportedly did not access critical infrastructure and materials.[86] 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.[87] 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 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."[88] 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."[89] Access to such locations where disposal takes place "are kept under constant surveillance with the help of bore-wells laid out in a planned manner."[90] Other techniques are used to handle the gaseous and liquid wastes.

High level waste is handled differently. When spent fuel is reprocessed, two to three percent turns into waste and the rest is recycled. The two to 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 after 30-40 years at Geological Disposal Facilities specially designed for this purpose.[91] Vitrification plants are located in Trombay, Tarapur and Kalpakkam.

While AERB has issued guidelines, codes and safety manuals on decommissioning of materials, these are essentially 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 ones. 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 or acts that are criminal in nature are handled primarily by the state police and the CISF stationed at the facilities. For incidents of greater magnitude, NDMA and the National Disaster Response Force (NDRF) are brought into play, with the immediate objective of containing any possible radiation exposure to the larger public. The district administration authorities are also called in at this stage who also maintain disaster management plans, which include evacuation of public from affected areas and provision of food and water supply (since the water supply is likely to be contaminated following a disaster).[92] Prior to an incident, the district authorities have the responsibility of ensuring motorable roads along identified evacuation routes and identifying possible emergency shelter and camping facilities for a large number of people, among others.[93] In case of incidents that may involve a major terrorist attack on a facility, NSG will be called into action. In all of these scenarios, AERB is kept in the loop, which will closely monitor the developments following such incidents.

In addition, to detect radiation, 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

BARC."[94] But the NDMA has not yet been able to identify appropriate vendors who could supply such equipment, though funding has been sanctioned. This is something that must be attended to on a priority basis.[95]

To detect illicit material, India has deployed indigenously developed detectors at airports, seaports and border posts.[96] Currently, there are 300 detectors installed across India.[97]

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), DAE, AERB, Nuclear Controls and Planning Wing (NCPW) and BARC. While AERB is primarily responsible for overseeing the civilian nuclear sector, DAE and BARC contribute on matters related to India's strategic nuclear programmes.

In September 2011, after the Fukushima crisis, India introduced the NSRA Bill (the deficiencies of the proposed bill has been addressed in an earlier section on regulations). The Bill aims at constituting the CNS under the leadership of the Prime Minister. When the Bill is passed, CNS 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.[98]

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 every year based on the recommendations of the Secretary to the Government of India (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.[99]

Department of Atomic Energy

The DAE, set up in 1954, is tasked with the development of nuclear power technology and 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 health care to our people through development and deployment of nuclear and radiation technologies and their applications."[100]

Primarily, the DAE is responsible for the design, construction and operation of nuclear power, 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 also developed with an aim to empower the industry through technology transfer. The DAE also makes a significant contribution to India's national security.[101]

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).[102] The Crisis Management Group within the DAE has as its 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 that gives directions to the Crisis Management Group). 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.[103]

Lastly, in its effort to instil greater confidence in nuclear energy among the public, the DAE also conducts workshops and seminars on nuclear safety.[104] 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 vulnerabilities that may exist in the security domain will 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."[105] The AERB has many committees under its umbrella to discharge its duties. Primarily, 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.

The SARCOP, established in June 1988, makes assessment of and enforces nuclear, radiological and industrial safety in all operating plants under the DAE.[106] 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.[107]

The AERB maintains records and tracks nuclear and radiological material movement and management throughout the country within the civilian nuclear domain.[108] The 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."[109] The AERB licences nuclear power plants for a period of five years, during which regulatory surveillance and monitoring of safety-related performance is carried out.[110]

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 licence 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 follow up, 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.[111]

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 four in number) comprises the members of the Committee for Reviewing Security Aspects of Nuclear Facility (CRSANF) who are trained and experienced in nuclear security aspects. The inspection team and the team leader (lead inspector) are authorised by AERB. Inspections usually take around three to four days depending upon the number of Operating Islands to be inspected.

The inspections are based on 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:**
  - 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 SARCOP for Plants
  - The respective Advisory Committee for Project Safety Review (ACPSR) for Projects
  - 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

The National Progress Report of India presented at the Nuclear Security Summit 2014 highlighted a new institutional initiative known as the 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."[112] For example, the head of the NCPW led the Indian delegation to the Sixth US-India Civil Nuclear Energy Working Group held at Idaho National Laboratory in July 2014.[113]

Global Centre for Nuclear Energy Partnership

India approved the establishment of Global Centre for Nuclear Energy Partnership (GCNEP) 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, 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 of 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

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, 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.[114] 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 RSOs for civilian installations and institutions which use small quantities of nuclear or radiological material.

Nuclear Power Corporation of India Limited

The NPCIL is a public sector undertaking functioning under DAE responsible for operating nuclear power stations in India. The company is managed by a Board of Directors appointed by the President of India. The 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."[115] The NPCIL functions with guidance and supervision from DAE, AERB, BARC and 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 increasing awareness among local communities, NPCIL conducts public awareness programmes near its nuclear power plant sites.[116]

Central Industrial Security Force

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. CISF personnel 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 is focused on chemical, biological, radiological and nuclear (CBRN) security and is considered one of the premier officer training institutions on the subject.

State Police

The state police is responsible for security of 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 mock drills in collaboration with other stakeholders periodically. The state police's intelligence wing keeps vigil around the nuclear facility to detect unusual activities. The state police is also responsible for conducting security audits in the outer 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

NDMA is the agency responsible for disaster mitigation and relief in India. Falling under the MHA, the NDMA was set up as per the National Disaster Management Act of 2005. The NDMA is equipped with its own response force, the 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.[117] Currently there are four battalions of NDRF personnel (about 1,000 persons per battalion) trained in tackling CBRN incidents.[118] 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."[119]

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 in 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."[120]

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, 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

The Indian 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 CBRN security. The deployment of the military to deal with nuclear security contingencies is considered a last option, to be used only if all other measures have failed. The mirrors 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.[121] For example, India uses a closed fuel cycle, which Indian nuclear scientists insist carries less proliferation risks.[122]

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 used to protect nuclear installations. These technologies are designed and developed indigenously by institutions such as BARC.[123]

As technology rightly assumes an important role in securing Indian nuclear facilities, 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.

Cyber security is also a crucial component in ensuring safety and security at nuclear facilities. The Stuxnet cyber attack reportedly impacted the Iranian nuclear programme adversely. The Iranian nuclear programme was 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 cyber security 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."[124] 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 cyber security 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.[125] However, smart phones 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. The 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

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. Former Prime Minister Manmohan Singh's presence at the first two nuclear security summits is an indication of India's support for global initiatives to secure and safeguard nuclear materials.[126] 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.[127]

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. However, the Amendment is yet to enter into force because it has not been ratified by two-thirds of its member states. Nevertheless, India "support(s) the fifth revision of the recommendations contained in the Information Circulars of the IAEA (INFCIRC/225)."[128]

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 UN General Assembly Resolution and was subsequently adopted in 2005. India signed and ratified this convention in 2006.[129]

India has expressed its support of 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 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.[130] India is also a member of the IAEA Commission on Nuclear Safety Standards and the Advisory Group on Nuclear Security. India has been an active participant of the IAEA's Action Plan on Nuclear Security as well. 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.[131]

India's efforts at the international arena have not been restricted to IAEA. Since 2002, India has shepherded a resolution in the UN General Assembly on measures to prevent terrorists gaining access to 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.[132] Most recently, India also signed and ratified the IAEA's Additional Protocol.

India's initiative to establish the GCNEP is a testament of 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.[133]

Conclusion

For a country like India which is situated in a particularly difficult neighbourhood, nuclear security has been of immense importance. Even as it considers nuclear incidents highly unlikely, the dangerous consequences, should there be any, 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, which is at the core of the physical protection of facilities, is a significant measure that minimises the potential for intruders to attack the core of a nuclear facility. This principle is further applied at multiple levels (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 quite 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 PRP that India has instituted is among the best anywhere in the world. Here too, however, it has been noted that it could be expanded to include temporary workers as well.

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 the best practices; it must also be seen doing so by the international community. This requires India to publicise its efforts more.

Chapter – IV

Best Practices – UK, France, Japan

The previous chapter examined 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 it is thus important to study some of the best practices from other countries that have nuclear materials. There are important similarities and differences between countries in the manner in which safety issues and security issues relating to nuclear material are handled. There are countries such as the Czech Republic that has 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.

Although the focus of this study is on the security aspects of nuclear materials and facilities, 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 respond to situations, both man-made and natural, effectively. Because the consequences of the impact of the Fukushima crisis was felt on both safety and security aspects, organisations such as the IAEA and the World Institute of Nuclear Security (WINS) began studying the relationship between the two. The publication titled *Time for an Integrated Approach to Nuclear Risk Management, Governance and Security/Safety/Emergency Arrangements* by the WINS was one outcome of these deliberations. This chapter largely reviews security rather than safety practices but also looks at some safety practices in passing, especially where they overlap security practices.

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 a variety of 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 them.

This chapter examines the policies and practices in the area of nuclear security in the UK, France and Japan. This exercise will also help India compare, contrast and gauge its own practices in this area.

Nuclear Security in the UK

Like India, the UK has also been subjected to homegrown terrorism, mostly from the Irish Republican Army, but the nature and face of terrorism has undergone a major change after 9/11. A 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."[134] Even though the 7/7 terrorist attacks in London were not directed against nuclear or other WMD sites, they have been considered as the worst attack since the Lockerbie bombing in 1988.

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 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."[135] 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."[136] 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 al Qaeda as the "first trans-national organisation to support the use of CBRN weapons against civilian targets and to try to acquire them."[137] 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. The UK has had such 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 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 "[t]o 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."[138] 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."[139]

Additionally, the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) is responsible for establishing emergency preparedness framework which ensures that the public are 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.[140] While the REPPIR does not alter the existing nuclear licence 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 Health and Safety Executive (HSE, as the regulator).[141]

Similarly, there are specific laws that deal with security of the civilian nuclear industry in the UK. The NISR of 2003 puts the legal obligation on operators of civilian 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 3 S's–security, safety and safeguards–and 3 P's–purpose (protection of people and society from hazards of nuclear industry), principles and processes (for effective regulation).[142]

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."[143] 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.[144] The ONR is also responsible for regulating transportation of nuclear and radioactive materials, decommissioning of nuclear sites and cooperating with international regulators on safety and security related matters.[145]

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. However, certain safety-related aspects are regulated by the ONR even at these sites.

Safety

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 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."[146] To achieve this goal, the ONR has set 36 conditions for each nuclear site license 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.[147] 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, 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 civilian 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.[148] 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 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."[149] The CNC also provides the security cover during transportation of nuclear materials.[150] Security of smaller institutions is handled by private security agencies that are approved by the ONR.[151] Moreover, the UK Cabinet Office is also involved in the process through its Nuclear Security Team.[152]

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 advisors. The role of the police is also extended to conducting visits and reviewing the security mechanisms in such places.

During the interviews conducted 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 very quickly.

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, radio pharmaceuticals needed for hospitals, sealed radioactive sources needed in the construction industry and, for instance, the non-destructive testing of North Sea oil rigs."[153] Quality controls for vehicles for the safe transport as well as storage of highly hazardous materials are ensured by the ONR.[154] 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.[155] 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.[156] 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 while CCA measures will apply in areas that are not covered by the REPPIR Regulations or in cases where they complement the REPPIR Regulations.[157]

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 the central government.[158]

While designing countermeasures, the ONR works closely with the Centre for Radiation, Chemical and Environmental Hazards (CRCEH), which falls under Public Health England. The CRCEH is responsible for providing guidance on response plans for public protection. Depending on the nature of operations and 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. Also, the UK National Health Service has stationed emergency coordinators across the country. These coordinators maintain regular contact and exercises with other stakeholders such as the police and fire services who will be responding at the time of an emergency.[159]

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."[160] 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 the 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.[161]

The Foreign and Commonwealth Office's CBRN team is responsible for supporting multilateral institutions when required and supports processes like the Nuclear Security Summit. The team also coordinates training with agencies responsible for nuclear matters as and when requested directly or through the IAEA.[162]

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 recent discussions that the ORF team held with security officials and experts in Paris as part of this project. France has also been subjected to anti-nuclear activism and groups such as Greenpeace have been strengthened in recent years. Despite all these internal disturbances, France has managed to avoid any major nuclear security incidents in the country, which is commendable because 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 this year proposes lowering the nuclear share from the current 75 percent level to 50 percent by 2025 and increasing the share of renewables from 15 percent to 40 percent by 2030.[163]

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 three key principles: "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.[164]

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.[165]

The PHC also lays down specific rules governing radioactive sources. In addition, specific legal regulations have also been put into place with provisions to deal with certain substances, activities and institutions.[166] 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 anti-terrorism laws and a proven prevention policy.[167]

More recently, in June 2006, France enacted the Nuclear Safety and Transparency (TSN) Act, which is considered one of the most comprehensive legislation, 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).[168] Prior to this, the French nuclear legislation was seen as scattered. 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."[169]

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, Alternative Energies and Atomic Energy Commission, Nuclear Safety Authority, the Institute for Radiological Protection and Nuclear Safety, General Secretariat for Defence and National Security and the French military.

Ministère de l'écologie, du développement durable et de l´énergie

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 also mandated to apply sanctions in case standards are not met. It operates through its Department of Nuclear Security (Département de Sûreté Nucléaire, DSN) and the French Institute for Radiological Protection and Nuclear Safety. The latter, which is under the DSN, is responsible for authorisation of national level transportation of materials.[170]

High level of attention is also paid to the decision-making 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. The DSN also inspects smaller installations periodically. These institutions have to demonstrate to DSN that their security standards and practices are up to date and effective. In case the standards are found to be weak, DSN prescribes certain standards.

With regard to tracking of material, Category 1, 2 and 3 materials[171] 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 DSN with assistance from the intelligence agencies.

Commissariat à l´énergie atomigue et aux énergies alternatives (CEA)

Established in October 1945, CEA is an extensive research organisation, with two key objectives: to become the leading technological research organisation in Europe and to ensure that nuclear deterrence 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, CEA maintains a cross-disciplinary culture with engineers and researchers from different fields, building on the synergies between fundamental and technological research. Within CEA, the Directorate of Nuclear Energy (Direction de l´énergie Nucléaire, 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.

Autorité de sûreté nucléaire (ASN)

Established through the June 13, 2006 Nuclear Security and Transparency Act, it is an independent authority with the mandate to regulate civil nuclear activities in France. The ASN has the responsibility of informing the public and stakeholders (local Information Committees, environment protection commissions, among others) of its activities and the state of nuclear safety and radiation protection. During emergencies, 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.[172] The ASN undertakes its regulatory 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, ASN undertakes regulation of nuclear safety and radiation protection that keeps the workers safe and prevents the environment from being affected by hazardous effects from nuclear activities.[173] In addition, ASN is mandated to validate safety equipment, including the containers that are used for transporting sensitive material.[174] 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 civilian 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.[175] 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)

IRSN is the French national public agency that provides the expertise in assessing nuclear and radiological risks. As a research and expert appraisal organisation, IRSN contributes to the implementation of public policies concerning nuclear safety and security, health and environmental protection against ionising 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 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–nuclear safety and security authorities, local authorities, companies, research organisations, stakeholders' associations, etc.

Secrétariat général de la défense et de la sécurité nationale (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 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 Councils in other countries like the US, 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 (Pelotons spécialisés de protections de la gendarmerie, PSPG) and Gendarmerie Nationale. The PSPG is trained by the Gendarmerie Nationale which also trains its special operation forces–the Groupe d´intervention de la Gendarmerie nationale (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, PSPG, which is under the command of Gendarmerie Nationale, is responsible for providing security. As the operator pays for the deployment of the PSPG, it becomes the first response of the operator in case the site faces an attack or a security-related incident. The PSPG, since it is under the Gendarmerie, also becomes the first responder of the state in case a crisis occurs. The Gendarmerie's special intervention forces, the GIGN, 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.”[176]

The 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 EDF (the largely state-owned electric utility company) and AREVA (French nuclear company).

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

Nuclear Security Culture in France[177]

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.[178] 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 used to test security devices, exchange best practices, enhance knowledge of performance as well as vulnerabilities of security equipment.[179] 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 in an attempt to avoid working in silos. This helps in becoming acquainted with the multiple and overlapping areas in nuclear security.

With regard to cyber security, the CEA has put in place a cyber-security policy. A charter, prescribing cyber-related rules to be followed, is also in place. Punitive actions are taken when matters of non-compliance are noted. The role of the individual and awareness of 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 and 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 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 Prime Minister is in charge of crisis management of major crises and 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.[180] There is also the Inter-ministerial Crisis Cell (Cellule inter-ministérielle de crise, 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 all the stakeholders such as the SGDSN, the MEDDE, the Ministry of Foreign Affairs and the Ministry of Interior.

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 the use of Improvised Radiological Devices (IRD) as well as physical attacks on a nuclear facility by terrorists.

Nuclear Security in Japan

Japan has a well-established nuclear programme, with nuclear energy making up about 26 percent of the total power generation prior to the Fukushima crisis. Following the crisis, the share of nuclear energy dropped to seven percent of its total energy consumption.[181] While Japan is faced with nuclear threats from North Korean nuclear weapons, it has also faced nuclear threats through natural disasters such as the Fukushima crisis. This has placed huge emphasis on the safety aspects though a sizeable number of persons interviewed for the study in Japan underlined the threats that emanate from North Korea as an important consideration.[182]

Legislative Framework

Because of Japan's history of operating nuclear power plants, it has a well-established legal framework, which has been reviewed and modified from time to time. 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 its 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."[183]

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.[184]

The Nuclear Reactors Regulation Law also has an important role in Japan's legal nuclear sphere.[185] The Regulation Law, for instance, stipulates 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, the Ministry of Education, Culture, Sports, Science and Technology

(MEXT) lays down clear directions for a framework for research reactors that are not utilised in power generation. Similarly, the Ministry of Economy, Trade and Industry (METI) is responsible for power reactors, refining, manufacture, reprocessing and waste disposal, and Ministry of Land, Infrastructure and Transport (MLIT) is responsible for nuclear shipment.[186] The Regulations Law underwent an amendment in 2005 to institute a regular inspection system 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."[187]

Institutional Architecture

The responsibility for the regulation of nuclear activities in Japan is undertaken by the METI, 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 and 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 various institutions are detailed below.

Ministry of Economy, Trade and Industry

Broadly, 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 coordination 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 ANRE, which was to be responsible for regulating both nuclear and industrial safety. As the regulatory authority, 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 NISA.[188] However, questions have been raised about the independence of NISA as a regulator, 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.[189] The same report, citing Asahi news reports, said the government was going to merge 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 came into existence on 19

September 2012 under the Ministry of Environment. The Authority will be responsible for nuclear safety, security, safeguards, radiation monitoring and radioisotopes regulation.

Minister of Education, Culture, Sports, Science and Technology

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 licences for research reactors, reactors that are not used for electricity generation, including those at the research and development stage, and facilities using nuclear fuel.[190]

Atomic Energy Commission

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 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."[191]

Nuclear Safety Commission

The NSC was established in 1978, a fallout of the 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. This would ensure a clear separation of interests and responsibilities, which would be in the interests of ensuring long-term nuclear security.

Following the Tokaimura criticality accident in 1999, the Secretariat of the NSC was transferred on 1 April 2000 from the Science and Technology Agency to the Cabinet Office, principally for instilling greater independence and autonomy. The NSA's key mandate includes defining regulatory for the safe use of nuclear energy, issuing guidelines for the safety of nuclear reactors and issuing guidelines for the prevention of radiation hazards.[192] On matters such as licensing procedures, the licensing authorities are mandated to have prior consultation with NSC on safety and radiation protection matters.

Japan Atomic Energy Agency (JAEA)

The JAEA, established under the 2004 Japan Atomic Energy Agency Law, came into existence as a result of merging two national nuclear R&D organisations– Japan Atomic Energy Research Institute and Japan Nuclear Cycle Development Institute. The respective roles and responsibilities of both these organisations have been handed over to 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 to not be required for the fulfilment of JAEA's objectives.

Conclusion

The three 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 PRP adopted by India and France are noteworthy. However, policies and programmes will depend on the socio-cultural milieu of each country/region. For instance, Japan has not adopted this programme because of privacy issues, which the Japanese see as particularly important.

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

Chapter – V

Conclusions

India strongly emphasises 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. This has extended to nuclear security–India has utilised policy governance and technology to counter terrorist threats in the nuclear realm. A terrorist nuclear attack might be a remote possibility but it is a high-impact one and it cannot be taken lightly. Thus, nuclear security is a high priority for India. It is this concern that has motivated this study, which looked at both safety as well as security issues, both in India as well as in three major nuclear powers–the UK, France and Japan. The study examined these countries in order to understand their nuclear safety and security practices and to see which of these practices might usefully be adopted in the Indian case.

Several conclusions can be drawn from this study. The first major conclusion is that India's nuclear security measures are fairly robust. Thus, the author disagrees with previous studies–in particular the NTI Nuclear Security Index–which have ranked India fairly low in global comparisons. There may be two reasons for this. One is that these previous studies have taken a quantitative approach that did not examine Indian nuclear security practices in depth. This study, on the other hand, is almost entirely on the Indian case (save one chapter wherein the author studied the best practices of UK, France and Japan) and the ORF team was able to examine Indian practices in depth and talk to senior officials from both the Indian atomic energy establishment as well as in the 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 very 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 India has a strong case to make. For a variety of historical and institutional reasons, the Indian nuclear establishment had developed very robust safety and security norms much before these issues became an international concern in the post-9/11 period. Sadly, the Indian 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, although that is far from true.

The third conclusion that the author can draw, 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 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 although Indian nuclear safety and security practices are fairly robust, India can also learn from best practices elsewhere. I have outlined a list of 20 recommendations in the last chapter. 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 that only secures nuclear facilities. Similarly, another recommendation is to increase the autonomy of the nuclear regulators. Finally, I also recommend conducting regular exercises at all levels. While the Indian nuclear establishment and security services do conduct some security exercises, it is not clear whether they exercise often enough or if they conduct multi-agency exercises on a more periodic basis. 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

Recommendations for Enhancing Nuclear Security in India

India's nuclear establishment is constantly reviewing and updating its security policies and practices. Therefore, India can benefit from the best practices that have been adopted by other nuclear powers. It is also vital to learn lessons from one's own as well as others' experiences and take appropriate action.

While there has been considerable transparency and openness around nuclear safety, India has not done the same on issues dealing with nuclear security. This might be understandable as a way of ensuring that undesirable elements and terrorists do not obtain information that they can then use to defeat security measures, but it also harms nuclear security by preventing legitimate assessments and criticisms that can help improve nuclear security. 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 it is on issues of safety. No one is arguing for total transparency, but the merit to spelling out its nuclear security policy in broad terms and the measures taken to address some of the vulnerabilities is real. The excellence of some mechanisms such as 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 PRP as part of its nuclear security regime.

While appreciating the merits and strengths of India's nuclear security policy and practice, it is equally important that I bring out the deficiencies 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. Ensure personnel reliability at all levels: It has been seen that extensive background verification measures are put in place for all the employees, including 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 a 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. Maintain 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. Keep an account 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 2010 Mayapuri incident. According to AERB officials, the incident occurred probably because of the fact that

this material originated from a foreign source before AERB was even established. Moreover, it was also the responsibility of the Delhi University to report the possession of radioactive material to AERB. It was not the only failure on the part of the university–it also did not follow the set 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. Tighten of the licensing process: Following the Mayapuri incident, intense discussions between the AERB and University Grants Commission led to the Commission 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. Prohibit Smartphones: Technological advances are creating new risks. Today's smart phones can do as much as a computer could do a few years ago and thus have the potential to compromise nuclear security. Therefore, use of smartphones in nuclear establishments should be strictly prohibited, which is currently not the case.

6. Strengthen cyber security measures: 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.

7. 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 UK's CNC, whose responsibility is only to protect nuclear materials and facilities. This is particularly important in the context of India's plans to expand its nuclear power sector significantly.

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

9. Make NDMA guidelines for radiological and nuclear emergencies mandatory: While the issuing 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 mandated through administrative and legal means.

10. Set up an independent regulatory board: There has to be clear separation of roles and functions between the nuclear establishment and its regulator to avoid even the appearance of a conflict of interest. This is not only important for independent and autonomous functioning as an independent regulator, but also, and particularly, because of widespread opinion that India's regulatory functions as subjugated to other agencies within the nuclear establishment.

11. Mandate security as 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 important stakeholders to have a say in devising their own security mechanisms and ensure that the security is double-checked.

12. Increase interaction between nuclear site operators and State disaster management authorities. 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.

13. 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 responders to any emergency situation.

14. 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.

15. Undertake tabletop exercises involving all the security agencies: While intra-agency exercises and mock drills are done fairly frequently, large-scale exercises involving all the different security agencies are done less frequently. 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 should be prepared precisely on how these drills must be executed so that all the agencies are on the same page.

16. Conduct periodic exercises involving NDMA and NDRF battalions to ensure efficiency during actual contingency situations: Local community agencies must be formed and given basic training to deal with contingency scenarios.

17. Ensure that all units of nuclear installations including the accommodation of staff working at nuclear installations such as a power plant 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.

18. Make robust attempts 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.

19. Consider international cooperation in sharing nuclear security best practices: This could potentially be undertaken under the aegis of GCNEP, which has the SNSS.

20. Make nuclear security an integral part of the annual report and a regular feature in other prominent GOI publications, particularly those of the DAE and the MEA.

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% $ThO2$) 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); 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 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 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 and 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 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 with 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. What 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 licences and other 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 licences and other 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 put in place 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. National Accreditation Board for Certification Bodies
5. Delhi Fire Service
6. All India Institute of Medical Sciences (AIIMS), Delhi
7. National Disaster Management Authority

Gujarat

1. State Police, Ahmedabad
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
4. Mumbai Fire Service
5. CISF, Mumbai
6. College of Military Engineering(Indian Army), 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 UK, France and Japan. Below is the list of officials and experts we met during the visit.

France

1. **General (2s) Christian Riac**
   Head of Department
   General Secretariat
   Security, Defense and Business Intelligence Directorate,
   Department for Nuclear Security, Ministry of Ecology, Sustainable Development and Energy

2. **Geraldine Dandrieux**
   Head of International Affairs and Regulation
   General Secretariat
   Security, Defense and Business Intelligence Directorate,
   Department for Nuclear Security, Ministry of Ecology, Sustainable Development and Energy

3. **Philippe Denier**
   Delegation for Strategic Affairs (Nuclear Affairs)
   Ministry of Defense

4. **Philippe Montarnal**
   Area Manager–India and Turkey
   International Affairs Division
   Commissariat à l'énergie atomique et aux énergies alternatives (CEA)

5. **Edwige Bonnevie**
   Risk Management Director and Security Director
   French Atomic Energy Commission

6. **Maxime Reynauid**
Nuclear Non-Proliferation and Disarmament Officer
Ministry of Foreign Affairs

7. **Frederic Aubry**
Representative
General Secretary, High Official for Defense and Security
Nuclear Security Office
Ministry of Ecology, Energy, Sustainable Development and the Sea

8. **Michelle Fontana**
Project Manager–Nuclear and Radiological Field
Development of Security Technologies State Protection and Security Directorate
SGDSN, Prime Minister's Office

9. **Frederic Journes**
Director, Governor for France to IAEA
Strategy and International Affairs Division
Commissariat à l'ènergie atomique et aux energies alternatives (CEA)

10. **Claire Amadei**
Desk Officer for Asia-Pacific
Division of International Affairs
SGDSN, Prime Minister's Office

11. **Matthieu Plailly**
Desk Officer–South Asia
Directorate for Strategic Affairs
Department for Regional Issues
Ministry of Defense

12. **Baskar Rosaz**
Desk Officer–India–Pacific

Delegation for Strategic Affairs
Department for Regional Issues
Ministry of Defense

13. **Souraya Boudiya**
Professor of Sociology
Universitié Paris-Est Marne-La-Vallée

14. **Bruno Tertrais**
Senior Research Fellow
Fondation pour la Recherche Stratégique

15. **Benjamin Hautecouverture**
Research Fellow
Fondation pour la Recherche Stratégique

16. **Camile Grand**
Director
Fondation pour la Recherche Stratégique

17. **Xavier Pasco**
Maître de recherche (Senior research fellow)
Fondation pour la Recherche Stratégique

18. **Richard Michel**
Independent Expert
Global Security and International Regulation
ARMIR Global Security Network

19. **Eric Danon**
CEO
Conseil Supérieur de la Formation et de la Recherche Stratégiques (CSFRS)

Japan

1. **Dr. Masao Senzaki**
   Director
   Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN)
   Japan Atomic Energy Agency (JAEA)
   Tokai

2. **Dr. Naoi Yosuke**
   Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN)
   Japan Atomic Energy Agency (JAEA)
   Tokai

3. **Naoko Noro**
   Research Fellow
   Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN)
   Japan Atomic Energy Agency (JAEA)
   Tokai

4. **Amb. Nobuyasu Abe**
   Deputy Chairman
   Japan Atomic Energy Agency
   Tokyo

5. **Dr. Masahiro Kikuchi**
   Executive Director
   Nuclear Material Control Center
   Tokyo

6. **Ms. Shoko Iso**
   Nuclear Material Control Center
   Tokyo

7. **Mr. Naoki Miyamoto**
   Nuclear Material Control Center
   Tokyo

8. **Dr. Ichimasa**
   National Institute of Defense Studies (NIDS)
   Tokyo

9. **Dr. Marie Izuyama**
   National Institute of Defense Studies (NIDS)
   Tokyo

10. **Shunichi Tanaka**
    Chairman
    Nuclear Regulatory Authority
    Roppongi, Tokyo

11. **Dr. Syouji Tsumita**
    Deputy Director of Office of Radiation Protection/Safeguard
    Nuclear Regulatory Authority
    Roppongi

12. **Dr. Seiichiro Takagi**
    Japan Institute of International Affairs (JIIA)
    Tokyo

13. **Dr. Yasuyuki Ishida**
    Japan Institute of International Affairs (JIIA)
    Tokyo

14. **Dr. Akira Shimotiro**
    Japan Institute of International Affairs (JIIA)
    Tokyo

15. **Prof. Nobumasa Akiyama**
    Hitotsubashi University
    Tokyo

16. **Prof. Yusuke Kuno**
    Prof. Nuclear Nonproliferation Lab
    Department of Nuclear Engineering and Management
    University of Tokyo
    Tokyo

17. **Prof. Horimoto**
    Retd. Professor in International Relations (specialisation on security issues)
    Kyoto University

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

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
   Counter Proliferation Department
   Directorate for Defence and International Security
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