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Preparing for Chemical Biological Radiological and Nuclear Disasters in India and the Role of Military

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Abstract

History of mankind has seen nuclear weapons being used only twice. The effects of mass destruction, caused by these weapons, have produced worldwide condemnation, thus ensuring their non-usage for the past six decades. Furthermore, the fear of "Mutually Assured Destruction" (MAD) between nuclear adversaries has prevented any adventurous war mongering between nations. However, with the emergence of a new world order post in the 1990s, there has been a paradigm shift. Certain countries, who felt left out, have acquired these weapons, or are on the path of acquiring them. Non-state players emerged in the arena and besides nuclear weaponisation, strides have been made in the delivery system, despite various control regimes.

The Indian sub-continent saw nuclearisation in the 1970s, after the Pokhran and Chagai tests. Today, both of India's adversaries are armed with weapons of mass destruction (WMD) and possess delivery means to strike targets deep within our country.

Chemical weapons lie in the tactical domain, whereas Biological weapons are in the strategic domain;

Key Points

- Three basic types of disasters, namely, chemical, biological, radiological, and nuclear, are together known as CBRN. India's CBRN defence planning is based on Avoidance, Detection, Protection, Decontamination, and Damage Control.
- Preparedness for any eventuality in this domain shall now mean managing nuclear, biological and chemical (NBC) events, most of which will be initiated by terrorists/rogue nations.
- Towards control, safety regulations enacted, including guidelines issued by the National Disaster Management Authority (NDMA)—what's needed is enforcement.
- India's Armed Forces (AF) need be prepared to operate in a nuclear backdrop, entailing changes in tac doctrine and concepts, especially CBRN training, which got a boost post-Pokharan II (1998), which led to preparation of a defence mechanism against the weapons of mass destruction (WMD) threat of Pakistan.
- Indigenous Defence Technologies for Chem-Bio Defence were developed by the Defence Research and Development Organisation (DRDO) starting early 1990s, but we still have a long way to go.
- Though it's National Disaster Response Force (NDRF) presently mandated for CBRN emergencies, AF will continue to support emergency functions, like SAR, communication, health, medical, and transportation, in the aftermath of any disaster.

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considering their effects. Also, long incubation of Biological weapons makes them a suspect to be used against field forces. Possibility of usage of improvised nuclear devices, Anthrax like substances, mustard gas, etc., by terrorist organisations cannot be ruled out. Thus, there will always be a chemical biological radiological and nuclear (CBRN) threat in counter insurgency (CI) Operations/Out of Area contingency (OOAC)/UN missions for the nation's Security Forces.

Therefore, there is a need to acquire the capability to operate in such an environment in the future battle field. CBRN weapons are WMD. Their effects are not confined to small areas or a unit. To avoid large-scale casualty, our soldiers must be trained to operate and take protective and defensive measures in a CBRN environment. Therefore, training must consider the likely scenario of the future into consideration and be prepared to counter the threat accordingly. India's Armed Forces need to be prepared to operate in a nuclear backdrop, entailing changes in tac doctrine and concepts. Also, the threat of the use of "dirty bomb" by terrorist groups being real, underlines the importance of CBRN Disaster Management (DM) training in India in general and the Indian Army (IA) in particular.

This paper brings out the regulations in each field, recent achievements of various Ministries/the National Disaster Management Authority (NDMA), in achieving synergy in counter CBRN measures and formulating Guidelines/SOPs for managing such disasters. It also discusses the levels of preparedness, shortages, and problems therein in implementing this mandate on the ground, generally in the Armed Forces. In the end, individual and community nuclear, biological and chemical (NBC) protection measures will also be analysed.

Introduction

India's CBRN defence planning is based on the following pillars: Avoidance; Detection; Protection; Decontamination; and finally Damage Control/Consequence Management. The actions of an effective response strategy are based on the above principles and the equipment available to carry out the various response actions appropriately.[1]

Preparedness for any eventuality in this domain shall now mean addressing the management of nuclear, biological and chemical (NBC) events, most of which will be initiated by terrorists/rogue nations, instead of traditional enemies. Any NBC incident, whether now, or in the future will be a mass casualty situation, with dangerous intent—the preparation for which will have to be under the assumption that it is intentional and malicious.

Threat Assessment

Non-state actors being faceless entities can use a proxy, either independently or in collusion with state adversaries. According to an IAEA report, there have been 300 attempted smuggling incidents of NBC materials during the last decade.[2] An explicit war may be a distant possibility but the threat of non-state actors' unleashing a foray of chemical and biological weapons can wreak havoc. Rogue states and regimes out of the chemical weapons convention (CWC) and bio and toxin weapons convention (BTWC) need to be brought into the global preventive frameworks. A recent reference to possible usage of "dirty bomb" was in the Wikileaks report,[3] according to which Al-Qaeda was likely to achieve faster results while developing dirty weapons, for possible use against British troops. Both our adversaries are armed with nuclear weapons and possess the delivery means to strike targets deep within our nation. Hence, their signing of any treaty in no way mitigates the possibility of the use of WMDs by terrorists or precludes their surreptitious use. Hence, our response and its preparatory actions must cater to such threats in a future defensive or offensive scenario.

What is a Disaster?

Any emergency that is beyond the coping capacity of the effected populace or which leads to death of tenor more, affects hundred or more people and there is a call for international support or declaration of a state of emergency, is classified as a disaster today, according to CRED[4] norms.

Man-Made Disasters

Man-made disasters are of three basic types, namely,chemical, biological nuclear and radiological, each of which is together known by the acronym CBRN, including those induced by accidents and terrorist acts. Each of these is explained next.

Chemical Disasters

Chemicals, being at the core of modern industrial systems, have attained a very serious concern. Chemical disasters (CDs) may be traumatic in their impacts on human beings and will result in casualty, as also damage to nature and property. The elements which are at highest risks due to CDs primarily include the industrial plant, its employees and workers, hazardous chemicals vehicles, residents of nearby settlements, adjacent buildings, occupants and surrounding community. They may arise in several ways, such as:

- Process and safety systems failures—human errors, technical errors, management errors
- Induced effect of natural calamities
- Accidents during transportation
- Hazardous waste processing/disposal
- Terrorist attack/unrest leading to sabotage.

Status of Chemical Disaster Risk in India

In 1984, India witnessed the world's worst CD, the "Bhopal Gas Tragedy", wherein, over thousands died due to accidental release of toxic gas. India continued to witness a series of chemical accidents even after Bhopal had demonstrated its vulnerability. Only in the last decade, 130 significant chemical accidents were reported, which resulted in 259 deaths and 563 injured. There are about 1,861 Major Accident Hazard (MAH) units, spread across 301 districts, 25 states, and 3 Union Territories, in all zones of the country.[5]

Safety Initiatives to Address Chemical Risks

A comprehensive legal/institutional framework exists in our country, with several regulations covering the safety in transportation, liability, insurance, and compensations. The Government of India has further reinforced the legal framework for chemical accidents, by enacting new rules. The NDMA has come out with specific guidelines[6] on Chemical Disaster Management (CDM), prepared to provide directions to ministries / departments / state authorities for the preparation of their detailed DM plans. These guidelines call for a proactive, participatory, and multi-sectoral approach at various levels for CDs preparedness and response.

Biological Disasters

These 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, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Examples of biological disasters include outbreaks of epidemic diseases, plant or animal contagion, insect or other animal plagues and infestation. Biological disasters may be in the form of an Epidemic affecting a disproportionately large population, community, or region at the same time. Examples are cholera, plague, Japanese encephalitis or pandemic (an epidemic that spreads across a large region, that is, a continent, or even worldwide of existing, emerging or re-emerging diseases and pestilences, an example being influenza H1N1 (swine flu).

Radiological and Nuclear Emergencies

The growth in the application of nuclear science and technology in the fields of power generation, medicine, industry, agriculture, research, and defence has led to an increase in the risk of occurrence of nuclear and radiological emergencies (NRE). NRE can arise in a nuclear facility at plant level leading to plant/site or off-site emergency depending on the extent of its impact on surroundings. It can also take place while using radiation sources, either in hospitals, industries, agriculture or research institutions due to loss or misplacement/faulty handling. Other events that can lead to NRE include accident of a vehicle carrying radioactive material due to an orphan source, i.e. the source which is not under regulatory control or due to usage of radioactive material in malevolent activities. Sad memories of the use of nuclear weapons dropped on Hiroshima/Nagasaki, and the wide publicity given to the reactor accidents at Three Mile Island in the US and Chernobyl in erstwhile the USSR, are still fresh in everyone's minds.

Moreover, nuclear emergencies can arise due to factors beyond the control of operating agencies like human error, system failure, sabotage, earthquake, cyclone, flood, etc. Such failures, even though of very low probability, may lead to an on-site or off-site emergency.

To combat this, several system upgrades are planned to mitigate or prevent them. However, we still need proper emergency preparedness plans to minimise avoidable loss of life, livelihood, and property and its impact on the environment.

Chemical Disasters and Their Management

The growth of chemical industries has led to an increase in the risk of occurrence of incidents associated with hazardous chemicals (HAZCHEM). Common causes for chemical accidents are deficiencies in safety management systems and human errors, or they may occur as a consequence of natural calamities or sabotage activities. These accidents result in fire, explosion or toxic release. The nature of chemical agents and their concentration during exposure ultimately decides the toxicity and damaging effects on living organisms as symptoms like irreversible pain, suffering, and death. Meteorological conditions such as wind speed, wind direction, the height of the inversion layer, stability class, etc., also play an important role by affecting the dispersion pattern of toxic gas clouds. The Bhopal Gas Leak of 1984, wherein over 3,000 people died due to the toxic gas MIC, is a live example.

A small accident occurring at the local level may be a prior warning signal for an impending disaster. CDs, though low in frequency, have the potential to cause significant immediate or long-term damage. Although efforts have been made to minimise such accidents and improve emergency preparedness at all levels, more efforts are needed to predict the occurrence of disasters, assess their damage potential, issue warnings, and take precautionary measures towards mitigation.

Sources of Chemical Disasters

Chemical accidents may originate during any of the following:

- Manufacturing and formulation installations including commissioning and process operations, maintenance, and disposal.
- Material handling and storage in manufacturing facilities and isolated storages; warehouses including tank farms in ports, docks, and fuel depots.
- During transportation (by road, rail, air, water, and pipelines).

Causative Factors

These may result from fire, explosion, toxic release, poisoning or combination of these. CDs may occur due to process deviations concerning the chemistry of the process, pressure, temperature, and other identified parameters concerning the state of the substance, i.e. solid, liquid or gas, proximity to other toxic substances and the probability of a runaway reaction due to the incidental mixing of two or more HAZCHEMs with dissimilar properties. In addition, it may be due to hardware failure, resulting in large-scale spills of toxic substances (in any form) due to loss of containment, or an explosion. Further, boiling liquid expanding vapour explosion (BLEVE) may occur due to sparks, shocks or frictional forces on chemicals during transportation. Any human/mechanical failure may cause large-scale spills of liquids or of compressed gases like chlorine or liquid petroleum gas (LPG) which can cause BLEVE and can directly affect human lives and the environment. The release of compressed gases gives rise to thermal or cryogenic stresses, which may impact the surroundings, compounding the damage. In addition to the loss of life, major consequences include impact on livestock, flora and fauna, the environment and losses to industry.

Regulatory Framework and Codes of Practices[7]

Regulatory framework on chemical safety started from the Factories Act 1948 and chemical class-specific regulations like the Explosives Act 1884, Insecticide Act 1968, Petroleum Act 1934. Later, an umbrella act, the Environment (Protection) Act 1986, was enacted, which also deals with chemical management and safety. Thereafter, a number of regulations covering safety in transportation, insurance, liability, and compensations were enacted and further reinforced.

Institutional Framework

The Ministry of Labour (MoL), Ministry of Environment and Forests (MoEF) and Ministry of Surface, Road Transport and Highways (MoS RT&H) are responsible for enacting regulations. The MoL through its state entities, the Inspectorate of Factories/Directorate of Industrial Safety and Health (DISH), the Central Pollution Control Board (CPCB), and the MoEF with its state entities, State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) of UTs monitors compliance of the various regulations. For petroleum products and explosives, the Ministry of Chemicals and Fertilisers, Ministry of Petroleum and Natural Gas, and Ministry of Heavy Industries and Public Enterprises (MoHI and PE) monitor compliance of these regulations.

Compliance

Of the 602 districts in India, 263 districts have MAH units. Of them, 170 have clusters of more than five MAH units. Presently, there are 1,666 MAH units in India. In addition, there are a large number of storages of hazardous substances; big warehouses including local factories or storage sites. On-site emergency plans are in place for 1,628 units. Off-site emergency plans for 166 districts have been prepared.

The MoEF has set up a Crisis Control Room (CCR) for the rapid exchange of information and coordination of activities during an emergency. It is also preparing a web-based accident information system for use by the concerned stakeholders, with better monitoring and management of CDs. Industries have also undertaken awareness programmes for communities residing in the vicinity of industrial units.

Salient Gaps in Chemical Disaster Management in India[8]

Chemical accidents pose a special challenge in their management. The present status for CDM is contained in various chemical-specific and general regulations. Several programmes and activities on preparedness, mitigation, and response are underway at national, state, district, and local levels. Chemical industries have also set up risk reduction measures and initiated resource sharing and other coordinated efforts. Research and development and standards set in CDM are also being pursued in various institutions. However, while considerable progress was made in the last two decades, critical gaps still exist in certain areas, which need to be addressed on priority. To start with, existing DM plans at various levels need to be revamped to address CDs.

These guidelines have set modest goals and objectives, to be achieved by mobilising all stakeholders, through an inclusive and participative approach. Appropriate allocation of financial and other resources, including dedicated manpower and targeted capacity building, would be the key to success. Periodic training, simulations, mock drills would further enhance the effort.

Bio-Warfare and Bio-Terrorism

Bio disasters are primarily of natural origin. They are largely the result of the entry of a virulent organism into a congregation of susceptible people, living in a manner suited to the spread of infection. Short-duration infections with high mortality rates harm societies by depleting their numbers. The longer duration infections, with varying immediate mortality, nevertheless, become important when they cause large-scale morbidities, like Malaria and tuberculosis.

As a tactical manoeuvre, the introduction of a communicable disease in enemy camp has been used by military leaders from the earliest times. Filth, cadavers, and animal carcasses have been used to contaminate wells, reservoirs, etc., till the nineteenth century. In the Middle Ages, military leaders used bubonic plague by catapulting infected bodies into besieged forts to spread the disease.

In the twentieth century,the use of bio-weapons became more scientific as the technology for the cultivation of pathogens and vaccinology developed. Significant research efforts were also made by both sides in World War II (WW II). Post-WW II, the Cold War saw serious development in bio-weapons. Currently, about 17 countries are suspected to be working on bio-weapons, as also on agents (like anthrax), including by terrorist groups, which poses a serious threat. Bio-terrorism, thus, is as great a threat as any natural epidemic causing agents.

Mitigation

The essential protection against the natural and artificial outbreak of disease includes the development of mechanisms for prompt detection of incipient outbreaks, isolation of infected persons, and mobilisation of investigational and therapeutic counter-measures. In the case of deliberately generated outbreaks (bio-terrorism), the spectrum of possible pathogens is narrow, while natural outbreaks can have a wider range.

Epidemics do not respect national borders. As international travel is easy, bio agents need to be tracked, so that they don't cross boundaries into other regions. This aspect has made international collaboration crucial for epidemic control. Organisations like the World Health Organization (WHO), Food and Agricultural Organization (FAO), etc., thus have an important role to play.

NDMA Guidelines for Managing Bio Disasters[9]

These are the bible of DM in India, post the 2005 overhaul and deal with all aspects of bio disasters. They are designed to acquaint us with the basics of Bio Disaster Management (BDM), in a balanced manner and give the information required by organisations to formulate SOPs at various levels. They will also be used for the preparation of national, state, and district biological DM plans, as part of 'all hazard' DM plans.

Nuclear and Radiological Disasters

Managing Nuclear and Radiological Emergencies

Nuclear and Radiological Emergencies being man-made in nature, the maximum emphasis has been laid on their prevention,without diluting other aspects of the disaster continuum. However, in an emergency taking place due to circumstances beyond control, the Guidelines[10] recommend a series of actions by various stakeholders at different levels that would: (1) mitigate the accident at source; (2) prevent deterministic health effects in individuals and limit the probability of stochastic effects in population; (3) provide first aid and treatment of injuries; (4) reduce psychological impact on population; and (5) protect environment and property, all under the constraint of available resources. These emergencies have been broadly classified into fivecategories.[11]

1. An accident taking place in any nuclear facility of nuclear fuel cycle including the nuclear reactor, or a facility using radioactive sources, releasing radioactivity in the environment.
2. A 'criticality' accident in a nuclear fuel cycle facility where an uncontrolled nuclear chain reaction takes place inadvertently, leading to bursts of neutrons and gamma radiations.
3. An accident during the transportation of radioactive material.
4. Malevolent use of radioactive material as a radiological dispersal device by terrorists for dispersing radioactive material in the environment.
5. A large-scale nuclear disaster, resulting from a nuclear weapon attack leading to mass casualties and destruction of large areas and property.

There are well-established international treaties for control of fissile materials, yet there exists the possibility of it falling into the hands of terrorists. Moreover, if these treaties are violated through state-sponsored activities, access to fissile materials by terrorist groups cannot be ruled out. Accidents during transportation of radioactive materials are of low probability,due to special design features of containers in which they are transported and special safety and security measures (to take care of all possible threats or eventualities, including the threat from misguided elements).

Approach to Nuclear and Radiological Emergencies Management

A four-pronged strategy is to be adopted for the holistic management of nuclear or radiological emergencies.[12] These are as follow:

1. The Nuclear Emergency Management Framework is supported on a prominent mainstay of strengths such as prevention, mitigation, compliance of regulatory requirements, preparedness, capacity development, response, etc., that constitute the DM continuum.
2. The existing legal framework is strengthened through various legal and regulatory means.
3. The framework to be institutionalised by identifying the stakeholders at various administrative levels with their respective responsibilities in a people-centric, bottom-up approach.
4. The framework is to be implemented through the strengthening of existing action plans, or by preparing new action plans at national/state/district levels. The Atomic Energy Regulatory Board is the nuclear regulatory authority in the country,with the mandate for issuing licenses to nuclear and radiological facilities and ensuring compliance with applicable standards and codes.

Present Status and Situation Analysis

A network of 18 Emergency Response Centres (ERC) is presently established by Bhabha Atomic Research Centre (BARC) to cope with NREs in the public domain, like transport accidents, the explosion of RDDs, etc. Their task is to monitor and detect radiation sources, train stakeholders, maintain adequate inventory of monitoring instruments and protective gear, and provide technical advice to first responders and local authorities. Further, BARC is actively training personnel from various forces, the NDRF, and the Central Industrial Security Force (CISF).

For any major nuclear accident wherein the situation is beyond civil administration, services of Armed Forces (AF) may be called for, to take over several critical functions. Civil-military coordination will thus be comprehensively developed so that the specially trained teams of AF personnel can be inducted to assist civil administration. Detailed SOPs to handle any type of NRE have to be worked out initially for all cities with a population of, say, 20 lakh or more and other vulnerable places in Phase 1 and other cities in Phase II. This preparedness is all the more significant for the country's metros.

Chemical, Biological, Radiological, and Nuclear Training in India: Present Status

Chemical, biological, radiological, and nuclear training commenced after the world's attention was directed at the use of chemical warfare agents by Iraq against the Kurd rebels in the 1980s. The training was basically to generate awareness among the troops about the basics of types of the agents and various survival drills. With the gradual availability of some categories of equipment either from the global market or from our DRDO laboratories, the options available to the service personnel gradually started increasing, while also allowing the facets of training to become more focused. CBRN training got a boost post-Pokharan-II nuclear tests (1998) leading to a systematic preparation of a defence mechanism against the WMD threat posed by Pakistan. Post the Kargil conflict (1999), awareness developed about the need to have a protective mechanism in place against CBRN weapons, creating the desired stimulus to increase the quantum of training within the Armed Forces(AF). The 9/11 attacks, which were followed by the anthrax mail scare, further heightened the possibility of a CBRN disaster and made the MHA wake up to a possible scenario of use of these weapons in the country by terrorist organizations/non-state actors, prompting it to raise Quick Reaction Teams (QRTs) and Quick Reaction Medical Teams (QRMTs) to respond to CBRN contingencies.[13]

In the absence of a pool of trained manpower, these teams were to be raised from within the cadres of the three services, initially by the IAF (2001), to be followed by the Faculty of NBC Protection (FNBCP), College of Military Engineering (CME), Pune, by the Army(2003). Central Armed Police Forces (CAPFs) came next, and training of their cadres commenced at various institutions, initially at the AFs training facilities and later at their training centers. With the National Disaster Management Mechanism taking concrete shape in 2005,four battalions of the NDRF were then earmarked to respond to CBRN contingencies and are today at the standby at bases with airlift facility to respond anywhere across the country. Though CBRN preparedness has come a long way, since the Bhopal Gas tragedy of 1984, a lot needs to be done. Some suggested immediate steps are as follows:[14]

- **Formation of the National Institute of CBRN Mitigation and Training:** Under the aegis of DRDO and NDMA, it is proposed to begin a new chapter in the field of CBRN defence training, in the form of an apex centre, which will be christened as the National Institute of CBRN Mitigation and Training (NICMT), as a centre of excellence.
- **CBRN defence as a component of basic disaster management at schools/colleges:** To ensure that the awareness levels are more broad-based, it is recommended that CBRN defence be introduced as a topic in schools and colleges as part of their DM curriculum.
- **International exchange:** At present, there is no official collaborative practice between any of the training facilities and any of the international institutions engaged in this field. To make these facilities truly world-class, it is suggested that international exchange programs be planned with some of these 'centers of excellence'. The assistance of IIMs and IGNOU may be taken to develop unique and innovative training programs.

- **Use of realistic simulators:** A new generation of highly sophisticated computer-driven modelling and simulators, using virtual reality and closed immersion models, are available in the international market, which realistically allows trainees to manage complex and high-risk situations in a real-life setting. The Institute of Nuclear Medicine & Allied Sciences (INMAS) and Air Force Institute of NBC Protection (AFINBCP) have embarked upon a research project on a similar basis for the management of radiological and nuclear casualties.
- **Involvement of the industry:** With the threat of CBRN disaster looming large, the industry also needs to be prepared and involved. The various chambers of commerce may act as catalysts in this endeavor to develop a practical model of Long Term Perspective Plans.

Preparedness for Nuclear and Radiological Emergencies[15]

The planning and preparedness for response to NREs will be integrated with an all-hazards approach, with planning for response to all types of conventional emergencies. The nuclear facilities must have a comprehensive emergency preparedness plan for on- and off-site emergencies. All these activities are guided and controlled from a pre-designated ERC located outside the boundary of the nuclear facility. Quality of the required emergency preparedness is ensured by periodic training courses for on-site and off-site administrative personnel, including government officials and other stakeholders.

A large number of agencies like police, fire and emergency services, medicos, no-government organizations (NGOs), civil defence and home guards, etc., have to be fully integrated into the NRE programmes, both at state and district levels, since for efficient handling, foremost is the availability of instruments for radiation detection and monitoring. A sufficient inventory of such instruments and protective gear will be built up by all state and district DM authorities and the selected first responders will be trained in their use. Four battalions of the NDRF are trained for specialised response during NREs. In addition, four more battalions are trained to provide a supporting role.

Indigenous Defence Technologies for Chem-Bio Defence

India's AF, deployed at various frontiers of the country, are vulnerable for exposure to micro-organisms and hazardous chemicals, causing harm to the physical as well as mental health of its personnel. DRDE Gwalior, established in 1973, under DRDO, was given the mandate 'to design and develop state-of-the-art technologies and products for chem-bio defence as well as to establish state-of-the-art repository and testing and evaluation facilities for developed products'[16] to make the country self-reliant with chem-bio defence. Chem-Bio defence needs detection of micro-organism and hazardous chemicals at the earliest, protection from these and decontamination. DRDE has developed technologies for its detection by developing chemical sensors, molecular markers/kits, and other quick detection techniques, various protective measures and technologies for physical, chemical and medical protection and decontamination of soldiers. All these measures have been widely tested, both in the laboratory and in the field.

Deterrence against NBC can also be achieved from a range of equipment and technology, including detectors and reconnaissance vehicles along with nanotechnology-based sensors, micro UAVs, dosimeters which can measure an individual's or an object's exposure to hazardous exposure in the environment. Also, portable gas chromatographs which are used for testing the purity of a particular substance, and roentgen meters which is used for measuring the cumulative quantity of x-rays or ã-rays.[17] The DRDO project works on the PPP, with around 85 per cent of its NBC defence inventory developed for Indian AF.[18] As on date,16 CBRN monitoring vehicles have been inducted. These were developed by the DRDO and manufactured by Ordnance Factories Board.

Limitations in Chemical, Biological, Radiological, and Nuclear Training

In spite of the tremendous growth in the last two decades, there are a few limitations that need to be addressed for effective uptake of knowledge. These are as follows:[19]

- **Lack of live agent training:** This aspect will go a long way to improve the confidence levels of first responders to handle actual chemical events. The Czech Republic and Sweden, considered as 'Centres of Excellence' for CBRN defence for the NATO forces, need to be co-opted here.

- **Motivation for personnel as a career option:** With limited career openings in the field, especially for other ranks in the services and CAPFs and no exclusive cadre of CBRN personnel, opting for a career in this field is not attractive. Hence, the government to come out with more vacancies/ career options. A Public Private Partnership (PPP) model could also be tried as the requirement for the services may arise in the corporate sector too.
- **Strengthening of state/district-level CBRN training:** Efforts at the national level need to be replicated at state and district level to enable the first responders to acquaint themselves with the nuances of CBRN response, through the platform of existing state training institutes.
- **Inadequate practical training:** Though CBRN training is a highly experimental form of learning and involves a fair amount of practical training, presently it's too theoretical, which needs to change, along with adequate equipping with the appropriate equipment.
- **Standardisation of CBRN training:** To have uniformity of curriculum, it is advisable to follow the NATO Handbook on minimum standards and non-binding guidelines on training to first responders.[20]
- **Integration of civil-military CBRN training:** Based on periodic review and appreciation of prevailing security threats, as well as the new technology available. Regular Civil-Military Liaison (as being done for other Disaster Management aspects) is hence the need of the hour.
- **Lack of simulation facilities:** Simulation is a proven method for training and planning, offering repeatability, controllability and the possibility for evaluation.[21] It also allows dangerous situations and materials to be replaced by harmless ones. Mixed and augmented reality software plays a key role here. CBRN training in India lacks in these unique simulation facilities pertaining to the medical management of CBRN casualties[22] which are prevalent the world over.
- **Lack of training Infrastructure:** Lack of CBRN protection and decontamination training equipment has affected practical aspects of training. Release of CBRN Recycled Training Equipment (RTE) issued to formations has to an extent solved the problem.

Training Methodology

In the Indian Army(IA), CBRN training has been in place for the last 25 years and has come a long way. However, some more improvements are envisaged. The need is that 100 per cent personnel, i.e. officers and JCO/OR must be 'Elementary CBRN' trained. All those who will operate in a CBRN environment must be 'Basic CBRN' trained and all CBRN units, subunits, and instructors at various schools/centres must be 'Advance CBRN' trained. To achieve an end-state as envisaged in the Mother Corps Concept followed by IA and CBRN Capability laid down by the Army HQs, the recommended methodology is to have Super Specialisation (1-2 Years) at the highest level, followed by Advance Training for 4-5 weeks,wherein an NBC Company/Platoon, and Command and Staff appointments are trained. Next level is the Basic Training (to 'Fight Dirty') for 4 weeks at the scale of limited troops (mostly Army Engineers) and lastly, elementary training for 1 week for the entire IA of 1.3 million personnel.[23]

Timelines: To start with elementary training, a capsule at all Regimental Centres, both the officers' training academies (OTA and IMA) and during individual training cycles of all units. Next is officers training, for which the target is to have about 60 per cent trained by the end of the 14th Army Plan. For other ranks, with approx 70,000 undergoing recruit training at centres every year,100 per cent IA should have acquired an elementary level of CBRN training, by the end of the 14th Plan.

Execution: Basic training needs to be conducted simultaneously at Faculty of NBC Protection (FNBCP) Pune, and Command CBRN schools and simultaneously bring up Corps CBRN schools. With about 2,600 persons being trained every year, it will take 20 years for basic training targets to be achieved. Advanced courses should be conducted at FNBCP, Pune. Bengal Engineering Group Centre, Roorkee will conduct four 'Training the Trainer' courses per year.

Implementation of National Disaster Management Authority Guidelines

The National Disaster Management Authority, as the apex body, is responsible for each phase of the DM continuum with seven major responsibilities, viz., pre-disaster (prevention, mitigation, and preparedness), during a disaster (rescue and relief) and post-disaster (rehabilitation and reconstruction) scenarios. It is assisted by the National Executive Committee (NEC), which is the executive arm of NDMA. Immediate response and relief operations will be carried out by the National Crisis Management Committee (NCMC). The preparation of action plan at the macro-level will be carried out by the NCMC/NEC, with technical assistance from the Department of Atomic Energy (DAE). District authorities of states/Union Territories will implement the nuclear or radiological disaster risk management programmes in respective areas. Each state is to develop a detailed micro-level action plan in a mutually interactive supplementary mode with its district-level plans. The implementation schedule at the national/state level will be in the following three phases:[24]

- **A short-term plan (0–3 years)** envisaging capacity development through education and awareness generation, training and community participation, etc., the establishment of critical infrastructure like the expansion of the network of ERCs, communication systems, strengthening of the regulatory framework, and emergency medical preparedness including the formation of QRMT, etc.
- **Medium-term plan (0–5 years)** includes further upgradation of all infrastructure, enhancement of regulation, and extension of the risk reduction framework, enhanced preparation for better response with a well-informed and trained community.
- **Long-term plan (0–8 years)** includes, inter alia, capacity development to the optimum level with preparedness and response mechanisms fully integrated up to community level. The establishment of secondary and tertiary care units for the treatment of radiation exposure cases is a priority area.

Conclusion

Even though it's the National Disaster Relief Force (NDRF) that's presently mandated for CBRN emergencies,[25] AF will continue to play a major role in emergency support functions, i.e. SAR, communication, health, medical and transportation,in the aftermath of a disaster. Airlift, moving assistance to other countries, all fall within their expertise and domain. They will also participate in training the trainers and act DM managers, especially in CBRN aspects, high-altitude rescue, waterman ship and training of paramedics, all in concert with the NDRF. At the national level, HQ IDS,with its Chief (CIDS) have been included in the NEC.[26] Similarly, at state/district levels, local representatives of AF are being made part of executive committees, ensuring closer coordination with boots on the ground.

Towards combating the existing threat, DRDO has also come out with new radiological defence equipment, all developed under the PPP model.[27] This range of equipment and technology can help achieve the required deterrence, to keep both our adversaries quiet. Besides, DRDO has developed other equipment like nano-technology based sensors, micro Unmanned aerial vehicles (UAVs), dosimeters (which measure an individual's exposure to hazardous radiation), advanced inflatable shelters to withstand water threats and ward off solid NBC agents for at least 48 hours. However, a few aspects remain, which are outlined in the roadmap given as follows:

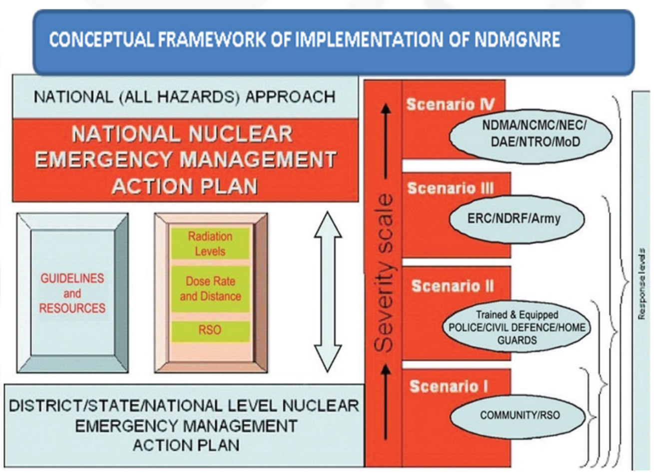

Figure 1

Source- NDMA Website-NDMP2016-

Roadmap[28]

- **Stakeholder Engagement:** Engage various NGOs, corporates, and individuals towards building an architecture of security, with close working relationships between all of these.
- **Private Sector:** It plays an important role in strengthening our security system. T3 at Indira Gandhi International Airport has installed an impressive array of security equipment, mostly procured from private manufactures.
- **Effective and Quick Response System:** Coordination in case of an accident or attack is critically important. Training and education can help in big ways. The 12 billion strong NDRF now conducts regular training for all other Para Military Forces/Central Police Forces and Security Forces. Its NBC combat team is now 300 personnel strong, i.e. 75 personnel each in four groups.
- **Enhancing Technical Capability in Detection of NBC Threat at Borders:** Further, establish a team capable of launching NBC shelters for Border Guarding Forces will be very helpful.
- **Community Preparedness:** Need to define the role of community for active participation during disasters or otherwise. Further, balance states to come out with their Disaster Management plans, to be implemented based on NDMA guidelines.

The chemical, biological, radiological, and nuclear defence training has evolved over the past couple of decades in India and, notwithstanding the difficulties faced by the virtually minuscule fraternity of professionals associated in this arena, the number of people trained has gradually risen to a significant number. With the proactive involvement of NDMA and other stakeholders in the field of CBRN DM, the future of CBRN training surely appears to be bright. Notably, Indian Navy has recently set up an NBC defence training facility to develop skills of its personnel in fighting such attacks and the Indian AF is in the process of doing so. The IAF has recently ordered 1,500 advanced NBC protection suits for it's armoured personnel carriers (APC), keeping Pakistan's arsenal in mind.[29] The advanced NBC protection suits will have sensors to detect incoming threats and take action to protect soldiers. Pakistan has recently developed the Hatf-9 (Nasr–a short-range ballistic missile (SRBM). Hatf-9 is equipped with a tactical nuclear warhead (TNW), which is Pakistan's response to India's 'Cold Start' doctrine (Proactive Offensive Operations) mobilising quickly to carry out immediate but limited retaliatory attacks.

This optimism will surely go a long way to ensure that the first responders will professionally respond to CBRN contingencies, should they arise at all. There is, however, a requirement to objectively improve the training and equipment scenario nationally, in an integrated manner,taking in the NDRF and PMFs, to achieve the ultimate objective of a CBRN-resilient India. Let's hope that happens, sooner than later!

Notes

1. Mudit Sharma, 'Chemical, Biological, Radiological and Nuclear Training Issues in India: A Fresh Perspective', *Journal of Pharm Bio-Allied Sciences*, July-September 2010, 2(3): 275–80.
2. IAEA Report on 2018, accessed from its website https://www.iaea.org on 05 oct 2019.
3. Wikileaks gave out a series of reports (leaks in the media) starting 2010, warning world of grave dangers of various kinds, which rocked the world.
4. CRED or Centre for Research on Epidemiology of Disasters is the most recognised world body in disaster research, giving its data to 186 countries worldwide.
5. Based on the date from *MHA Handbook on Disasters*, 2011, a Government of India publication
6. NDMA guidelines for communities to tackle disasters available atwww.ndma.in, accessed on04 oct 2019
7. Regulatory framework for CDs in India can be seen in the tenets of the DM Act 2005 and the NDMP 2016.
8. Based on CDM Guidelines, available at https://nidm.gov.in › pdf › guidelines › new › chemicaldisaster, accessed on 02 oct 2019.
9. Ibid, available at http://www.smithsdetection.com/1025_5446.php, accessed on 29 Sep 2019.
10. Ibid.
11. From *MHA Handbook on Disasters*, 2011.
12. Guidelines issued by NDMA, available at www.ndma.in, accessed on 25 Sep 2019 and subsequent days.
13. Mudit Sharma, Op.cit (i).
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...and Nuclear Disasters in India and the Role of Military

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26. As per amended SOP on the subject, issued by HQ IDS, November 2017.
27. 'The Latest Policy is to Develop Such Technology/Equipment Jointly With Public/Private Entities, Since They are the Ultimate Users', as enunciated in a 'restricted circulation' note to DRDO issued by the MoD, as emerged in interaction with some MoD officials.
28. As outlined in the new NDMP, 2016, promulgated by the Prime Minister, as available on www.ndma.in, accessed on 29 Sep 2019 and subsequent dates.
29. As per media reports, for example *Huffington Post* https://www.huffingtonpost.in › 2016/12/23 › indian-army-will-soon-have... accessed on 05 Oct 2-019.

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