IPCS Special Report

82

SEPTEMBER 2009

How Prepared Are We?

India and the Challenge of Nuclear Terror

Sitakanta Mishra

Institute of Peace and Conflict Studies

B-7/3, Safdarjung Enclave
New Delhi 110029
91-11-4100 1900

www.ipcs.org

The Institute of Peace and Conflict Studies (IPCS), established in August 1996, is an independent think tank devoted to research on peace and security from a South Asian perspective.

Its aim is to develop a comprehensive and alternative framework for peace and security in the region catering to the changing demands of national, regional and global security.

Address:
B 7/3 Lower Ground Floor
Safdarjung Enclave
New Delhi 110029
INDIA

Tel: 91-11-4100 1900, 4165 2556, 4165 2557,
4165 2558, 4165 2559

Fax: (91-11) 4165 2560
Email: officemail@ipcs.org
Web: www.ipcs.org

HOW PREPARED ARE WE?

INDIA AND THE CHALLENGE OF NUCLEAR TERROR

SITAKANTA MISHRA
Associate Fellow, Centre for Air Power Studies, New Delhi

INTRODUCTION

In the post-9/11 period, according to the California-based Saga Foundation survey, "Nuclear terrorism is the top fear for Americans".[1] Irrespective of the strength of this survey, if the citizens of the sole superpower have such perceptions, how afraid should Indians be when they are surrounded by unstable nations and have an active presence by many non-state entities from the subcontinent? India harbours a sizeable atomic infrastructure located across its geography. Also the phenomenon of terrorism is ubiquitous in the country. But a plausible conjunction of the two – 'nuclear terrorism' – is surprisingly not publicly debated for more than one reason.

First, owing to the unlikelihood of such a precedent, it is assumed that such an incident would not take place. Second, it is also believed that the nuclear installations in India are comparatively safe – under strict civilian control, with an adequate security blanket. Third, until 1998, the entire attention of the strategic community was concentrated on the country's nuclear weapon status. Though recently, the issue of India's energy security and the role of nuclear energy in its energy-mix have dominated the strategic discourse. Lastly, following the 'culture of secrecy,' the scientific-political leadership is extra cautious to avoid unnecessary public panic as the popular perception is vague. However, the Indian nuclear establishment is confident of its emergency preparedness, the strength and structure of its nuclear facilities and opines that "the regulatory infrastructure currently in place is adequate" to face any eventuality.

I
REAL RISKS OR FALSE ALARMS?

It is really difficult to fathom the exact risks, probabilities and consequences of such an incident. This study, therefore, examines the general trend of terrorism in and around the subcontinent, the geographical distribution of nuclear facilities vis-à-vis the existence of terrorist belts, motivation and operational capabilities of various terrorist/extremist groups. Thereby, the risk and vulnerabilities of the Indian nuclear infrastructure is assessed, and if a nuclear terror incident was to take place, is India prepared to face it.

Though the Indian public seems to be apathetic, the political-scientific community is seriously concerned for a probable nuclear terror incident for four overlapping reasons. Firstly, the post-9/11 global debate on nuclear terrorism has reflected on the Indian national security discourse. Secondly, the evolving Indo-US strategic relationship has led to fears of a threat from Al-Qaeda because allies of the US may be a likely target. Thirdly, political instability in Pakistan and the fear of nuclear arsenals falling into wrong hands has attracted attention. Fourthly, the apprehension has been precipitated due to the number of increasingly reported incidents of the smuggling of fissile material in and around India.

[1] "Nuclear Terrorism Top Fear, Survey Says," United Press International, 4 January 2008.

During the last five years, a series of intelligence reports have revealed that terrorists could target India's nuclear infrastructure. Consequently, the Indian government had to enhance security at vital nuclear installations. On the eve of Independence Day, 2006, security was stepped up at India's premier nuclear organization, the Bhabha Atomic Research Centre (BARC), with the deployment of the elite National Security Guards (NSG) for the first time, following inputs of a possible terrorist attack. Also the Central Industrial Security Force (CISF), Mumbai Police, NSG and army personnel were posted inside BARC. Inaugurating a three-day conference of state police chiefs in New Delhi on 22 November 2006, former Home Minister Shivraj Patil said that the proposed civil nuclear deal with the US has made the country's atomic power plants and other critical infrastructure "highly vulnerable" to terrorist threats. He further pointed out that the main threat came from Lashkar-e-Tayyeba (LeT).

In August 2003, three radioactive isotopes of Cobalt-60 were reportedly stolen from Tata Iron and Steel Company (TISCO) in Jamshedpur. A uranium-based ash analyser was also reportedly stolen from the Coal Mines Planning and Designing India Limited (CMPDIL) Complex in Ranchi, in December 2006. In July 1998, the Central Bureau of Investigation (CBI) was reported to have unearthed a uranium theft racket when it seized 6 kg of uranium, and arrested two persons. In 1998, BBC brought out a report on the arrest of a politician, Maheswar Singh Deo, in West Bengal who was allegedly carrying unrefined uranium. But, before drawing any alarmist conclusion from the above reports, a few things need to be kept in mind: (i) most of the above information is compiled from news reports, therefore of limited credibility; (ii) the amount of material smuggled is very small and unrefined, hardly sufficient to make any explosive device.

These reports indicate the existence of a nuclear and drug-trafficking route in Southern Asia. In fact, South and Southeast Asia has seen illicit nuclear proliferation and radioactive material smuggling. The sporadic incidents of fissile material smuggling are hardly surprising given that South Asia, particularly India, is situated between the Golden Crescent and Golden Triangle. Besides the traditional trafficking and smuggling routes, the proliferation network in Asia led by A.Q. Khan indicate that a nuclear black market did, and can, flourish in or from Asia.

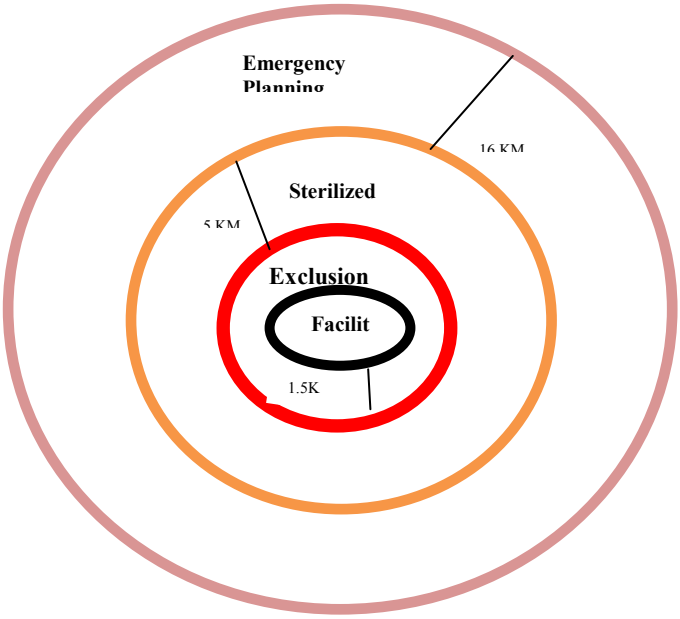
EXISTING SECURITY STRUCTURES

The Indian nuclear infrastructure is located across the country and, comprises a range of activities. They constitute fuel fabrication facilities, research reactors, power plants, plutonium reprocessing plants, spent fuel pools, breeder reactors, waste immobilization plants, waste storage areas, Uranium/thorium mines & milling plants, etc. Radioactive materials are also being used in numerous institutions like cancer treatment centres, food processing units, oil and gas exploration industry, road construction industry, steel manufacturing industry and academic/research centres. Except for the nuclear power plants, the security arrangements at other facilities are not only unknown but also unclear whether they have been accorded adequate attention. According to one viewpoint, "Physical protection at these sites is rather lax, at best comparable to the protection provided at a jeweler shop…."[2]

---

2 Rajesh M. Basrur and Friedrich Steinhausler, "Nuclear and Radiological Terrorism Threats for India: Risk Potential and Countermeasures," http://jps.lanl.gov/vol1_iss1/3-Threats_for_India.pdf.

There are different levels of security rings around every power plant. All the facilities are surrounded by physical barriers aiming to restrict easy access to sensitive areas. Access control is maintained over personnel by verifying identity cards. Every facility is surrounded by two fences – inner and outer – having a double-layer security structure. The distance of the outer fence is about 1.5 km (sterilised zone) from the inner fence (exclusion zone), therefore, even if an intruder manages to penetrate the outer security ring, it would be extremely difficult to breakthrough the inner security circle as the second layer of security is more restrictive, and is deployed with sophisticated surveillance systems.



In the sterilised zone, which expands up to 5 km, habitation is restricted. In the emergency planning zone that expands up to 16 km, there is no restriction on population settlements, and constant monitoring is undertaken. A close watch is kept over transportation networks, means of communication, etc. Considering the advanced means of communication and transport facilities available now, intruders can stay outside the security circles but traverse the distance easily to enter at an appropriate time. Therefore, it may be prudent to put in place another security ring covering a larger area, perhaps of a minimum of 50 km radius, around the facility.

The CISF is developing the necessary ability to deploy specially-trained first responders in case of a nuclear attack. Four companies of the CISF have been sanctioned, and specialized training is being imparted to some 400 personnel. This elite force is deployed in four locations: Ghaziabad unit to cater to Delhi and northern areas, Ranchi unit to cater the eastern areas, Kota unit for the western, and Chennai unit for the southern part. Many officers of these units have undergone eight weeks of nuclear and biological response training in the United States, and others are being trained to share skills with fellow CISF members in a train-the-trainer approach. However, the CISF, though independent of the Department of Atomic Energy (DAE) and a well organized agency, is viewed as "overburdened with additional responsibilities".

In 2004, India's Border Security Force (BSF) announced that it was forming a battalion with special skills in countering nuclear, biological, chemical threats. In April 2002, the chairman of India's Nuclear Power Corporation announced that he was aware of the terrorist threat and mentioned that the DAE and CISF have performed security drills at nuclear facilities. The Indo-US Working Group on Counter-terrorism has discussed a variety of issues, including nuclear terrorism. The United States has reportedly brought up the issue of assistance to secure Indian nuclear facilities. The IAEA has provided security training for the Indian officials. Also, Indian experts have participated in the IAEA-sponsored International Training Course on the Physical Protection of Nuclear Facilities and Materials operated by the Sandia National Laboratories.

The safety and security of a facility depend on mainly four factors: (1) adequate

number of guards; (2) comprehensive training of these guards; (3) strict monitoring, warning systems, disaster management arrangements; and (3) proper personnel reliability procedures. It seems that the DAE has instituted all four aspects. But considering India's ambitious plan to expand its nuclear establishment, it is necessary to simultaneously expand their security measures to avoid complacency. While increasing the number of guards might appear to increase security, countervailing human behaviour might actually weaken security if only the number of guards is increased. Therefore, a strict implementation and periodical assessment of an advanced personnel reliability programme is important. Also it is crucial to undertake a thorough assessment of the design basis threat (DBT) of all Indian nuclear facilitates. The inbuilt safety mechanisms in the nuclear installations assume greater importance when the inside-sabotage factor is concerned.

II
FACETS OF PROBABLE NUCLEAR TERROR IN INDIA

Terrorism has spread globally and it is evidenced that sporadic instances of smuggling of radioactive materials have occurred. It would be detrimental if the terrorists were to gather the required capabilities, because it could lead to the growth of a nuclear terror plot. Terrorist outfits operating in India or in the subcontinent would be expected to have the basic knowledge of Indian security arrangements, vulnerable areas and topography. Therefore, it would be prudent to think about the kinds of terror incident that could take place in India and the types of entities that might resort to such acts. Broadly, nuclear terrorism is of two types: (1) terrorism using nuclear weapons/materials which is of low probability, but high consequences; (2) terrorism using non-nuclear strikes on nuclear installations/facilities whose occurrence is more probable but would have lower consequences. Nuclear terrorism also involves radiological terrorism.

The most plausible scenario of nuclear terrorism in India would be the misappropriation of a smaller radioactive source like Co-60 from a cancer radiotherapy unit and dispersed by TNT. This would contaminate an area of about 2 sq km, or about 33 city blocks. If this kind of incident takes place in Delhi, depending upon the location of detonation and direction of the wind, it would immediately affect Connaught Place, India Gate, South and North Block, Darya Ganj, etc. As the capital of India, the possible impact on the political life of the country would be vast and severe. Even if such an extreme situation does not take place, false news of a nuclear terror incident would create massive disruption, throwing life into chaos. Such a hoax would raise a false alarm among the public, causing mass disruption. The entire Ring Road of Delhi would be choked, entry and exit out of the city would be difficult, many patients on their way to hospitals would die, and rescue operations would face difficulty. The same would be the case in Mumbai or any other metropolis in India. In any such incidence, "Public hysteria would overwhelm local authorities, the economic consequences would be long lasting, and government agencies responsible for public safety would come under severe scrutiny." [3]

Another form of terrorism which has a greater likelihood of occurrence compared to the use of nuclear weapons is the use of

[3] Kishore Kuchibhotla and Matthew McKinzie, "Nuclear Terrorism and Nuclear Accidents in South Asia," http://www.stimson.org/southasia/pdf/reducingnukes-section5.pdf

radiological dispersal device (RDD) or the 'dirty bomb.' A small amount of radiological material mixed with conventional explosive, if exploded in a public place would cause sufficient radiation. Even a small amount of HEU, which is odourless, kept in a crowded place, subway of a city, market or railway station would cause radiation without being detected, as radiation detection devices are not widely used in India except in the nuclear facilities, airports, etc.

Adnan Gill, a Pakistani columnist, in a report titled "How Secure is Indian Nuclear Programme?" in The Pakistan Tribune on October 17, 2006[4], branded the security standards in place for the Indian nuclear programme as "primitive and outdated." He has identified five scenarios where a well-conceived attack on Indian nuclear assets by any number of highly-motivated insurgents and/or their sympathisers can potentially materialize: (1) The insurgents steal an intact nuclear weapon; (2) the insurgents fashion a crude nuclear weapon by stealing fissile material; (3) the insurgent sympathisers smuggle highly radioactive material out of the nuclear fuel complex to detonate a 'dirty bomb'; (4) Naxalites may sabotage a facility; and (5) most realistically, in the aftermath of a massive tsunami, insurgents may get their hands on unguarded nuclear weapons.

Gill's assertion seems biased from all angles. First, India's nuclear arsenals are known to be stored in a disassembled state. Also, the inbuilt security structure with the warhead – a multi-layered electronic locking system (PAL) which, at each stage, requires the code to make it functional – is extremely difficult to penetrate. Even if the terrorists manage to acquire some fissile materials, it would be impossible for them to fabricate a complete bomb as fashioning such a bomb requires state-level resources. His fourth assertion that Naxalites may sabotage a facility is unlikely on the grounds that the Naxalites would not venture to that extent since it would affect their operation in the area. However, this doesn't mean that the Indian nuclear establishment is completely secure. It can be targeted in many other ways. Broadly, this can be categorized as:

- Threats from terrorists operating inside the country: JeM, LeT, HuM, etc.
- Threats from terrorists operating outside the country, but with sufficient presence and links with groups operating inside: Al Qaeda, LTTE, etc.
- Vandalism by politico-religious groups, other extremist religious groups
- Acts by nationalist/separatist groups: Kashmiri separatist groups, Naga insurgents, Naxalites, etc.
- State sponsored terrorism from across the border.
- Destruction by natural disaster and nuclear accidents owing to human or technical errors.

Therefore, the forms of threats that the Indian nuclear establishment may experience are: (a) Threats from outsiders; (b) Threats from insiders; and (c) Threats from the nature. These threats from the first two may occur in the following forms: aerial attacks, land attacks, sea route attacks, damage by natural disasters, nuclear hoax, and cyber attacks.

III
ASSESSING THE CAPABILITY AND MOTIVATION OF THE TERRORISTS

Though terrorism is a major challenge before India and contemporary terrorists intelligently leverage communication and financial networks, the probability of a

[4] Adnan Gill, "How Secure is Indian Nuclear Programme?," The Pakistan Tribune, 17 October 2006.

nuclear terror incident may be determined by factors like: (1) the location of nuclear facilities (source of the radioactive material); (2) area of operation of the terrorist groups; and (3) their capabilities and motivations. For instance, the threat to the nuclear infrastructure in the northern part of India may emanate from the terrorist and extremist groups active in Jammu & Kashmir (J&K), Al Qaeda operatives, terrorists active in the Indo-Bangladesh border region, etc. The nuclear infrastructure in the eastern part of India is vulnerable to the activities of the Naxalites and natural disasters like cyclone, tsunami and earthquake. The facilities in the southern part may be vulnerable to activities of the LTTE, cyclone, tsunami and earthquake, while facilities in southwestern India are prone to natural disasters, religious-chauvinistic elements and attacks from the sea. The facilities in the northwestern part are vulnerable to attacks from across the border.

The 9/11 Commission Report says that the idea of attacks on nuclear power stations by Al-Qaeda, perceived to be raised in the early stages of the planning of the 9/11 attacks, was vetoed, apparently by Bin Laden himself, perhaps because of the enormous resources and sophisticated technology required.[5] But this does not discount the probability of Al-Qaeda acquiring such a capability in the future. In any case, with the level of technological expertise it has, it can easily fabricate an RDD or IND. At the extreme, they can attempt a suicidal attack similar to 9/11 – hijacking of an aircraft and crashing it on the premises of a nuclear facility.

[5] The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States, Official Government Edition (Washington, DC: US Government Printing Office, 2004), URL: http://www.gpoasccess.gov/911/pdf/full-report.pdf, p. 172.

AIRCRAFT CRASHING

To assess whether Indian nuclear plants can withstand an aircraft crash, one needs to know how strong the containment buildings are. The containment buildings have concrete walls with a minimum thickness of four feet. Reactors like the Kaiga-1 and 2, Rajasthan-3 and 4 and Tarapur-3 and 4 are housed in double-domed structures. The domes of these reactors are constructed using the microsilica-based high performance concrete. They also have added safety features like automatic, quick acting poison injection system to shut down the reactor in an emergency, and micro-processor-based systems for reactor protection and control. However, the containment structures of the old commercial reactors like Tarapur are viewed as less robust as those of the modern reactors. Though Indian scientists have made extensive modifications to the safety structure of the reactor, its weak containment building might not withstand a large airplane crash.

Reports claimed that the Atomic Energy Commission (AEC) was seeking "no-fly zones' over nuclear installations to prevent terrorist attacks from the air. Within a month after 9/11, New Delhi promulgated no-fly zone restrictions around nuclear power plants but these have not been strictly implemented yet. Surprisingly, even today, aircrafts can fly over BARC. Also, it is uncertain whether these facilities are adequately protected by anti-aircraft defences. Nevertheless, security at India's nuclear installations has been improved in many other ways. The Indian Coast Guard deploys additional boats off the coast of Bombay to guard BARC. The requisition for additional anti-aircraft guns was made for deployment to the Narora Atomic Power plant in Rajasthan and for two atomic power plants in southern India.

NAXALITES

The second grave threat to Indian nuclear facilities would be from the Naxalites. They are active in states where many of India's nuclear facilities are located. Though they haven't yet undertaken such strikes, their tactics, motivation and capabilities suggest that they could sabotage a facility in their area. They can cause harm to uranium mines by simply destroying the infrastructure and capturing and diverting the raw materials to smugglers. However, it is difficult to assess the level of their awareness about nuclear technology and radiation effects. Also, it is not known how far the Naxalites are involved in radiological material smuggling. Irrespective of all the speculation about their intentions, the Naxalites must be aware of the repercussions of attacking a nuclear facility and the consequent release of radiation which, in turn, would hinder their activity in the area. Therefore, they may not take the extreme step of attacking a reactor; they might attack the security personnel or steal some equipment, more for impact and show of their strength, than to cause actual damage.

THREATS FROM FUNDAMENTALIST GROUPS

In India, most of these groups are deeply nationalistic and consider nuclear weapons or facilities as national wealth, and a matter of national pride. Therefore, it indicates that they would not cause any harm to the nation's nuclear infrastructure. Even sectarian violence may not be directed against nuclear facilities as was seen during the Godhra incident in Gujarat. Gujarat has a history of sectarian violence for decades, even prior to Indian independence in 1947, but there is no evidence of a single incident ever being aimed at the nuclear infrastructure in the state.

THREATS FROM BEYOND THE BORDER

The other category of threat that the Indian nuclear facilities might face is the possibility of an attack from across the border. Most of the neighbouring countries are politically unstable and extremist groups have a strong hold in these countries. Theoretically, during the time of domestic turmoil, terrorist groups may get hold of nuclear or radiological devices and use them against India. Also the nexus between the state and extremist groups in different countries of the region is well known; therefore, chances of state-sponsored nuclear terrorism cannot be ruled out.

IV
EXAMINING THE SAFETY STANDARDS OF INDIAN FACILITIES

On March 31, 2005, India ratified the Convention on Nuclear Safety and submitted its first National Report (September 2007) for review by the contracting parties. The Report says that all operating nuclear installations in India are subject to "continuous regulatory appraisal of safety as per the established requirements" and the "utmost attention is given to safety in every stage of realization of nuclear power plants to ensure safety of operating personnel, the public as well as the environment". The "principle of safety is the overriding priority," and the measures are "comprehensive," covering the entire gamut of activities i.e. siting, design, construction, commissioning, operation and decommissioning and so on.

According to Charles D Ferguson, a senior fellow at the Council of Foreign Relations, the sheer complexity of the Indian "three-pronged plan could complicate management of ensuring adequate security throughout the programme. Further, he says:

- The CANDU-type reactors, such as the Indian Pressurized Heavy Water

Reactors (PHWRs), have certain safety features that make them capable of surviving an attack or sabotage.

- India's most recently built PHWRs have an added safety feature: double-domed containment structures. These PHWRs are the Kaiga-I and 2 reactors, the Rajasthan-3 and 4 reactors, and the Tarapur-3 and 4 reactors.
- The containment structures of the Tarapur reactors are not as robust as more modern water reactors BWRs. A weak containment building might not withstand the crash of a large airplane.
- The Russian supplied VVER-1000 reactors at Kudankulam have a relatively large coolant-to-power ratio and some inherent protection in the event of a loss of coolant incident. The VVER-1000 has some inherent weaknesses such as, steam lines and isolation valves located in close proximity, which a single blast could knock out; the control room is located at the lower level of the reactor building, potentially prompting a quick evacuation if the containment is breached, thus, minimizing the amount of time the operators have to control the reactor; and the relatively weak containment structures might be easy for an airplane to penetrate.
- Many research reactors in India do not use containment buildings, and if they do, the containments tend not to be as strong. Research reactors, especially those at universities, also have less security.
- The decommissioned reactors could present a potential target because of the possible presence of radioactive materials on-site.
- The pool at Tarapur-1 was initially designed to store a maximum of 72 metric tons of spent fuel; presently it contains more than twice that amount. The spent fuel at the CANDU plant is located outside the containment building and is thus more exposed to a terrorist attack.
- Presently, India uses the PUREX reprocessing method, considered to be proliferation-prone, as it completely separates plutonium from the self-protecting highly radioactive materials in spent fuel. Thieves or terrorists can carry separated plutonium without suffering near-term harm to health.
- As India's rate of reprocessing and production of plutonium-based fuel increases at Tarapur and Kalpakkam, there is likely to be an increase in material unaccounted for (MUF).

However, India's National Report to the Convention on Nuclear Safety, September 2007, mentions that systematic approaches are being followed in the design, commissioning, operation, performance, quality, and safety of the Indian nuclear plants. Proper regulation and standards are being maintained for site selection and construction, regulatory framework and operation, commissioning, design of plants, performance monitoring, waste management, quality assurance, periodic safety review and public awareness programmes.

In the aftermath of the Chernobyl disaster, Prime Minister Rajiv Gandhi asked for a complete review of the safety standards and emergency preparedness plan of Indian nuclear plants and then only did he agree to sanction new nuclear power projects. The DAE consulted the chief secretaries of the states, where nuclear installations were located, along with the concerned district administrations, and drew up comprehensive plans to deal with such an emergency. Detailed plans were prepared for each site in conjunction with the district collector and his principal officers and these are updated periodically. Since then, plant emergency exercises are carried out four times a year, site emergency exercises are carried out once a year, and off-site emergency exercises once every two years.

V
LEGAL MECHANISM IN PLACE

Though India does not have an overarching integrated legislative provision to address the issue of nuclear terrorism, several national acts on export controls and import restrictions, trade regulation, atomic energy policy, industrial policy resolutions, licensing policies and international obligations emanating from its adherence to the international conventions, provide an exhaustive legal framework to address this issue. Starting with the formulation of the Explosive Substances Act in 1908 and the Atomic Energy Act in 1962 to the promulgation of the Weapons of Mass Destruction and their Delivery System (Prohibition of Unlawful Activities) Act in 2005 and the Disaster Management Act 2005, India has consistently sought to restrict possible pilferage of radioactive materials. However, all these provisions, including the Special Chemical, Organisms, Materials, Equipment and Technology (SCOMET) section of the Export-Import Act, Customs Act of 1962, Chemical Weapons Convention Act of 2000, Biological Weapons Toxin Convention, Environment Protection Act, the POTA, etc. were actually designed for specific aspects and control in scattered ways. Moreover, besides the WMD Act of 2005, none of these laws are actually directly concerned with non-proliferation and terrorism.

VI
IS INDIA PREPARED?

As per the Indian official position, preparedness for a response to nuclear or radiological terrorism is intact; however, what is urgently required is a robust improvement of the existing preparedness to respond effectively to a large scale nuclear or radiological emergency. The question is, whether the mechanisms in place are competent to tackle a nuclear terror incident, 'anywhere, anytime'.

The radiation protection framework in India broadly comprises:
(1) Legal provisions
(2) Surveillance and safety mechanisms
(3) Emergency response mechanisms
(4) External collaboration

The safety mechanism at Indian nuclear facilities, as the DAE proclaims, "is on very sound footing and is constantly being strengthened." Other initiatives of the DAE in this regard are:

- BARC and the laboratories accredited by it, conduct countrywide personnel monitoring in about 3000 industrial, medical, research organizations.
- Environmental radiation monitoring and environmental surveillance are regular features of the environmental protection programme of the DAE. Sophisticated weather monitoring SODAR systems are operational at Kaiga, Kalpakkam, Tarapur and Trombay. The environment around nuclear sites is well-conserved.
- To educate the public living around nuclear power plants, public awareness programmes are organized by the DAE on a regular basis.
- The World Association of Nuclear Operators (WANO) conducts peer reviews of all the atomic power stations.
- The Atomic Energy Regulation Board (AERB) receives advice from the Advisory Committee on Nuclear Safety (ACNS). ACNS provides recommendations on the safety codes, guides and manuals prepared for siting, design, construction, operation, quality assurance and decommissioning/life extension of plants.
- The BARC Safety Council maintains its regulatory function to ensure the safety of all facilities under its purview. A comprehensive programme

on radiation protection services covering all installations in power, medicine, agriculture, industry, environment, and human resources development is being carried out by the DAE with full government budgetary support and commitment.

- The Indian Association for Radiation Protection, established in 1968, promotes safety in the various uses of ionizing radiation in India.

A network of 18 Emergency Response Centres (ERC) with skilled Emergency Response Teams (ERT) comprising the Aerial Survey Team (AST), Field Monitoring Team (FMT), Source Recovery Team (SRT), Assessment and Advisory Team (AAT), Medical Team (MT) and Bioassay Team (BT) has been established in different parts of the country, including BARC (Mumbai) as the nodal agency. In case of any such incident, an urgent response would be extended after conducting a Quick Impact Assessment (QIA) with the use of Impact Assessment Software (IAS) especially developed in BARC to predict the impact. As per the arrangement, the ERC nearest to the site of such an incident will be activated by the centralized Emergency Communication Room (ECR – Mumbai) of the Crisis Management Group (CMG) of the DAE, on receipt of confirmation. The CMG coordinates between the various state and central agencies to facilitate an effective response to such emergencies. During the past few years, the first-responders – custom officials, police, fire brigade personnel and paramilitary forces – are being trained to handle radiological emergencies. State of the art monitoring systems and methodologies are developed and kept prepared in various parts of the country. Systems that have already been developed by India are:

- Aerial Gamma Spectrometry System (AGSS) which can be installed in an aircraft for quick impact assessment by aerial surveys: Aerial Monitoring Methodology is developed for the quick assessment of large scale ground contamination for locating and identifying radioactive orphan sources, and tracking of radioactive plume.
- Environmental Radiation Monitoring with Navigational Aid (ERMNA) system for periodic mobile radiation monitoring of major cities and Emergency Planning Zones (EPZ) of nuclear power plants to generate baseline dose rate data.
- Compact Aerial Radiation Monitoring System (CARMS) for remote aerial monitoring.
- Environmental radiation monitoring systems (Indian Environmental Radiation Monitoring Network-IERMON) with data transfer facilities to Emergency Response Centres.

To carry out effective counter-measures and rescue operations during any emergency, the Geographical Information System (GIS) developed by Indian scientists can be used to obtain the details of the shelter locations, road network, buildings, population density, water bodies, agriculture, etc. of an affected area to initiate urgent protection actions. Mapping of the contaminated area based on an aerial survey using advanced software and satellite imagery, would be very effective for the quick implementation of countermeasures. Environmental radiation monitoring is conducted by state of the art systems, like CARMS, ERMNA, AGSS, and so on, by aerial survey, sea, road and rail routes. Till March 2007, at least 13 major aerial surveys have been conducted on different cities across India. Other countermeasures devised to reduce probable consequences are: iodine prophylaxis, sheltering, decontamination, access control,

evacuation, restriction of the consumption of potentially contaminated foodstuffs, agricultural countermeasures, permanent relocation, and so on.

Indian scientists have designed a few "prototype nuclear shelters" that are self-contained units with sleeping bunks for around 30 people, equipped with captive power and water supply systems. Also keeping in mind a nuclear eventuality, the Indian government has planned to construct underground shelters, equipped with electronic networks, at different locations in the country. Equipped with nuclear warheads on long-range surface-to-surface ballistic missiles, they will be directly linked to a central command of the Nuclear Defence War Council (NDWC). Using secret electronic codes, these are intended to instantly unleash retaliatory nuclear strikes. However, the cost of nuclear a shelter is very high and it cannot be produced on a mass scale. The legal-technical mechanisms that are available may not serve the purpose unless they are accompanied by an efficient implementation process.

VI
WHAT MORE SHOULD BE DONE?

Form a legal point of view, India requires legislation in the realm of a national Nuclear Technology Management Act, containing clear guidelines for nuclear disaster management. The Atomic Energy Act provides only broad outlines on the management of national atomic resources and the emerging challenges related to terrorism need to be addressed. Though the Disaster Management Act of 2005 embodies provisions for managing nuclear disasters, a dedicated policy framework with a supporting infrastructure for managing nuclear disasters would provide an efficient response and expertise in meeting the challenges.

During India's ambitious expansion of its nuclear enterprise, India must ensure credibility by reassessing its current security practices. The assessment must reflect new challenges posed by terrorist threats, such as including a paramilitary guard force and a personnel reliability programme.

India also needs to master a credible "attribution capability" to identify the source of the threat. To dispel public misperception, a credible Nuclear Information Management (NIM) programme needs to be devised to disseminate unbiased information regarding nuclear activities. Most importantly, the readiness of the medical establishment and equipment at their disposal requires urgent attention. The recently organized training programme by the NDMA and DRDO for medical, paramedical and nursing staff to deal with chemical, biological, radiological and nuclear disaster is a timely action. It needs to be understood that the nuclear discourse concerns politics rather than science, psychology rather than physics; therefore, any effort to arrest the possible chances of a nuclear terror incident must be all inclusive.