Chemical, Biological, Radiological and Nuclear (CBRN) Disaster Management: Indian Perspective

A Dissertation submitted to Panjab University, Chandigarh for the award of Master of Philosophy in Social Sciences, in Partial Fulfilment of the requirement for the Advanced Professional Programme in Public Administration (APPPA)

By

Brigadier Amandeep Singh Randhawa

(Roll Number 4426)

Under the guidance of

Prof. Vinod K. Sharma

44th ADVANCED PROFESSIONAL PROGRAMME IN PUBLIC ADMINISTRATION (2018-19)

INDIAN INSTITUTE OF PUBLIC ADMINISTRATION

NEW DELHI

CERTIFICATE

I have the pleasure to certify that **Brigadier Amandeep Singh Randhawa** has pursued his research work and prepared the present dissertation titled "**Chemical, Biological, Radiological and Nuclear (CBRN) Disaster Management: Indian Perspective**" under my guidance and supervision. The dissertation is the result of his own research and to the best of my knowledge, no part of it has earlier comprised any other monograph, dissertation or book. This is being submitted to Panjab University, Chandigarh, for the purpose of Master of Philosophy in Social Sciences in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration of the Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of **Brigadier Amandeep Singh Randhawa** is worthy of the award of M.Phil degree of Panjab University, Chandigarh.

(Prof. Vinod K. Sharma)
Indian Institute of Public Administration
I.P. Estate, Ring Road
New Delhi-110002

Date:
Place: New Delhi

ACKNOWLEDGEMENTS

I wish to place on record my sincere gratitude to IIPA for giving me this opportunity to research and write this dissertation, which has immensely increased my awareness about the subject.

I am indebted to Prof Vinod K. Sharma, leading expert on disaster management, for support and valuable guidance at every stage of my dissertation work. He was the inspiration behind my taking up the subject of CBRN Disaster Management for my dissertation.

I am also grateful to the staff of APPPA Office for their positive and timely administrative support.

March 2019

Brigadier Amandeep Singh Randhawa
Roll Number: 4426

DECLARATION

I, the undersigned, hereby declare that this dissertation entitled, "**Chemical, Biological, Radiological and Nuclear (CBRN) Disaster Management: Indian Perspective**", is my own work, and that all the sources I have accessed or quoted have been indicated or acknowledged by means of completed references/bibliography. The dissertation has not been submitted for any other degree of this university or elsewhere.

March 2019

Brigadier Amandeep Singh Randhawa
Roll Number: 4426

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER - I

INTRODUCTION, LITERATURE REVIEW AND METHODOLOGY

Introduction

India has been, and continues to remain one of the most disaster prone countries in the world. Over a period of time, especially after the enactment of Disaster Management Act (2005) and constitution of National Disaster Management Authority (NDMA), disaster response mechanisms, both at the centre and the state level have improved significantly. In the last decade, with raising of National Disaster Response Force (NDRF) battalions under a clearly defined hierarchy, India has been able to streamline and strengthen the disaster response mechanism. The disaster relief operations in J&K, Uttarakhand, Odisha and Kerala amply demonstrate the enhanced capabilities of the NDRF battalions, although, significant assistance is still required from the Armed Forces to deal with large scale disasters.

However, the capability, experience and the expertise is generally limited to responding to natural disasters like floods, cyclones, earth quake, droughts and fires, and does not extend to mitigating or responding to a disaster caused by a Chemical, Biological, Radiological and Nuclear (CBRN) incident. Bhopal Gas Tragedy, the largest industrial disaster ever, caused by leakage of a deadly gas, ought to have set alarm bells ringing in the government hierarchy, but after some immediate fire fighting, has slipped out of the mind space. The near nuclear and radiological disaster at Fukushima caused by a Tsunami has focussed attention on this neglected domain. However, the voids and challenges in the CBRN response capability of the Armed Forces and the NDRF are conspicuous. These capability voids, coupled with lack of well considered threat perception, vulnerability matrix, coordinated strategy and lack of domain expertise in the disaster response hierarchy, will adversely impact a synergised response to a disaster caused by a CBRN incident. It is

therefore imperative that all dimensions of CBRN disaster & response are holistically analysed to deduce an effective response mechanism.

While Indian society in general is attuned to occurrence of natural disasters and their aftermath, public reaction to a CBRN disaster is likely to be significantly more paranoid and fearful. Likelihood of panic and fear spreading in the public will be much more than what follows a natural disaster. Lack of knowledge about CBRN disasters, leading to the fear of the unknown is a recipe readymade for wide spread panic and paranoia in the society. Therefore, there is urgent need to educate the public in general about the probability of occurrence of CBRN disasters, their likely fallout and the precautions to be taken. In sum, public needs to be made aware and educated about CBRN disasters.

Disasters occur when a trigger event, a hazard (earthquake, cyclone, flood, industrial accident, act of terrorism, nuclear explosion, spill and so on) drastically affects human population. Most disasters have common characteristics – they lead to disruption of normal activity pattern of societies, they result in a degree of loss (human, material, economic and environmental) and they often outstrip the ability of the affected societies to deal with the problem themselves without resorting to external help. Though efforts of the NDMA to increase awareness and strengthen disaster preparedness in the country have been somewhat successful, much remains to be done to make India disaster resilient.

Our approach to disasters has generally been reactive, focusing on post disaster relief and rehabilitation. Less attention was paid to prevention, mitigation and preparedness, although, to its credit NDMA has worked hard to change this. It is possible to reduce vulnerability by instituting adequate mitigation and preparedness measures. It is important that adequate pre-disaster preparation/actions are taken by various agencies involved in provisioning and execution of aid. The term ‘CBRN Defence’ is being increasingly used in

reference to CBRN passive protection, contamination avoidance, and CBRN mitigation. The Mayapuri Cobalt-60 radiation exposure incident in March 2010 that resulted in seven radiation injuries and one death highlighted the gaps in the knowledge, infrastructure and legislation in handling radioactive materials.

Other than the war time use of nuclear weapons in the Second World War, there have been a few nuclear disasters around the world; two prominent ones being the Three Mile Island incident in Pennsylvania, USA (28 March 1979) and Chernobyl disaster in Ukraine (26 April 1986). Both these nuclear accidents started as a result of minor technical failures, which were accentuated into disasters due to human errors or wrong perception and reading of the situation. The one in India at Kalpakkam Nuclear Reprocessing Plant, Tamil Nadu on 21 January 2003 was reportedly successfully contained and a major disaster averted. (Subramaniam 2003) The reverberations of Fukushima were immediately felt in India, with the government ordering a safety audit of all nuclear plants and agencies elucidating upon the pros and cons of nuclear energy. India has numerous industries producing toxic and dangerous chemicals and gases as by-products and a small accidental discharge or leakage of may result in significant number of casualties; the Bhopal Gas Tragedy is a case in point. Since the probability of a worldwide nuclear war has receded after the breakup of the Soviet Union, devastating impact of a nuclear disaster has slipped out of the mind space of the general population. However, with the proliferation of the nuclear technology, the chances of a localised nuclear accident taking place nearer home have multiplied. With easy access to nuclear know-how, possession of a crude radiological dispersal device or 'dirty bomb' by terrorists/ militants is theoretically, a possibility.

The bombing of Hiroshima and Nagasaki had come as a major surprise to the international community because the massive destructive capacity of the atom was only fictional before that. Today, with technological development outpacing security preparedness,

it is becoming increasingly difficult for a country to undertake correct threat assessment. (Tiwari 2012) While the state's security is relatively assured with the obsolescence of major wars, the non-state actors are using innovative techniques to spread panic through acts of terrorism. It is a well known fact that in the past terrorist groups have tried to gain access to the CBRN means to spread terror. The threat of proliferation of weapons of mass destruction (WsMD) to terrorist organisations and rogue states that support terrorist proxies is a major challenge for the international community. India shares global concern on nuclear terrorism and clandestine proliferation, which pose serious threat to international security. (pmo.in 2012) In addition to the radiological threat, India faces major challenges with respect to chemical and biological disasters too.

Each component of the CBRN disaster response requires specialised domain expertise, equipment and training. Threat perception and probability of a CBRN incident has to be mapped for different regions before capabilities are built and resources deployed accordingly. It is imperative that the current status of CBRN disaster response in all its' dimensions is holistically analysed, shortcomings deduced, measures to address these identified, capability and capacity developed and deployed.

Operational Definitions (UNO 2016)

- **Accident** An undesirable or unfortunate event that occurs unintentionally arising from carelessness, unawareness, ignorance, system failure or a combination of these causes which usually leads to harm, injury, loss of life, livelihood or property or damage to the environment.
- **Contamination** Radioactive substances (in the form of dust, dirt, liquid) deposited on surfaces (e.g., skin, walls, etc.), or within solids, liquids or gases where their presence is normally neither expected nor desirable.

- **Disaster** When the dimension of an emergency situation grows to such an extent that the impact of the hazard is beyond the coping capability of the local community and/or the concerned local authority.
- **Emergency** An abnormal situation or event that necessitates prompt action, primarily to mitigate the impact of a hazard or adverse consequences on human health and safety, quality of life, property or the environment. This includes nuclear and radiological emergencies and conventional emergencies such as fire, releases of hazardous chemicals, storms or earthquakes. It includes situations for which prompt action is warranted to mitigate the effects of a perceived hazard. Normally, in such an emergency, the impact of the hazard is within the coping capability of the administrative authority of the affected area.
- **Emergency Preparedness** To develop the capability during normal conditions to take action for utilising all available/mobilised resources that will effectively mitigate the consequences of an emergency and ensure safety and health of the people, quality of life, property and the environment.
- **Emergency Response** Actions under conditions of stress created by an emergency, to mitigate the consequences of the emergency on the safety and health of the people, their quality of life, property and the environment. It may also provide a basis for the resumption of normal social and economic activities.
- **Disaster Risk Management** Disaster risk management aims to decrease the vulnerability by adopting prevention and mitigation measures to reduce the physical impact and to increase the coping capacity and preparedness of the community, in addition to response once the disaster has occurred.
- **Disaster Risk Assessment** A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of

vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment.

- **First Responder** The member of an emergency service to arrive first at the scene of an emergency to provide rescue and relief operations.
- **Response** The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration**.**
- **Reconstruction** Reconstruction means construction or restoration of any infrastructure or property after a disaster.
- **Rehabilitation** Decisions and actions taken after a disaster with a view to resettle and improve the pre-disaster living conditions of the disaster stricken community.
- **Recovery** Rehabilitation and reconstruction together constitute recovery and include all decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. It affords an opportunity to develop and apply disaster risk reduction measures.
- **CBRN** These are weaponized or non-weaponized Chemical, Biological, Radiological and Nuclear materials that can cause great harm and pose significant threats in the hands of terrorists. Weaponized materials can be delivered using conventional bombs (e.g., pipe bombs), improved explosive materials (e.g., fuel oil-fertilizer mixture) and enhanced blast weapons (e.g., dirty bombs). Non-weaponized materials are traditionally referred to as Dangerous Goods (DG) or Hazardous Materials (HAZMAT) and can include contaminated food, livestock and crops. (CEEP)

- **CBRN Incident** An accidental CBRN incident is an event caused by human error or natural or technological reasons, such as spills, accidental releases or leakages. These accidental incidents are usually referred to as DG or HAZMAT accidents. Outbreaks of infectious diseases, such as SARS, or pandemic influenza are examples of naturally occurring biological incidents.

- **Yield** The energy released in a nuclear weapon explosion is called ‘yield’, which is usually measured in kilotons or megatons of TNT equivalent. One ton of TNT releases 4.2 billion joules of energy on detonation.

Statement of Problem

The Disaster Management Act (2005) has led to the raising of the NDMA at the apex & NDRF battalions at the execution level. As a consequence of the same, response mechanism to natural disasters has been streamlined and has improved significantly. However, preparedness to deal with CBRN disasters, in terms of trained manpower, specialised equipment and other resources still remains questionable. The Bhopal Gas Tragedy, Ebola outbreak in Africa, Chernobyl & Fukushima nuclear incidents are relatively recent examples of the devastating aftermath of CBRN disasters. With India's renewed thrust towards nuclear energy, ever expanding industries using Toxic Industrial Chemicals / Materials (TICs & TIMs), unstable internal and external security situation & potential outbreak of deadly viruses like Ebola & MERS Co-V, is a pointer to a potential CBRN disaster in the making.

Although India has been able to chart a workable roadmap to deal with natural disasters, the existing CBRN disaster response mechanism is inadequate and does not cater adequately for the envisaged CBRN threats. India is a fast developing globalised industrial

economy with volatile internal & external security environment and probability of a CBRN incident remains relatively high, even in peace time. Probability of a CBRN disaster unfolding in India is increasing by the day, whereas, society in general remains oblivious to the threat.

The need for prevention, preparedness and effective response to effectively deal with a CBRN disaster cannot be over emphasized. It is imperative to assess and analyse the probability of a CBRN disaster in India, analyse the envisaged impact, identify the inadequacies of existing response mechanism and recommend measures to address the same.

Objective of the Study

The objective of this research is to identify the critical voids in the CBRN disaster management preparedness in respect of all stakeholders: Political and administrative executive, NDMA, NDRF battalions and the Armed Forces. After identifying the critical voids, study would recommend restructuring of existing resources and measures for capacity building & capability enhancement for a synergised and effective response.

Research Problems

- What is the probability of occurrence of CBRN disasters in India?
- What kind of destruction is anticipated in a CBRN disaster?
- What are the stated / envisaged roles & responsibilities of various stakeholders in the response mechanism to a CBRN disaster?
- What are the shortcomings in the existing levels of preparedness to cope with a CRBN disaster?
- What capability and capacity enhancement is required for an effective response in a CBRN disaster?

Limitations of the Study

The study will be limited to disaster responses to a CBRN incident in a non combat environment in India, that is, CBRN incidents that occur during peace time and not those that are deliberate acts of a conventional or nuclear war. However, deliberate acts to initiate CBRN incidents, specially a radiological incident (the so called dirty bomb) by non state actors or terrorists will be covered by the study. Due to paucity of time, there will be no field visits outside the NCR. Data collection will be restricted to secondary sources and opinions and views of the domain experts will be obtained through unstructured interviews and interaction.

Literature Review

Though there is enough literature on Disaster Management but very few books and research articles are available on CBRN Disaster Management. Some of the books / articles that have been reviewed are as follows:-

- **Silent Warfare: Managing NBC Disasters** covers the general and specific threat perception including the threat posed by non state actors. The author also analyses the existing response mechanism and recommends certain measures to address the shortcomings in the then existing setup. The author concludes that CBRN threats, though improbable, are in realms of reality and preparedness levels are, at best, rudimentary. The book was published prior to the enactment of Disaster Management Act (2005) and does not encompass the progress made thereafter. (Dar 2005)
- **Development of Integrated Disaster Management System in India: Importance of Reliable Information** discusses the role of National Institute of Disaster Management in the fields of training, research, education and institutional cooperation. The author concludes that availability of information and its'

promulgation to the decision makers is a key ingredient for an effective disaster response mechanism. Therefore, there is a need for compilation and promulgation of disaster response resource inventory as an integrated information system. This book too predates the Disaster Management Act (2005) and does not encompass the systems put into place thereafter. (A. K. Sinha 2003)

- **The Bhopal Saga** covers the prevent, incident and post event phases of the Bhopal Gas Tragedy. Safety violations at the plant, lack of education and training of the staff/workers and non compliance to the standard procedures are identified as main reasons for the incident that morphed into a big chemical disaster. The author also analyses and recommends certain actions to prevent and efficiently manage such disasters in the future. The book lays far too much stress on the economic and social impact of the disaster and does not adequately address the technical response mechanisms to deal with such disasters. (Eckerman 2005)

- **The Social Impact of Chernobyl Disaster** deals with the consequences of the Chernobyl Nuclear Disaster. It analysis how the Soviets handled the impact programme. The conclusion is very obvious: Nuclear power industry should keep safety as an overriding factor; even at the cost of political and economic consequences. Though relevant, book has limited lessons for the Indian scenario. (Marples 1998)

- **Safety Evaluation of Nuclear Power Plants post Fukushima Accident** is a study of the Fukushima incident by the Nuclear Power Corporation of India ltd (NPCIL) to draw out lessons for India. The report concludes that complete loss of on-site power at the Fukushima Nuclear Power Plant resulted in non removal of decay heat removal on shut down. The report, rather optimistically, concludes that Indian nuclear power plants are equipped to deal with complete power shut down

emergencies. This is an overtly optimistic view of the robustness of the safety procedures and mechanisms at the Indian nuclear power plants. The report also fails to analyse the effective post incident response by the Japanese and hence misses out on certain important lessons. (NPCIL 2012)

- **CBRN and Hazmat Incidents at Major Public Events: Planning and Response** addresses the measures to minimise the possibility of a HAZMAT incident at public events, incident response including initial response detection and identification, and law enforcement. Author discusses fourteen specific scenarios and concludes that it is far more useful to analyse the HAZMAT threat environment from the viewpoint of actual impact on people and property than to plan for specific categories of biological and chemical agents. Though the book is useful reference in general, it is not India specific. (Kaszeta 2012)
- **Disaster Management: The WMD Dimension** describes scenarios wherein a WMD can be used by state or non state actors especially in the Indian context. The author traces the history of organisational arrangements in India to manage such disasters and their adequacy. The book concludes that though a national policy is in place, implementation is questionable. Society as a whole continues to remain oblivious to such a threat scenario. The book fails to recommend an institutionalised and comprehensive response mechanism to deal with such disasters. (Chari 2008)

Research Methodology

The research on the subject has been carried out in two parts: Analysis of CBRN threat perception & its manifestation in India's context and identification of existing voids in CBRN Disaster Management. Consequently, executable actions for various stakeholders including the armed forces have been recommended.

Organisation of the Dissertation

The research design is as under:-

- **Chapter I – Introduction, Literature Review and Methodology** covers the aim of the research and highlights the research problems, scope of the research and review of selected literature on the subject.
- **Chapter II - India's Vulnerability to a CBRN Disaster** covers some historical CBRN incidents to include the lessons learnt. The chapter also delves into the vulnerability of India to a CBRN disaster in the contemporary scenario in view of the developments in CBRN fields. The chapter also covers the CBRN threat posed by the non state actors. The vulnerability assessment of our nation to each of these disasters has also been analysed.
- **Chapter III - Manifestation of a CBRN Disaster** focuses on detailing the potential damage at vulnerable locations based on the existing research data and hazard templates.
- **Chapter IV - Multi Agency CBRN Response: Coordination & Inter/Intra Agency Operability Issues** brings out inter operability challenges amongst NDRF, SDRF and Armed Forces and shortcomings in the existing response system. A Strength Weakness Opportunity Threat (SWOT) analysis of existing stakeholders and their capabilities has been carried out in this chapter.
- **Chapter V – Recommendations: the Way Ahead towards a Synergised Response** covers the recommendations to overcome the said shortcomings. A model for raising dedicated CBRN units in the Armed Forces has been suggested to effectively deal with CBRN disaster management.

CHAPTER II

INDIA'S VULNERABILITY TO A CBRN DISASTER

India is one of the ten most disaster prone countries in the world. A combination of natural and human induced factors including adverse geo-climatic conditions, topographic features, environmental degradation, population growth, urbanization, industrialization, etc substantiates the same. Almost 58.6 per cent of the landmass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12 per cent of land) are prone to floods and river erosion; of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis. (Management 2003-04 - 2011-12) Around one million houses are damaged annually, compounded by human, economic, social and other losses (A. Sinha 2003).

CBRN Warfare is the offensive use of CBRN material in warfare. This could be in the form of atomic weapons and/or chemical and biological warfare agent dispersal by munitions, rockets and bombs. CBRN warfare was resorted to during both the world wars, Iran-Iraq War and even during the on-going Syrian conflict. While the use of gas in the First World War and atomic bombs in the Second World War is widely known, more recent use of chemical agents has escaped attention of the general populace. Iraqi forces used chemical agents to gas Kurds in North West Iraq and Syrian Regime allegedly gassed civilians in Damascus more recently. The use of chemical and biological agents by states or state actors is now severely restricted due to binding conventions, pacts and treaties. However, threat of use of these deadly agents by dictatorial regimes, non state actors and terrorists, who may have access to these, remains and is a major concern. Presence of terrorist groups in Pakistan and Afghanistan pose a credible threat to India.

Coupled with this is the rapid industrialisation, increased (and mostly uncontrolled) use of chemicals and radiological substances, bio-engineering and genetic research, disregard

to waste disposal norms (industrial and medical) and gross public and administrative apathy to rising threats. Industries, especially Chemical, Petrochemical, Paint, Fertilizer and Pesticide industry, use highly toxic chemicals which can by themselves be used or can form precursors to lethal chemical warfare agents. It is incumbent on these industries to put procedures in place and ensure that chemicals being used have the necessary clearances from the authorities, proper secure storage is catered for and waste material is disposed off as per environmental norms under proper supervision. Pilferages, accidents and spillages/overruns must be reported and investigated and necessary safety equipment, response plans and medical aid catered for.

The Fukushima disaster has clearly demonstrated that natural disasters can no more be viewed in isolation. The tsunamis, cyclones and earthquakes can trigger a CBRN incident in a nuclear power plant or a chemical / biological research facility. CBRN threat can also manifest itself, either as a well coordinated deliberate attack or an unintentional accident at one of the nuclear power plants or research facilities. While, the former will be a deliberate act of terror & is steadily gaining on the probability curve, the latter, is being increasingly compensated by high end safety mechanisms & foolproof technologies. Whatever be the primer, both will be equally devastating. (Dar 2005)

Chemical Disasters

Chemical Disasters have been defined as an occurrence including any particular major emission, fire or explosion involving one or more hazardous chemicals leading to serious effects both immediate or delayed,

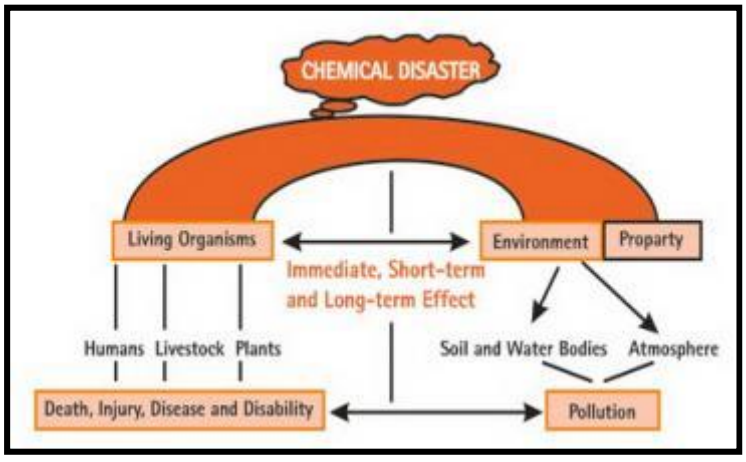


Figure 1 : Short & Long Term Effects of Chemical Disasters

Source : DMI, Bhopal

likely to cause substantial loss of life and property including adverse effects on the environment. (DMI 2010) Accidents involving major hazards could include:-

- Leakage of flammable material, mixing of material with air, formation of flammable vapour cloud to a source of ignition, leading to a fire or an explosion affecting the site and possibly a populated area.
- Leakage of toxic material, formation of a toxic vapour cloud and drifting the cloud, affecting directly the site and possibly populated area.

The Bhopal Saga The gas leak from Union Carbide Plant in Bhopal in 1984 was one the biggest industrial disasters ever experienced. Approximately 5,20,000 people were exposed to the gases of which 8,000 died during initial weeks and more than a lakh suffered permanent injuries. (Eckerman 2005)

Acts of Terror Rightly termed as a poor man's atomic bomb, the chemical paradigm of CBRN offers a viable alternative to terror organisations because they are easy to manufacture, inexpensive, and relatively more stable. Following examples stand out:-

- **The Alphabet Bomber (1974)** Muharem Kurbegovic, known as the "alphabet bomber," threatened to fire chemical-laden artillery shells at Capitol Hill and mailed postcards to each of the nine Supreme Court justices, securing tiny nerve agent filled vials under the stamps. (Simon 2009)
- **The Covenant, the Sword, and the Arm of the Lord (1986)** The Covenant, the Sword and the Arm of the Lord (CSA) was a paramilitary survivalist group in Arkansas. 30 gallons of potassium cyanide was seized from them which they had obtained to poison urban water supplies. (FBI 1986)

- **LTTE** In June 1990, the LTTE used chlorine filled mortar bombs against government troops, marking the first battlefield use of industrial toxin as a weapon by a non-state actor. (Hoffman 2009)
- **Aum Shinrikyo** Japanese extremist group 'Aum Shinrikyo' launched Sarin gas attacks on the Tokyo subway in 1995 demonstrating capability to develop and use of weapon of mass destruction. (NDTV 2018)
- **Halabja Chemical Attack (1988)** Also known as Bloody Friday, it was a genocidal massacre by Sadddam Hussein's Armed Forces against the Kurdish people that took place on March 16, 1988. The attack killed between 3200 and 3500 people and injured 10,000. (Dar 2005)

Bloody Friday : Halabja Massacre

- **Syria** The use of Sarin gas on August 21, 2013 at Damascus, allegedly by Syrian regime forces in the rebel held areas resulted in 1500 fatalities and nearly dragged the US into the Syrian conflict at that time. (News 2013)

Toxic Industrial Chemicals / Materials Toxic Industrial Chemicals and Toxic Industrial Materials commonly referred to as TICs and TIMs are those chemicals which are used in various industries on a day to day basis for legitimate purpose. (ACMT 2008) Apart from being a catalyst for a Bhopal like accident, these are also a potential source for manufacturing a chemical weapon for terrorist groups. Some dual use chemicals are tabulated below:-

Serial No	Chemicals / Materials	Effects	Use
(a)	Acids, Ammonia, Acrylates, Aldehydes and Isocyanates	Irritants	Plastics, Dyes, Inks
(b)	Chlorine, Hydrogen Sulphide and Phosgene	Choking	Insecticides
(c)	Aromatic Hydrocarbons and Benzene	Water Supply contaminants	Paper and Pulp
(d)	Organophosphate	Nerve agents	Pesticides
(e)	Aniline, Nitrile and Cyanide compounds	Chemical Asphyxiants	Dyes, Pigments, Gold recovery

Table 1 : Dual Use Chemicals and Their Effect
Source : The American College of Medical Toxicology (ACMT)

Binary Chemical Weapons These weapons are those that store two inert chemicals as separate precursors, and are made to combine to form the final lethal product, as and when required. These weapons offer following advantages over traditional chemical weapons:-

- Reduced risk during storage, handling and transportation.
- Reduce the threat of exposure due to accidental dispersal of the agent.
- Can be activated with a time-delay mechanism to facilitate the escape of the perpetrator.

From the aforesaid facts it is clear that chemicals in crude form are readily accessible to potential perpetrators as an option in asymmetric warfare against all targets. In addition, the vast quantities of chemicals in various industries and the lack of fool proof safety mechanisms can have potentially catastrophic effects in a developing nation like ours.

India's Vulnerability Assessment

- There have been a number of chemical incidents in the last decade at plants using chemicals or hazardous solutions. Major accidents such as the 1984 Bhopal gas tragedy have brought to light the importance of proper management and procedural action in case of accidents. The Bhopal incident has sharpened awareness to the impact such an event could have and brought about several new initiatives. Post-Bhopal, several legislations in India were amended and introduced to prevent such accidents in the future. Primarily, the Factories Act was amended to make the owner of the factory accountable. However, studies on these issues found that despite these amendments and new legislations, serious incidents have since taken place in India. Inept reporting of accidents has been identified as a major weakness. Thus, while these changes were a good move forward, they did not adequately address the question of security of these materials. Chemicals used in explosives, such as ammonium nitrate, have been smuggled and traded widely by non-state actors and groups with criminal intent. These groups are largely believed to be motivated by economic benefit rather than to use it for triggering a chemical accident. However, in the recent past, several individuals with close linkages to terrorist organisations have been arrested for possessing or supplying ammonium nitrate for criminal purposes. In numerous cases of bomb blasts in India, such as the July 2011 attacks in Mumbai, ammonium nitrate has been used as the basic explosive. Given the increasing number of incidents involving ammonium nitrate, government agencies cracked down on the smuggling rackets which has led to the seizure of vast quantities of material in transportation or storage facilities. In an effort to regulate the availability of ammonium nitrate, the government has classified the chemical as 'explosive'. However, given its large-scale use in the agricultural sector, the government added a

rider to say that ‘its possession and use would invoke penal action only if the composition had 45 per cent or more ammonium nitrate content’. (Industry 2012)

- India, over a period of time has emerged as a leading manufacturer of pharmaceuticals, pesticides, fertilizers etc. It is estimated that several hundred chemical compounds are being synthesised every day. The effect of these compounds on human beings, animals & ecosystem has not been assessed holistically. The fact that many such industries are located close to major population centers highlights the need for adequate mitigation & response measures to avert another Bhopal. The location of major chemical industries & fertilizer industries is depicted below:-

Figure 2: Location of Chemical & Fertilizer Industries in India
Source : Maps of India
https://www.mapsofindia.com/maps/india/chemicalindustries.htm

- **Likely Targets**. The manifestation of a chemical threat is a grave possibility wherein terrorist groups can employ hazardous chemicals to target civil populace with a view to spread panic and terror with impunity. Though, the time and place for such attacks cannot be accurately predicted, shopping malls, metros & railway stations & high visibility events can be the likely targets for such attacks.

Biological Disasters

Definition (NDMA 2009) Biological disasters are causative of process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, social and economic disruption etc. Biological disasters can take either of the following forms:-

- An epidemic affecting a disproportionately large number of individuals within a population, community, or region at the same time like Cholera, Plague, Japanese Encephalitis (JE) etc.
- A Pandemic: an epidemic that spreads across a large region, a continent, or even worldwide of existing, emerging or re-emerging diseases and pestilences, example being Influenza H1N1 (Swine Flu).

There has so far been no major instance of biological terrorism in India. However, there have been frequent outbreaks of diseases, leading to fears that such illnesses could be intentionally introduced by terrorist organisations and that even natural outbreaks demonstrate vulnerability. For example, a sudden hepatitis outbreak in Gujarat in 2009 happened due to the recycling of biomedical waste, leading to a charge of attempted murder. (Seetharam 2009) There have also been instances of food contamination that could have been deliberate and malicious acts. However, it is difficult to verify the exact cause in the case of biological incidents. Lack of evidence in these cases as to the cause, deliberate or otherwise, makes it impossible to definitively categorise these events as threats, but they do demonstrate certain vulnerability.

Types of Biological Agents The biological agents include both microorganisms like bacteria, protozoa, rickettsia, viruses, and fungi and **t**oxins which are produced by these microorganisms, plants, or animals.

Classification of Biological Agents Biological Warfare Agents have been classified on the basis of ease of dissemination, mortality rate, infectivity, transmissibility and possibility of engineering the agent. (Sciences. n.d.)

Serial No	**Cat A**	**Cat B**	**Cat C**
(a)	Easily disseminated, high mortality & high spread	Moderately easily disseminated & low mortality	Agents that can be engineered
(b)	Smallpox, Anthrax, Plague & Botulinum	Q fever, Ricin, Brucellosis & Aflatoxin	Nipah virus & Hantavirus

Table 2: Types of Bio Agents

Source : NIAID, USA

Historical References The following major incidents are highlighted:-

- In 1346, the invading Tartar Army, catapulted the bodies of plague victims into the Crimean city of Kaffa & infected its' citizens.
- Japan contaminated food and released plague infected ticks during their conflict with China in WW II. They even had a dedicated chemical & biological research facility in the form of Unit 731 wherein such agents were tested leading to death of some 10-12,000 people.
- In 1990, Aum Shinrikyo, a religious cult, attacked Japanese and US military sites with Aerosolized Botulinum toxin on at least three occasions. Further, in 1993, they sent a group of doctors and nurses, disguised as a medical mission, to then Zaire

with the purpose of bringing back samples of Ebola virus for weaponization. (Olson 1999)

- In 2001, 11 days after the terror attack on World Trade Centre, cases of anthrax began appearing in US. Altogether, 22 individuals were affected, of which five died. (Landers 2016)

Figure 3: Anthrax Envelopes after 26/11

Source : https://www.smithsonianmag.com/smithsonian-institution/anthrax-letters-terrorized-nation-now-decontaminated-public-view-180960407/

Biological Agents: A Lucrative Option for Terrorists Unlike nuclear & chemical threats, bio agents have some distinct characteristics elucidated as under:-

- **Toxicity** The biological agents are extremely toxic. Type-A Botulinum toxin is ten thousand times deadlier than nerve agents. It is estimated that just eight ounces of the substance could kill every single living creature on this planet.
- **Infectivity** With capability to multiply inside the host, the amount of bio agent required for infecting a person is very small. Moreover, their capability to spread from a person to person makes the containment unmanageable.
- **Incubation Period** (Group 2015) Their long incubation period can enable the perpetrator to safely leave the country or target area.

S.No	Agents	Lethality	Effective Dose	Environment Stability	Incubation Period
(a)	Anthrax	High	10,000-50,000 Spores	Very stable for years	1-6 days
(b)	Plague	High	100-500 Organisms	Stable for 1 year	1-6 days
(c)	Smallpox	High	10-100 Organisms	Very stable	7-17 days
(d)	Ebola Virus	High	10-100 Organisms	Unstable	2-6 days
(e)	Botulism	High	0.001 µg/ Kg Weight	Relatively stable	-
(f)	Ricin	High	3-5 µg/ Kg Weight	Stable	-

:

Table 3: Various Bio Agents and Their Characteristics

Source : Research Paper on Infections: Incubation and Contagious Periods by Summit Medical Group dated 23 Nov 15

- **Multiple Targets - Multiple Modes - Psychological Effects** They are capable of infecting more than one kind of target through more than one mode of entry and compliment this with tremendous psychological impact.
- **Difficult to Detect, Identify or Protect Against** Unlike chemical & nuclear detection instruments, portable & effective bio agent detectors still remain a distant dream.

]

Acquisition of Bio Agents The possible sources of acquisition of these agents are as under:-

- **Stealing from Existing Legitimate Facilities** Some BSL-4 labs across the world are holding strains of all such agents. Such facilities are not as well-guarded as nuclear facilities rendering them vulnerable.

- Buying it either in black market or from illegitimate sources like rogue state or non-state actors.

- **Receiving such Weapons from a Friendly or a Sponsor State** With undisclosed research programs being pursued even by the signatories of existing conventions, the extent of proliferation of the technology involved may never be known.

- **Production** While some technical impediments do exist, a pathogen can be extracted from the environment sources such as soil, water & infected animals. To substantiate:-

    - The most effective and easy-to-use agents like anthrax, plague, brucellosis, and tularemia occur naturally in the environment.
    - Tricothecene is a fungal toxin derived from corn; Aflatoxin is derived from peanuts & Ricin from castor beans.

- **Technological Advancements** It is now possible to synthesize a virus based on genome; and toxins can be produced by adding DNA coding for its production as bacteria.

India's Vulnerability Assessment. While no case of Ebola in India has been reported thus far, courtesy the protective measures in place at the various entry / exit points namely the international airports, India hasn't remained untouched by Bird Flu & Swine Flu viruses. Given the high population density, lack of adequate hygiene & sanitation measures especially in slums within the urban pockets, lack of adequate healthcare facilities and lack of awareness & education make India an extremely vulnerable country to outbreak of an epidemic. (Narain 2013).

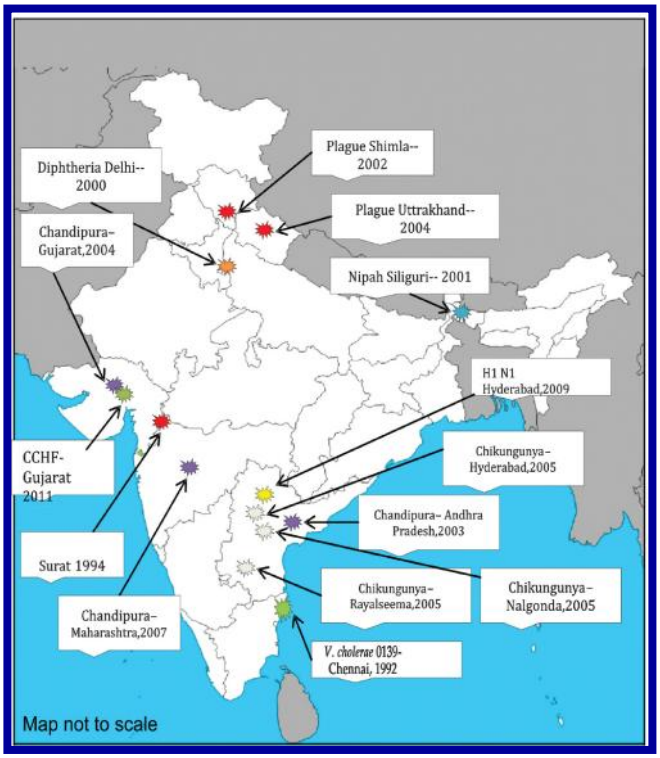


Figure 4:Sites of Re-emerging Infections in India
https://pdfs.semanticscholar.org

Some recent epidemics are highlighted:-

- **Swine Flu**. Commencing in the year 2009 & repeated virtually every year ever since, Swine Flu has claimed significant number of human lives in India. (Ranjan 2015)

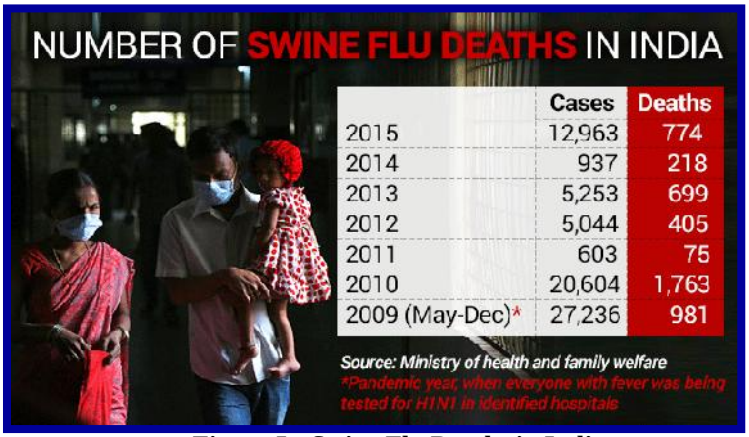


Figure 5 : Swine Flu Deaths in India
Source: Hindustan Times of February 22, 2015

- **Bird Flu** Daily routine came to a standstill in the year 2007 when bird flu was first reported in West Bengal. The pandemic, though controlled at that time, hit West Bengal three more times till 2009. (D. NDTV 2009)
- **Ebola Virus: The Threat in Being** Ebola Virus which is one of the most deadly viruses ever known to mankind is present in Central and West Africa and surfaces occasionally. Passed through close contact with body fluids such as blood, saliva or sweat of infected person, this disease claims lives of 80% of those infected and has caused approximately 14000 fatalities. (WHO 2018)

Nuclear / Radiological Disaster

"As we pursue our national growth objectives to meet the rising aspirations of our people, the supply of affordable clean energy will be one of our foremost national challenges and a key priority for our government. Nuclear energy will remain an essential and increasingly important element of our energy mix. We are in the process of expanding our indigenous Nuclear power programme."

Dr Manmohan Singh, 15 Jan 2013

Definition A nuclear and radiation accident is defined by the International Atomic Energy Agency as "an event that has leads to significant consequences to people, the environment or the facility. Examples include lethal effects to individuals, large radioactivity release to the environment, or reactor core melt."

Past Incidents The most dreaded threat posed by a nuclear reactor is a core meltdown which is characterized by liquidation of highly radioactive fuel rods due to coolant circulation failure. It can kill and injure tens of thousands of people, leaving large regions uninhabitable. The following major accidents are highlighted:-

- **Three Mile Island** The partial core meltdown at Three Mile Island in 1979, led to evacuation of nearly 150000 personnel. (Walker 2006)
- **Chernobyl** On 10 Apr 86, an exponentially large power output lead to the rupture of reactor vessel in Chernobyl which led to a series of explosions resulting in a plume of highly radioactive fallout into the atmosphere and over an extensive geographical area. The following are highlighted (Marples 1998):-

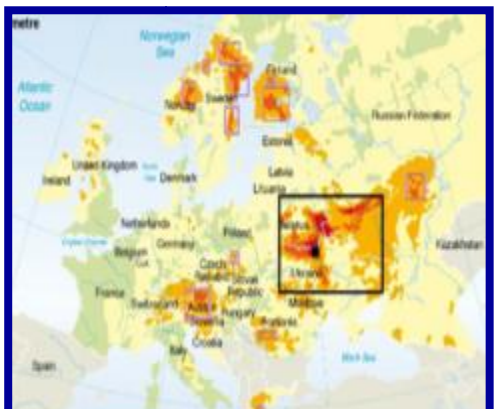


Figure 6: Chernobyl Fallout Across Europe
Source : European Environment Agency

  - The contamination was spread over two lakh square km of area over Western USSR and Europe. Nearly 15,000 died from the direct exposure.
  - Over 1.3 lakh personnel received more than acceptable levels of radiation. Nearly four thousand square km of area was rendered unsuitable for habitation.
- **Goiania, Brazil** (IAEA 1988) In 1985, an unaccounted tele-therapy, containing highly radioactive Cs 137, was stolen by scrap dealers at Goiania, Brazil. They broke open the container unit and released a shiny bluish material. Unaware of the associated dangers, the radioactive material emitting high level of radiation was handled by many, leading to the immediate symptoms. It is a classic example of the contamination of a dwelling area with the radiological dust, which eventually required intensive efforts for decontamination, complete sanitization of the area by excavation, storage and disposal of the radioactive waste and involved a huge monetary loss to the state.
- **The Aum Shrinkyo Cult** As far back as 1992, cult members contacted Russian officials seeking access to advanced weapon technologies and even tried to buy a

nuclear weapon reportedly for US $15 million. (Shukla 2013) The cult recruited two Russian scientists and purchased land in Australia to mine uranium to be shipped back to Japan for enrichment by Aum's scientists and subsequent use in a nuclear device. The group also resorted to computer hacking to obtain information about nuclear facilities in Russia, Ukraine, China, South Korea and Taiwan. Nominated front companies sought to collect information about Japanese nuclear and research facilities to include names of participating scientists. None of these attempts, however, reached a stage wherein the cult was in a position to successfully detonate a nuclear device. (Shukla 2013)

- **Chechen Rebels** In November 1995, a group of Chechen rebels planted a dirty bomb in Ismailovsky Park in Moscow—a 70 pound device composed of Cesium 137 (a compound with radioactive properties which is widely used for cancer treatment) and dynamite with potential to kill few hundreds and injure thousands more. Significantly, the rebels seemed to be interested mainly in creating panic while taking a conscious decision not to detonate the device. According to Brian Michael Jenkins, the rebels did not detonate either because they knew that the device would not work or that it would have little actual effect—it was far more useful as an instrument of terror. The planting of the device was more in the nature of a threat, a calling attention to the cause and not one of actual use. (Shukla 2013)
- **Al Qaeda** While the Al Qaeda has deep-seated nuclear ambitions, there is no evidence of demonstrated success as yet. It was in the 1990s that it first began to explore ways and means to buy a nuclear weapon, acquire fissile material and recruit nuclear expertise. In 1992, Osama bin Laden transferred funds to Sudan's National Islamic Front, seeking laboratory assistance to develop advanced

weapons. Laden's points man on nuclear weapons, Mandoub Mahmud Salim, reportedly offered $1.5 million to purchase enriched uranium in 1993, but was conned with the sale of low-grade reactor fuel instead. In 1996, Al Qaeda tried to recruit a Russian weapons expert without success; in 2001, it successfully recruited two Pakistani scientists to its cause. After the Al Qaeda was forced to flee Afghanistan in November 2001 (consequent to Operation Enduring Freedom), a treasure trove of documents revealing its nuclear intent were recovered from Al Qaeda camps: diagrams, manuals, schematics, target folders, and records of meetings, among others. A detailed examination of the documents, however, revealed that critical steps in the schematics were missing and that they were not credible weapon designs. Writings from the top Al Qaeda leadership are focused on justifying the mass slaughter of civilians, including the use of WsMD, and are intended to provide a formal religious justification for nuclear use. Interestingly, even within organisations like the Al Qaeda, there is evidence of leaders debating the futility of indiscriminate carnage, thereby suggesting that even supposed mad caps impose discrete limits on their indiscretion. (Shukla 2013)

- **Fukushima Nuclear Accident 2011** On 11 March 2011, twenty thousand people were washed away in northeastern Japan by a devastating tsunami just minutes after a 9.0-magnitude earthquake. The meltdown at Fukushima Daiichi Nuclear reactor followed, causing displacement of 110,000 residents and the spread of an invisible radioactive terror across the archipelago. (Samuels 2013)

- **Mayapuri Incident** An old and unused "Gamma Irradiator" of the Delhi University, containing highly radioactive Cobalt 60 was sold to a scrap dealer, who broke open the lead covering, exposing the radioactive source leading to his death & exposure to six others. (Ramachandran 2010) Investigations revealed that

the material had been lying unused in the university premises for 25 years.

- The source, a gamma unit containing Cobalt-60 pencils, was improperly disposed by Delhi University in violation of national regulations for radiation protection and safety of radioactive sources. The unit was sold off to unsuspecting scrap dealers who dismantled the equipment. This event subsequently caused the most severe radiation accident reported in India to date, resulting in seven radiation injuries and one death. (Dev AB 2012)

- Five affected persons suffered from the haematological form of the acute radiation syndrome and local coetaneous radiation injury. While four persons exposed to doses between 0.6 and 2.8 Gy survived with treatment, the patient with the highest exposure of 3.1 Gy died due to acute respiratory distress syndrome and multi-organ failure 16 days after hospitalisation. (Dev AB 2012)

- The incident highlighted the gaps in the knowledge, infrastructure and legislation in handling radioactive materials. Medical institutions need to formulate individualised triage and management guidelines to immediately respond to future public radiological accidents. (Dev AB 2012)

- The incident was reported on April 07, 2010 and the final completion could be done by June 18, 2010, after about 70 days. (Kumar 2014)

- **Lessons Learnt** (Kumar 2014)

    - Negligence on part of the management of the licensee.
    - Non-compliance with the national regulations, possibly because of lack of awareness about the same.

- Unauthorized disposal of radiation source violating statute for safe disposal of radiation sources by the university.
- This incident was an eye opener for users of radiation sources in the country. Academic institutions, regulatory bodies, other concerned agencies and the general public became aware of the devastating effects of a radiological accident.

- **Follow Up Actions** (Kumar 2014)
  - Verification and updating inventory of radiation sources being used in the country has been carried out.
  - Spread of awareness on regulatory requirements by way of issuing notices through print media.
  - Training programmes on safe use and secure management of radiation sources were conducted at various educational and research institutes.
  - Regulatory inspections of radiation facilities have been significantly enhanced.
  - eLORA (e-Licensing of Radiation Applications) system is being implemented by AERB for automation of regulatory processes associated with the use of ionizing radiation in India.
- Whether we learnt our lessons from the Mayapuri incident, and have instituted adequate and effective measures is still open to question. Awareness about the radiological threat posed and the safety measures to be undertaken still remains inadequate. The ‘knowledge’ of the threat is still confined to a select lot of functionaries and has not percolated down to the executive level.

Use of a Nuclear Weapon in War Pakistan has propagated its nuclear red lines to include use of tactical nuclear weapons to counter India’s proactive strategy and conventional capability. Nuclear sabre rattling is now being considered as an accepted norm and part of deterrence strategy by Pakistan. As articulated, possible thresholds of Pakistan to use a

nuclear weapon are space, military, economic strangling and domestic de-stabilization. While the possibility of such use by our western adversary in the hinterland in the wartime scenario seems remote given the possibility of escalation, however the same cannot be completely ruled out. Moreover, it necessitates the necessary preparedness by the Armed Forces.

Probability of use of "Dirty Bomb" by Terrorists/ Non State Actors

The debate in India has generally equated WsMD with nuclear weapons, which is incorrect, since the acronym also includes biological and chemical weapons, and also radiological weapons — the so-called 'dirty bomb.' There is little doubt that the use of nuclear weapons can inflict incalculable destruction instantaneously due to heat, blast and immediate radiation effects. More horrendous is the still uncharted territory of secondary radiation within weeks and tertiary radiation that could last for years after the nuclear incident. The most horrific aspect of nuclear weapons is the largely unknown effects of their use that might be at least of equal importance to their known effects. (Chari 2008) For instance, the breakdown of civil society might lead people to try and survive in near-anarchical conditions. Public health and municipal systems would break down, especially if the first responders become the victims of the nuclear attack, and take weeks to restore. All these possibilities supplemented by studies made and simulation exercises conducted have privileged nuclear disasters over those that might occur due to the use of chemical, biological and radiological weapons.

However, these perceptions have begun to change after 9/11. There is a growing realisation that radiological weapons could become the real WsMD threat since radioactive materials are widely dispersed over research laboratories, hospitals, industrial enterprises and so on, quite apart from their generation by atomic power plants. The Bhopal gas tragedy offers a good example of what might happen after a chemical weapons' attack. The use of

biological or radiological weapons in a WMD mode has not occurred yet, but the probability of their use by terrorist groups remains a threat. In fact the “Doctrine for Sub Conventional Operations” issued by Integrated Defence Headquarters recognises that: “Advances in bio-technology, molecular biology and genetic engineering and the availability of such technology in the public domain would be used with malicious intent to cause widespread panic and breakdown of public health systems.” The doctrine includes biological agents and technologies within asymmetric warfare. A national intelligence estimate in the US has assessed that terrorists have an interest in these unconventional weapons, and specifically that, “the interest the Al Qaeda has shown in WsMD is real and needs to be taken seriously.”

Therefore, there is a need to carry out a detailed analysis of the probability of a WMD disaster and its likely parameters. There are three possible scenarios: an attack could be launched by a state, a non-state actor or by a state equipping a non-state actor-as is possible in South Asia. Are these scenarios unrealistic? By general consent it is believed that state actors are unlikely to use WsMD due to political and strategic implications. There is less assurance, however, that states falling in the genre of ‘states of concern’ or ‘failing states’ might use non-state actors to launch a WMD attack against their adversaries. (Chari 2008) There is little to suggest that non-state actors would eschew WsMD in the knowledge that they are too amorphous to be counter- attacked. In that sense, non-state actors cannot be deterred, since they have no territory or valuable asset to defend that could be placed at risk. There were reports that Osama bin Laden believed the acquisition of WsMD is a “religious duty”, and had threatened to use such weapons. The documents retrieved from Al Qaeda facilities in Afghanistan contained information on CBRN materials. George Tenet, former Director of the CIA, writes in his memoirs that, “ *I am convinced that this is where Osama bin Laden and his operatives desperately want to go…They understand that bombings by cars, trucks, trains*

and planes will get them some headlines, to be sure. But if they manage to set off a mushroom cloud, they will make history."

However the problem of acquiring a nuclear weapon still persists. The only way a terrorist organisation could acquire a nuclear weapon is to either steal one or manufacture one after acquiring weapons-grade fissile material. These are no easy tasks given the tight security surrounding facilities storing nuclear weapons and/or weapons-grade fissile materials. Strategic opinion now has veered to suggesting that a terrorist group intent on using WsMD is unlikely to undertake these onerous exercises, but, instead, acquire radioactive materials, and disperse them with conventional explosives to cause damage and spread panic. The same is true for terrorists using chemical and biological weapons. Though not as effective as a nuclear or a radiological weapon as WsMD, they can be very effective "Weapons of Mass Disruption".

Therefore, CBRN security is a matter of grave concern for many nations today. The increasing sophistication of terrorist incidents, the changing profile of terrorists (including the association of highly-qualified persons with such organisations), the access to know-how through the use of internet, and the globalised nature of terrorism has increased the probability of a CBRN attack. CBRN materials transported across India's borders are closely monitored, but this is not true for their movement within Indian borders. Given that India is battling threats such as terrorist attacks, bombings, insurgency and left-wing extremism probability of a CBRN threat though low, does exist.

Options for Nuclear / Radiological Attack

The nuclear power plants, much like chemical and biological research facilities, serve as a lucrative option for the terrorists. The following options elucidate nuclear terror:-

- **Acquisition of Nuclear Weapon** This can be made possible through acquisition

from a rogue / sponsor state or theft while movement / transfer of such assets.

- **Dirty Bomb** A dirty bomb or Radiological Dispersion Device (RDD)/ Radiological Emission Device (RED) are bombs that combine conventional explosives, such as dynamite, with radioactive materials in the form of powder or pellets. The main purpose is to frighten people and make buildings or land unusable for a long period of time. The function of a dirty bomb is to blast radioactive material into the area around the explosion. Of the various threats being discussed, the threat from terrorists carrying out a dirty bomb attack tops the list in terms of likelihood and impact, with ports, airports, metro, railway network and major marketplaces providing possible target locations. (Rajagopalan 2011) The various options are as follows:-
    - **RDD** It is a conventional high explosive combined with radioactive material, which scatters when exploded. It kills or injures people through the initial blast and also results in spread of radioactivity, sickening people and contaminating large swaths of territory.
    - **RED** This implies placing unshielded radioactive material in hidden location to expose people to harmful radiations. A strong gamma emitting source, if planted in densely a populated area, apart from subjecting the irradiated population to an increased risk of cancer has the potential to sow considerable panic amongst the local populace.
- **Uranium Bomb- Improvised Nuclear Device (IND)** (Shukla 2013)**/** Another option to spread nuclear terrorism is by using an IND**.** The IND can be an illicit nuclear weapon, bought, stolen, or otherwise originating from a nuclear state, or a weapon fabricated by a terrorist group from illegally obtained plutonium or highly enriched uranium that produces a nuclear explosion. Should terrorists be able to

lay their hands on highly enriched uranium (wherein the percentage of the U235 isotope is greater than 20 per cent), they would be theoretically able to make a uranium bomb. The most likely design to be used is gun-type, which employs two hemispheres of Uranium 235 at sub critical level, which fuse together as a supercritical mass with the help of a conventional explosion. Though the design requirements are much simpler, the challenge remains because the quantity of uranium required to make a nuclear device is in the region of a couple of hundred kilograms. Nuclear thefts/losses from nuclear/research reactors have never exceeded a couple of milligrams— access to nuclear fuel by terrorists, therefore, remains a significant challenge.

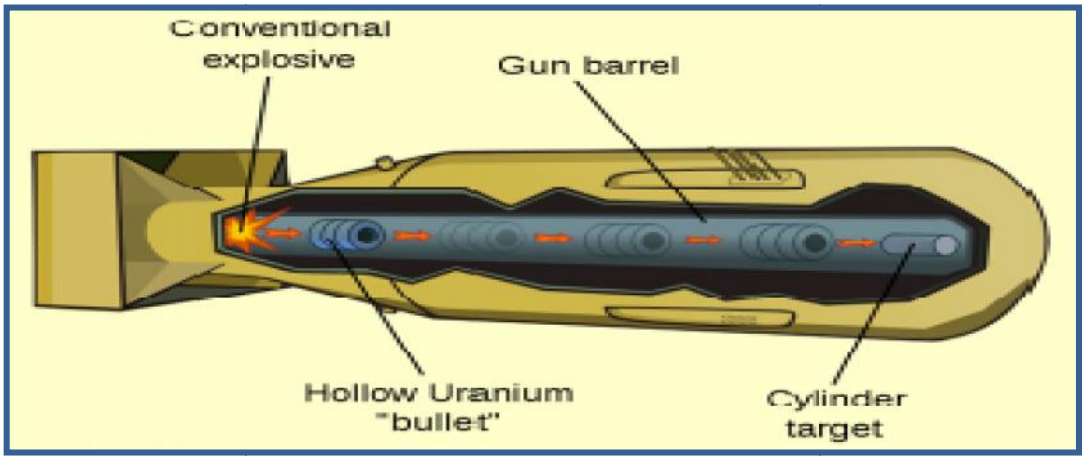


Figure 7: Gun Type Nuclear Weapon
Source : American Nuclear Society - Ansnuclearcafe.org

- **Armed Assault** Another possibility is an armed assault on power stations, industrial facilities and laboratories that handle CBRN materials. Terrorist groups that are active in India, including LeT, JeM and HuJI have demonstrated both the capability and the intent to carry out attacks of this kind. In 2006, the Indian Army deployed special commandos at the Indira Gandhi Centre for Atomic Research, Kalpakkam in Tamil Nadu, after an alert was issued by the intelligence agencies. (The Times of India 2006) Disclosures made by David Headley, the LeT

facilitator accused of aiding the attack, clearly indicated that the terrorist group had shown interest in targeting nuclear installations in India; Headley himself had surveyed some of the installations in Western and Northern India. The armed assaults on Pakistan's naval base at Mehran and air base at Kamra has also strengthened fears in India about terrorist groups' growing ability to target even highly secured CBRN installations.

- **Sabotage** (Shukla 2013) Terrorists could seize and sabotage a nuclear reactor, causing a meltdown and the consequent release of radioactive material. This would, however, require the terrorists to have an intimate knowledge of nuclear reactor operations, expertise, which is not easily available. While a mere rocket attack would cause the nuclear reactor to automatically shut down, the consequences of a large commercial airliner crashing into a nuclear reactor are debatable; however it may be useful here to recall that in 1972, hijackers threatened to crash a hijacked airliner into the nuclear reactor at Oak Ridge, Tennessee, USA.
- **Stolen Nuclear Device** It will be extremely difficult for terrorists to manufacture their own fissile material. State sponsorship is also unlikely because of the grim international consequences. There is widespread speculation, therefore, about the possibility of terrorists detonating a stolen nuclear device. In today's awakened world, with measures like the Nunn-Lugar initiative[1] and measures initiated consequent to the Nuclear Security Summit in Washington in April 2010, the possibility of theft of nuclear devices has reduced significantly. Even if such thefts were to occur, detonating a stolen nuclear weapon would be

[1] Steps taken as a consequence of an initiative launched by American Senators Sam Nunn and Richard Lugar to help the Russian government reduce, consolidate and secure Russia's nuclear arsenal as also provide alternative employment to Russian scientists.

difficult for terrorists since most modern nuclear weapons are equipped with technical safeguards such as electronic locks known as Permissive Action Links (PALs). (Zolotarev 2011)

- **Insider Threat** Since 1993, there have been instances of doctors, engineers and even software personnel being arrested for their links to terrorist groups and the possibility of such men infiltrating sites and facilities containing dangerous materials remain high. While there has been no reported case of an insider sabotage or attack on a CBRN source or laboratory in India thus far, the insider threat remains a serious concern.

Likely Targets (Joesph 2007)

Should terrorists obtain WsMD, how might they employ them? The targets could include:-

- Demonstration targets such as less populated areas to display capability and make demands.
- Actual attacks on establishments which possess CBRN sources so as to cause a release of toxic substances, harmful organisms or radioactivity.
- Attacks on CBRN materials during transportation.
- Attacks on symbolic targets such as government buildings, HQ of a major firm, a place of worship, or a national monument.
- Attacks on centers where urban populations are concentrated, such as shopping malls, airports, railway stations, and markets.
- High visibility events like national games, Summits, Seminars which entail a congregation of high value targets can be subjected to chemical attacks by terrorists. Here, the pepper spray incident of 13 February 2014 is an apt example of the ease with which the Indian Parliament, which is one of the most secure locations in the

country was subjected to such an attack.

Analysis of terrorist incidents reveals preference for crowded areas resulting in maximum casualties, and areas which have the potential to break into violence arising from communal tensions. This is apart from symbolic attacks on symbols of national identity, such as Red Fort or the Indian Parliament. Domed and closed structures would be apt targets too for biological and chemical attacks. Other potential targets could be the newly developed Metro Networks or the increasingly busy and crowded airports. India has not suffered any CBRN incident till today; however, the threat should not be underestimated. Major attacks are hard to carry out owing to technical, organisational and financial challenges, but their consequences can be very serious. On the other hand, relatively minor attacks can also have significant consequences.

India's Vulnerability Assessment

In the 1990s, improper use of X-ray machines led to the staff working at hospitals and educational institutions in Delhi, Mumbai, and Gujarat among others, suffering from radiation burns. Since then, more threatening incidents have emerged in the form of the theft of radiological equipment containing various radioactive isotopes. Examples include recovery of Uranium 235 weapons grade material from criminals in Tamil Nadu in 1998 (Sultan 2001); the theft of more than 8 kg of natural uranium from the Indira Gandhi Centre for Atomic Research (IGCAR) in Chennai (later seized by the Central Bureau of Investigation in 1999); the recovery of 26 kg of uranium from illicit traffickers in Hyderabad in 2000; a gamma radiography camera containing Iridium 192 with an activity of 729 GBq stolen during transportation in Assam in July 2002 (Jalalzai 2015); industrial ionising radiation-gauging device (IRGD/nucleonic density gauge) containing about 9.25 GBQ Cs-137 source, used in a coal washery, stolen on 16 November 2006; the arrest of five people in Meghalaya following

uranium theft in 2008 (Bhaumik 2008); seizure of around 4 kg of low quality uranium after the Bihar police arrested a group of smugglers from the Nepal border in 2008 (Reuters 2008); and 15 disused Cobalt-60 isotopes stolen from the Steel Authority of India Limited (SAIL) Durgapur plant in January 2011. (The Economic Times 2011)

With limited coal & petroleum reserves & heavy dependency on imports, India is exploring alternate sources of energy including nuclear energy to meet its energy requirements.

The vulnerability assessment for India with regards to a nuclear disaster is as under:-

- **Nuclear Power Plants** In its safety evaluation report for the Nuclear Power Plants undertaken post Fukushima accident, NPCIL has highlighted that six Nuclear Power Plants (NPPs) are located in Seismic zones III and above, thus placing them in the criteria of moderate risk. While the NPPs have adequate design provisions to cope up with these events, the possibility of a nuclear accident caused due to either an earthquake or a tsunami cannot be ruled out. (NPCIL 2012)
- **Nuclear / Radiological Terror Attack** Yasin Bhatkal during his interrogation in the year 2013 had revealed that attempts were made to source a '*small*' Nuclear bomb from Pakistan for use at Surat. (Chauhan 2013) With increasing internal turmoil in Pakistan, a Nuclear Weapon falling into the hands of extremist organizations is possible, though not probable. Terror attacks on Sargodha & Kamra Air Bases in Pakistan, where nukes are allegedly stored, have further fuelled this line of thought.

Figure 8: Excerpts of Interrogation of Yasin Bhatkal
Source : Times of India dated December 30, 2013

Summary of CBRN Threat Assessment: The Indian Perspective

In India and the region around it, the factors that may lead to CBRN attacks certainly exist. (Joesph 2007) Both within India and around it, terrorism is ubiquitous; while materials are widely available, though nuclear materials are generally tightly guarded. The potential for CBRN attacks appears to be limited by the fact that most terrorist groups seek to replace the state and hence would be unlikely to find the use of unconventional weapons appealing. There is to date only one case of such weapons being used in South Asia. In 1990, the LTTE attacked a Sri Lankan military base with chlorine gas, which injured sixty soldiers and enabled them to capture it. (Hoffman 2009) However, this was never repeated as the LTTE feared the loss of support from their Tamil supporters in Sri Lanka and abroad. Not all terrorist groups may choose to carry out CBRN attacks. Conventional bombing is less difficult to carry out since explosives are widely available, and the effects sought through terrorist acts would be achieved quite easily. Some groups may have reservations about crossing the WMD threshold as it would alienate the public. Though suicide terrorism changes the calculus somewhat, CBRN materials are hazardous, difficult to handle, and would expose the perpetrators to injury, disease or death.

Externally India faces a structural problem given its location in one of the world's most volatile neighbourhoods in South Asia - which is now the epicentre of Islamist radicalism. Internally, the Indian state due to left-wing extremism and Pak sponsored/home grown radical Islamist organisations is witnessing challenges to its authority. India is gradually emerging both as a target and a recruitment base for organizations like Al Qaeda/ISIS. In the light of the foregoing, Yasin Bhatkal's plans of nuking Surat should not come as a surprise (Chauhan 2013). It might be a hoax but the excerpts of his confession quote him having been assured of a nuclear bomb by his Pakistani handlers. Given the expanse of the nation, populated & countless vulnerable areas, the terror strikes have been carried out at will in the past by home-grown jihadist groups. The results could have been devastating had CBRN means been used at even one of the incidents.

In the keynote address at a National Export Control Seminar at Institute for Defence Studies and Analysis (IDSA) on 18 April, 2012 Foreign Secretary Ranjan Mathai mentioned that 'the danger of terrorists gaining access to WsMD is a facet to this grave threat'.[2] Any WMD attack may not have a major impact at the initial stage, however the long term effects of this can be quite harmful. With the global economic system being increasingly dependent on supply chains, it can have a cascading impact on productivity if transportation networks were to be disrupted. As per International Atomic Energy Agency's (IAEA) report, there have been nearly 300 attempted smuggling incidents of CBRN materials during the last decade. (IAEA 2013) An explicit war may be a distant possibility but the threat of non-sate actors' unleashing a foray of chemical and biological weapons can definitely wreak havoc. Rogue states and regimes out of the Chemical Weapons Convention (CWC) and BTWC need

[2] Keynote Address by Foreign Secretary Sh. Ranjan Mathai at Institute For Defence Studies and Analysis (IDSA) April 18 2012; http:// www.idsa.in /event / Key note Address by Foreign Secretary Shri Ranjan Mathai, accessed on September 15, 2014.

to be therefore brought into the global preventive frameworks. The most recent reference to the possible usage of ‘dirty bomb’ was in the Wiki Leaks reports which hinted that the Al Qaeda was likely to achieve faster results while developing the dirty weapons for possible use against British troops in Afghanistan. (Hope 2011) The CBRN threat remains an important area of concern and therefore, establishment of competent strategic trade control system for the purpose of preventing the spread of WMDs and dual use technologies that facilitate their development is an important requirement. (Kassenova 2012)

The current threat to Indian security is posed by cross-border terror groups and sleeper cells within the country as well as by insider threats. Global precedents from groups like Aum Shinrikyo, Al Qaeda etc suggest that the perpetration of terror incidents requires a strong institutional backing with resources (both material and intellectual), training and sophisticated planning and execution. It is unlikely that even with the requisite motivation, separatist groups, left wing extremists or criminal elements could perpetrate such incidents in the near term. If a module of CBRN terror were included as part of the ‘terror curriculum’ by Pak sponsored terror groups like LeT/JeM and there were sufficient institutional backing to provide the material, then this could become a credible threat. These groups are known to have links with Al Qaeda which has shown interest in acquiring CBRN material. The uncertain political condition of Pakistan, especially along its border with Afghanistan, where Al Qaeda is believed to have established a strong base, is a major source of worry for Indian policy makers. (Sanger 2007) All of these are indirect indicators, but together they do produce a picture that gives rise to concern about the potential for CBRN attacks.

The Pakistan Link Although Al Qaeda has announced India as a target; however, if and when, it embarks on a nuclear venture, it is more likely to pursue targets in USA/Europe. The threat in the Indian context, therefore, flows principally from the prospect of ‘loose Pakistani nukes’ or a home grown cell in India setting off a radiological device or a

crude bomb of 1/10 KT yield. How real is the threat from 'loose Pak nukes'? While the widespread view is that Pakistan's nuclear arsenal is reasonably secure, terrorist attacks on the Mehran Naval Base and Kamra Air Base have renewed concerns. If the country's key military installations are vulnerable to penetration through force, stealth and the exploitation of insider information so could be country's nuclear weapons.

There are a few reassuring features, however, about the Pakistani nuclear security system. It is reliably learnt that not only are Pakistan's nuclear warheads de-mated from the delivery systems, the warheads themselves are disassembled. (Tertrais 2012) Base security at nuclear installations or military bases housing nuclear material is three-tiered, under the command of the Strategic Plans Division (SPD). The first level (or inner ring) is managed by the SPD whose directorate in charge of nuclear security is led by a two star general and is endowed with its own counter-intelligence teams. The second level is physical to include electronic fencing, a web of sensors, and so on. The third level (or outer ring) consists of surveillance and monitoring of suspicious activities around the sites, with ISI involvement. The SPD has set up a 'Special Response Force' to deal with nuclear incidents; it has a system of sensitive material control and accounting which involves regular and surprise inspections. It has adopted inventory systems to track individual components of warheads even as the vehicles and containers used for storage and transportation are theft and tamper-proof. (Tertrais 2012)

Additionally, the Pakistan Nuclear Regulatory Authority (PNRA) created in 2001 has on its roster 200 experts who are in charge of the physical security of fissile material and radioactive sources. The military is intimately involved and the SPD's Director General is a member of the PNRA. A five-year Nuclear Security Action Plan, designed to enhance the safety and security of nuclear material and radioactive sources, has also been put into place by the PNRA since 2006. (Tertrais 2012) Screening checks of personnel associated with

nuclear weapons/installations are stringent—personnel are screened every two years. Screening procedures have been set up to ensure the loyalty and mental balance of personnel serving in the most sensitive positions. Two different programmes exist; a Human Reliability Programme for civilian personnel and a Personnel Reliability Programme for those from the military. The SPD plans to extend these programmes to 10,000 personnel (nuclear scientists, engineers and military personnel) with access to sensitive information. (Tertrais 2012) Modern security safeguards do appear to be in place since Pakistan's nuclear weapons are controlled by a 'code-lock' system and a viable authentication process. Further, it is extremely unlikely that the Pakistani state would deliberately provide a terrorist group with a nuclear weapon since it would run the risk of being discovered and suffer the very grim consequences.

Concurrently, however, there are a few worries. The first and foremost of these is the radicalisation of the lower ranks of the military and the prospect of insider collusion. The second is the well-known embrace of certain anti-India terror groups by the Pakistan Army/Inter Services Intelligence (ISI). If, by a quirk of circumstance, insider collusion by radicalised elements leads to a well resourced and well planned terrorist attack on a nuclear related facility, particularly when Pakistan has mated and readied its nuclear assets, the outcome could be dangerous. Even so, both collusion and physical assault are unlikely to yield a usable nuclear device or manipulable fissile material and the small nucleus of individuals able to collude would be unlikely to cut across every tier of security. There are reports to suggest that Pakistan's black marketers have sold 'nuclear starter kits', including advanced centrifuge components, blueprints for nuclear warheads, uranium samples sufficient for a small bomb, and even personal consulting services to assist nuclear development. (Allison 2006) While this is a worrying development meriting close monitoring and attention, experts are of the view that such an enterprise is ambitious in the extreme; the

huge design challenges associated with successful detonation and the likelihood of detection of collusion (between terror cells and nuclear scientists) will prevent it from attaining fruition.

CHAPTER III

MANIFESTATION OF A CBRN DISASTER

In order to develop capability to deal with a CBRN disaster and incorporate necessary mitigation techniques, it is important to analyse the possible effects and damage from a CBRN disaster. It is equally important to learn lessons from previous CBRN incidents in the world in general and in India in particular.

Effects (Allison 2006) The effects of CBRN attacks are categorized as physical, psychological, economic and socio-political.

- **Physical Effects** (Allison 2006)
    - Chemical weapons can be used to kill and injure people either through direct dispersal (as in the case of the Tokyo Sarin attacks) or in conjunction with bombs (as in the use of gas cylinders in the Iraq war). Powerful chemicals such as Sarin might kill significant numbers of people. According to one estimate, a 300 kg Sarin bomb exploded in a densely populated area would cause approximately 3,000 fatalities and an equal number of injuries. The effects of less complex weapons are generally likely to be comparatively limited owing to dispersal and dilution of the chemical. Nevertheless, the possibilities are significant. The Bhopal gas tragedy of 1984 is estimated to have caused 4,000 immediate deaths and 20,000 long-term deaths (an estimate made in 2005). The physical effects of chemical explosives are well known and need not be recounted here except to emphasise that these are the materials most frequently used to inflict death and injury on large numbers of people.
    - Biological weapons can cause millions of deaths if a deadly contagious virus to which people have little or no body resistance is released. In a

worst-case scenario, 100 kg of anthrax spores air-delivered over an area of 300 sq km could cause 1-3 million fatalities. More realistically, such effects are extremely hard to produce because of the challenges involved, but effects could still be severe.

- In the case of an RDD, the immediate impact would be from the blast effect, which may result in fatalities, with the number depending on the strength of the blast. Intense gamma rays can cause tissue damage and acute radiation poisoning. Low levels of gamma rays can cause genetic mutations leading to cancer. Alpha particles emitted by plutonium and americium cause serious health hazards, especially if these are inhaled for extended periods, causing damage to lung tissue. Longer-term effects are also produced by radiation, e.g., bone, lung, thyroid and liver cancer, in addition to other minor ailments and these effects could be transmitted to the next generation. A nuclear detonation can have very severe effects. One study shows that a 15-kiloton fission bomb dropped on Mumbai may cause from 160,000 to 866,000 fatalities, depending on the exact location of ground zero. A crude low-yield device would have correspondingly lesser effects.

- **Psychological Effects** (Allison 2006) These are likely to affect not only those directly exposed to the attack, but also responders, those in the vicinity and, more generally, the society as a whole. The main problems created are as follows:-
  - Distress responses, such as fear, insomnia, impaired concentration and a range of ailments that fall under the rubric of Multiple Idiopathic Physical Symptoms (MIPS).
  - Behavioural changes, such as fear of travel, increased use of tobacco and

alcohol, and compulsive use of medication.

- Psychiatric illness, notably post-traumatic stress disorder (PTSD), acute stress disorder (ASD) and severe depression.

- **Economic Effects** (Allison 2006) Costs are difficult to estimate. In the case of chemical weapons, some indicators are available in the context of the Bhopal gas tragedy. Initially, the Government of India estimated that the damages due from Union Carbide amounted to $3.3 billion, but eventually the company paid a much smaller sum of $370 million (inclusive of interest). The effects included varying degrees of impoverishment and a general decline in economic activity. The economic effects of a major bio-terrorism attack can be very high, depending on the organisms used. According to one study, this can range from about $477.7 million per 100,000 persons exposed (in a brucellosis scenario) to $26.2 billion per 100,000 persons exposed (anthrax scenario). With respect to radiological terrorism, a US study has estimated that if a typical quantity of americium used for oil well surveys were to be blown up with about half a kilogram of TNT, the cost of decontamination could reach $50 billion. Similarly, a study on New Delhi estimates that as little as nine grams of Cobalt-60 (which could be taken from a single cancer tele therapy unit) dispersed with five pounds of TNT would probably require cleanup covering an area of about two square km. The economic impact of a nuclear explosion, needless to say, would be extremely high. In every case, there will be effects on insurance rates, investor confidence and share markets, depending on the extent of the damage and public perceptions.

Targets (Joesph 2007) Should terrorists obtain WMD, how might they employ them? The targets could include:-

- Demonstration targets such as less populated areas to display capability and make

demands.

- Actual attacks on establishments which possess CBRN sources so as to cause a release of toxic substances, harmful organisms or radioactivity.
- Attacks on CBRN materials during transportation.
- Attacks on symbolic targets such as government buildings, the HQ of a major firm, a place of worship, or a national monument.
- Attacks on centers where urban populations are concentrated, such as shopping malls, airports, railway stations, and markets.
- High visibility events like national games, Summits, Seminars which entail a congregation of high value targets can be subjected to chemical attacks by terrorists. Here, the pepper spray incident of 13 February 2014 is an apt example of the ease with which the Indian Parliament, which is one of the most secure locations in the country was subjected to such an attack.

An analysis of terrorist incidents in the last seven years reveals terrorists' preference for crowded areas, resulting in maximum casualties, and areas which have the potential to break into violence arising from communal tensions. This is apart from symbolic attacks on places like the Red Fort in New Delhi or the Indian Parliament. Market places, especially before religious events, are clearly a target. Since the target location is likely to be Delhi, Mumbai or some other metropolis for high impact, visibility and media attention, there may be a preference for prominent markets places, shopping malls and cinema complexes. Domed and closed structures would be apt targets for biological and chemical terrorism. Another potential target could be the Delhi Metro Network. Among these targets, entering a mall or the Delhi metro could be challenging given the security arrangements in place. An open market, equally if not more crowded, would be an easier target. Till today, no act of CBRN terrorism has occurred in India. However, as noted earlier, the risk should not be

underestimated. Major attacks are hard to carry out owing to technical, organisational and financial challenges, but their consequence can be very serious. On the other hand, relatively minor attacks can have significant consequences.

Stages (Dar 2005) Calculation of the effects of the release of a chemical or biological agent or of nuclear radioactivity can be broken down into several stages:-

- **Stage I - Determination of Source** The first stage is the determination of how much agent or radioactive material has been released. The source could be a nuclear explosion, radiological radiation or intentional/ accidental release of a chemical or biological agent.
- **Stage II - Estimation of Deaths & Serious Injuries** The next stage is the estimation of deaths and injuries due to prompt (immediate) air-blast effects, thermal effects, and initial nuclear radiation.
- **Stage III - Fallout & Spread of Hazard** Radioactive material or chemical/biological agent released into the atmosphere is transported by winds until it settles on the ground. The transport also depends on the details of the terrain, and the material can be affected by temperature, radiation from the explosion, sunlight, atmospheric stability, and so on, during its transport.

Nuclear / Radiological Disaster

Time Domain of Physical Effects Having discussed the possible sources of a nuclear / radiological disaster, there are roughly three phases in the generation of a radioactive cloud, with corresponding time intervals in which the fallout phenomena can occur:-

- **The Early Time (Less Than 20 Seconds) M**ixing of ejecta and entrained sweep-up (dirt, vegetation, and rubble) with fission debris occurs in the fireball in this phase.
- **The Rise and Stabilization Phase (~10 Seconds To 10 Minutes)** The cloud rises and early fallout is produced. The impact is dependent on the local atmospheric profile including temperature, relative humidity and wind speed.
- **The Late Time (10 Minutes to 2 Days)** Wind transport and diffusion, as well as particle size, are major factors for the precipitation scavenging that occurs during this phase.

Fukushima Nuclear Disaster The accident at Fukushima Daiichi Nuclear Power Station on March 11, 2011, did put safety concerns of use of nuclear energy in the public domain. The radiation spread from the accident was detected over a distance greater than 75 km from the reactor site as shown in the figure below. The following lessons can be imbibed from the incident (Mark Holt 2012):-

- IAEA guidelines for improvement of plant structures to keep up with the safety procedures should be made mandatory for all the operational nuclear power plants.
- **Seismic & Tsunami Analysis of the loc of the Nuclear Power Plant**s A seismic analysis of India's nuclear power plants has revealed that while all the existing & proposed nuclear power plants are outside potentially dangerous seismic zones, the same may not be true for a possible tsunami.
- Inherent safeguards & redundancies against contingencies like power blackout, flooding, dysfunctional operating systems etc.
- Rapid evacuation plans of the neighbouring community & alert procedures.

- Strict enforcement of regulatory control & practices.

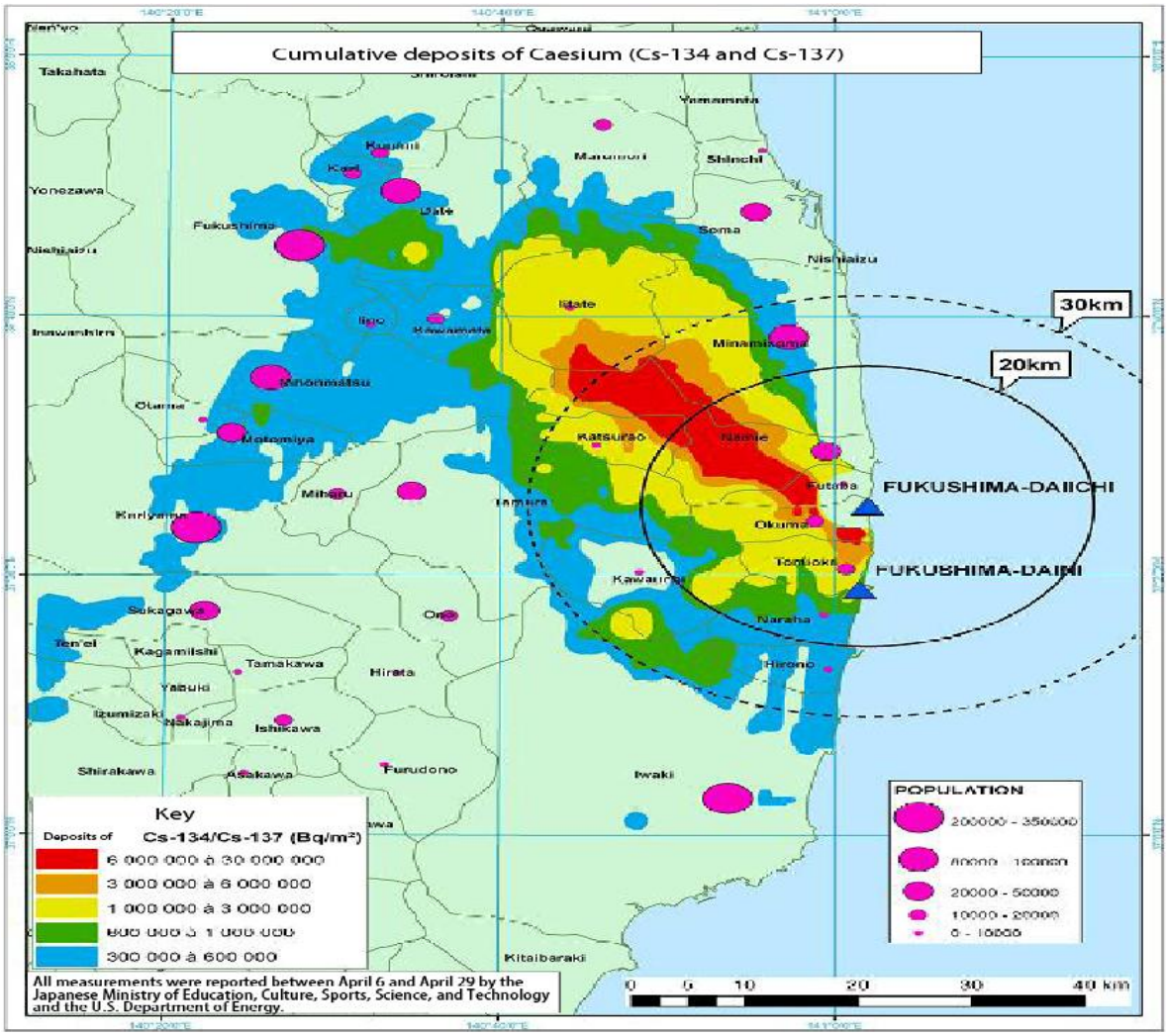


Figure 9: Spread of Radiation from the Fukishama Accident

Source: Institut de Radioprotection et de Surete Nucleaire (IRSN)

Use of a Tactical Nuclear Device The first step in surviving is making it through the initial detonation. A credible threat is a 5 kiloton (KT) pure fission explosion that detonates in a building at a height of 60 m (200 ft). The energy of the explosion is distributed between blast (about 50 percent), thermal radiation (about 35 percent) and ionizing radiation (about 5 percent in the initial burst, and about 10 percent in fallout). The diagram below depicts a sub KT Nuclear explosion. Following are highlighted:-

- **Blast Zone** The inner black circle is the size of the crater, and the red ring marks the edge of the 20 psi overpressure zone, wherein most buildings will be destroyed.

- **Radiation Zone** The green ring marks the zone where an unprotected person will receive a marginally lethal dose of prompt radiation.

- **Thermal Zone** Peach ring, which has a radius of 1 mile (0.62 km), is the region in which second-degree thermal burns are likely.

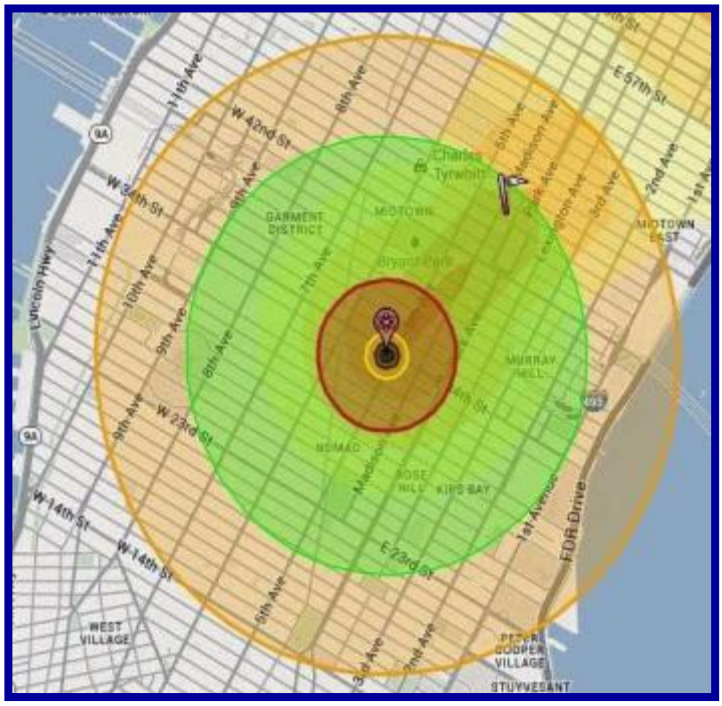


Figure 10: Blast Radiation and Thermal Zones as Depicted after a Nuclear Explosion of 5 KT
Source: http://blog.nuclearsecrecy.com/2012/02/03/presenting-nukemap/

- **Survival Zone** Outside of this region an unprotected person has a decent chance of surviving the prompt effects of the blast, if they don't get hit by debris. (Dar 2005)

- **Fallout** Assuming one has survived these early effects, the next objective is to avoid being killed by radiation exposure from the fallout. Exposure to radiation is measured in a variety of units; here we will use rems (Roentgen equivalent man) and rems/hr. Lethal dose is about 500 rems. The fireball is 760 ft (230 m) in diameter, large enough to touch the ground, producing substantial local fallout. The total amount of radioactive material resulting from a 5 KT explosion is only

about 1 lb (0.5 kg), but that material is extremely radioactive. Over time the radioactivity decays, and eventually the fallout hazard decreases. (Medicine 2005) Assuming a wind speed of 10 mph (16 km/h), the fallout is distributed over a narrow plume, as shown in the figure below. (Youngsoo Choi 2010)

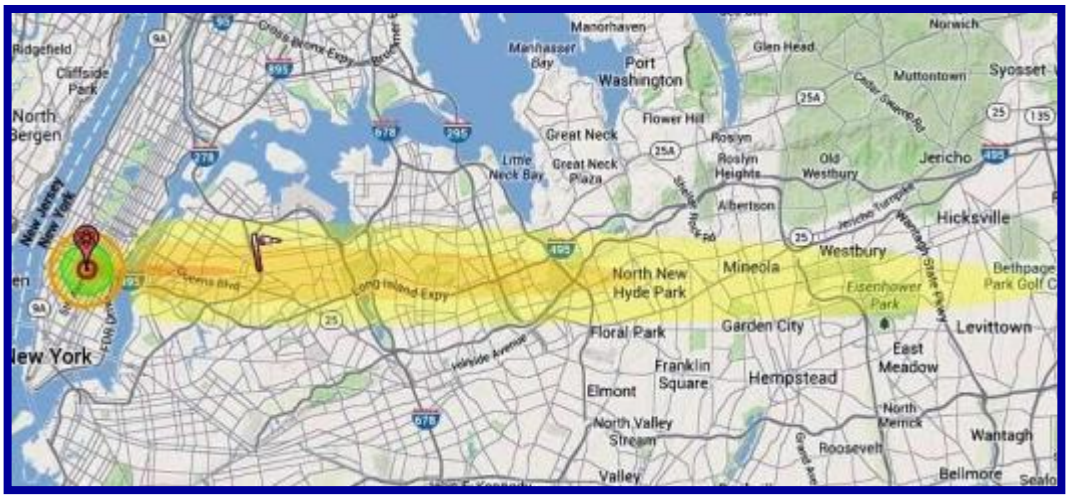


Figure 11 :Range of Nuclear Fallout Over Approx 6 km As Calculated over US for a 5 KT Explosion under Standard Weather Conditions
Source : Analyzing Evacuation Versus Shelter-in-Place Strategies After a Terrorist Nuclear Detonation

Chemical Disaster

Bhopal Gas Tragedy A pesticide factory of Union Carbide located in Bhopal produced carbonate pesticides using Methyl Isocynate (MIC) as a key ingredient. The MIC production unit had been shut down for two months for routine maintenance. (Eckerman 2005) A jumper line was installed several months prior to the disaster to ease routine maintenance of several interconnected lines. Along with another leaky pipe, water was able to pass into tank containing MIC leading to production of chlorine gas expulsion into the atmosphere. An estimated 5,20,000 persons were exposed to the gases and up to 8,000 died in the first week. Nearly 1,00,000 or still more suffered permanent injuries. The following were analysed as the factors of failure (Eckerman 2005):-

- Instrumentation and control devices were inadequate and were not extensive enough.
- Plant safety systems were not designed to meet extreme cases.
- The plant design was severely affected by economic issues.

Mangalore Chemical Accident (Maruthappa 2009) There was a chemical accident in the Urea Plant at M/s. Mangalore Chemicals and Fertilizers Limited, Panambur, Mangalore on 09 Feb 2000. It unfolded as under:-

- An 8" diameter high-pressure pipeline with pressure of 141kg/cm2 and temperature of 180 C was used for supplying solution containing 29% toxic ammonia, 18% carbon di-oxide and 32% of partially toxic urea.
- A substantial quantity of Ammonium Carbamate solution was found leaking on 09 Feb 2000. In attempt to repair, joint gave way resulting in sudden release of pressurized hot Ammonium Carbamate solution. Subsequently out of the eight persons affected, four died.
- Since the solution was primarily liquid in content, the effects were localised. However, if a gas of toxic nature had been released, possibly a Bhopal like situation would have re-occurred.
- **Lessons Learnt** Investigation conducted by the department under the guidance of an expert committee revealed the following:-
    - Structural weakness in the materials.
    - Non adherence to the laid down procedures.
    - Maintenance/repair works should not be undertaken online.
    - Inadequacy of suitable personal protective equipment.
    - Lack of contingency planning and training of personnel in response procedures.

Biological Disaster

Potential Ebola Outbreak & Effects (Qazi 2014) Nearly 45,000 Indian nationals live and work in Guinea, Liberia, Sierra Leone and Congo, the worst Ebola virus affected places. Therefore, India remains at a high risk as an infected Indian national may travel to India and slip in undetected. The following are highlighted to put the threat in correct perspective:-

- The risk multiplies if the infected person travel back India's megacities like Delhi, Mumbai or Chennai.
- India is not adequately prepared to deal with the Ebola pandemic due to inadequate health care facilities to deal with a fast-spreading virus.
- Given the high density of population in large cities, there is every possibility that disease could become a major epidemic.
- Poverty and lack of awareness might also prevent affected people from approaching appropriate medical authorities.
- India's health care system is already stretched to the limit. According to World Bank data, India has one nurse per 1,000 people compared to 1.6 nurses that Nigeria has or 10 per 1,000 in the US.
- Inadequate quarantine facilities.

What is true for Ebola is true for the other biological threats too, especially the ones in which India has no expertise to deal with. Overstretched health care system, lack of awareness and corruption make a good recipe for an uncontrolled spread of a biological disaster.

CHAPTER IV
EXISTING STRUCTURE AND ORGANISATION: MULTIPLE AGENCY INVOLVEMENT & INTER/ INTRA OPERABILITY CHALLENGES

Organisational Setup

Background Prevention, mitigation and preparedness are preferable to response and management. The Government of India has, accordingly, adopted mitigation and prevention as essential policy parameters to promote development strategy. The Tenth Five Year Plan document had a detailed chapter on disaster management, emphasising the fact that development is not sustainable without mitigation being incorporated into the developmental process. All states were exhorted to prepare a scheme for disaster mitigation in line with the approach outlined in the plan. In other words, mitigation was planned to be institutionalised within developmental planning. The Twelfth Finance Commission was also mandated to review the financial arrangements for Disaster Management.

The Government of India's detailed approach to disaster management, which includes WMD-related emergencies, started finding mention in the annual reports of the MHA from 2002 onwards. Planning and coordination used to be undertaken in Disaster Management Cell, which had evolved out of the Civil Defence Organisation (CDO) established before independence. (Chari 2008)It replicated the organisation in UK, and was designed to save life, minimise damage to property and interestingly also to maintain industrial production during war. The border conflict with China in 1962 and the Indo-Pak war of 1965 necessitated fresh thinking on this policy, for which legislation was passed in 1968. Several more CDOs were established, but only in areas assessed to be vulnerable to enemy attack. They were raised primarily on a voluntary basis with a small paid core staff that would be augmented during emergencies. A three-tier administrative set-up was envisaged at the local/town, state and national level. Apart from imparting training and demonstrations, these

CDOs were employed for relief and rescue work during natural calamities like floods, earthquakes, cyclones and drought.

The portfolio (Chari 2008) of “Disaster Management” was transferred from the Ministry of Agriculture that was mainly concerned with providing drought relief, to the MHA in 2002. This change was significant, in that “The focus was now on prevention, mitigation and preparedness to ensure that in the event of a calamity striking, casualties are kept to the minimum and post-calamity response is professional and better organised. For this purpose, a strategic roadmap has been framed.” The mechanisms and capabilities of the Disaster Management Cell were reviewed to deal with different disasters, including WsMD. The policy orientation has changed from “management of damage against conventional weapons to also include threat perceptions against Nuclear weapons, Biological and Chemical warfare and environmental disasters.”

A National Civil Defence College (NCDC) was established to conduct courses in both civil defence and disaster management. Over the years it has become the premier institution for training administrators, civil defence personnel, training of trainers, and conducting courses on disaster management, including “Nuclear/Biological/Chemical emergencies, Incident Command System, first Responder for Biological emergencies and Training of Trainers (TOTs) on Radiological emergencies.” The college is the nodal training institute in India for WMD- related emergencies, and has evolved a first responder training programme for biological incidents to train paramilitary forces to handle biological terrorist incidents since 2005.

On 23 December 2005, the Government of India enacted the Disaster Management Act, which envisaged the creation of National Disaster Management Authority (NDMA), headed by the Prime Minister and State Disaster Management Authorities (SDMAs) headed by respective Chief Ministers to spearhead and implement a holistic and integrated approach

to disaster management in India. DMA provided the framework for a proactive, holistic and integrated approach as opposed to a reactive one. It provided the much needed legal authority to respond and take action as demanded by the situation and was backed by an institutional framework. And, last but not the least, it had what its predecessor organisations did not have viz. financial support by the creation of a Response Fund and a Mitigation Fund. (Chari 2008)

As per provisions of the DMA 2005, NDMA was constituted in 2006. The envisaged vision of the NDMA is "To build a safer and disaster resilient India by a holistic, pro-active, technology driven and sustainable development strategy that involves all stakeholders and fosters a culture of prevention, preparedness and mitigation."

Organisation The present organisation of the NDMA is given below.

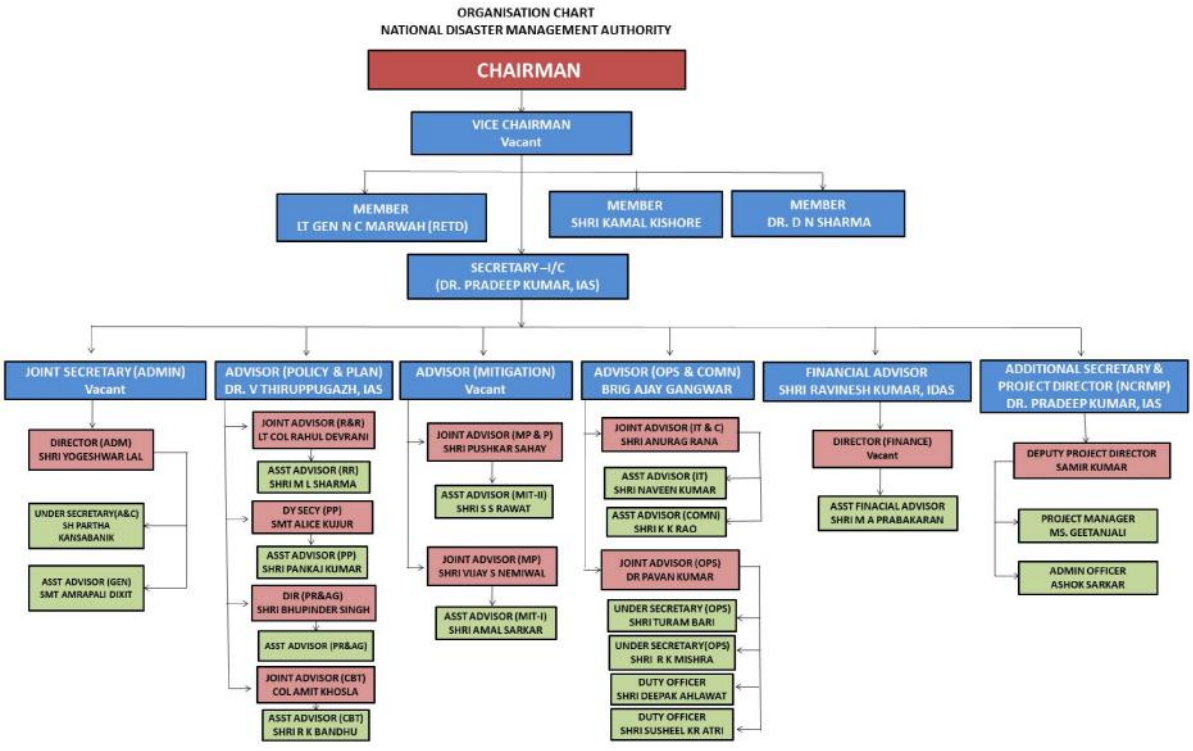


Figure 12:Organisation of the NDMA

Source - https://ndma.gov.in/en/about-ndma/org-structure.html

Prime Minister of India is the Chairperson and the position of Vice Chairperson is presently vacant. Since its inception, NDMA has had a retired services officer in the top hierarchy and serving officers on deputation, emphasising the role of the armed forces in the management of natural and manmade disasters. The Disaster Management Policy of India was framed in 2009 on the basis of this Act. The Government of India established institutional and policy mechanisms for response, relief, and rehabilitation. The orientation for handling disaster situations was also changed from relief-centric to a holistic, multi-dimensional, and multi-disciplinary approach involving diverse scientific, engineering, social, and financial processes. It encompasses the entire scope of disaster management activities, i.e., prevention, mitigation, preparedness, response, relief, and rehabilitation. (MOHA 2011)

State Guidelines on Disaster Management Road Map States have set up a State Disaster Management Authority with State Relief & Rehabilitation Department converted to department of Disaster management with State/District/Block/village Disaster Management plans & setting up of Emergency operations Centre.

SDMA Set up under the Disaster Management Act, 2005, SDMA is headed by the Chief Minister as its Chair person and has a 14 member Governing Body. The authority is primarily responsible for the following:-

- Promoting an integrated and coordinated system of disaster management and act as a central planning, coordinating & monitoring body for disaster management and post disaster reconstruction, rehabilitation, evaluation and assessment as well as promoting general awareness.
- Evolving a total Disaster Management Support System by making use of Satellite Remote Sensing and imagery data, GIS.
- Allocation of responsibilities to the various stakeholders.

- Acting as repository of information concerning disasters & disaster management.

- Ensuring establishment of communication links and setting up of emergency communication and early warning systems in the State.

- Developing guidelines for preparation of disaster management plans at all levels -state, district, block & village level.

- Dissemination of information and awareness building among the public.

Emergency Operation System (Standard Operating Procedures (SOPs) 2011) The State Emergency Operation Centre (SEOC) is the hub of all disaster management related activities. Primary function is to implement the SDMA Plan which includes coordination, data collection, operation management, record keeping, public information and resource management. Emergency Operations Centres at the State (SEOC) and the District (DEOC) and Incident Command Post (ICP) at the disaster site are the designated focal points that will coordinate overall activities and the flow of relief supplies from the State.

At the national level, in 2006, the NDRF with 8,000 paramilitary personnel (Chari 2008) was set up to train, equip and respond to any type of disasters. Strength of the NDRF presently is 12 Battalions with each Battalion consisting of 1149 personnel. In the beginning, the personnel of NDRF were deployed for routine law and order duties also. In a meeting of the NDMA with the Prime Minister on October 25, 2007, the need of NDRF being made a dedicated force was highlighted and accepted. This led to the notification of NDRF Rules on February 14th, 2008, making NDRF a dedicated force for disaster response related duties, under the unified command of DG NDRF. (NDMA 2019) The NDRF units are located near the disaster prone areas to enable them to respond speedily. The NDMA has issued various guidelines to all states, districts and municipalities for instituting disaster response plans for

each type of disaster including CBRN disasters. Like the NDRF, states have dedicated SDRF battalions to respond to disasters.

The key points being addressed under this programme are the need to ensure sustainability of the programme; development of training modules, manuals and codes; focusing attention on awareness generation campaigns; institutionalisation of disaster management teams; disaster management plans and mock-drills; and establishing techno-legal regimes.

The Union MHA is the nodal ministry for disaster management. The National Crisis Management Committee (NCMC), headed by the Cabinet Secretary and constituted under the Ministry, oversees the various disaster related activities in the country. (NIDM 2010) It functions as a decision-making body and gives directions to the Crisis Management Group (CMG). The CMG is the vital body that actually deals with all the matters related to relief activities in the case of any major disasters. (NDMA 2009)

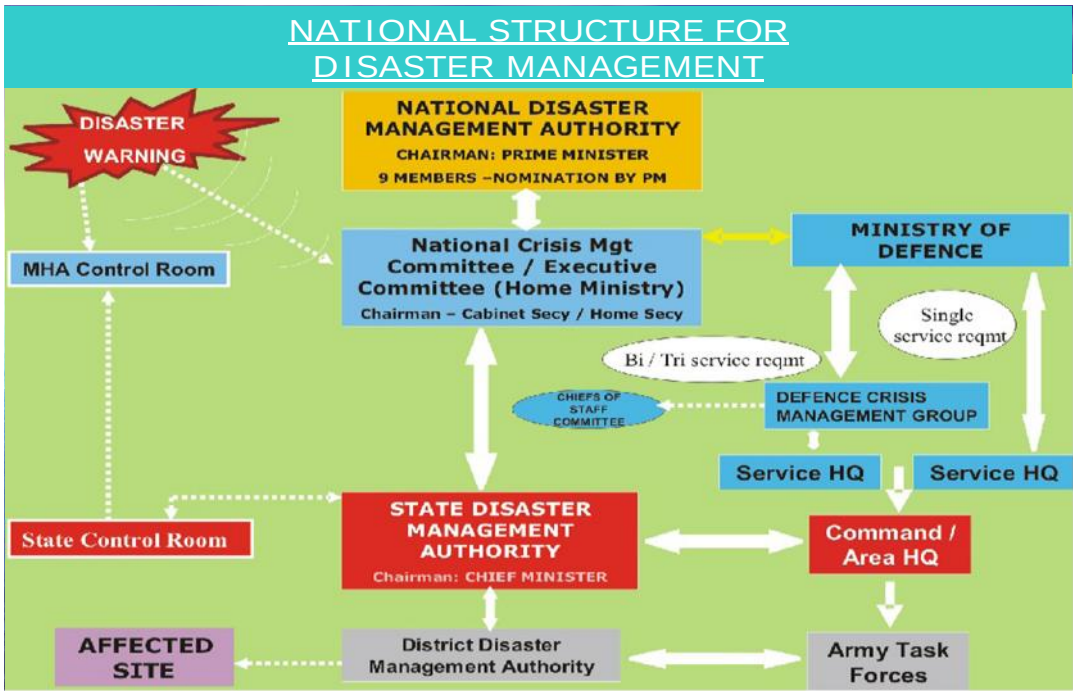


Figure 13: National Structure for Disaster Management
Source: National Policy on Disaster Management 2009

Further, for execution of polices formulated in the ministry, the Central Relief Commissioner (CRC) is designated as the nodal officer for coordination of relief operation.

The office of the CRC receives all the information related to forecasts and warnings from the Indian metrological department and issues directions for an action plan in response to the situation. Various other ministries are also assigned the responsibility for hazard identification and risk assessment, and respond to disasters related to their field of expertise as shown in the table below.

Disasters	Nodal Ministry
Earthquake and Tsunami	MHA / Ministry of Earth Sciences/India Metrological Department (IMD)
Floods	MHA / Ministry of Water Resources/ Central Water Commission (CWC)
Cyclones	MHA / Ministry of Earth Sciences / IMD
Drought	Ministry of Agriculture
Biological Disasters	Ministry of Health and Family Welfare
Chemical Disasters	Ministry of Environment & Forests
Nuclear Disasters	Ministry of Atomic Energy
Air Accidents	Ministry of Civil Aviation
Railway Accidents	Ministry of Railways

Table 4: Responsibility of Various Ministries During Disasters

Source: National Disaster Management Authority, Government of India, 2011

A National Institute for Disaster Management (NIDM) has been established to train personnel from NDRF, CPOs, CDOs, and States Police forces to respond to disasters. National Disaster Mitigation Resources Centers have been established all over the country

(Naidu 2013). The CDOs, the Central Police Organisations (CPOs), Home Guards (HGs) are being trained and equipped to be the first responders to assist in disaster management. In case needed, the efforts of the these organisations would be augmented with the resources of the armed forces depending on the magnitude of the disaster, as it has happened in the recent cases of natural disasters in Kerala, Uttarkhand. Kashmir etc. With specific reference to CBRN related disasters, the Indian Army has formed Quick Reaction Teams (QRT) and Quick Reaction Medical Teams (QRMT) to respond anywhere in India.

Approach to CBRN Disaster Management The four-pronged strategy recommended to be adopted for a holistic management of nuclear/radiological emergencies is as follows:-

- The Nuclear Emergency Management Framework should be supported on the mainstay of prevention, mitigation, compliance of regulatory requirements, preparedness, capacity development, response, etc. that constitute the Disaster Management continuum.
- The existing legal framework should be strengthened through various legal and regulatory means.
- The framework is to be institutionalized by identifying the stakeholders at various administrative levels with their respective responsibilities in a people-centric, bottom-up approach.
- The framework to be implemented through the strengthening of existing action plans, or by preparing new action plans at the national, state and district levels.

For the success of a nuclear emergency management programme, it is essential to develop an institutional framework which will transform the guidelines into reality by preparing action plans and implementing them. Accordingly, for handling nuclear/radiological

emergencies as part of an all-hazard approach for any type of disasters in the country, the following four types of administrative bodies have been instituted:-

- National Disaster Management Authority at the National Level under the Chairmanship of the Prime Minister of India.
- State Disaster Management Authorities at the state level, under the Chairmanship of the Chief Ministers.
- Creation of District Disaster Management Authorities at the district level, under the Chairmanship of the District Collectors/ Magistrates.
- Local authorities to also deal with mitigation, preparedness and response.

Emergency Management Structure DAE is the nodal agency for providing the necessary technical inputs to the national or local authorities for responding to any nuclear or radiological emergency and the MHA is the nodal ministry in such emergencies. For this purpose a CMG has been functioning at DAE which is chaired by the Additional Secretary, DAE, and has on board expert members from different units of DAE and AERB. In the event of any nuclear/radiological emergency in the public domain, CMG is immediately activated and it coordinates with the local authority in the affected area and all the concerned authorities at the centre (NCMC/NEC/NDMA) to ensure that the necessary technical inputs are available to respond to the nuclear/radiological emergency.

Regulatory Body The AERB is the nuclear regulatory authority in the country which, as per the Atomic Energy Act (1962), has the mandate for issuance of licenses to nuclear and radiological facilities and ensuring compliance with the applicable standards and codes. It is emphasised that the AERB, which oversees nuclear and radiological safety in the country, has the powers to not only licence the operation of a facility but also the power to order partial or full shutdown of any facility that violates its guidelines. (NDMA 2009) 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. The AERB has been playing a very crucial role in the prevention of nuclear/radiological accidents by ensuring that proper safety design features and operating procedures in all nuclear and radiation facilities are in place.

The AERB has systems to ensure that the authorised users (industries, hospitals, etc) adopt safe procedures. These include safety audits, periodic checks on the users, qualification and re-qualification of safety officials, etc. Simple guidelines have been circulated to all States and Union Territories (UTs) on the handling of postulated nuclear emergencies in the public domain. These include situations arising out of malicious acts involving radioactive materials and also give the contact details of the nearest DAE facility to respond. If required, CMG can be activated to send additional response personnel/ resources from other DAE facilities to the affected site. The basic regulatory framework for safety of all activities related to the atomic energy programme and the use of ionising radiation in India is derived from Sections 3 (e) (i), (ii) and (iii), 16, 17 and 23 of the Atomic Energy Act, 1962. The AERB carries out certain regulatory and safety functions under these Sections of the Act. The mandate for AERB, inter alia, includes:-

- Powers to lay down safety standards and frame rules and regulations with regard to the regulatory and safety requirements envisaged under the Atomic Energy Act, 1962.
- Powers of a Competent Authority to enforce the rules and regulations framed under the Atomic Energy Act, 1962 for radiation safety in the country.
- Authority to administer the provisions of the Factories Act, 1948 for ensuring industrial safety of the units of DAE as per Section 23 of the Atomic Energy Act, 1962 and enforce the rules and regulations promulgated there under.

Medical Preparedness for Nuclear Emergencies In each constituent unit of DAE few doctors have been dedicated and given the necessary training in the medical management of radiation emergencies. (NDMA 2009) All nuclear power plants and the Bhabha Atomic Research Centre (BARC) are equipped with radiation monitoring instruments, have personnel decontamination centres and the necessary stock of antidote medicines and specific de-corporation agents for typical radio isotopes. A few hospitals in the country are also equipped with the facilities required for bone marrow transplantation, which will be useful in managing cases of acute whole body irradiation. Further, doctors from various defence units and other organisations in the country are also trained in the medical management of nuclear emergencies.

Network of Emergency Response Centres and Crisis Management Group A country wide network has been established for monitoring (IERMON, Seismic) and linked to BARC's Site Emergency Centre (SEC). As a basic regulatory requirement, emergency preparedness exists at all nuclear and radiation facilities to respond to any on-site or off-site emergency in their areas. But to handle radiological emergencies arising from a transport accident or from the movement/handling of 'orphan sources' (radioactive sources that have lost regulatory control) or due to malevolent acts like explosion of an RDD/RED or an IND any time or anywhere in the country, a network of 18 units of Emergency Response Centres (ERCs) has been established by BARC, DAE. These ERCs are spread all over the country and have facilities to handle large scale emergencies. The ERCs are expected to communicate to SEC and CMG on the occurrence/confirmation of the nature of emergency and report the continuous state of the counter measures and its effects. Any request for help has to be considered by the CMG based on the current radiological status of the region and the advice of the local ERC and SEC based on technical inputs.

However the number of ERCs is far too inadequate and there is a need to enhance their numbers in future. This network is basically meant for responding to such emergencies and also providing timely advice and guidance to first responders at the state and national levels. The ERCs are equipped with radiation monitoring instruments, protective gear and other supporting infrastructure. Many units of nuclear Emergency Response Teams (ERTs), consisting of personnel from different DAE units, are also being raised. The CMG being the centralised agency, at DAE coordinates the nuclear/radiological emergency management activities not only by activating these ERCs and ERTs but also by mobilising resources from all DAE facilities at the time of crises (NDMA, National Policy on Disaster Management 2009 2009). The geographical locations of 23 ERCs are given below (PIB 2015):-

1. Mumbai
2. Tarapur (Maharashtra)
3. Kakrapar (Gujarat)
4. Kota (Rajasthan)
5. Jaipur (Rajasthan)
6. Narora (Uttar Pradesh)
7. Shillong (Meghalaya)
8. Jaduguda (Jharkhand)
9. Kolkata (West Bengal)
10. Nagpur (Maharshtra)
11. Hyderabad (Telangana)
12. Kaiga (Karnataka)
13. Bengaluru (Karnataka)
14. Kalpakkam (Tamil Nadu)
15. Alwaye (Kerala)

16. Delhi (Delhi)
17. Indore (Madhya Pradesh)
18. Kundankulam (Tamil Nadu)
19. Gandhinagar (Gujarat)
20. Mysuru (Karnataka)
21. Manavalkurichi (Tamil Nadu)
22. Chatrapur (Odisha)
23. Turamdih (Jharkhand)

NDRF Battalions in CBRN Role The Disaster Management Act, 2005 has made statutory provisions for the constitution of the NDRF for the purpose of specialised response to natural and man – made disasters. Four out of the 12 battalions have been trained and equipped for response during CBRN emergencies. (PIB 2011) In future, the key to efficient disaster response will depend primarily on effectiveness of training and re-training of Specialised Disaster Response Forces (SDRF). With this vision, a detailed "Training Regime for Disaster Response" has been prepared by NDMA identifying the specific disaster response training courses and devising a unified, structured and uniform course module as well as syllabus for these training courses. The proposition behind a unified, structured, uniform course module and syllabus is that first the personnel of NDRF battalions will graduate these courses, and subsequently the SDRF and other stakeholders will be trained on the same lines. The need of uniformly structured course module emerged out of the fact that if all the NDRF battalions and other 'first responders' undergo the same training exercise, the coordination between different stakeholders would be expedient and well planned at the time of any major disaster where different NDRF battalions, SDRF battalions and other stakeholders will be working together in close coordination with each other.

Strength Weakness Opportunity Threat (SWOT) Analysis of the Institutional Arrangements A SWOT analysis of the current institutional arrangements have been carried out by studying the features of the existing arrangements.

Strengths	**Weaknesses**
• Refined vision and national strategy. • Formalised institutionalised structure & hierarchy incorporating all stakeholders. • Pyramidal structure from the highest level to the grassroots thus increasing accountability. • Adequate funds and resources. • Dedicated response force in the form of NDRF. • Headed by the Prime Minister at the Apex level. • Provisions to involve the concerned ministry in the eventuality of the disaster at the highest level. • Procedures, SOPs and competence likely to refine further with experience in managing disasters. • Pre emptive focus on prevention and mitigation as against response and recovery.	• Delayed execution at state levels. Act yet to be completely implemented effectively by all states. • Lack of CBRN preparedness and planning. • Inadequacy of training. • Focus on mitigation but limited implementation at grassroots level. • Cumbersome procedure for requisitioning Armed Forces. • Lack of common operating picture / situational awareness especially for the Armed Forces prior to induction. • Command and control issues between crisis management group and the Armed Forces. • Lack of coordination between FCBRNP, CME & NIDM. • Lack of adequate number of SDRFs at

	State level as mandated by the act.
Opportunities • Evolution of coordinated response strategy especially at VAs and VPs in the neighbouring countries and sharing best practices especially in SAARC & ASEAN. • Gradual evolution of NDRF into a specialised force with increased number of battalions and specialised CBRN elements with dedicated airlift capability. • Joint training and rehearsals between all stakeholders especially in CBRN field. • Cooperation with corporate sector. • Introduction of Information Management system to synergise resources and response. • Enabling the first responder that is the common man through awareness programs by the NDMA. • Enabling the fire brigades for CBRN incident management.	**Threats** • Lack of permanency - tenure based induction and de-induction. • Inadequate infrastructure for CBRN disaster management training. • Large number of VAs/ VPs due to rapid industrialisation. • Ease of access to technology to manufacture CBRN weapons in future. • Lack of experience especially in handling the CBRN incident. • Lack of proper media management strategy. • Lack of CBRN risk assessment study at National level. • Lack of medical services and preparedness for CBRN Disaster.

Table 5: SWOT Analysis of NDMA/NDRF/SDRF Response to CBRN Disaster

Role of Armed Forces in CBRN Disaster Management The Civil Defence Organisations (CDOs), the Central Police Organisations (CPOs) and Home Guards (HGs)

have been reorganised, revamped, reoriented, trained and equipped to be the first responders for all disasters. Should the above organisations be inadequate to meet the challenge, Armed forces can be requisitioned in aid to civil authorities to respond to the disaster. Unlike the NDRF, Army does not have a dedicated force for CBRN disasters.

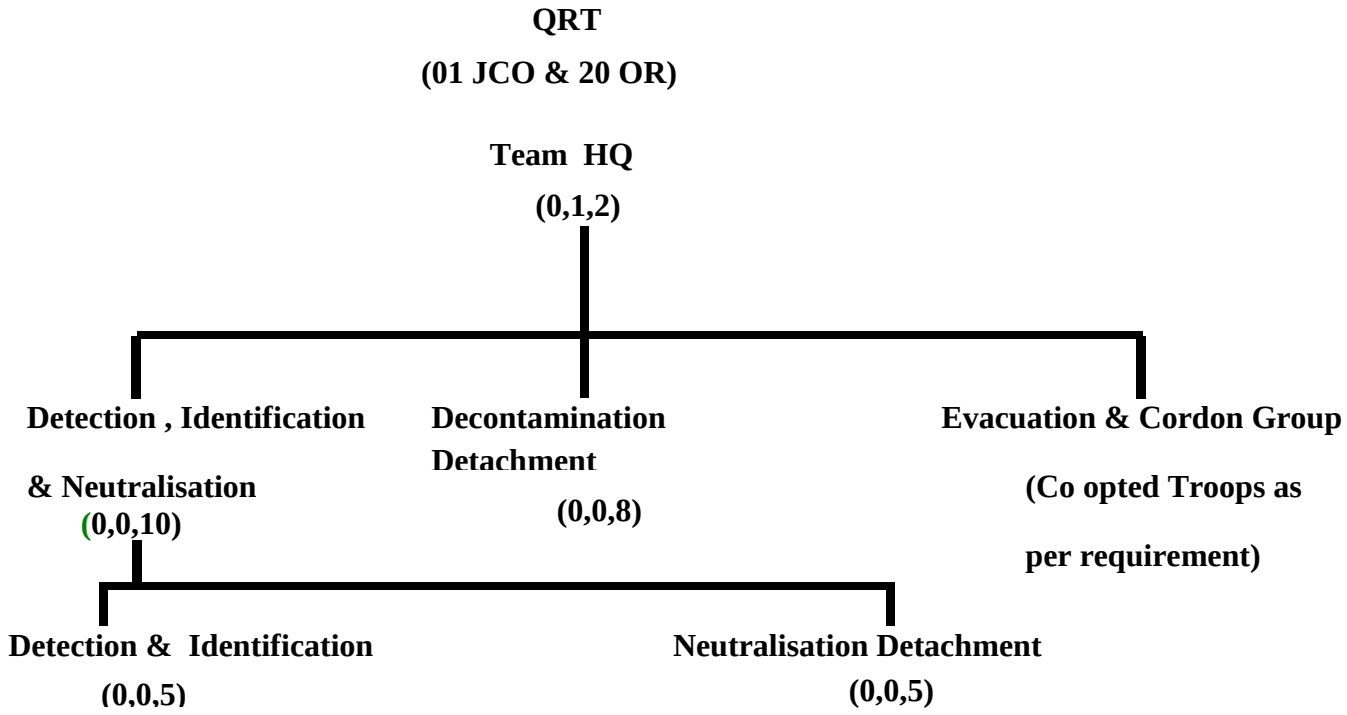
In 1997 Army HQ decided to raise the Quick Reaction Teams (QRTs) based on existing Bomb Disposal Units and Quick Reaction Medical Teams (QRMTs) based on available field ambulances in each command theatre. These are primarily to cater for CBRN related disaster situations i.e. both man made and/or accidental. They also cater for assistance to civil authorities and are located near metropolitan cities to facilitate rapid response and are required to be supplemented by troops as per situation. Overall command of operations will be vested with the formation rendering aid. However, the executive orders for move of these units will rest with the respective command/sub area HQ.

QRT Handling of CBRN disasters is most challenging as it requires years of training and synergized and swift response by multiple agencies. The response becomes complex due to the fact that it poses risk to lives of personnel operating in it. the actions of QRT will depend on the scenario in which they are tasked to be employed, which will in turn depend on whether they are tasked to act as **'First Responders'** due to non availability of NDRF within the **'Golden hour'** for unforeseen reasons or act as second responders to reinforce the efforts of the first responders. The QRT may be tasked to undertake the following:-

- Detection and identification of source of contamination.
- Neutralize the source if possible.
- Determine the likely extent of hazard to enable civil administration to carry out evacuation of the same.
- Immediate decontamination of affected personnel.

- Evacuation of casualty to decontamination and treatment centre set up by QRMT in the vicinity.

Organisation and Equipment of QRT The organisation and CBRN stores and equipment of QRT are as given below.



Serial Number	Equipment	Team HQ	Detection Detachment	Neutralisation Detachment	Decontamination Detachment
1.	CBRN Suit (Permeable)	03	06	05	08
2.	Respirator	03	06	05	08
3.	Canister	09	18	15	24
4.	Facelet Mask	03	06	05	08
5.	Over Boots	03	06	05	08
6.	Gloves	03	06	05	08
7.	Haversack	03	06	05	08
8.	Integrated Hood Mask				
9.	Three Color Detector paper	03	06	05	08
10.	Automatic	18	36	30	48

	Injector				
11.	Nerve Agent Pretreatment Set	18	36	30	48
12.	Personal Dosimeter (Including reserve)	03	06	05	08
13.	Reader for Dosimeter		01		
14.	Dose Rate meter	01	01		
Chemical Detection Equipment					
15.	Automatic Chemical Agent Detection Alarm System		03		
16.	Chemical Agent Monitor (CAM)		03		
17.	Water Testing Kit			02	
Decontamination Equipment					
18.	Decontamination Suits (Impermeable)				05
19.	Personnel Decontamination Kit (PDK)	03	03	04	05
20.	Portable Decontamination Apparatus				06
21.	Air Portable Decontamination System				01

Table 6: Stores and Equipment of QRT
Source : Army HQ SOP

Organisation and Equipment of Co-opted Troops One Officer, three Junior Commissioned Officers and 96 Other Ranks constitute co-opted troops. More troops may be detailed by the formation HQ if situation demands. The detailed equipment to be held is as given below:-

Serial Number	Nomenclature	Authorisation
1.	NBC suit permeable (jacket & trousers)	100
2.	Respirator mask without canister	75
3.	Canister	300
4.	Facelet mask Type 'B'	100
5.	NBC Over boot	100

Table 7: Equipment with Co-opted TroopsEquipment with Co-opted Troops
Source : Army HQ SOP

Actions by Team HQ The actions that the team HQ is supposed to perform are as follows:-

- Establishment of Incident Command Post.
- Carry out hazard prediction.
- Assist in deployment of various teams.
- Monitor progress of operations and seek external assistance if required.
- Advice civil administration on the mitigation measures to taken to minimize the damage.
- Advice police, fire brigade and other state resources on optimal utilisation of their resources towards damage control.
- Keep the Formation HQ/Station HQ/Sub Area HQ updated on the progress of operations.
- Seek additional assistance from army depending upon the severity of situation and availability of NDRF resources.

Deployment of QRT Team The QRT Commander is responsible to deploy various teams as per the situation on ground. However, this would vary from site to site depending on

the type of incident, its severity, location, population density around incident site, environment conditions etc.

Action by Detection and Identification Team The tasks performed by the team are as follows:-

- Carryout detection of the source of contamination as per available information.
- Try to ascertain and identify nature of contamination.
- Detection to be progressed simultaneously with casualty evacuation.

Actions by Neutralisation Detachment The tasks performed by the detachment are as follows:-

- Effort for immediate containment.
- Neutralisation of source, where feasible.
- Seek specific expertise for containment and neutralisation from BARC/DAE/Chemical Industry/Health Officials through Incident Command Post depending on type and severity of the Incident.

Actions by Decontamination Section The tasks performed by the section are as follows:-

- Siting of decontamination station in consultation with QRT and QRMT commanders in the upwind direction.
- Establishment of decontamination station in conjunction with decontamination and treatment centre.
- Carryout decontamination of contaminated non casualties as per the type and nature of contamination.
- Assist Decontamination and Treatment Centre (DTC) in carrying out decontamination prior to treatment of casualty.

- Seek stores for decontamination and water supply as per requirement of decontamination.
- Update records on number of personnel undergoing decontamination.
- Direct personnel with any type of injuries to DTC.
- Decontaminate personnel of QRT and co-opted troops post completion of operation.
- Carryout decontamination of personnel of decontamination station post successful decontamination of QRT personnel and Co-opted troops.

Actions by Co-opted Troops The actions to be carried out by the co opted troops are as follows:-

- Establish cordon of the Exclusion Zone with assistance from detection and identification team.
- Assist in establishment of decontamination station and DTC.
- Provide stretcher bearers to carryout casualty evacuation to Forward Aid Post (FAP) and thereafter to DTC.
- To assist QRMT in decontamination of personnel.
- Assist QRMT in evacuation of personnel to civil/military hospitals.
- Securing of Vantage Area and Vantage Points around the exclusion zone.

Damage Assessment Assist civil administration in carrying out damage assessment by providing inputs obtained while carrying out various tasks.

QRMT The QRMTs will get deployed with QRTs to provide emergency medical aid in case of CBRN incidents.

Functions of QRMT The main functions of QRMT are as follows:-

- To provide immediate first aid.

- To evacuate casualties out of the contaminated area away from source of CBRN contamination to DTC with help of co-opted troops.
- To carry out triage of casualties.
- To carry out limited decontamination of casualties.
- To provide specific antidotes and symptomatic treatment to casualties.
- To evacuate casualties to earmarked hospitals.
- Provide assistance to QRT for obtaining samples, if required.

Organisation and Equipment QRMT has three functional sub units, namely, Decontamination Section, Treatment Section and FAPs , with the capability to handle 180 – 200 casualties in six hours. The organisation of QRMT and the authorisation of stores and equipment are as given below:-

Serial Number	Name of Equipment	Quantity
1.	IPE	14
2.	Respirator	14
3.	Canister	42
4.	Facelet masks	14
5.	Overboots	14
6.	Gloves (Outer and Inner)	14
7.	Integrated Hood Mask	05
8.	Three Colour Detector Paper	14
9.	Personal Decontamination Kit	14
10.	Personal Dosimeter Watch Type	14
11.	Pocket Dosimeter	02
12.	Residual Vapour Detection Kit	01
13.	Portable Decontamination Kit	02
14.	Decontamination Suit Impermeable	02
15.	Decontamination Solution 20 ltrs	05
16.	Fuller's Earth (05 Kg Container with Pads)	05
17.	First Aid Kit Type 'A'	20
18.	First Aid Kit Type 'B'	20
19.	Casualties Bag Half	20
20.	Casualties Bag Full	40
21.	Resuscitator	50

22.	Combopen	1039
23.	Nerve Agent Pretreatment Set	42
24.	Water Poison Detection Kit	01
25.	Four Outlet O_2 Concentrator	04
26.	Single Outlet O_2 Concentrator	16
27.	NBC Protective Plastic Film (mtrs)	40
28.	Individual Communication Set	02
29.	Torch (Four Battery Type)	14
30.	Battery Operated Flood Light With Charger	03
31.	Portable Communication Set (RS-VC)	01

Table 8: Stores and Equipment of QRMT
Source : Army HQ SOP

Organisation of QRMT

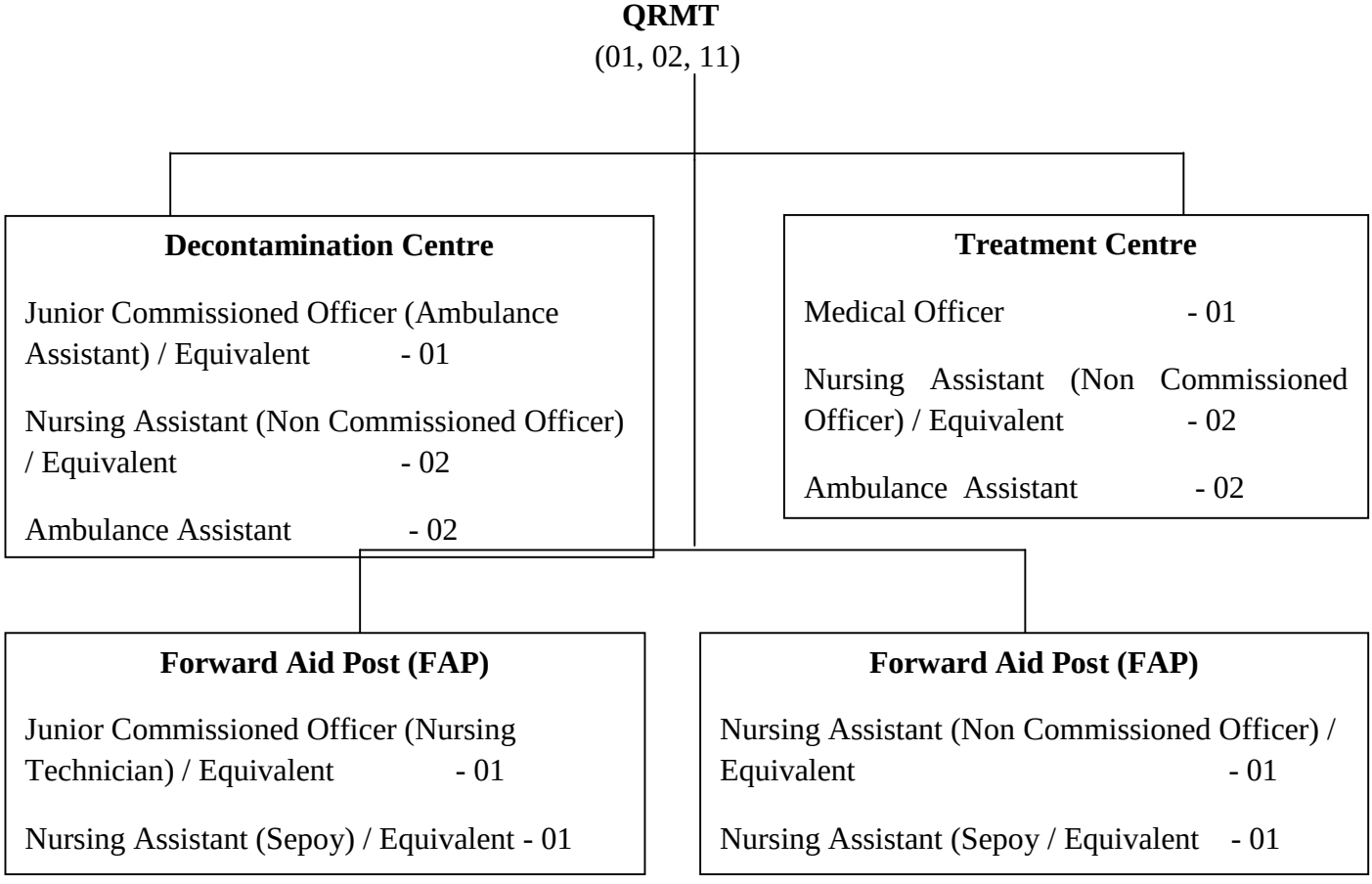


Figure 14: Organisation of QRMT

Source : Army HQ SOP

Role The role of various sections of QRMT is as given below:-

- **Decontamination Section** This section is capable of handling limited decontamination of casualties received from contaminated zone. Although it receives casualties from decontamination section of QRT, some casualties might still require decontamination before they are taken up for emergency treatment. This section is critical in limiting the spread of contaminant to members of Treatment Section of QRMT. This section will be established outside the contaminated (Red) zone.
- **Treatment Section** Medical Officer in this section will conduct triage and the priority discs to casualties. This section will provide specific antidotes and emergency treatment to casualties before evacuating them to earmarked hospitals. Necessary minimal record of casualties will be maintained by this section. This section also will be established outside the 'Red' zone.
- **FAPs** Each QRMT is capable of establishing two FAPs. They will be manned by JCO (NT) and Nursing Assistant (NCO) each, assisted by Ambulance Assistants (AAs). FAPs will be established in the 'Red' zone.

SWOT Analysis The SWOT analysis of the Armed Forces with respect to the CBRN Disaster Management is as under:-

Strengths	**Weaknesses**
• Adequate resources and manpower. • Experience in handling disasters. • Formalised CBRN training at elementary, basic and advanced levels at the regimental	• Lack of realism in CBRN training; theory inclined. • Cumbersome requisitioning procedures for Armed Forces - affects employment

centres and CBRN training institutes of the three services. • Discipline and effectiveness of response. • Pillar of faith and assurance for general public in these situations. • Accessibility and presence in far flung areas. • Best poised for use overseas with Naval and Air Force support. • Well defined command and control structure capable of amalgamating the civil resources for an effective response.	within Golden Hour. • Lack of common operating picture / situational awareness especially for the Armed Forces prior to induction. • Command and control issues between crisis management group and the Armed Forces. • Lack of any National CBRN Emergency Plan unlike natural disasters co-opting the Armed Forces. • Lack of coordination between FCBRNP, CME & NIDM. • Lack of experience in handling a CBRN disaster like situation.
<u>Opportunities</u> • Boost to training against CBRN threat in conventional scenario can be utilised for CBRN Disaster Management. • Boost equipping for the CBRN disaster especially for formations at Vas & VPs. • Joint training and rehearsals between all stakeholders especially in CBRN field. • Introduction of Information Management system to synergise resources and response.	**<u>Threats</u>** • Lack of permanency - tenure based induction and de-induction of orbatted units. • Perception deficiency as regards the CBRN threat. • Inadequate infrastructure for CBRN disaster management training. • Lack of medical services and preparedness for CBRN Disaster. • Outdated inventory - unable to keep pace

• Development of Live Chemical & Radiological training facility at Faculty of CBRN Protection at CME Pune to increase realism in training. • Exploitation of courses abroad to refine the available expertise.	with the evolving technologies across the World.

Table 9: SWOT Analysis of Armed Forces Response to CBRN Disaster

It is evident from the two SWOT analyses that much needs to be done with respect to the CBRN disaster management. Inter-operability issues between the armed forces and the other stake holders pose a significant challenge. Currently, each has its own equipping norms and functional drills. The administrative responsibility for disaster preparedness and management and the task of responding to any kind of disasters has been entrusted to the states. The centre intervenes only when the magnitude of disaster escalates beyond the capability of the state authorities. In such scenarios, standard procedure for the centre's intervention is determined by the gravity of the disaster, the required scale of relief operations, and the central assistance required for augmenting the financial resources at the disposal of the affected state government.

CHAPTER V

RECOMMENDATIONS: WAY AHEAD TOWARDS A SYNERGISED RESPONSE

Current Status (Gautam 2012)

Although The Disaster Management Act was enacted more than a decade ago in 2005 many states are yet to establish and operationalise SDMAs. In some states, the department of relief and rehabilitation has been re-christened as the department for disaster management with home guards and emergency fire services added as an ad hoc measure. Although twelve battalions of NDRF have been raised for various types of natural and man-made disasters and four battalions have been specially organised and equipped for handling CBRN disasters, considering the extent of India's hazardous environment and the escalating uneven trend in the occurrence of disasters, the present capability of the civil administration for combating disasters remains inadequate. As a result, the civil authorities rely on the armed forces for major emergency responses.

Broad Recommendations: National Level

Increasing Public Awareness to CBRN Related Disasters Until the 9/11 attacks in the US and closer home, the 26/11 Mumbai attacks, CBRN was a forgotten subject and discussed only in the military domain. The world has now woken up to the threat of CBRN weapons against common public via the terrorism route. Homeland Security has gained prominence, and the public, especially in western countries prone to Jihadi terror, is getting increasingly sensitised to CBRN threats. It is time that public in India too is made aware of this threat. CBRN Incidents demand immediate response to save lives as casualties can manifest within minutes. There is the **'Golden Hour'**, or the first hour which is most critical for administering treatment/antidotes to save lives. Given the size of our nation and the meagre resources (trained response forces and equipment), it is nearly impossible to react with the requisite trained responders to CBRN incidents in most parts of the country. It thus

becomes incumbent on the available **'First Responders'**, the common man on the street or the local police, to respond to CBRN situations. These are the people we need to train, to be made aware and to be capable to respond to CBRN incidents. Increased public knowledge is therefore probably the best defence or response to the CBRN threat. The ideal case would be a public knowledge campaign to make people aware of the threats. Community based training should be conducted by district and block level agencies. Media and NGOs should contribute positively in enhancing the awareness level. Certain other methods to enhance awareness levels for responders and general public are as follows:-

- Lectures, workshops and talks in colleges and high schools for the youth.
- Special classes and workshops for district administration personnel.
- Training and awareness workshops for police and paramilitary personnel.
- Corporate workshops and mock drills to display required skills and SOPs in CBRN incidents.
- Creation and maintenance of resource database at state and district levels.
- Creation of **Citizen Emergency Response Teams** (CERTs) in colleges, corporate offices, residential societies, factories and such institutions.
- Special training to civic bodies, NGOs, medics & paramedics to handle CBRN casualties

Similarly, citizens have a responsibility to aid in vigilance and reporting of unnatural circumstances, unaccompanied packages/bags, suspicious persons and occurrence of unusual events. For this, there is a need to display and provide contact details of key functionaries, help lines of emergency services and circulate Do's and Don'ts to the public. The industry too has a major role to play in prevention of CBRN incidents. Some of the measures could be ensuring only the required raw material/chemicals are procured and stored as per safety norms, prevent pilferages and thefts, maintain machines, pipelines and systems in proper

condition to avoid accidents, explosions, spills, fires and vapour leaks and lastly generate awareness and follow guidelines for effective Corporate Social Responsibility (CSR) by industry. This will lead to the staff carrying the message to their social environments and spreading awareness and best practices to other areas.

Response Framework As mandated by the Disaster Management Act of 2005 the NDMA has formulated a set of guidelines to deal with CBRN disasters. The span of focus, however, is too wide and the number of stakeholders (Chairman Atomic Energy Commission, Home Secretary and Chairman CMG, Chairman AERB, Director BARC, the Armed Forces and the NDMA) are far too numerous to enable the formulation of an actionable and effective response. (Shukla 2013) Such guidelines, while being laudable as an initial first step, appear to be perfunctory and not sufficiently literate to deal with the frightening realities of the threat. We need to anoint an **Ambassador at Large/Commissioner for Nuclear Terrorism** (backed up with a suitably tailored organisation and resident investigative and domain experts) to address the issue of nuclear terrorism/terror with the assistance of relevant stakeholders in a well thought through and focused manner. The Commissioner should be assigned the sole mandate of prevention/pre-emption and efficient consequence management of acts of CBRN terrorism; ensuring synergy between all stakeholders; ensuring dialogue with the Nuclear Command Authority (NCA) and NDMA to develop discrimination capacities/mechanisms to distinguish between an adversary launched and a terrorist-driven nuclear attack; reducing leadership uncertainties as also putting in place the tenets of an effective disaster management and recovery system in the public domain.

Blueprint The nation, first and foremost, needs to put in place a concrete action plan to prevent the occurrence of a nuclear event, while concurrently developing a response philosophy for a range of possibilities across the probability spectrum: a bogus nuclear

device, an aircraft crashing into a nuclear reactor, a radiological fizzle, and detonation of a crude nuclear device of 1/10 KT yield. It may also be pertinent to point out that the threat of CBRN terrorism/incident is not limited to mega polis, fast developing Tier II cities are just as vulnerable. The response plans, therefore must at the very least, cover all Tier I and possibly Tier II cities in the country. Cities like Varanasi, Amritsar and Haridwar, which are vulnerable due to their visible religious profile, also need coverage. It may also be reasonable to conclude that given the gravity of an act of nuclear terrorism, the widespread belief that such an act would be Pakistan-sponsored and the war hysteria that would inevitably ensue, it will almost certainly lead to mobilization/deployment of the Indian Armed Forces. One of the trained primary responders i.e. the armed forces therefore, will not be available to respond to the crisis, the handling of which will fall entirely on the shoulders of the NDMA/Civil Administration, an aspect which needs to be factored into the response plans. The NDRF Battalions of the NDMA assigned for nuclear disasters must, therefore, undergo significant up-gradation in training and capacity and be able to deploy QRTs suitably equipped to detect and identify sources of contamination, diagnose/monitor radiation hazard levels, man control points to prevent entry into contaminated areas, and assist in evacuation of the exclusion zone. Concurrently, capacity-building of fire and rescue crews and deployment of sufficient internal security columns to maintain peace and calm must also be ensured. It may also be wise to test our real response capacities through conduct of annual mock exercises/drills. (Shukla 2013)

Coordination Exercise with Politico Military Leadership It may also be useful to conduct an exercise (Shukla 2013) involving the politico military leadership, key appointments from the strategic establishment, the NDMA and domain experts to war game the occurrence of a possible CBRN event, think through the various response dilemmas and formulate a comprehensive and credible response.

Institutionalisation of Specialised CBRN Training Disaster Management is a multi discipline task in which all stake holders have to take a pro-active approach. All agencies involved in CBRN disaster response must have well defined responsibilities with their roles clearly defined. Various agencies that are likely to get involved have set up, or are in process of setting up establishments to train their personnel. To overcome this problem, institutes like NIDM, NCDC, Faculty of CBRN Protection (FCBRNP) at CME Pune and BARC, to name a few, are recommended to be entrusted with responsibility to train the civil administration, personnel of CDOs, armed forces and technical staff. To ensure that all agencies work in sync at the time of disaster, it is of paramount importance to establish uniform training standards. The training should be organised at directional, technical and execution levels. A multi tiered approach should be established to train, certify and validate the training. There should be standardised certification which should be recognised by all agencies so that on occurrence of disaster one could be employed as per his level of competency.

Capacity Development To handle any CBRN threat, a large number of detection/monitoring instruments and personal protective gears will be required. Presently, outside the DRDO/DAE/defence establishments, there is hardly any availability of such equipments. Even in DAE establishments, the total numbers may just suffice for an off-site emergency condition from nuclear power plants but not for any large-scale disaster. The non-availability of adequate instruments/protective gear as well as trained manpower will severely hamper the capability to effectively handle any CBRN emergency/disaster scenario. There is a vast contrast between demand and supply which is required to be filled in order to impart realistic training as also to equip the personnel to counter the disaster.

Multi-layered Defence A multi-layered defence capability to include acquisition of equipment to detect radiation exposure as also capacities to clean up radioactive debris must

also be put in place. (Shukla 2013) To preclude the possibility of insider sabotage in our nuclear facilities enhanced surveillance, screening and cyber policing needs to be ensured. Such a defence must also include specific measures to secure air space in the vicinity of nuclear reactors to obviate the possibility of a hijacked airliner being crashed to create a nuclear incident.

Shortcomings of the Present Organisational Structure in the Indian Army (Dayachand 2010) There are certain limitations of the armed forces which must be made known to the civil authorities during the civil - military liaison conferences held at various HQ and during interaction with the state and district authorities for disaster management. The limitations of the armed forces are analysed in detail in the subsequent paragraphs.

- The armed forces are not in a position to carryout large scale evacuation, crowd control, traffic control, protection duties or patrolling of the area, for which civil administration may utilise its own resources, resources of the NDRF or seek assistance from other agencies, including NGOs.
- **Limited Strength** The strength of the QRT/QRMT is limited and therefore they do not have the capability to carry out large scale decontamination of personnel, vehicles, equipment, roads etc within the affected area. Therefore, for large scale management of evacuation, crowd control, traffic management, medical treatment and large scale decontamination, resources held with the QRTs and QRMTs are grossly inadequate and hinder undertaking independent missions.
- **Vast Expanse** The existing QRTs/QRMTs are widely separated geographically and their deployment is heavily biased towards the Northern region. In the event of a CBRN disaster manifesting in the peninsular India, response may not be adequate.

- **Inadequate Training Infrastructure** At present, the FCBRN Protection at CME Pune conducts structured courses for operating in CBRN environment for the Army. In order to train optimum number of personnel for CBRN disaster management, the capacity is totally inadequate. It will require considerable enhancement of capacity to train personnel in handling CBRN disasters too.
- **Dual Tasked Assets** The QRTs and QRMTs discussed above are dual tasked, implying their primary role is different and CBRN disaster management is only a secondary role; hence their availability during hot war scenario becomes uncertain.
- **Deficient Equipment** The QRTs and QRMTs were initially equipped by MHA but the equipment has already outlived its shelf life. Further the canisters of the respirators as part of NBC equipment held by the QRTs/QRMTs are basically manufactured to afford protection against known **"war gases"** and not against leaks of poisonous gases from chemical plants and other such establishments. In case of leaks of poisonous gases from chemical plants and other such establishments, canisters specific to that gas or other specialized breathing equipment would have to be provided by the civil authorities. The services do not hold any clothing/equipment/vehicles providing protection against radiation hazard. The NBC suits of the armed forces prohibit ingress of radioactive dust and in case the incident is of a large magnitude, there would be a requirement of additional NBC equipment.
- **Insufficient Medical Equipment** On the similar lines, medical kits with the QRMTs do not contain antidotes/drugs to manage casualties resulting from industrial toxic chemical agents. As the medical treatment specific to that

chemical would become necessary, therefore the same should be catered for in nominated military/civil hospitals.

Broad Recommendations: Armed Forces

Though the NDRF is mandated to deal with CBRN disaster response, the armed forces may be required to respond to CBRN disasters, if and when they occur in peace time, on the principle of **'Second Responder'**. It may not be entirely incorrect to assume that the armed forces would continue to be an important stake holder in the national endeavour to manage and fight disasters. Though theoretically, Indian Armed Forces would get involved only once NDRF has expended all its resources or it is not possible for them to respond in an acceptable time frame due to terrain peculiarities, invariably Armed Forces may end up to be as responder due to their large footprint. Notwithstanding the above, the response of the armed forces should never become ineffective and inefficient and hence they should continue to train and equip themselves for a befitting response. Essentially, operational capability of CBRN response would have to be employed for peacetime disaster response. Also military stations/cantonments are potential targets for subversion/sabotage activities perpetrated by inimical forces. Therefore military stations must be self contained to respond and not depend upon response from civilian agencies to salvage the situation. Therefore certain recommendations to improve the overall effectiveness are deliberated upon in the subsequent paragraphs.

- **Centre of Excellence** There is a difference in response to CBRN disasters vis-a-vis other disasters since CBRN weapons are WsMD and responders need to be optimally equipped and trained. Sending untrained and inadequately equipped personnel for responding to CBRN disasters could result in life threatening situation for the responders. Presently, Indian armed forces handle disasters without any database of the resources, skills, and services essential for effective

response at short notice. (Gautam 2012) Emergency preparedness, drills, and forecasting of possible disasters that can be anticipated over time and space are absent. The forces do not have any training establishment dedicated for CBRN except for one at CME. Therefore there is a need to establish a centre for excellence in disaster management for the Indian Armed Forces. It could provide the much needed training for disaster management to enable commanders to facilitate effective response. It also needs to be noted that it is unlikely that lessons from previous major disasters have been recorded or consolidated. Therefore, a centre of excellence in disaster management for the three services must be set up under the aegis of HQ, Integrated Defence Staff (IDS), and the Indian National Defence University (INDU), as and when it is established. (Gautam 2012)

- **Staff Expertise** There is a requirement for necessary staff expertise in disaster response and relief operations. The experiences of response and the relief work during various calamities needs to be recorded and analysed for further up-gradation of capacity building.
- **Enhancing Capacity of Civilian Administration** Efforts should be made for using the expertise of the armed forces for bolstering the capacity of the civil authorities, including the disaster response forces. It would enable the latter to achieve self-reliance and thus reduce their dependence on the armed forces. Enhancing capability for risk reduction in urban as well as rural areas and having suitable legislative and regulatory mechanisms to promote safe buildings should be encouraged as part of the civil–military relations programme. Specialised workshops and seminars also need to be conducted at the various command levels.
- **CBRN Platoon of Engineer Regiment** The detailed analysis on this sub unit of an engineer regiment is as follows:-

- **Removal of Dual Tasked Tag** The CBRN Platoon of an engineer regiment is dual tasked and operationally committed. At a time when any response is sought, which should be well coordinated and rehearsed, the platoon may be committed elsewhere. Thus the regrouping and deployment of such dual tasked CBRN platoon may get delayed precluding an immediate response which is the basis for any disaster relief. It is therefore recommended that the dual tasking of the CBRN platoon of the engineer regiment should be removed and dedicated CBRN platoon be earmarked for such tasks. A special and dedicated CBRN response team will be better trained and far more suitable for dedicated response.
- **Nomination as QRT** The capability and capacity of the NBC platoon of the engineer regiment should be enhanced both in terms of manpower and state-of-the-art equipment. Its mandate and capacity should be enhanced to deal with disasters as this is one organisation which is readily available to carry out immediate disaster relief at the place where it is stationed. With the divisional level field formations located across the length and breadth of the country, this step would assist us in increasing our CBRN mitigation footprint in the country. The primary advantage in terms of availability of trained manpower on CBRN issues is a big plus that should be built up on. Therefore capacity building for CBRN disasters is much needed with the field formations deployed in the rear and border areas. This would imply nomination of troops, scaling of CBRN disaster management brick and training of troops. These QRTs need to be given brick formations (logistics) specifically for disaster response as this would ensure that the military equipment meant for war is not used for secondary tasks.

- **Restructuring of QRMT** The existing number of QRMTs in the country do not meet the requirement if we consider this threat in a rationale manner and hence there is a requirement to increase their numbers. It is recommended that each field ambulance of the division be restructured to comprise of a CBRN section with the aim to provide one QRMT to be able to treat 50 -100 casualties. In addition, the corps field ambulance too should be able provide one QRMT. In addition, with the present strength, the QRMT is not in a position to carry out any worthwhile task, hence there is an urgent requirement to increase its manpower so that it becomes a viable entity to carry out its mandated tasks in a more efficient manner. It is proposed to enhance the strength of the QRMT to two officers, four Junior Commissioned Officers and twenty four other ranks. This would enable them to handle 350 to 400 casualties in 6 hours and which would be twice the capability of the present set up.

A Case for Raising dedicated CBRN Units in the Indian Army

In any future conflict, one of the key objectives of Indian Army is to retain its ability to operate in CBRN environment. To meet this challenge CBRN protective equipment is being catered for as per the equipping policy, however organisational voids for undertaking such specialist tasks remain a major concern. The IA doctrine visualises conventional operations against a nuclear backdrop and hence CBRN defence must form an integral part of all our operational planning. Such defensive measures not only reduce the vulnerability of our forces but also act as a deterrent. The operations in CBRN environment are primarily based on three principles of CBRN defence i.e. contamination avoidance, protection and decontamination. Presently at theatre level there is no specialised unit to perform CBRN tasks like reconnaissance, monitoring, survey, decontamination and Post Strike Damage

Assessment (PSDA). Thus, in the present operational milieu, the threat of use of WsMD available with our adversaries reinforces the need for dedicated CBRN units.

In addition to the operational role that the new outfit would be required to perform, this unit would also be asked to be carry out disaster relief in the eventuality of a CBRN disaster. After analyzing the threats it is quite evident that India is a potential target and vulnerable to CBRN disasters. Unlike other disasters, CBRN disasters are not only accompanied by heavy human casualty, but also require expertise, to handle the situation and mitigate the effects.

The "National Disaster Management Guidelines—Management of Nuclear and Radiological Emergencies" clearly states "that for any major nuclear accident where the situation is beyond the coping capability of the civil administration, the services of the armed forces may be called for to take over several critical operations related to response (i.e., rescue and relief); rehabilitation (i.e. evacuation and sheltering) and reconstruction activities, including the immediate restoration of essential infrastructures like communication, electrical power, transportation, etc. For such operations, specially trained teams in the armed forces will always be available from within their existing sources." (NIDM 2009) This further necessitates the requirement of raising a dedicated force in the Indian Army which is trained, equipped and organized to undertake CBRN disaster mitigation and management. The proposed organisation and equipment profile of such a force is as elucidated in succeeding paragraphs.

- A CBRN unit should be raised in each of the operational commands to provide specialised CBRN defence support in a command theatre to enable troops to operate in a CBRN environment. In addition, the unit will also provide dedicated support to the civil administration during CBRN disasters.

- **Role** To provide specialised CBRN disaster management support to the civil administration and civil population in a command area of responsibility in addition to its operational tasks.
- **Tasks Related to CBRN Disaster Management**
  - To serve as a nucleus of expertise for training and operational preparedness in the command theatre.
  - To provide suitable response to a CBRN incident by providing a rapid response capability in the event of an intentional or unintentional release of CBRN threats and hazards.
  - Assist local, state, and central departments and agencies in conducting CBRN consequence management by providing capabilities to conduct personnel decontamination, emergency medical services, and casualty search and extraction.
  - Provision of QRT/QRMT for CBRN disaster management.
  - Be responsible for the functioning of the command CBRN schools.
  - To act as a nucleus for further expansion.
- **Capability** The broad capabilities of the unit would be as under:-
  - CBRN incident assessment, search and rescue, decontamination of personnel and equipment, evacuee and casualty decontamination.
  - Medical care (patient triage, along with trauma and emergency medical care), patient holding, ground and rotary-wing air patient movement.
  - Force health protection measures, military personnel and equipment operational security, site accessibility, logistics, general support to enhance lifesaving and reduce human suffering, C2 aviation lift and transportation.

- **Organisation** The unit should comprise of the five functional sub units and a HQ element primarily to cater for the administration, housekeeping, communication and workshop related facilities. The broad organisation is given below.

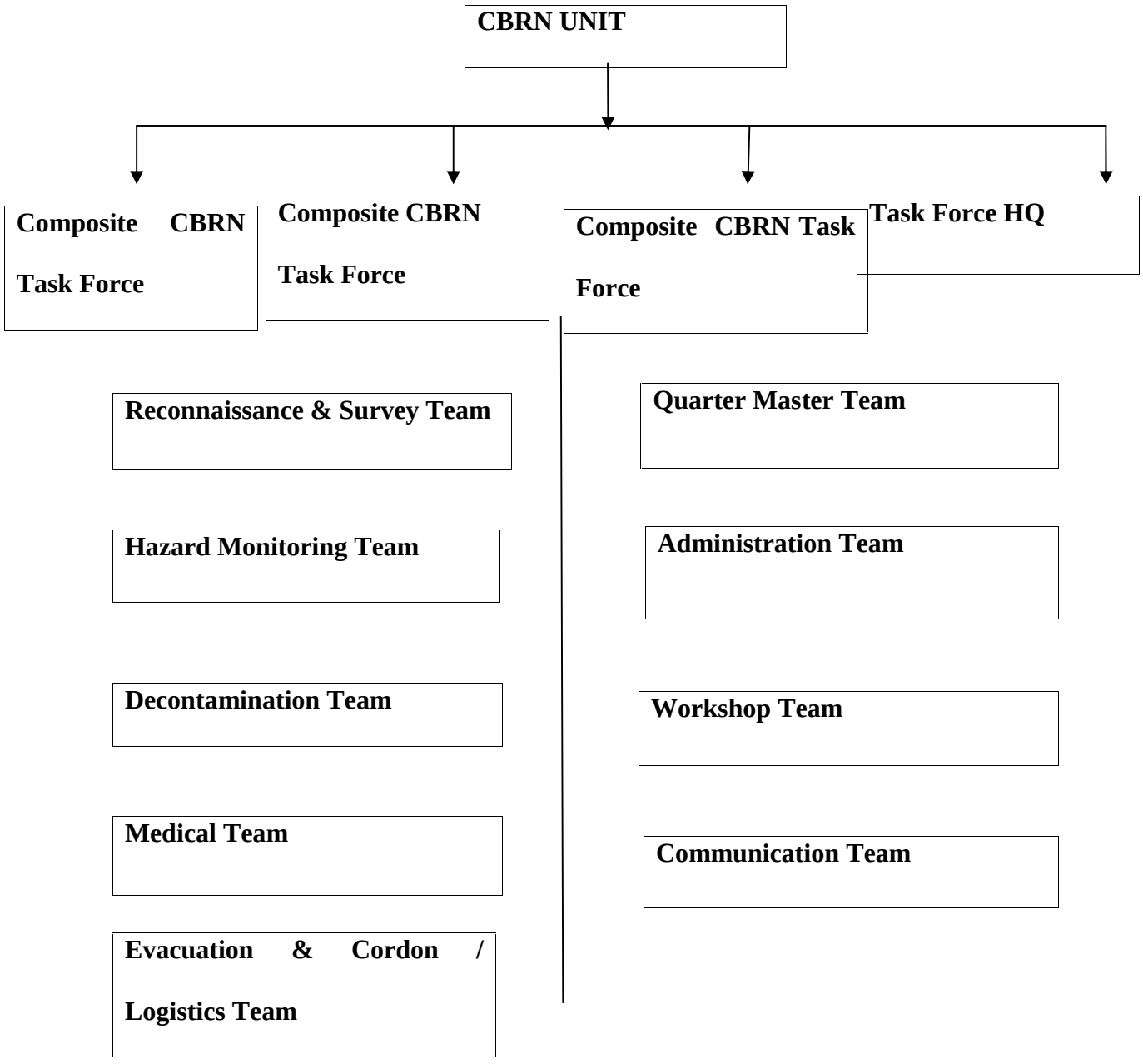


Figure 15: Proposed Organisation of CBRN Unit

- Tasks of the sub units would be as follows:-
  - **Reconnaissance, Survey and Investigation Team** The basic task of this sub unit would be to carry out initial reconnaissance and survey of the ground zero or the area affected by the CBRN leak/attack. The team would also have a mobile chemical, biological and nuclear laboratory for analysis of the exact element involved in the contamination and the antidote or type of decontamination required.
  - **Hazard Monitoring Team** The team would be responsible for the monitoring of hazard and the extent/spread of the CBRN leak/attack.
  - **Decontamination Team** This team would be responsible for carrying out decontamination of civilian/military personnel and equipment. The actions of this sub unit would be similar to the decontamination section of the existing QRTs.
  - **Evacuation and Cordon Team** This team as an integral part of the unit would be responsible for conducting casualty evacuation and rendering assistance to the other teams in executing their tasks. It would also be responsible for meeting the logistics requirement of the unit.
  - **Medical Team** This sub unit would be responsible for rendering medical assistance to the affected casualties.

A dedicated CBRN unit in each command along with the existing QRTs and QRMTs will exponentially enhance the response expertise to a CBRN accident during peace time. These units will have more focussed approach as their primary role would be CBRN defence and they can, accordingly, concentrate on training, equipping and rehearsing for this task. They will also act as nodal agencies for coordinating with NDRF Battalions responsible for CBRN defence. Civil administration and other stake holders to ensure a synergised response.

Conclusion

Though four NDRF battalions have been earmarked and equipped specifically for CBRN related disasters, the armed forces also need to be prepared to respond to these disasters as the capacity of NDRF is limited considering the geographical expanse of India and the envisaged threats. Keeping the same in view, the Indian Army has earmarked QRTs based on bomb disposal units and QRMTs based on specific medical units, in each command theatre. These are primarily to cater for CBRN related disaster situations i.e. both man made and/or accidental as also provide assistance to civil authorities.

The NDMA has promulgated guidelines for CBRN disasters in 2009. In addition, DAE has been identified as the nodal agency for developing national level plans, SOPs etc in general, as also for training of the first responders ie the components of NDRF. It is, however, felt that local administration would continue to be the key player in responding to such emergencies/disasters and critical areas would be the level of preparedness at state/local level, role of NDRF, civil defence, training, public awareness programmes etc. The concepts of mobile hospitals and mobile laboratories, enhanced NBC organisational capabilities, dynamic equipping policy, detailed SOPs for Task Forces and co-opted troops etc will have to be factored for an effective disaster management plan related to CBRN disasters.

Indian Armed Forces, when called upon to provide relief and succour to communities distressed by severe disasters, have performed admirably. In India, the necessity of 'quick response' will inevitably, in the near future, continue to involve the armed forces as an agency of first resort. The more cataclysmic the event, the more this will be true, simply because the local response entities themselves, become unwitting victims of the disaster. A balanced involvement of all agencies will manifest, only once we completely refine and upgrade our civil response mechanism in line with the government's proactive policies on disaster

management. CBRN threats, though improbable are possible and we need to prepare ourselves with knowledge, expertise and effective response measures.

Bibliography

ACMT, The American College of Medical Toxicology. *Chemical Agents of Opportunity and Terrorism.* 2008.

Allison, Graham T. *Nuclear Terrorism: The Risks and Consequences of the Ultimate Disaster.* Constable, 2006.

Bhaumik, Subir. "BBC News." *BBC.* September 10, 2008. http://news.bbc.co.uk/2/hi/south_asia/7608984.stm (accessed December 11, 2018).

CEEP, Ontario. *Centre for Excellence in Emergency Preparedness, Ontario.* http://www.ceep.ca/education/CBRNintrosheet (accessed December 15, 2018).

Chari, PD. " Disaster Management : The WMD Dimension, CBW Magazine ." *CBW Magazine IDSA January- March* , 2008.

Chauhan, Neeraj. "Times of India." *Times of India.* December 30, 2013. https://timesofindia.indiatimes.com/india/Indian-Mujahideen-wanted-to-nuke-Surat-Yasin-Bhatkal-tells-cops/articleshow/28116663.cms (accessed January 12, 2019).

Dar, H K. *Silent Warfare: Managing Nuclear Chemical Biological (WMD) Disasters: Weapons of Mass Destruction.* Manas Publiocations, 2005.

Dayachand. *Armed Forces response Plan to Disaster Management: Working Paper.* Paper, New Delhi: CLAWS, 2010.

Dev AB, Mohanan S, Damaodaran D, Soneja M, Jain N, Mohan A, Sood R. *Pubmed.Gov.* October 15, 2012. https://www.ncbi.nlm.nih.gov/pubmed/22914329 (accessed March 07, 2019).

DMI, Bhopal. *DMI, Bhopal.* 2010. http://www.hrdp-idrm.in/e5783/e17327/e27015/e27708/ (accessed January 02, 2019).

Eckerman, Ingrid. *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster.* University Press, 2005.

FBI. *The Convenant, the Sword, and The Arm of the Lord.* FBI, 1986.

Forest, Ministry of Environment &. *Chemical Disasters in India 2001-2010.* Ministry of Environment & Forest, 2011.

Gautam, Shivananda H. and P.K. "Reassessing India’s Disaster Management Preparedness and The Role of Indian Armed Forces." *IDSA - Journal of Defence Studies Vol. 6 No. 1 January 2012* , 2012: 102-113.

Group, Summit Medical. *Research Paper on Infections, Incubation and Contagious Periods.* Research Paper, Summit Medical group, 2015.

Hoffman, Bruce. "The first non-state use of a chemical weapon in warfare: the Tamil Tigers' assault on East Kiran." *Small Wars and Insurgencies*, 2009: 463-477.

Hope, Heidi Blake and Christopher. "The Telegraph World News." *The Telegraph.* February 02, 2011. https://www.telegraph.co.uk/news/worldnews/wikileaks/8296956/WikiLeaks-al-Qaeda-is-planning-a-dirty-bomb.html (accessed December 10, 2018).

IAEA. *Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources.Historical Evidence of Terrorist Incidents or Threats which have Involved Nuclear or Radiological Material, and Forecasts about the Future.* Vienna: IAEA, 2013.

—. "THE RADIOLOGICAL ACCIDENT IN GOIANIA." *IAEA.* 1988. https://www-pub.iaea.org/mtcd/publications/pdf/pub815_web.pdf (accessed January 04, 2019).

Industry, Ministry of Commerce and. *Gazzette of India Extraordinary.* Gazzette of India Extraordinary, Ministry of Commerce and Industry, 2012.

Jalalzai, Musa Khan. *The Prospect of Nuclear Jihad in South Asia: Pakistan's Army, Extra-judicial Killings, and the Forceful Disappearance of Pashtuns and Balochs.* Algora Pub lishers, 2015.

Joesph, Rajesh M Basrur and Mallika. *CBRN Terrorism Threats in India – A Case Study.* Landau Network- Centro Volta South Asia Security Project, 2007.

Kassenova, Togzhan. "Carnegie Endowment for International Peace." January 25, 2012. https://carnegieendowment.org/2012/01/25/preventing-wmd-proliferation-myths-and-realities-of-strategic-trade-controls-pub-46631 (accessed January 27, 2019).

Kaszeta, Dan. *CBRN and Hazmat Incidents at Major Public Events: Planning and Response.* Amazon Boopks, 2012.

—. *CBRN and Hazmat Incidents at Major Public Events: Planning and Response, First Edition.* Amazon Booka, 2012.

Kumar, Rajoo. "AERB.gov.in." *AERB.gov.in.* 2014. https://gnssn.iaea.org/CSN/Abu%20Dhabi%20Conference/Shared%20Documents/Session%207%20presentations/INV-26%20Kumar.pdf (accessed March 07, 2019).

Landers, Jackson. *Smithsonian.Com.* Septemebr 12, 2016. https://www.smithsonianmag.com/smithsonian-institution/anthrax-letters-terrorized-nation-now-decontaminated-public-view-180960407/ (accessed January 21, 2019).

Management, National Institute of Disaster. *Annual Report.* Annual Report, New Delhi : National Institute of Disaster Management, 2003-04 - 2011-12.

Mark Holt, Richard J. Campbell & Mary Beth Nikitin. *Fukushima Nuclear Disaster .* Paper, Washington DC: CRS, 2012.

Marples, David R. *The Social Impact of Chernobyl Disaster.* Macmillan Press, 1998.

Maruthappa, Dr. S. "Case study on Major Chemical Disasters-One day Symposium on“Prevention of Industrial/Chemical Disasters at Bengaluru." Paper, Bengaluru, 2009.

Medicine, National Academies of Science Engineering. *Effects of Nuclear Earth Penetrators and Other Weapons.* The National Academies Press, 2005.

MOHA. *State Level Programmes:Strengthening Disaster management in India.* Paper, New Delhi: Ministry of Home Affairs India, 2011.

Naidu, Gade. "India Prepares to Respond to CBRN Disasters." *CBRNe*, 2013.

Narain, T. Dikid S.K. Jain A. Sharma A. Kumar J.P. "Emerging & re-emerging infections in India: An overview." *Indian J Med Res 138*, July 2013: 19-31.

NDMA. *Learn about Disasters - man made disasters.* 2009. http://www.ndma.gov.in/en/learn-about-disasters/man-made-disaster/.html (accessed January 13, 2019).

—. "National Policy on Disaster Management 2009." *NDMA.* 2009. https://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf (accessed February 10, 2019).

—. *NDRF.* March 02, 2019. http://www.ndrf.gov.in/about-us (accessed March 02, 2019).

NDTV. "NDTV." *NDTV.* July 26, 2018. https://www.ndtv.com/world-news/japan-executes-cult-members-of-aum-shinrikyo-behind-1995-tokyo-subway-sarin-attack-report-1889843 (accessed February 20, 2019).

NDTV, Doctor. "Fresh bird flu outbreak in West Bengal." *NDTV.* January 2009. https://doctor.ndtv.com/news/fresh-bird-flu-outbreak-in-west-bengal-1703179 (accessed January 11, 2019).

News, BBC. "BBC News." September 24, 2013. https://www.bbc.com/news/world-middle-east-23927399 (accessed November 06, 2018).

NIDM. *National Disaster Management Guidelines: management of Nuclear and Radiological Emergencies.* Guidelines, New Delhi: NDMA, 2009.

—. "National DisasterManagement Guidelines : Incident Response System." *NIDM.* July 2010. https://nidm.gov.in/pdf/guidelines/new/incidentresponsesystemjuly.pdf (accessed March 02, 2019).

NPCIL. New Delhi: NPCIL, 2012.

Olson, Kyle B. "Aum Shinrikyo: Once and Future Threat?" *Emerging Infectious Diseases*, 1999.

PIB. "3 Emergency Response Centres of Department of Atomic Energy operational at various sites of DAE ." *PIB.* May 06, 2015. http://pib.nic.in/newsite/PrintRelease.aspx?relid=121282 (accessed January 11, 2019).

—. "National Disaster Response Force." *PIB.* August 09, 2011. http://pib.nic.in/newsite/PrintRelease.aspx?relid=74225 (accessed February 13, 2019).

pmo.in. "Former Prime Minister of India Dr Manmohan Singh." March 27, 2012. https://archivepmo.nic.in/drmanmohansingh/speech-details.php?nodeid=1153 (accessed February 01, 2019).

Qazi, Reshmi. "Ebola : Global Challenge & India’s Preparedness." *CBW Magazine*, 2014.

Rajagopalan, Rajeshwari Pillai. "CBR Security: India's Threats and Vulnerabilities." *CBW Magazine*, 2011.

Ramachandran, R. "Radiation shock." *Frontline, Volume 27- Issue10*, MaY 08-21, 2010.

Ranjan, Pratyush. "Swine flu outbreak: 774 deaths, 13,000 cases set alarm bells ringing." *Hindustan Times.* February 22, 2015. https://www.hindustantimes.com/india/swine-flu-outbreak-774-deaths-13-000-cases-set-alarm-bells-ringing/story-qKeRWZ9QocPLll3Oif09RL.html (accessed February 25, 2019).

Reuters. "reuters.com." *reuters.com.* February 19, 2008. https://www.reuters.com/article/us-india-uranium/india-police-seize-8-lbs-of-uranium-from-smugglers-idUSB65928720080219 (accessed November 30, 2018).

Samuels, Richard J. *Disaster and Change in Japan.* Ithaca, NY, USA: COrnell University Press, 2013.

Sanger, By Mark MazzettI and David. E. "New York Times." *New York Times.* July 18, 2007. https://www.nytimes.com/2007/07/18/washington/18intel.html (accessed February 12, 2019).

Sciences., National Institute on Allergy & Infectious Diseases-US Department of Health &. *Biodefence research paper on NIAID Emerging Infectious Diseases/Pathogens .* US Department of Health & Sciences.

Seetharam, Sridevi. "Hepatitis B outbreak in Gujarat: a wake-up call." *Indian Journal of Medical Ethics*, 2009.

Shukla, Raj. "(2013): Nuclear Terrorism Inevitable But Preventable?,." *Journal of Defence Studies, Vol-7*, 2013: 173-188.

Shukla, Raj. "Nuclear Terrorism: Inevitable But Preventable?" *IDSA - Journal for Defence Studies Vol 7 Issue 1*, 2013: 183-191.

Simon, Jeffrey D. *The Alphabet Bomber.* Nebraska: University of Nebraska Press, 2009.

Sinha, AK. "Development of an Integrated Disaster Management System in India: Importance of Reliable Information." *The International Conference on Total Disaster Risk Management .* New York, 2003. 5.

Sinha, Anil K. "The International Conference on Total Disaster Risk Management." *The International Conference on Total Disaster Risk Management.* New Delhi, 2003.

"Standard Operating Procedures (SOPs)." *TDMA tripura.* 2011. https://tdma.tripura.gov.in/sites/default/files/SOP-EOC.PDF (accessed January 12, 2019).

Subramaniam, T S. "The Kalpakkam `incident'." *Frontline*, August 2003.

Sultan, Dr. Shireen M. Mazari & Maria. *ISSI.Org.Pk.* 2001. http://webcache.googleusercontent.com/search?q=cache:http://www.issi.org.pk/wp-content/uploads/2014/06/1295853468_7989924.pdf (accessed February 19, 2019).

Tertrais, Bruno. *Pakistan's nuclear and WMD programmes: status, evolution and risks.* Stockholm: SIPRI, 2012.

"The Economic Times." *The Economic Times.* March 14, 2011. https://economictimes.indiatimes.com/industry/indl-goods/svs/steel/15-disused-cobalt-60-isotopes-stolen-from-sail-in-jan/articleshow/7701938.cms (accessed February 13, 2019).

"The Times of India." *Times of India.* August 15, 2006. https://timesofindia.indiatimes.com/india/Kalpakkam-N-unit-under-army-cover/articleshow/1894057.cms (accessed January 2019, 2019).

Tiwari, Saumya. "NBC threats and India's Preparedness." *CBW Magazine*, 2012: 6.

UNO. *The United Nations Office for Disaster Risk Reduction.* June 10, 2016. https://www.preventionweb.net/documents/oiewg/Terminology%20related%20to%20disaster%20risk%20reduction%20-%20technical%20non-paper.pdf (accessed December 15, 2018).

Walker, J. Samuel. *Three Mile Island - A Nuclear Crisis in Historical Perspective.* University of Californioa Press, 2006.

WHO. "Ebola virus disease." *WHO.* February 12, 2018. ttps://www.who.int/news-room/fact-sheets/detail/ebola-virus-disease (accessed February 12, 2019).

Youngsoo Choi, Lawrence M Wein and Sylvie Denuit. "Analyzing Evacuation Versus Shelter-in-Place Strategies After a Terrorist Nuclear Detonation." *Research GAte*, 2010.

Zolotarev, Matthew Bunn Rolf Mowatt-Larssen Simon Saradzhyan William H. Tobey Yuri Morozov Viktor I. Yesin Pavel S. *The U.S.-Russia Joint Threat Assessment of Nuclear Terrorism.* Harvard Kennedy School, 2011.