THEMATIC SESSION C2:
NUCLEAR AND BIOLOGICAL DISASTERS

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ABSTRACTS

GIS BASED HAZARD PREDICTION AND MANAGEMENT TOOLS FOR COUNTERING NUCLEAR EMERGENCIES

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Utility of Geospatial Information System (GIS) for hazard prediction from and management of natural and technological disasters has been well established. Number of relevant expert systems and databases are linked to a user-friendly GIS package that could be utilized as a comprehensive management aid in different scenarios. Such a system is also sometimes linked to different on-site monitoring systems for apt and prompt first responder actions and subsequent real time updates for comprehensive real time hazard prediction, mitigation and management. Damage estimates with such management aids have been proven to be near accurate in case of natural disasters like hurricanes and earthquakes. Preventive response actions taken in case of some potential technological hazards like chemical and biological hazards as well as nuclear hazards in the context of some important international events like G-8 were based on predicted damage estimates from such GIS packages.

Emergency response systems have to have a GIS coupled with relevant expert systems for detection and real time monitoring of chemical

and nuclear facilities. It also should be linked with real time meteorological data and other relevant databases. By such systems the first responders would get immediate geographical information such as definite location and nature of the facility, real time plume path, transportation routes, blocked waterways, public facilities, population in the area, risk levels and spatial relationships for facilitating transportation and evacuation decisions in case necessary. For the success of any such emergency response system information sharing with seamless linkages of relevant databases and real time updates from monitoring systems is essential between different organizations both public and private; Center and State. Establishing of standards for seamless data transfers to the lead GIS system in the central emergency response coordinating agency is an important immediate step.

GIS systems utilize different expert systems for hazard prediction depending on the nature of disaster; remote sensing and GPS technologies for real time mapping; and a variety of databases relevant to logistics and infrastructure. But unfortunately, many of these systems are developed independent of each other and hence lack uniformity of data standards for seamless linkage to GIS packages for optimal utilization of the information generated by them.

In the present review salient features of some of the commercially available GIS packages and those of the expert systems used for hazard prediction and assessment are presented in the context of the developments taking place in the country for the management of nuclear and radiological emergencies.

NUCLEAR EMERGENCY AND MEDICAL MANAGEMENT

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The occurrence of nuclear or radiological emergency is of great concern. Sudden release of huge amount of energy in the form of blast, heat, ionizing radiations and electromagnetic pulse in the confined area is severely devastating. Within first minute after detonation, blast waves, thermal radiations and Initial Nuclear Radiation (INR) shall cause very critical damages. Then will be followed by fallout nuclear radiations. The inflicted wound injury when exposed to ionizing radiations assumes detrimental effects. The event, thus, happens to be chaotic and complex. As a consequence, several hundred thousand people shall die and majority of them in the first few days. Detonation of 20 kT device in air shall produce few lakh casualties and majority of them in the first day. Millions of hectares shall be contaminated with radioactive material forbidding its use. The radiation induced illnesses may be manifested into variety of cancers and casualties shall prolong for decades. However, if someone survives INR, there is all possibility of saving his life.

The protection gears, and post event management focusing at entry control, prophylaxis, sheltering, rehabilitation, contamination monitoring and decontamination, medical management, psychological treatment and event management are meant for prohibiting exposure of people to hazardous radiations. Medical management demands expertise in diverse areas, and specialized stores. DRDO has made indigenously available several systems, equipments and gadgets to combat the situation. These accomplishments for surveillance, protection and decontamination imbibe confidence in operational safety and security.

RESPONSE TO NUCLEAR DISASTER

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Today the society's Interest in Disaster Management precedes and outlasts the response phase of Disaster cycle. Moreover, there is increase in recognition of interdependency between development and disasters. The path taken for development may contribute to the destructive consequences of disasters although it may be the only option for the socioeconomic development of the society.

The threat of Nuclear Weapons has become a reality with the presence of nuclear weapons in our neighborhood and the possibility of a dangerous lexicon between the External aggression, Terrorist induced event at Nuclear Power Plants or Deployment *of* improvised nuclear device by forces beyond the control of Governmental regulation is very real. There is no escaping the fact that nuclear disaster would leave a tragic world but there is much that communities can do together. The response operations against nuclear disaster will be heavily manpower intensive and require extraordinary assistance from local population and response agencies.

The concept *of* Civil Defence Operations will involve a comprehensive Threat analysis, Web Defence Planning, Need for Mutual Aid, deployment of critical support mechanism, Evacuation Planning & Policy and extensive public protection measures both at community as well as individual levels.

It is realistic planning that can make the possibility of catastrophe unlikely by adoption of wise and Positive policies pursued with imagination and faith. The experience *of* a Nuclear Disaster would be terrible, perhaps beyond imagination and description but there is much that can be done to assure that it would not mean the end of the life of our nation

DEVELOPMENT OF NOVEL FORMULATIONS FOR RADIOACTIVITY DECORPORATION

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Incorporation of medically significant amounts of radioactivity will be a major medical problem in the fallout area as well as in the far-flung catchment areas receiving radio- contamination by water, food chain and animal/bird movement. Radionuclides like I- 131, Strontium-90, Cesium-I 37, Cobalt-60, and radio-isotopes of Cerium, Uranium, Plutonium, Americium, will persistently enter the body through inhalation and ingestion. This will cause increased incidence of cancers, genetic defects and reduced life-span of the affected people, potentially numbering several thousands to a few lakhs.

Short-term or prolonged use of decorporating drugs is the only viable specific drug treatment available today. It is however well known that their efficacy is suboptimal particularly when taken post-facto (which will be the case with civil population) due to a variety of reasons. These formulations are few in number and costly and even these either minimally or simply not available in the market today.

INMAS has already developed and characterized two such novel de corporation formulations and proved their efficacy in humans. Few others are under development and it can be said with some assurance that these will be available for human use within a few years.

INMAS INITIATIVE ON NUCLEAR DISASTER MEDICAL MANAGEMENT NETWORKING IN DELHI CLUSTER ZONE

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Assuming a 20-kiloton nuclear weapon explosion over central Delhi, it is estimated that radioactive fall-out of medical significance will occur in a radius of 20-25 k.m. and directional fallout will involve land masses upto 150-200 k.m. away from Delhi. We estimate that 5-7 lakh people shall require specialized medical treatment for acute radiation syndrome, 25-30 lakh asymptomatic people will require medium-term treatment and long term medical surveillance, and 2-3 crore people will seek or require radiation dose assessment and medical advisory in the several months post-facto. This will need to be done on the platform of temporary breakdown of services, exodus, partial breakdown of law and order, confusion, lack of information, rumour-milling and initial individual and societal inertia in face of the calamity.

Clearly, creation and maintenance of pre-facto functioning network between the key establishments is the only way the situation can be redeemed. INMAS has proposed a mission mode program to create and maintain such a network for Delhi cluster zone so that the medical mitigation can reach the grass-root levels in and around Delhi. This paper describes the efforts initiated by us to create a multidentate network involving such diverse agencies as health departments of Delhi and the neighboring states, NGOs, individual hospitals, pharma majors, radiation experts, Delhi Metro Rail Corporation, chemists & druggists, and peoples' representatives for such an eventualities. The challenges and the help

required from specialized disaster management agencies shall also be discussed.

MANAGEMENT OF NUCLEAR ACCIDENTS: SAFETY ASPECTS

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The first Atomic Bomb exploded on Aug. 5,1945 and since than more than 1000 nuclear accidents including those involving nuclear weapons have been reported world wide. Most of these accidents occurred at nuclear facilities early in the development of the applications of nuclear energy.

The nuclear accidents can be broadly classified into three categories i.e. (i) Easy to handle, (ii) Difficult to handle and (iii) Catastrophic or disastrous. These accidents can be further subcategorized as those that are recognized from the start and those that are only discovered late. Accidents occurred at Chernobyl, Three Miles Island, Tokaimura and Goiania have been some of the worst nuclear disasters. More than 32 nuclear weapons have been reported including six lost nuclear weapons, which were never recovered.

At Chernobyl, the worst reactor disaster took place on April 26, 1986. Extremely large quantities of radioactive materials and gases were released from the reactor and got deposited on the ground in Soviet Union and parts of Europe. 29 persons died due to radiation exposure and many more were treated for acute radiation syndrome. Immediately after the accident, 45000 people were warned to take shelter and advised to take stable iodine. 500 cases of thyroid cancer were reported in children.

In Goiania, Brazil in September 1987, 1400 curie Cs-137 radiotherapy source found its way to a junk dealer and gave acute radiation exposure to number of persons including children. The accident resulted in four casualities and about 20 people were hospitalized with some of them receiving dose as high as 7 Gy.

In Sept. 1999, Japan reported a major uranium leak at Tokaimura nuclear fuel processing plant fire and explosion requiring complete evacuation of people in 6 km zone. 35 workers were heavily contaminated and three workers were hospitalized out of which one died.

The best way to manage a nuclear accident is to prevent it in the first place from occurring. The solution lies in developing a good working habit. It is well established that almost all accidents in the past were due to human errors - often simple and silly errors. The majority of these accidents would not have taken place if the established safety regulations had been followed.

In the event of nuclear accident, the primary aim should be to reduce the radiation exposure as far as possible, to control the accident from expanding and to bring back the normalcy as early as possible. If the accident involves public also, then public relations become an important issue to further aggravations of the accident due to rumors and possible panic. The various steps needed for achieving this are also dealt with in this paper along with the details of Radiological Emergency Kit and Decontamination Kit.

RADIATION DISASTER: ECOLOGICAL PERSPECTIVE

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Nuclear event of either planned or unplanned nature leads to the dispersion of a variety of radionuclides in the atmosphere but isotopes of Cs, Sr, Ce, Ru, Pu, I are more important for radiological consequences to man. These radionuclides deposit in the planetary boundary layer and depending on the atmospheric circulation (local to global scale) diffuse and. are transported widely. Subsequently the radionuclides are removed either by precipitation scavenging or dry deposition under influence of factors like gravitation, impaction, electrostatic forces, diffusophoresis and thermophoresis.

Transfer of radionuclides from atmosphere to terrestrial and aquatic ecosystems involve deposition, interception and retention; however the particle size and chemical nature of radionuclides, vegetation, ground surface, prevailing weather conditions state of growth of ground cover, physicochemical nature of water bodies also playa pivotal role. Resuspension of radionuclides occurs by wind and water mediated erosion and human activities. Bioturbation by burrowing animals, mass transport of soil by physical means and movement of soil through macropores, leaching by water, geochemical factors and presence of particles at various depths from the surface also contribute appreciably towards resuspension. In the aquatic environment radionuclides present in living and nonliving compartments keep cycling at a faster pace and the aquatic biota plays an important role in their phase distribution.

Transfer of radionuclides to plants: Plants absorb radionuclides through foliage and roots. Foliar absorption ofradionuclides in solution occurs via stomata and cuticle and phyllosphere microbes also play an important role. Absorption through roots depends on soil to plant transfer factor, abiotic factors like physicochemical nature of soil and radionuclides, depth distribution etc and biotic factors like presence or absence of mycorrhiza and carrier molecules at root surface. The absorption in the plant is not dependant on total radionuclides present in the ecosystem. Cs and Sr since substituted K and Ca *in vivo*, ratio of these nuclides in the soil were more important to assess the absorption rates. Once in the plant, the radionuclides are translocated downwards or upwards and get stored in specific part of the plant where the radio labelled biomolecule is physiologically required. Pu reaches the soil through roots. Cs was accumulated in the fruits, pulses and hazelnuts. The plants are since primary producers; accumulation of radioactivity has important consequences on the consumers in the food web.

Transfer to and metabolism in animals and humans: The radionuclidesenter the animals through skin, inhalation and oral ingestion. Skin of domestic animals is practically impermeable for many substances in aqueous solution with the exception of tritium. The damaged skin may lose its protective function. Radionuclides sticking to skin can however irradiate and cause skin burns. Inhalation of particles of less than 5-6 micron may be retained in lungs and translocation to internal organs will depend predominantly on the solubility. Inhalation however is at least three orders of magnitude less than that from pasture. Since respiratory structures of animals are not edible, the risk through inhalation for the food chain is not appreciable. Oral ingestion through feed is the route of entry into the animals. The contamination risk however depends if radionuclides are absorbed through GI tract and accumulate in the tissues, which have edible value. The gastrointestinal mucosa in principle is impermeable to large majority of electrolytes and organic compounds; hence different radionuclides are absorbed at different rates. Some radionuclides can pass through diffusion (Sr) while others can diffuse as well as be actively transported (Ca). Gut is impermeable to rare earths but nearly impermeable to Ba and actinides. Interestingly, some radionuclides (Cs) undergo endogenous excretion from the body to the gut. The absorbed radionulides may get localized in specific organs, iodine in thyroid, strontium in bones and bone marrow, caesium in bones and soft tissues while some (I, Sr, Ca) may selectively get secreted by epithelial cells into milk of lactating animals

Computation of radioactivity in an ecosystem is extremely important and a number of mathematical models have been developed with certain presumptions. However none is satisfactorily applicable to a situation other than the one for which it was developed. Seasonality, which relates to the time of a year when contamination event occurred, is another important point. The data available on accidents pertains to the events that occurred during early spring or autumn; significant changes could be expected if accident took place during summer or winter.

Subject will be discussed with examples from the well-known radiation disasters.

Simulation and Modelling of Chemical Disaster Scenarios

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Major accidents which have occurred in the last few years in MOD establishments and outside as well as heightened threat perceptions post 9/11 and 11/7, have highlighted the imperative need for carrying out systematic risk and hazard evaluation studies for identifying potential hazards, assessing the associated risk, making the risk contours, initiating appropriate steps and ensuring adequate preparedness for responding to any scenario involving chemical emergencies in order to contain the damage and casualties as well as to promote the recovery and restoration of community life within a reasonable time.

The use of simulation tools for carrying out such complex assessments has been found to be both feasible and necessary in order to reduce processing time, get reliable results in an integrated form suitable for inputs to decision-making in a chemical disaster scenario. These
tools are very useful in the automation of the routine parts of the analysis. Further knowledge based techniques which are needed in the development of more powerful tools to support human reasoning, particularly in hazard identification and system modeling also need to be developed.

An integrated package has been developed at CFEES for simulation of risk and hazard assessment and management of chemical disaster scenarios involving explosive, reactive, flammable, toxic and other hazardous materials, which includes software for Hazard identification (HAZID), Probabilistic Analysis, Consequence Analysis and Risk Evaluation, estimation of actual response and evacuation times in case of emergencies.

The outputs from the RHA modules developed are used for risk contour and disaster mapping. This is an essential for input for all phases of chemical disaster management including on -site and off- site emergency planning.

Operational Management of Nuclear Emergency Mitigation

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Nuclear Power Plants are designed, constructed, commissioned and operated in conformity with stringent nuclear safety standards and defense in depth to have adequate margin of safety without undue radiological risks to the plant personnel and members of the public. Not withstanding these safety standards, as a measure of abundant caution and in conformity with international practice, emergency response plans are developed and evaluated for effective handling of a nuclear emergency. Hence in the Indian Nuclear Power programe, it is mandatory that all the nuclear facilities must have comprehensive emergency preparedness plan prior to go into operation.

The over all organization for nuclear emergencies include National and regional level Emergency Response Committee and Crisis Management Group of DAE. Emergency Response Committee of the nuclear facility comprise of Site Emergency Committee and Off-site Emergency Committee. The Site Emergency Committee is headed by Station Director, who is also designated as the Site Emergency Director (SED) and assisted by service groups. The Off-Site Emergency Committee is headed by the District Magistrate who is also designated as Off-site Emergency Director (OED).

For successful emergency mitigation, it is important to have intensive training to all the functionaries involved in emergency management and periodical evaluation of the emergency preparedness plan.

CHALLENGES IN COMBATING NUCLEAR, BIOLOGICAL & CHEMICAL DISASTERS

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From the early days of civilization, one individual tries to over power the other to have control over him. Same is the approach of a country stronger than the other. For this purpose, different types of weapons are used. These are conventional, Nuclear, Biological and Chemical Weapons.

Conventional weapons release energy in the order of KJ/g. Nuclear weapons have fissile/fusion materials, release energy in the order of Mev/Mole. The effects of conventional weapons are instantaneous and for very short duration and localized. In case of nuclear weapons, its electromagnetic radiation will have long term effects. Biological & Chemical Weapons can cause damage in terms of human losses, failure of nervous systems & various types of injuries to human beings.

The fissile materials can be carried in a small suitcase and can be assembled to make small nuclear device, known as dirty bomb. All the consignments coming from other countries must pass through radiation detection devices to ensure that those do not contain fissile/fusion materials. There are various sensor systems which can be used, to detect the chemical weapons.

The most important preparation for a city or region to combat Nuclear, Biological & Chemical attack is to have an emergency operations centre

(EOC). Training should be arranged for community emergency response team.

Preparation for nuclear attack consists of building blast shelters and fallout shelters, arranging Duck and Cover training, providing Civil Defense Geiger Counters and prepositioning information, supplies and emergency infrastructure. On an individual scale, one means of protection from exposure to nuclear fallout is to obtain potassium (KI) tablets as a safety. Best way for protection from chemical attack is to avoid contact and use of appropriate counter medication before the attack.

RAPID INVESTIGATION OF SUSPICIOUS MATERIALS AND ENVIRONMENTAL SAMPLES FOR THE PRESENCE OF ANTHRAX SPORES

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Bacillus anthracis, the causative agent of anthrax has gained the status of most potent biological warfare/bioterror agent. It is a Gram-positive, encapsulated, spore-forming, non-motile rod shaped bacterium which infects both humans and animals. The vegetative cells form metabolically dormant endospores, which are highly resistant to a number of environmental factors. These spores may remain viable in the environment for decades before coming in contact with any susceptible host. If properly disseminated and acquired, Bacillus anthracis could cause serious public health problems. Therefore, a simple and quick detection system of anthrax spores is always desired from the suspicious materials. Moreover, its early environmental detection by active surveillance is very useful for implementation of preventive measures. Several methods of detection of anthrax spores have been employed including growing the organism on selective media followed by biochemical and molecular characterization. But, these methods are time consuming, laborious and often impractical for analysis of a large number of samples. We have developed a rapid enrichment and detection method of B. anthracis spores by bi-phasic extraction buffer and immunofluorescent assay. Subsequently, a direct cell PCR has been designed for confirmation of B. anthracis and its toxicity.

CHALLENGES AND TECHNOLOGIES IN COMBATING THE NBC DISASTERS

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Disaster planning is a difficult task. There is no such disaster which is more difficult to combat than one resulting from the NBC event. NBC disaster make the country vulnerable across each domain, including communication, professional training, inter-agency collaboration, public healthcare infrastructure, surveillance capability, food supply and environmental resource allocation. The complexity of the response operation and perils of inadequate preparation for NBC disaster cannot be overemphasized. Even with detailed planning, the deviation from anticipated emergency operation plans are likely to occur. The usage of nuclear weapons in the battle causes large-scale contamination of the environment in a short span of time. The combat challenge begins with the rapid assessment and initial detection of uncontrolled release of radioactivity in the environment. Then NBC reconnaissance is carried out to search, survey, surveillance, and sampling of environmental matrices to obtain significant information about the NBC condition of routes, areas, and zones. This information confirms or denies the presence of NBC hazards with detection and identification equipment. The exiting technologies in the world are to protect the public from immediate or delayed health effects due to exposure to uncontrolled sources of ionizing radiation, and to mitigate the impacts of a nuclear emergency on property and the environment. This paper describes the details of the challenges encountered and available technologies in combating the nuclear disaster in regard to detection and monitoring of radioactivity.

ESTABLISHMENT OF A MODEL RADIATION INJURY TREATMENT CENTER

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After Pokhran our country has acquired a Nuclear deterrent but it also becomes its liability to be fully prepared to face the aftermath's of a nuclear disaster. More than likely the international situation leading to nuclear war will develop over the period of time and we shall have no time to prepare. There is a prime need to be prepared to handle such an unfortunate incidence in advance. General hospital facilities in high-risk cities should not be relied on, as most of them shall be destroyed after such an eventuality. Even if a few hospitals survive they shall be effected and contaminated by the Nuclear fallout and moreover shall not be equipped well to handle such emergency situations.

Radiation isolation wards with barrier nursing facilities are needed .to handle the patients of radiation injury and contamination. Radiation injury leads to different medical effects on the human body depending on the dose of radiation received and types of radioisotopes involved in causing radiation injury. There are special treatment regimes, which require specific drugs for internal and external decontamination of such patients. Bone marrow bank and drugs like growth factors and Interleukin, which are not routinely available in a routine hospital, shall have to be provided for. Special waste disposal facilities with delay tank facility are needed. Apart from this such a medical center has special food, water and ventilation requirements. Special manpower from various specialties are required to manage such patients .In this paper the author shall describe the

architecture and various parameters required to set up a radiation injury management center.

EMERGENCY PLANNING FOR DIRTY BOMB ATTACK

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The easiest way to create threat and harm the health and safety of public, and to spread radioactive contamination in the environment is the usage of Radioactive Dispersal Devices(RDD).Any device that causes the purposeful release of radioactive material across an area without a nuclear detonation is called a Dirty Bomb or RDD. It can be achieved by coupling the conventional explosive, such as TNT (trinitrotoluene), with radioactive material. The yield of explosion/weapon is not much significant. But the lethality of the weapon is determined by the cumulative effect of explosion and radiation emitted. The severity of the attack is based on the radioactive material used and the dispersion method followed. It necessarily depends on the atmospheric conditions prevailing and area of attack.

The emergency response to RDD is divided into three phases, Initial Phase (Onset of attack), Intermediate Phase, Post Disaster Phase. The onset of event is the most critical phase. Generally the RDD are planted without prior warning therefore immediate response is vital as danger of acute radiological exposure to high radiation field is immense. The response procedure for such attacks is based on three concepts:

(1) Prevention of acute effects

(2) Protection measure to reduce severity

(3) Reduction of chronic effects.

A plan for such emergency has been suggested in this paper comprising the following:

1. Consideration of RDD attack scenario.
2. Performance of consequence analysis using the dispersions and Fire & Explosion modeling tools for selected attack scenario.
3. Formulation of Risk Reduction Measure
4. Planning of response activities in phases based on the Consequence Modeling
5. Preparation of Emergency Management plan.

Even Radioactive waste can be used for a RDD attack. The implementation of Emergency Management Plan alongwith Mobile/Standalone Environmental Radiation Monitoring Centers at Metro Cities and at potential location can make the nation capable to cater to such emergency.

NBC PROTECTION: EFFORTS AT BEL

SE Sawant

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Bharat Electronics Ltd. (BEL), Navi Mumbai is presently engaged in the manufacture and supply of systems related to wheeled vehicles used in Military application. These systems consists of Shelters for electronic equipment and other related accessories like Vehicle platform, Outriggers, Mast, Generator set, Air-conditioners, BC system, Internal electrical fitments. The accessories are selected and sourced from reputed manufacturers and integrated with the in house manufactured shelters for supply to various projects of Indian armed forces.

EMI/EMC and non-EMI/EMC shelters are manufactured, and achieved EMI attenuation level of 60 dB at 10 GHz. As the requirement of shelters is huge, we are in the process of installing latest and reliable technology for manufacturing high quality shelters in large scale.

BEL is interested in bulk production of various items of relevance to NBC protection apart from Integrated Field Shelters. The proven and acceptable technologies for manufacture of the following shall be explored on priority.

Individual Chemical Agent Detector (ICAD)

Multi Purpose Decontamination System (MPDS)

NBC Protective Film

NBC Protection System for BMP2 Vehicle

BEL shall harness its maximum potential to enhance protection of the country from the weapons of mass destruction (WMD).

DOSIMETER GLASS LUMINESCENCE ORIGIN & ITS MONITORING

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Dosimeter Locket Assembly, manufactured by BEL since 1996, is supplied to Defence for sensing higher dose of Nuclear Radiation (Gamma and Neutron) ranging 1-1000 Rad. In other words this equipment is meant to be used as detector in case of nuclear wat, nuclear reactor disasters as happened recently in Chernobyl, USSR and France.

The Glass and Pin diode are the main components of the products housed suitably inside wrist watch type Locket assembly for rugged use of Army. An un - irradiated Dosimeter glass doped with Silver ions (Ag^{+}) exhibits an absorption peak at 245 nm and weak Luminescence (L) Center at 417 nm & 548 nm. On exposure to high energy Gamma radiation (100-500 Kev) the electrons ejected from Phosphate glass (PO_4^{-3}) matrix get entrapped and strongly bonded with Ag^{+} leading to formation "Atomic silver"
($O^{-2} + Ag^{+} \longrightarrow O^{-1} + Ag^{0}$) that exhibit a red shift of its Absorption peak (at 281 nm). The irradiated glass on further excitation with UV light (~350 nm) undergoes radiation induced photo chemical reaction that manifests a strong L – emission Peak at the range 591-600 nm. This L- spectrum known as Radio Photo Luminescent (RPL) spectrum is the measure of Gamma radiation.

For achieving reproducible RPL properties of glass, several melting parameters like mixing of raw Materials, time temperature controlled melting, casting, annealing, elimination of impurities like Fe^{+3}, Ti^{+4}, Mn^{+2} etc. are monitored carefully for the generation , stabilization and homogenous distribution of Ag^{+} ions embedded in the glass host.

Considering the target ---- delivery of customized product, RPL Dosimeter MK-II ---- the present paper reports fine tuning of some preparative parameters often overlooked during melting process and subsequent glass processing for improvement of quality and yield of the product. The variation of gamma provoked photo chemical behavior of Dosed Glasses is explained in terms of Luminescent spectra analysis.

Reference

Dosimetry of X-rays and Gamma Rays by Radio photoluminescence, J.H. Schulman, J Ginthei, CC Klick RS Alger and RA Levy, J Appl. Phys. 22 (12), 1479-87 (1951)

BIO TERRORISM: CONSEQUENCE MANAGEMENT

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Introduction:

The spectre of biological weapons has haunted human kind for nearly a thousand years. However, over the past 5-6 years the threat of bio terrorism has become the subject of wide spread concern and bio terrorism along with bio warfare will thus be a feature landscape in the 21st Century.

PART I

Threat Perception:

Why bio terrorism

Motivating factors

Severity of the threat

Reality of bio threat in Indian context

Vulnerabilities to bio terrorism

Historical Perspective

Threat Perception: to include perception of risk.

PART II

Consequence Management:

Consequences of using biological weapons

Imperatives for consequence management

Organisation for consequence management

Disaster Management Bodies

Public Health Preparedness and Response

(a) Preparedness: Threat analysis

Pre emption of attack

Preparing to respond

Public awareness

(b) Validation of Response Capabilities

Response to Bio terrorist incident

Determine that release has occurred

Identification of agent involved

Evaluation of potential spread

Protections of responders and health care workers

Infection control

Decontamination

Triage

Medical Care

Conclusion

CHALLENGES & TECHNOLOGIES IN COMBATING NBC DISASTERS

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The World is witnessing increasing levels of disasters of various types and magnitudes. National disasters, such as Flood, Earthquake and Fire have been taking their toll of human life and property in a periodic manner from time immemorial. Along with the evolution of Civilisation, newer forms of disaster came into being. The possible disaster scenario resulting from deliberate use of mishap arising out of Nuclear weapons, nuclear and chemical establishments etc. are the examples of those created by human being. The major differences between other forms of disasters and those occurring from Nuclear, Chemical and Biological (NBC) sources are the complexity of devastation and more important is the speed with which these could occur and escalate.

Consequently, the NBC disasters pose much greater challenges to those entrusted with creating and implementing mitigation measures. They have to, therefore, look for newer and more comprehensive technologies that would enable them to address the challenges adequately.

In the present paper following are discussed briefly:
Causes of Nuclear, Chemical and Biological disaster.
Various types of equipments, particularly vehicle mounted and which are useful for decontamination of affected vehicles, equipments, personnel and terrain.
Design approach for mobile NBC Hardened Shelter.

AN OVERVIEW ON NBC PROTECTIVE ENSEMBLE FOR THE AIRCREW

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Nuclear, biological and chemical (NBC) agents are used as the ultimate powerful tactical challenge in Warfield. Providing adequate equipment is the essential part of preparedness to continue operation in the contaminated environment. Airfields are considered to be the prime targets for chemical and biological warfare agents attack among other strategic locations and the aircrew is also subjected to some critical missions that have the potential to expose him to NBC environment. Hence, it is imperative to provide a comprehensive protection for the aircrew against nuclear fall outs, biological and chemical agents. Such system of protection is must for the aircrew of all aircrafts and most of the developed nations provide NBC protective ensemble for their aircrew. Only and integrated approach to the problem of protection can allow individuals to provide and effective response in a warfare environment with a minimum degradation in human performance. The protection given to the individual is primarily for above the neck to protect the respiratory tract against volatile agents and aerosols and protection for below the neck is by providing proper over garment which protects the individual against dermally active chemical agents. This paper discusses about the NBC protective ensemble for the aircrew with a special reference to protective garments. The recent developments in the material technology and the protective garments elsewhere in the world are being discussed.

THE ROLE OF PROTECTIVE EQUIPMENTS IN COMBATING THE NBC DISASTERS

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Nuclear, Biological and Chemical (NBC) warfare is a powerful tactical challenge in defence. While there are good counters to it through comprehensive detection and protection, it still has the power to frustrate operations and slow momentum. The hazards of nuclear, biological and chemical war fares have been underestimated by the society due to inadequate knowledge of these means of mass destruction. During recent years, the effectiveness of these threats has tremendously increased both in full-fledged war scenario as well as localized terrorist operations due to the improvements in their long range tactical deployment capabilities. The role of protective equipments in combating the NBC disaster is very crucial. In the present paper, the effectiveness of individual and collective protection systems is discussed. The protective capabilities, limitations and evaluation criteria of various devices like NBC respirator, face piece, canister, NBC protective clothings, NBC decontamination suit, NBC gloves, NBC over boots etc. have been highlighted. The paper examines the global scenario and concludes with recent trends in development and future research focus in this critical area of disaster management.

MANAGING CHEMICAL DISASTERS

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Plans for prevention of chemical disasters cannot be divorced from an overall strategy for facing disasters whether they are due to human error or due to technological development or due to terrorist's attacks. The measures may include large scale evacuation of people and cattle and supply of their immediate needs of food and shelter, medical care anticipating epidemics and their rehabilitation once the emergency phase is over. On the other hand, technological disasters, particularly, those involving toxic chemicals would require, in addition, institution of an immediate emergency plan of antidotal treatment of the victims, cleaning the environment affected by the toxic chemical and a long term health surveillance of the population exposed to the toxic chemical. Chemical Disaster Management also includes appropriate legislation for control of toxic chemicals. The hazard assessment that must precede this exercise as well as on-site and off-site emergency plans for mitigation require inputs from several agencies and a coordination mechanism which will have the back up support of documented information and continuing research in the relevant areas of chemical safety. In recent past, large number of industrial accidents involving hazardous chemicals has taken place. The flixborough explosion, the Beek disaster consequent on the release under pressure of propylene, the Seveso disaster, the Mississagua accident due to collision of wagons of chlorine and propane, the Houston soil of anhydrous ammonia, the Sommerville, Massachussetts spill of phosphorous trichloride, the Mexico explosion involving liquefied gas and the worse of all, the Bhopal

Disaster of Dec 1984. An act of chemical terrorism might range from dissemination of aerosolized anthrax spores to food product contamination and predicting when and how such and attack might occur is not possible. However, the possibility of chemical terrorism should not be ignored, especially in light of events in recent past e.g., the sarin gas attack in the Tokyo subway. Preparing the nation to address this threat is a formidable challenge, but the consequences of being unprepared could be devastating.

LIAISON & RESOURCE MANAGEMENT IN NUCLEAR DEFENCE PREPAREDNESS

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Any untoward happening in the peaceful application of radioisotopes in Industry, Nuclear Power Production, medical field, agriculture use satellite crash or in transportation of radioisotopes in India may affect concerned occupational workers and limited population. The effect in India due to such scenario in neighboring counties can also be anticipated. There is an international nuclear event scale of 1 to 7 for grading the event and identifying it as anomaly, incident, accident for action by Department of Atomic Energy which is self sufficient to deal with. It may require support from Ministry of Home Affairs and Ministry of Defence in particular and Govt. of India in general in terms of mitigation, logistic, strengthening of border control, provision of mobile radiation detection, protection, decontamination.

Further to deal with terrorist created Dirty Radiological Device (DRD) explosion, Nuclear explosion in India or in neighbouring countries, of late efforts are on to assess our preparation through National Disaster Management Agency (NDMA). A consolidated view involving concerned agencies, their requirement, awareness, training needs to be considered. DRD and Nuclear device explosion will differ in terms of magnitude of thermal, blast, nuclear effects. DRD will involve a micro level blast, nuclear radiation effect and no thermal and electro magnetic pulse compared to Nuclear explosion. This paper proposes to highlight initiative

& availability of liaison, resources required. It will call for awareness about the scenario, in terms of detection, protection; training as a first responder; ingestion of prophylaxis; early warning and action direction with Command Control Centre; provision of nuclear shelters; Capability of segregating sufferers for medical attention with effective national networked medical professionals; infrastructure for evacuation; decontamination; radiation injury treatment; national networking of Radiation Safety Officer; working tele-communication links; amateur radio operators; relief and response capabilities with police/fire services/civil defence & paramilitary forces / defence services; radiation monitoring; search & rescue; capability to serve essential commodities to needy; radioactive waste disposal. It will be reviewed in Indian context.

GAMMA IRRADIATED ALLOGRAFTS: ROLE IN THE NUCLEAR DISASTER MANAGEMENT

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Atomic explosions at Hiroshima and Nagasaki demonstrated the human agonies on vast scale. Medical modalities are required to decrease the morbidity and mortality from the heat, blast and radiation effects of these weapons. Allograft tissues have the potential to repair or reconstruct damaged tissues and can be of great assistance in the treatment of injuries due to the nuclear weapon.

Tissue grafting has long been applied in plastic and orthopaedic surgery using patient's own tissues. But now tissues from human donors can be processed and used for wound closures or diverse transplantation. Allografts provide an excellent alternative to autografts without donor site morbidity. By eliminating the need for an additional surgical procedure, they reduce the operating time, expense and trauma associated with the acquisition of autografts. Further, allografts do not compromise the normal structures. Allografts have the added advantage of being available in quantity. This is particularly valuable in large defects where the quantity of available autograft is limited.

Gamma radiation is used to sterilize the allogenic tissues to make them safe for clinical use. Various allograft tissues like bone, skin, amniotic membrane and other soft tissues are recovered, preserved and provided by the tissue banks for repair or reconstruction of the injured part of the body.

Heat causes partial or complete destruction of the skin and underlying tissues. Human allograft skin and amniotic membranes can be used for the treatment of thermal burns. Temporary skin coverage provides protection from mechanical trauma and promotes healing. Ionizing radiations also cause injury to the skin. Adverse effects of radiation exposure are dose related and include erythema, dry and moist desquamation, and chronic skin ulceration. Allogenic skin grafts and substitutes are also useful for the treatment of radiation induced skin injuries.

Bone allografts can be employed for the treatment of fractures, filling in destroyed regions of bone and in reconstructive surgery. The bone allografts act as a scaffold on which new bone can grow. Allograft bones can be prepared in different forms like small / morselised grafts or massive grafts for structural purposes as required for specific clinical conditions.

Defence Laboratory, Jodhpur is involved in the processing of allograft tissues. Sterilization is carried out by gamma radiation at Multipurpose Gamma Irradiation Facility, RAVI (Raksha Anusandhan and Vikas Irradiator). Placentae are collected from Military Hospital, Jodhpur and amniotic membranes are processed as biological dressings. Gamma irradiated amniotic membranes have been found to be promising for the treatment of burn injuries at different centres. Femoral heads excised during surgery are collected from the Dept. of Orthopaedic Surgery, Dr. S.N. Medical College, Jodhpur and processed as bone allografts.

GIS BASED NBC DISASTER MANAGEMENT SOFTWARE

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Disaster management encompasses a wide range of activities. Disaster management programs are developed and implemented through the analysis of information. The NBC disaster management is a bigger challenge as compared to natural and other man-made disasters. All phases of disaster management depend on data from a variety of sources. GIS allows the life, property and environmental values to be combined with hazards. NBC disaster events can be modeled and displayed in GIS. Once information is mapped and data is linked to the map, the disaster management personnel can begin to formulate mitigation, preparedness, response and recovery program needs. The software can be used for modeling and training, for actual tactical deployment during a NBC disaster or to analyze the consequences of a possible NBC disaster. This paper discusses the design of GIS based NBC disaster management software.

INTEGRATED CONTROL PANEL FOR NUCLEAR DISASTERS

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This item is a part of N.B.C.W. systems. In the case of any nuclear disaster or explosion, proper detection and measurement of nuclear radiation activity is important. The nuclear radiations are very harmful for human organs, which cannot sense nuclear radioactivity. The instrument INTEGRATED CONTROL PANEL has been designed and developed to control equipment fitted inside NBC UNDER GROUND FIELD SHELTER field shelter. This CONTROL PANEL performs the following functions.

Detects intense burst of gamma radiation from a nuclear detonation and activate Automatic NBC protection system inside the field shelter for a set time.
Measures the gamma dose rate from 0.1R/h to 1000 R/h
Controls Lights and Fan fitted inside the field shelter.
Built in battery charger
Generates Audio and Visual alarms when receives INR.
Calculate the set time from the last INR pulse (If sequence of burst of gamma radiation receives)

The instrument has one INR sensor and one Gamma sensor inside a blast proof MS dome that can be fitted outside the NBC field shelter and all control system can be fit inside. The compact and rugged design of the instrument can withstand the harsh environmental specification of Armed forces.

The Integrated Control Panel provides some degree of protection from blast by activating the NBC protection system that halts and stops all mechanical system before the arrival of blast wave. The protection from radiation and radioactive contamination is provided by means of collective protection system and radiation alarms. The critical information about the radiation levels provided by the system helps the crewmembers and the planners to decide weather permitted for go outside the shelter.

It is used to detect Nuclear Radiation blast (INR), measures Nuclear Radiation (Dose rate) out side the UNDER GROUND FIELD SHELTER and give audiovisual alarm against Nuclear Radiation blast for protection of persons in side the UGFS. It will also shutdown the blowers for 45 sec. when detects (INR). All electrical supplies are also controlled by the ICP in side the UGFS.

MICROBES FOR DECONTAMINATION OF FISSION PRODUCTS

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Toxic metal and radionuclide contamination of soil and water pose major environmental and human health problems worldwide. Nuclear fall-out or radioactive dust is created when a nuclear weapon explodes or some other event causes a thermonuclear explosion. The nuclear fission of uranium or plutonium produces a large number of fission products with different yield values. Radioisotopes characteristic of nuclear fission are released into the environment. Radionuclides can not be degraded, so they have the potential to accumulate in plant species and enter the food chain with the possibility of eventual ingestion by humans. Humans can also be directly exposed to the radionuclide through contact in soil or water. The fission products require appropriate decontamination to avoid human health hazard.

Bioremediation offers an attractive alternative or supplement to more conventional clean-up technologies. Bioremediation takes advantage of the natural abilities of microorganisms and plants to metabolize, sorb, oxidize or reduce organic and inorganic compounds. While bioremediation of organic contaminants involves their transformation to benign products such as carbon dioxide, bioremediation of metals and radionuclides involves their removal from the aqueous phase to reduce risk to humans and the environment. Bioremediation generally has low cost, wide public acceptance and creates no secondary wastes.

The catalytic potential of microorganisms in nature is enormous and has been exploited for use in environmental clean-up. Microbial processes may affect solubility, mobility, and bioavailability of toxic metals and radionuclides by various mechanisms. Microorganisms can directly transform metals and radionuclides by changing their oxidation state to a reduced form that leads to *in situ* immobilization. Microorganisms can indirectly immobilize metals and radionuclides through the reduction of inorganic ions which can, in turn, chemically reduce contaminants to less mobile forms. Immobilization of toxic metals and radionuclides are also brought about by precipitation, biosorption and bioaccumulation. These processes have received considerable attention because of their potential application for treatment of waste containing toxic metals and radionuclides. Biosorption of toxic metals and radionuclides is based on non-enzymatic processes such as adsorption. Adsorption is due to non-specific binding of ionic species to cell surface associated or extracellular polysaccharides and proteins. Metallic ions can be removed by alive or dead biomass. Bioaccumulation by microbes through an energy-dependent transport system has also been described for toxic metals and radionuclides. A wide variety of microorganisms, including bacteria, fungi, and yeasts are reported to interact with metals and radionuclides through several mechanisms to transform them. Bacteria were isolated from different water and soil samples collected from Jaisalmer and Pokharan area. 90 bacterial strains were screened for their resistance to various metals characteristic of fission products. Efficiency of the resistant strains for biosorption / bioaccumulation was evaluated for identification of potential microbes for decontamination.

TESTING AND CALIBRATION OF RADIOLOGICAL INSTRUMENTS

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Nuclear radiations application and its harmful effect to the living system are well understood at present. It is well established that ionizing radiations in any amount is hazardous to all biological systems and bears certain risk. The health risk is proportional to the amount of radiation received by the body. Therefore, monitoring of radiation received by radiation workers, public and during any radiological emergency is the only way that any safety measure could be implemented. Radiation monitoring can only be accomplished by the use of radiation monitors and sensors. Only tested / calibrated radiation monitors and sensors can be used for monitoring the radiation exposure and for the survey of radiation area or installations. As a matter of fact calibration and testing of nuclear radiation sensors, monitors and equipments used for measuring ionizing radiation are of prime importance, as human's natural sensors cannot recognize the radiation. The instruments and sensors used for quality control in an industry, R&D or in field should be certified by the competent authority for its use, calibration and methodology. The instrument used for measuring and monitoring the nuclear radiation must be tested/calibrated by the national or international calibrating authority. To ensure compatibility and tractability in testing and calibration in various fields of science and engineering throughout the country, Govt. of India has established National Board for Testing and Calibration of Laboratories (NABL). Defence Laboratory, Jodhpur has been provided NABL accreditation for testing & calibration of radiological instruments. This

paper reports the NABL activities at Defence Laboratory, Jodhpur in field of Testing and Calibration of Radiological instruments since its inception. The testing and calibration methodology and quality control in this activity has also been discussed in this paper. A statistical data on the test and calibration of radiological instruments in last five years has also been reported in this technical paper. All nuclear instruments/devices/ monitors/ systems developed by the laboratory are calibrated at the NABL facility before sending it for use by Defence personnel and for fitting in the Vehicles, tanks and mobile laboratories with the Army, Navy and Air force. The laboratory developed items such as RPL dosimeter; Roentgenometer, PDRM, PDM, Gamma Flash Sensors, GM Probe and other radiological systems are calibrated/ tested at manufacturing level as well as at regular interval of time after supply on request by the users. NABL facility of the Defence Laboratory, Jodhpur can be used by the Defence departments for their all type of radiation monitoring equipments /sensor /survey meters and other radiological equipments

GAMMA RADIATION MONITORING THROUGH TISSUE EQUIVALENT ORGANIC SEMICONDUCTOR BASED THIN FILM DEVICES

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The quest towards the search of suitable sensors for developing radiation dosimeter has been subject of extensive investigation. The p-Type metal phthalocyanines have recently been identified as radiation sensing element and can be employed for developing tissue equivalent sensitive, compact and cost effective radiation dosimeter for gamma radiation.

The mechanism of interaction with gamma rays involves the electronic excitation leading to ionization. Exposure to radiation imparts carrier's removal with subsequent increase in structural defects. In the present communication, metal-pthalocyanines which is a p-type material, thermally very stable and can be sublimed into thin film structure, were taken as a semi conducting sensing element. The ITO/M-Pcs/Ag Schottky device structure and M/MPcs/M were fabricated and ties I-V characteristics were analyzed before and after exposure to radiation.

Chloroaluminium pthalocyanine (CIAIPc) and Lead pthalocyanines (PbPc) synthesized by adopting focused microwave synthesis approach were developed into the Thin film sandwiched devices by spin coating technique covering 1cm^2 as an active area. The so fabricated device having initial dark current of the order of mA were exposed to variable dose of gamma radiation ranging from 1cGy to 10Gy at a dose rate of 1 Gy/hour. Exposure to radiation imparts an accelerated decrease in forward bias current and capacitance characteristics and reveals linear relationship between dose vs current behaviour for a definite dose rang. This kind of observation supports its potential application as pocket dosimeter for gamma radiation monitoring. The results are emphasized in terms increase ideality factor, dielectric permittivity and decrease in forward bias current and capacitance characteristics. Also, absorption characteristics analyzed before and after exposure to radiation showing successive decrease in optical band gap on exposure to radiation.

NUCLEAR EMERGENCY PREPAREDNESS: STRATEGY AND CHALLENGES

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Nuclear Emergency Preparedness aims at providing an organized and integrated capability approach for a timely coordinated response to incidents involving nuclear emergencies. A Strategic Framework capable or providing necessary infrastructure, trained manpower and interface management has become a bare necessity. Paper describes issues relevant to development and implementation of such a framework.

The framework should cover nuclear/radiological incidents, including sabotage and terrorist incidents, involving the release of radioactive material that poses an actual or perceived hazard to public health, safety, national security, and environment. This includes terrorist use of radiological dispersal devices (RDDs) or improvised nuclear devices (INDs) as well as reactor plant accidents commercial or weapons production facilities, lost radioactive material sources and transportation accidents involving nuclear material.

Framework should address the critical issues of safeguarding classified information and restricted data but at the same time be transparent enough to provide necessary and sufficient expertise to handle radiological emergencies. The structure and charter of duties at National, Regional and zonal levels need to be defined clearly along with the Coordinating bodies and Interface Management Experts. In the event of radioactive contamination, the rescue operations and timely evacuation demands need for systematic training of all the concerned agencies with clarity of roles and limits of each one involved.

Variety of Critical issues make this task difficult e.g. Radiological incidents may not be immediately recognized as such until the radioactive material is detected or the effects of radiation exposure are manifested in the population, Radiological Terrorism Handling may require sophisticated technology, Requirement for Concurrent Implementation of other emergency plans and procedures e.g. Biological & Chemical may add to complexities, Distribution & Location of Protective infrastructure will need an in depth study for optimization of Resources, Planning of continuous training with mock drills and exercises for various response teams is itself a difficult task.

Paper addresses the Strategic issues and challenges involved in Integrated & Planned Framework for handling Nuclear Emergencies.

TRAINING AND SIMULATION NEEDS FOR MANAGEMENT OF NUCLEAR DISASTER / RADIOLOGICAL EMERGENCIES

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The detonation of atomic weapon is characterized by release of vast amount of energy. Blast (50%), heat (35%), nuclear radiations (15%); consisting of initial nuclear radiations (INR) (5%) and residual or fallout radiations (10%). A strong Electromagnetic Pulse (EMP) is also produced that is detrimental to the electronic instruments but not to man. A catastrophic devastation shall be manifested in the first second after detonation of the nuclear device at moderate height in air. However, from technical angle and to be on safer side first minute is granted the duration of maximum damage. The massive damages to houses, flash fires and burns and radiation injuries will be inflicted. A zone of 1 square kilometer which will be a sure kill zone will be almost whipped out on detonation of atom bomb of moderate yield.

The severe damages and burn injuries will be seen up to a radius of five kilometers. Breakages of window glasses will be noticed at more than a kilometer from ground zero. Secondary fires will continue for several hours. There will be chaos and cry for help from all corners. People of illicit motives who are unaware of dangerous nuclear radiations may march towards ground zero. Also people caring for their dear ones may attempt to go in the highly radioactive area.

The winds will carry fallout to several hundred kilometers, in elliptical zone depending upon wind speed and direction, away from the ground zero. Intense deposition of radioactivity shall forbid into safe living. These wide spread nuclear war effects make it the weapon of mass destruction. This kind of situation needs careful handling, from all angles.

With advancement in missile and other deployment technologies, there is practically very little reaction time available for protection from such deadly weapons. Thus leaving out the only option of minimizing the devastating after effects. This requires various types of protective devices, trained manpower and meticulous planning, all in functionally operational and ready to deploy state.

Effective efforts are very much needed to minimize the devastating effect of atomic weapons witnessed in Hiroshima and Nagasaki in the Second World War. India, being vast country in terms of its geographic and demographic spread, requires the efforts of very high magnitude to come to a level at par with that of the, advanced countries like USA, UK, Russia and other erstwhile WARSAW and NATO countries, which are seriously working on such preparedness. The task becomes more difficult as very little data and information is available in open literature and practically there is no way to verify the same and no experience to handle such events at national level.

Specialized technical nature of the subject matter makes it all the more important to devise a suitable training programmes, which will create the trained manpower and will keep it abreast over the years through continuous on going regular training and well planned mock-ups. This is required to enhance the survivability and handle the large scale devastating after effects of ill fated doomsday event. Radiological incidents involving radiological dispersal devices (RDDs) are of concern and require special efforts to overcome the hazardous effects of radioactive material contamination.

It is practically impossible to devise suitable mock drills using radioactive materials, use of simulators can be explored to demonstrate the spread of radioactive contamination, thermal and blast effect etc. Use of software simulations involving 3 D animation, virtual reality and effects modeling can be explored effectively for planning and training on various elements of radiological disaster managements like entry control, sheltering relocation, contamination monitoring, decontamination, medical aid to predict performance, trained decision makers and responders, analyze resources, explore alternatives, plan operators with a flexibility to simulate terrain and population, resources, task organization and actual operation procedures for functional action of explosion, simulation, fire simulation, radioactive contamination, blast and thermal effect, information flow modeling, emergencies, infrastructural damage, response team actions, coordination at various levels, emergency vehicle response, traffic flow and hospital system.

Through organized training, modeling and simulation it is feasible to evaluate and visualize capabilities, understand current and future impact on rescue operations, its effectiveness, shortcomings for improvement in intra – inter agencies communication/notifications intra – inter agency coordination, incident command, victim contamination monitoring, decontamination, medical management, public information etc.

The paper discusses the relevant details in this regard.

AN APPROACH TO MITIGATE EFFECTS OF EMP

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The Electromagnetic Pulse (EMP) is a serious threat to the electronics and electrical infrastructure of the country. The EMP could be an outcome of a Nuclear weapon or could be independently generated with a Electromagnetic bombs. Although the electric field created from an Electromagnetic Pulse lasts for only a short time, its effects can be devastating.

Computers used in data processing systems, communications systems, displays, industrial control applications, including road and rail signaling, and those embedded in military equipment, such as signal processors, electronic flight controls and digital engine control systems, are all potentially vulnerable to the EMP effect. Other electronic devices and electrical equipment may also be destroyed by the EMP effect. Telecommunications equipment can be highly vulnerable, due to the presence of lengthy copper cables between devices. Receivers of all varieties are particularly sensitive to EMP, as the highly sensitive miniature high frequency transistors and diodes in such equipment are easily destroyed by exposure to high voltage electrical transients. Therefore radar and electronic warfare equipment, satellite, microwave and communications equipment and television equipment are all potentially vulnerable to the EMP effect.

Modern military platforms are densely packed with electronic equipment, and unless these platforms are well hardened, an EMP device can substantially reduce their function or render them unusable.

The challenge now lies in promoting the implementation of EMP protective devices in all future defence command and control systems. This effort must be accomplished early in the acquisition cycle. It has been proven over and over again that any effort at modifying or changing a fielded item of equipment results in costs that often exceed the original production model.

RADIATION DETECTION, MEASUREMENT AND CONTROL UNIT FOR NUCLEAR DISASTERS

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In order to survive and combat a nuclear disaster, proper detection and measurement of nuclear radiation is important. The nuclear radiations are silent killers as they can not be sensed by any human sense organs. The instrument Radiation Detection Measurement and Control Unit (RADMAC) has been designed and developed to address all the nuclear related challenges in a nuclear disaster environment. This state-of-the-art instrument performs the following functions:

Detects intense burst of gamma radiation from a Nuclear detonation and activate Automatic collective NBC protection system
Measures the gamma dose rate from 1 mR/h to 1000 R/h
Measures gamma commutative dose from 0.1 mR to 1000 R.
Generates Audio and Visual alarms when dose rate or cumulative dose exceeds pre-set values and activates the NBC system
Provide situation dependent helpful tips to crew members in a nuclear disaster.

The instrument has microcontroller for data acquisition and control of digital display devices. The compact and rugged design of the instrument can withstand the harsh environmental specification of Armed forces.

The RADMAC provides some degree of protection from blast by activating the NBC protection system that halts the tank and stops all mechanical system before the arrival of blast wave. The protection from radiation and radioactive contamination is provided by means of collective protection system and various radiation threshold alarms. The critical information about the radiation levels provided by the RADMAC helps the crew members and the planners to estimate the permitted stay time in a contaminated area affected by a nuclear disaster.

SURVEILLANCE METHODOLOGIES FOR RESPONDING NUCLEAR THREAT

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The occurrence of nuclear threat or radiological emergency is of the great concern. It is accompanied with sudden release of huge amount of harmful radiation or radioactive materials or both together in environment. The emergency can occur under various circumstances mainly due to accident with the carriage of radioactive material during transportation, wrong/faulty practices, failure of machinery of nuclear power plant or radiation facility, non-communication of critical work plan etc are considered as unintentional means. Now these days, terrorist attack is become more prominent worry compare to others reasons. Terrorist can easily assemble and explode the ‘Radiological Dispersion Device’ (ROD) or Dirty bomb. This device will not produce acute radioactive contamination in the environment but creation of hoax of radioactivity to general public will be sufficient for terrorist’s aim. The last but not least mean of creation of nuclear threat in the event of war, using nuclear weapon one of the other pretext like, end of war, show of superiority, save the loosing battle, as deterrent.

Emergency preparedness and response capability to meet any emergency situation arising out of a nuclear/radiological accident are very essential to reduce the radiological consequences. This emergency management is carried out through environment radioactive monitoring and interpretation of the monitoring data. Having an effective emergency preparedness and response capability developed and by implementing proper counter measure in time, public at large can be protected from the harmful effects of radiations. The developed country has given this issue as prime important for nuclear threat management. Environment radioactivity surveillance is performed in two modes, depending upon situation:

i) Static

ii) Mobile

In the case, static mode, static environment radioactivity laboratory is to be used, which must be equipped with various nuclear monitoring, counter and analysis instruments. While in the mobile mode, surveillance techniques will be used by manned and unmanned techniques. In India efforts are being made to give more attention and Defence Laboratory, Jodhpur is involved in such activities by working on both mode static & mobile mode and established the methodologies for measurement in the case of static as well as mobile mode was attended through development of various systems.

ENVIRONMENT RADIOACTIVITY MONITORING USING MOBILE NUCLEAR FIELD LABORATORY

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The technological development has given us many comforts through the fruits of pure science research. At the same time this technological progress has given us the nuclear warhead, the inter-continental ballistic missile, biological and chemical warfare agents, precision guided munitions. All these developments are the examples of remorseless humanity in military research projects taken by various countries. The main aim of these projects was to gain superiority over poor/neighbour country by developed nation.

In all above these, nuclear power based nuclear bomb is the most important arsenal for today's war scenario. Its destructive power is self explanatory by nuclear boom attack on Hiroshima and Nagasaki during 1945. It is also interesting to note that after this tragedy no one country use this during any military operation against each other but mostly developed countries are trying to acquire this technology.

In the context of present scenario as well as surrounding countries ambitious development programmes, India must also take some measures for protection of population and environment from nuclear threat perception. In this regard, it requires, among other things, accept concepts and technical systems for the assessment of the dose and of the environment contamination. The explosion of nuclear bomb releases tremendous amount of radiation dose in the form of INR and fallout radiation. This radiation level arises in the environment due to contamination of various matrices viz. air, soil, water, milk, vegetables etc. The numbers of causalities are more with this nuclear bomb than any other weapon due to individual gets radiation exposure from inhalation and injection of contaminated matrices. Therefore it is mandatory to monitor environmental radioactivity in various matrices and generate data bank for various parts of country. This programme is considered as pre nuclear threat preparedness because this data will be very useful if any nuclear explosion / nuclear reactor accident take place.

Defence Laboratory, Jodhpur has developed “Mobile Nuclear Field Laboratory” based on TATA-207 platform for surveillance of the natural and artificial radioactivity released in the environment. This TATA-207 vehicle is suitably modified as per the requirement of laboratory in the field conditions. In this vehicle various nuclear instruments viz. alpha and beta counting systems, food monitor, air monitoring pump, gamma spectrometry system, hand held anemometer, contamination monitors, nuclear survey meters, Roentzenometer etc. were fitted for the measurement of radioactivity in different environmental matrices.

NUCLEAR RADIATION SHIELDING EFFICACY EVALUATION IN CONTEXT OF RADIOLOGICAL PROTECTION

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It is well known that nuclear explosion gives the nuclear radiation, high overpressure due to blast and intense heat due to thermal radiations in the environment. For the sake of convenience nuclear radiation from a nuclear explosion is categorized into initial nuclear radiation and residual radiation because of fallout. The initial nuclear radiation is the radiation emitted within the first minute of explosion. It consists of high energy gamma rays and neutrons. The other accompanying radiations alpha's, beta's are all absorbed within the near vicinity of explosion and expanding debris. The fallout or residual nuclear radiation is the radiation emitted later than one minute after the explosion of nuclear weapon. Fallout from a high air burst is practically negligible; it mainly occurs in the case of ground burst of low air burst.

All materials provide, to a lesser or greater extent, shielding against nuclear radiations. To know their shielding efficacy experimentally, gamma radioactive source, fission neutron source and gamma spectrometry, neutron detection system are required. For INR simulation study Co-60 source for gamma radiation and Cf-252 source for neutron radiations while for fallout radiation, Cs-137 source are using. Defence Laboratory, Jodhpur is involved for evaluation of lining material for fitment into armoured fighting vehicles (AFVs) viz. T-72, MBT-Arjun, BMP-II, BLR-III, ICV-ABHAY and Integrated mobile shelter. These material were evaluated against INR and fallout radiations and selected for fitment into AFVs as per the suitability of protection factor as well as weight penalty. The evaluation of shielding efficacy will also be utilized in reinforced hardened shelter which will be fabricated as command control centre. A detail experimental procedure and results will be presented during the time of presentation.

SUPERHEATED EMULSION DETECTORS IN NUCLEAR EMERGENCY

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Superheated emulsion based nuclear radiation detectors for detection of neutron and gamma has emerged as a latest technology. Superheated emulsion detectors contains the superheated droplets of low boiling point liquid suspended in polymer matrix, when exposed to nuclear radiations these droplets get converted into visible bubbles in proportion to radiation dose. The superheated emulsion neutron sensor contains superheated drops of low boiling point refrigerants sensitive to fission neutrons. The detector is gamma insensitive and energy independent.

Gamma sensitive superheated emulsion detectors has also been developed using gamma sensitive refrigerants having gamma response at 18keV onwards. These detectors were characterized for dose rate effect, neutron dose response, gamma response, energy response, neutron and gamma sensitivity, reproducibility and temperature effect. The above detectors are useful in pure neutron radiation field as well as mixed field(neutron & gamma) associated with wide range neutron and gamma energy spectrum. The detectors of different sensitivity can be obtained by changing amount of superheated liquid. It enables to measure neutron or gamma radiation in radiological event or nuclear emergency. This paper describes the performance evaluation of superheated liquid neutron sensor(SLNS) and a superheated gamma sensor (SLGS) at RSSD, BARC, Mumbai.

PROTECTION OF AGRICULTURAL AND FARM PRODUCTS FROM NUCLEAR FALL-OUT

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When a nuclear weapon explodes, radioactive dust is created which is released to the environment. Release of radioactive materials into the environment pose a threat to the agricultural community and to the safety of the food supply. The deposition of radioactive materials can contaminate crops, livestock, uncovered water supplies and land above established safety levels. Ingestion of contaminated food and water can have a harmful, long-term effect on health. Therefore, measures to reduce contamination and consumption of contaminated food and farm products are required.

Vegetables and fruits including roots and tubers should be washed, scrubbed and peel to remove surface contamination. Green vegetables from farm should not be used. Peas and beans inside the pods would be safe to eat. Homegrown produce should be tested for radioactive contamination before it is consumed. Grains, potatoes and other roots stored in weatherproof building would be safe to eat. Growing vegetables and fruits that are exposed to heavy fall-out may become highly contaminated. If the fall-out occurs in growing season or just before harvest, it is not advisable to market or consume the farm produce.

Poultry raised indoors and given protected food and water are not likely to be contaminated. Poultry raised outdoors, especially those kept for egg production, should be monitored by taking samples and performing lab tests to determine the presence of radioactive contamination. Samples of

water and fish from open bodies of water should also be analyzed to ensure that they are safe. All dairy animals should be sheltered and provided with protected food and water. If dairy products are found to be contaminated, it is recommended that milk and milk products be withheld from the market. For protection of meat and meat products from the nuclear fall-out, it is advised to place meat animals on protected feed and water, and if possible, to provide them with shelter. Water from enclosed wells or other covered or underground sources will normally be safe for livestock. It is unlikely that these water supplies will be affected. If livestock consume feed and water contaminated with radioactive materials, some of the contamination will be absorbed into their bodies and could enter the human food supply through meat and meat products.

Protection of food products from nuclear fall-out also requires appropriate measures both for the food processors and packaged food products. Windows and vents to the outdoors should be closed. Vacuum systems should be shut down as should compressed air systems. Any system that draws air from outdoors to the inside should be shutdown. Food in finished packaging would not be harmful to eat as long as the outer wrappings are discarded.

Open sources of water such as rain barrels and tanks should be covered to prevent contamination. Storage containers should be protected from contamination. Intake valves on water systems should be closed if contamination of water source is suspected. This will prevent distribution or irrigation until the water source is tested and found to be safe. If the soil is contaminated above established safety levels, proper soil management procedure can reduce contamination to safe levels. Idling – the nonuse of land for a specific period of time may be necessary. Growing alternative non-food crops may also be recommended in some situations. In situations involving highly contaminated soil, removal and disposal of the soil may be appropriate. Bioremediation to treat contaminated soil and water may also be employed as an alternative to costly and energy-intensive physical methods.

Protective measures to reduce contamination of agricultural and farm products can prevent the harmful health effects. Appropriate measures should therefore be taken to reduce the contamination and consumption of contaminated agricultural and farm products.

SOLVENT FREE RESIN SYSTEMS FOR ADHESIVES AND COMPOSITES IN THE LIGHT OF ENVIRONMENTAL DISASTER MANAGEMENT ISSUES: A GREEN TECHNOLOGY APPROACH

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It is the industry that turns raw materials into consumer products. But ironically, through traditional technology, industry is not only wasting raw materials but is regularly impairing the environment and in course of time their integrated impairment attributes to adverse impacts on eco-system to cause ultimate disaster to our pleasant planet. Mindless handling and discharge of harmful chemicals are damaging the geo- and ecosystem which otherwise could have been largely avoided. Directly or indirectly, every environmental problem has short-term as well as long-term impact on environment towards augmenting eco-disaster but we often neglect the latter, mainly because of lack of serious understanding to assess the gravity of impacts of different dimensions, particularly in future context. But, hopefully in recent times, “GreenPeace Movement” has been active worldwide to promote knowledge on the issues for protection of ecology from disaster. In support of such movement, chemical professionals have laid down a protocol of T*welve Principles of Green Chemistry* (GC) to aim at diffusing the disastrous effect of chemicals on environment. In this context, deliberation on such twelve principles currently has acquired more importance and relevance than ever before. One of the important GC principles is to forbid organic solvents as they have both short-term as well as long-term adverse effect on environment and human health. In fact, nowadays pollution caused by handling of solvents during manufacture or processing is identified as one of the most serious issues of concern for ecological disaster management program.

This paper informs awareness and scope towards generation of environmental friendly material systems like solvent-free resin as ingredients for host of items like adhesives, functionally gradient material (FGM) and allied composite systems. In this perspective, thermoplastic epoxy resins (TPE) were synthesised from the controlled reaction of bisphenol A, epichlorohydrine and isomers of dimethylaniline to prepare solvent-free processable glassy *solid* resin intended for use in the areas of hot-melt-adhesives (HMAs), FGM composite or syntactic foam without employing any solvents unlike needed for usual material processing purpose. Here TPE is miscible with biodegradable additives like solid polyethylene glycol (SPG) up to optimum limit (~20%) to ensure best mechanical property. Spectroscopic and SEM data on such system reveal strong interactive action of the solvent-less components and also unfold their features of failure. Use of solid additives like SPG in TPE not only provides maximum adhesive strength but more importantly, it also diffuses the possible problem of disaster from the hazardous organic solvents.

It is expected that these evaluated data and discussion in effect will enrich the knowledge base and data bank on the subject of solvent- free resin system for application in the areas of adhesive and composites to honor the current trends of technology development program in line with the principle of Green Chemistry for modern materials.

PROCESS APPROACH TO MANAGE NUCLEAR DISASTER

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Many a times activation of a nuclear device by a false trigger is a major threat. Four cases from US & Russia having different root causes for false-alarm have been narrated. As for as India is concerned, a lot has been done but still more is yet to be done. By adaptation of process approach, functioning of Disaster Management System can be systematized thus probability of false alarms can be reduced. Focus has also been laid on identifying and meeting primary & secondary requirements of victims. Further, preventive measures must be given utmost importance for effective & efficient functioning of Disaster Management.

WATER PURIFICATION CHALLENGES IN INDUSTRIAL & NATURAL DISASTERS

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Water Purification forms an essential part of disaster management activities. Events like Tsunami, a Nuclear, Chemical or Biological catastrophe either manmade or natural make the water totally unsafe for drinking. Other similar situations like the Bhopal gas leakage incident, Latur or Bhuj Earthquakes, Gujrat cyclone and so on can also lead to water contamination. Potable water, a commodity more essential than even food, is often found scarce in such disasters. Defence Laboratory (DRDO), Jodhpur has developed a “RO based mobile Water Purification System (WPS)” addressing the above situations.

The Water Purification System is a rugged, mobile and self supporting system perfectly suitable for the demanding situations of a man made or natural disaster. It is a Reverse Osmosis (RO) based system capable of continuously providing 2000 to 3000 Liters per hour of purified potable water. It is highly mobile being mounted on a 5 / 7.5 ton Stallion vehicle. The WPS also houses a Diesel Generator set thus making it totally self sufficient in meeting its power requirements. The system also has a set of Pre & Post filtration & dosing to supplement the RO membranes. It can bring down the dissolved salt contamination from 4000 ppm TDS to below 500 ppm. Similarly biological and Chemical contaminants are reduced to safe limits.

During the “TSUNAMI” disaster the above Water Purification System was able to reach from Jodhpur to the most affected Nagapettinam district of Tamil Nadu on 31st Dec 2005, on short notice from the Ministry of Defence, Govt of India. It was deployed at highly affected villages like Akkaraipettai, Kameshwaram & Sherathure, and provided around 70,000 liters of potable water to a number of affected villagers. The well water in the coastal villages was biologically contaminated, highly saline (5000 ppm TDS) and turbid. The WPS treated product water was also tested for biological contamination by several Health officials of Tamil Nadu & Central Govt. before being supplied to people and was found to be fit for human consumption.

The developed mobile Water Purification System is fully capable to meet the challenges posed by disasters for timely providing potable water to remote affected areas. The system was also found to be very effective for removing radioactive contaminants during Lab evaluation. More compact, containerized, light weight systems are also being planned looking into the futuristic requirements like Air-droppable Water Purification Systems. This will prove to be a right step in the direction of achieving self sufficiency during any disaster management by the country.

RECENT TRENDS IN RADIO DECONTAMINATION – AN OVERVIEW

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Decontamination in general is the removal of material from areas in which it is not wanted. Radiological decontamination is the removal of radioactive material, from equipment or humans by washing, heating, chemical or electrochemical action, mechanical cleaning or by other techniques.

The objectives of the decontamination are to reduce radiation exposure, salvage equipment and materials, remove loose radioactive contaminants and fix the remaining in place in preparation for protective storage or permanent disposal work activities. Decontamination may be carried out using chemical, electrochemical, and, mechanical means. There is no decontamination technology that will be applicable in all situations and for all types of contamination, like chemical decontamination may be used to dissolve corrosion products while mechanical methods may be employed to decontaminate structural surfaces, concrete etc. like materials, humans may also be contaminated with radiological contamination. This may result from a nuclear detonation or a radiation dispersal device or a nuclear reactor accident. The two most significant radiosensitive organ systems in the body are the hematopoietic and the gastrointestinal (GI) systems. The simplest effect is cell death. Changes in cellular function can occur at lower radiation doses than those that cause cell death. External contamination by radionuclides will occur if a person traverses a contaminated area without appropriate barrier clothing while internal contamination can occur when unprotected personnel ingest, inhale or wound have contamination by radioactive material. The primary difference between the mechanics of radiological decontamination and chemical decontamination is the method of monitoring. Set up and containment of waste are performed in the same manner.

Decontamination of casualties is an enormous task requiring dedication of large number of personnel and large amount of time. Removal of outer clothing and rapid washing of exposed skin and hair removes about 95% of contamination.

CHALLENGES AND TECHNOLOGIES IN COMBATING THE NBC DISASTERS

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Under the prevailing scenario there is a high possibility of Nuclear, Biological & Chemical warfare agents falling in the hands of terrorist groups, imposing great challenge of NBC terrorism. Chemical and Nuclear agents can be used as **"Dirty Bomb"**where these agents are packaged with explosive material. On explosion "Dirty Bomb" will cause contamination of environment causing hazardous effects on health. Nuclear agent can be used as **"Suitcase Nuke"** having a weight of 10 kg only while it will have a yield of 10-20 KT, with radiation effect upto 4-5 km radius. Usually Cesium-137 or Cobalt-60 are the nuclear material used in the dirty bomb which has got long half life causing the delayed radiation effect in the form of cancer, cataract, genetic damage, premature aging and infertility. The virulence of biological agent can not be undermined as they are cheap, easy to produce and only small amount is required to play havoc. Bacteria like anthrax, virus like small pox, toxic like botulisms toxin are most commonly used as biological agents. In addition to NBC terrorism, nuclear or chemical disaster can also occur due to accident either in nuclear reactors, chemical plants or during transportation of nuclear or chemical material. Accidental release of biological agents from a Biosafety lab will cause biological disaster. NBC disaster will cause tremendous devastation to human and other living beings, flora fauna and environment including air, water and soil.

Management of disaster in nuclear, chemical or biological scenario poses the great challenge because of the contamination. In NBC environment search, rescue and quick reaction medical team has to put on protective clothing, respiratory masks, boots and gloves which reduces the working efficiency. Personal protection, detection, decontamination, decorporation, vaccination and antidote administrations are extra special requirement for management of NBC casualties along with the usual care of heat, blast and infection effects. Nuclear agents mainly cause acute haemopoetic, gastrointestinal, cutaneous and CNS syndrome while chemical agents adversely affect eyes, skin, respiratory and nervous system, of course biological agents can severely infect any part of body causing casualties in pandemic proportion. For managing NBC disaster, prevention, mitigation, preparedness, capacity building training and communication is to be considered as integral part of National framework for disaster management planning. The emergency response plans have to be deviced at all levels i.e. community, district, state and nation as a whole. District Disaster Management authority is the nodal agency for planning, preparedness and implementation of plants in case of any eventuality. Rescue and quick reaction medical team, doctors, paramedical and nursing staff are to be trained. Standard Operating Procedures (SOPs) need to be written. Mock drills and exercises to be carried out regularly.

NBC disaster management can only be possible by full involvement and total commitment of various organizations like fire services, police, communication, health services including ambulance service, hospitals. Multi-dimensional impact of NBC disaster requires multi sectorial and multi-disciplinary approach for development of trained manpower, equipment and other facilities needed for the handling of NBC disaster. Provision of clean water supply, safe food, hygiene and sanitation, environmental health and control of vectors is to be planned to prevent any epidemic in the aftermath of NBC disasters. Health care facilities are an essential component of emergency medical response system, but at the present, are poorly prepared for an incident. The greatest challenge may be the sudden presentation of large number of contaminated individuals. The key elements of the health care facilities response plan include prompt recognition of the incident, staff and facility protection, patient decontamination and triage, medical therapy and co-ordination with external emergency response and public health agencies. Special facilities to treat NBC casualties are to be created in the hospitals including NBC filter fitted ward and bio-waste disposal system. Earmarked hospitals are also to be geared up for restitution of immune system, bone marrow/stem cell transfusion, medical stores containing antidotes, vaccines, decorporation agents and antibiotics. Management of post-traumatic stress disorders is also to be catered. Planning is to be done to deal with long term effects of radiation like cancer, cataract, genetic damage and premature ageing. Documentations, research and analysis is to be carried out in post-disaster scenario for future lessons.