सत्यमेव जयते

Ministry of Health & Family Welfare
Government of India

World Health Organization
India

Preparedness, Surveillance & Response

for Public Health Management of Chemical Emergencies

2025

Preparedness, Surveillance & Response

for Public Health Management
of Chemical Emergencies

Firefighters responding to Industrial fires in Ahmedabad,2020

ABOUT THE BOOK

The “Preparedness, Surveillance & Response for Public Health Management of Chemical Emergencies” is a specialized module that focuses on providing public health professionals and administrators with the knowledge and skills necessary for Preparation and Surveillance for Chemical Emergencies.

The module is typically offered as a part of training programs for Public Health Professionals , Medical Officers, Surveillance Officers, Medical Colleges ,Policymakers , Administrators, Airport and Health Officers, International Agencies and Occupational Health Professionals. The module may also be included as part of broader public health management training programs for emergency management professionals, government officials and other relevant stakeholders.

Gas leak at Giaspura, an industrial area of Ludhiana, Punjab, 2023

ACKNOWLEDGEMENT

India is rapidly emerging as a major global hub for industrial and technological development. As chemicals form an integral part of modern industrial systems, the pace of industrialization has simultaneously heightened the risk of exposure to chemical hazards. Uncontrolled releases of such substances can have serious implications for public health and the environment, potentially resulting in chemical emergencies. These chemical emergencies have a profound impact on human health, often resulting in casualties, long-term consequences, and damage to property and the environment.

These modules have been developed recognizing the importance of addressing public health concerns arising from chemical incidents. India's health sector is expanding its role and aligning with the International Health Regulations (IHR) to strengthen capacities for chemical emergency preparedness and National Centre for Disease Control (NCDC), as the national focal point for IHR implementation, coordinates with relevant sectors to enhance capacities for the management of chemical emergencies and undertakes capacity-building initiatives across all related core areas.

The Public Health Management of Chemical Emergencies modules are the outcome of an extensive process of consultation and collaboration among national and international experts, practitioners, and institutions engaged in health emergency preparedness, disaster risk management, and chemical safety, through a series of technical consultations, systematic peer reviews, and capacity-building workshops convened to ensure the relevance and applicability of the content to India's health and disaster management systems context.

From the Conceptualization, Contribution, Development and further scaleup capacity building efforts for Public Health Preparedness for Chemical Emergencies, the collective insights and experiences of all contributors have shaped this module into a practical tool to strengthen preparedness, response, and resilience against chemical emergencies across all levels of the health system.

We extend our sincere gratitude to the National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF), Ministry of Health and Family Welfare (MoHFW), Ministry of Chemicals and Fertilizers, Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, Office of The Principal Scientific Advisor to the Prime Minister, Defense Research and Development Establishment (DRDE), National Authority for Chemical Weapons Convention(NACWC), National Institute of Disaster Management (NIDM), Directorate General of Factory Advice Service and Labour Institutes (DGFASLI), Disaster Management Institute (DMI) Bhopal, Employees' State Insurance (ESI) Hospitals,All India Institute of Medical Sciences (AIIMS), Indian council of medical research (ICMR), State Disaster Management Authorities, Gujarat Institute of Disaster Management (GIDM), State Governments, Local governments, Industry partners, World Health Organization (WHO) India - State and Field offices teams, and other institutions, hospitals and stakeholders who contributed to the development of the Chemical Emergencies Module. Your expertise and collaboration have been instrumental in shaping this module and enhancing preparedness, response and management for chemical emergencies.

ABBREVIATIONS

AAR	After Action Review
ALS	Advanced Life Support
BIS	Bureau of Indian Standards
BLS	Basic Life Support
CA (EPPR) Rules	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules,1996
CAS	Crisis Alert System
CCG	Central Crisis Group
CCR	Central Control Room
CFEES	Centre for Fire, Explosive and Environment Safety
CPCB	Central Pollution Control Board
CSR	Chemical Safety Report
CLI	Central Labour Institute
DAE	Department of Atomic Energy
DGFASLI	Directorate General Factory Advice Service and Labour Institutes
DDMA	District Disaster Management Authority
DISH	Directorate of Industrial Safety and Health
DM	Disaster Management
DMP	Disaster Management Plan
DOCP	Department of Chemicals and Petro-chemicals
EMS	Emergency Medical Services
EPA	Environmental Protection Act
ERF	Environment Relief Fund
ES	Exposure Scenario
EOC	Emergency Operations Centre
FE	Functional Exercise
FSE	Full-Scale Exercises
GIS	Geographic Information System
HAZAN	Hazard Analysis
HAZCHEM	Hazardous Chemical
HAZMAT	Hazardous Material
IDSP	Integrated Disease Surveillance Program
IHR	International Health Regulations
ILO	International Labour Organization
MAH	Major Accident Hazard
MoEFCC	Ministry of Environment, Forests and Climate Change
MoHFW	Ministry of Health & Family Welfare
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NIDM	National Institute of Disaster Management
OISD	Oil Industry Safety Directorate
OR	Operational Requirements
PESO	Petroleum & Explosives Safety Organization
PPE	Personal Protective Equipment
PCC	Pollution Control Committees
RLI	Regional Labour Institute
RMM	Risk Management Measures
RRT	Rapid Response Team
SAICM	Strategic Approach to International Chemicals Management
SDMA	State Disaster Management Authority
SPCB	State Pollution Control Boards
WHO	World Health Organization
TTX	Tabletop Exercise

SYMBOLS

INDUSTRIAL ZONE

TOXIC MATERIALS

CORROSION

WARNING OF
SLIPPERY SURFACE

EXPLOSIVE MATERIAL

WEAR RESPIRATOR

WARNING OF
GENERAL HAZARD

FLAMMABLE MATERIALS

OXIDIZING AGENT

CHEMICAL
STORAGE AREA

WEAR SAFETY GLOVES

WARNING OF
MOVING MACHINERY

STRONG
MAGNETIC FIELD

GAS UNDER
PRESSURE

ELECTRICAL
HAZARD

HAZARD TO
ENVIRONMENT

TOXIC MATERIALS

WEAR SAFETY
HELMET

TABLE OF CONTENTS

An explosion at a chemical factory on the Pirana-Piplaj road in Ahmedabad, Gujarat, 2020

"Hope for the best, plan for the worst"

INTRODUCTION

By the end of this chapter, you will be able to understand:

1. What are chemical emergencies?
2. What are the causes of chemical emergencies?
3. What is the need for the management of chemical emergencies?

1.1 Hazardous Chemicals

Hazardous chemicals are substances which are capable of causing adverse effects to people and/or the environment under conditions of exposure. Hazardous materials are poisonous by-products produced in manufacturing, farming, construction, automotive, laboratories, and hospitals.They may contain chemicals, heavy metals, radiatioactive materials, dangerous pathogens, or other toxins. Common examples are Hydrogen cyanide,Hydrogen sulfide, Nitrogen dioxide, Ricin, Organophosphate pesticides, Arsenic,etc.

Toxic waste has become more abundant since the Industrial Revolution, causing serious global health issues. Disposing of such waste has become even more critical with the addition of numerous technological advances containing toxic chemical components. Even households generate hazardous waste from items such as batteries, used electronic equipment, and leftover paints or pesticides. Toxic materials can either be human-made or naturally occurring in the environment. Not all hazardous substances are considered toxic.

1.1.1 Routes of Chemical Exposure

1. **Ingestion** - Absorption through the digestive tract. This process can occur through eating with contaminated hands,through contaminated food or in contaminated areas.

2. **Absorption** - Absorption through the skin often causes dermatitis. Some toxins that are absorbed through the skin or eyes can damage the liver, kidney, or other organs and through misuse of sharp materials such as hypodermic needles.

3. **Inhalation** - Absorption through the respiratory tract (lungs) through breathing. This route is most critical in terms of severity.

4. **Injection** - Percutaneous injection of a toxic substance through the skin. This process can occur in the handling of sharp-edged pieces of broken glass apparatus and through misuse of sharp materials such as hypodermic needles.(Fig 1)

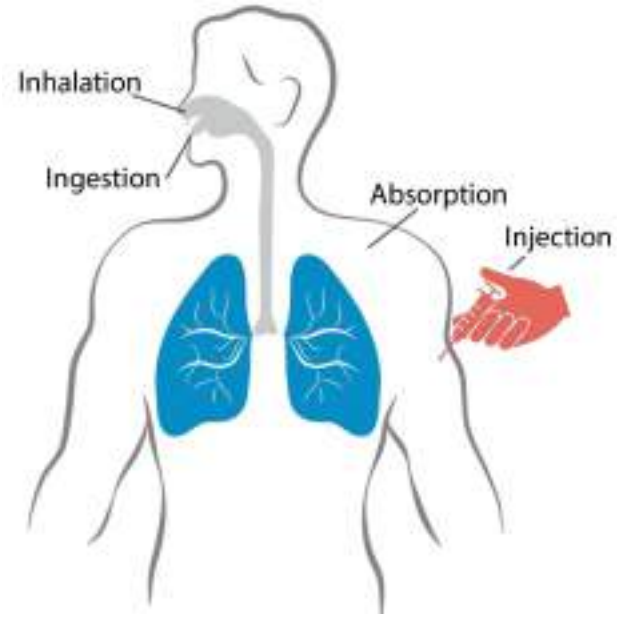


Fig. 1 : Routes of chemicals entering the body

1.2 Chemical Hazards

- Chemical emergencies can occur when hazardous substances are released into the environment, either accidentally or intentionally. These substances can pose a serious threat to human health and the environment, and it is important to respond quickly and effectively to minimize the potential damage.

- Chemical emergencies can range from small spills that can be contained relatively easily, to large-scale disasters that require a coordinated response from multiple agencies and organizations.

- It is essential to have plans and protocols in place to manage chemical emergencies, including strategies for assessing the situation, evacuating affected areas, and providing medical treatment to those who have been exposed to the hazardous substances.

- Proper training, equipment, and communication are also critical components of any effective response to a chemical emergency. The use of chemicals to enhance and improve life is a widespread practice worldwide. While on one side, there are benefits of using these chemicals, on the other side, there is also potential for adverse effects on people and the environment.

During the last decades, there has been increased concerns about the release of toxic chemicals in congested industrial sites or urban areas as many hazardous chemicals are being stored or transported in such places. If an accident/incident occurs,the impact on the population can be significant.

Chemical emergencies are sudden in nature, provide less time to think and act and therefore consequences are catastrophic. In case of chemical emergencies, the abnormal situation involving chemicals demands prompt action to mitigate the associated hazards such as fire, explosion, toxic gas release, etc.

CORROSIVES

Corrosives are materials that can injure body tissue or cause corrosion of metal by direct chemical action.

Major classes of corrosive substances are:

1. Strong acids (e.g., Sulphuric, Nitric, Hydrochloric & Hydrofluoric acids)
2. Strong bases (e.g., Sodium hydroxide & Potassium hydroxide)
3. Dehydrating agents (Sulphuric acid, Sodium hydroxide, Phosphorus pentoxide, & Calcium oxide)
4. Oxidizing agents (e.g., Hydrogen peroxide, Chlorine, & Bromine)

FLAMMABLES

Flammable substances have the potential to catch fire readily & burn in air. A flammable liquid itself does not catch fire; it is the vapors produced by the liquid that burn.

Important properties of flammable liquids:

» Flash point is the minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with air.
» Ignition temperature is the minimum temperature required to initiate self-sustained combustion

OXIDIZERS/ REACTIVES

Oxidizers/ reactives include chemicals that can explode, violently polymerize, form explosive peroxides, or react violently with water or atmospheric oxygen.

1. Oxidizers: An oxidizing agent is any material that initiates or promotes combustion in other materials, either by causing fire itself or by releasing oxygen or other combustible gases.Examples of oxidizers - Aluminum nitrate, Ammonium persulfate, Barium peroxide.
2. Reactives: Reactives include materials that are pyrophoric (“flammable solids”), are water reactive, form explosive peroxides, or may undergo such reactions as violent polymerization.

TOXINS

» Toxins are a broad class of chemical hazards that are distinguished by their capacity to damage living things via biochemical interactions. These compounds are very dangerous because they have the potential to cause serious health impacts even at low exposure levels. They can be created synthetically or organically. Toxic substance is one that even in small amounts, can injure living tissue.
» Examples – Hydrogen cyanide, Hydrogen peroxide, Hydrogen fluoride etc.

Fig.2 : Four categories of common chemical hazards: corrosives, flammables, oxidizers/ reactive, and toxins.

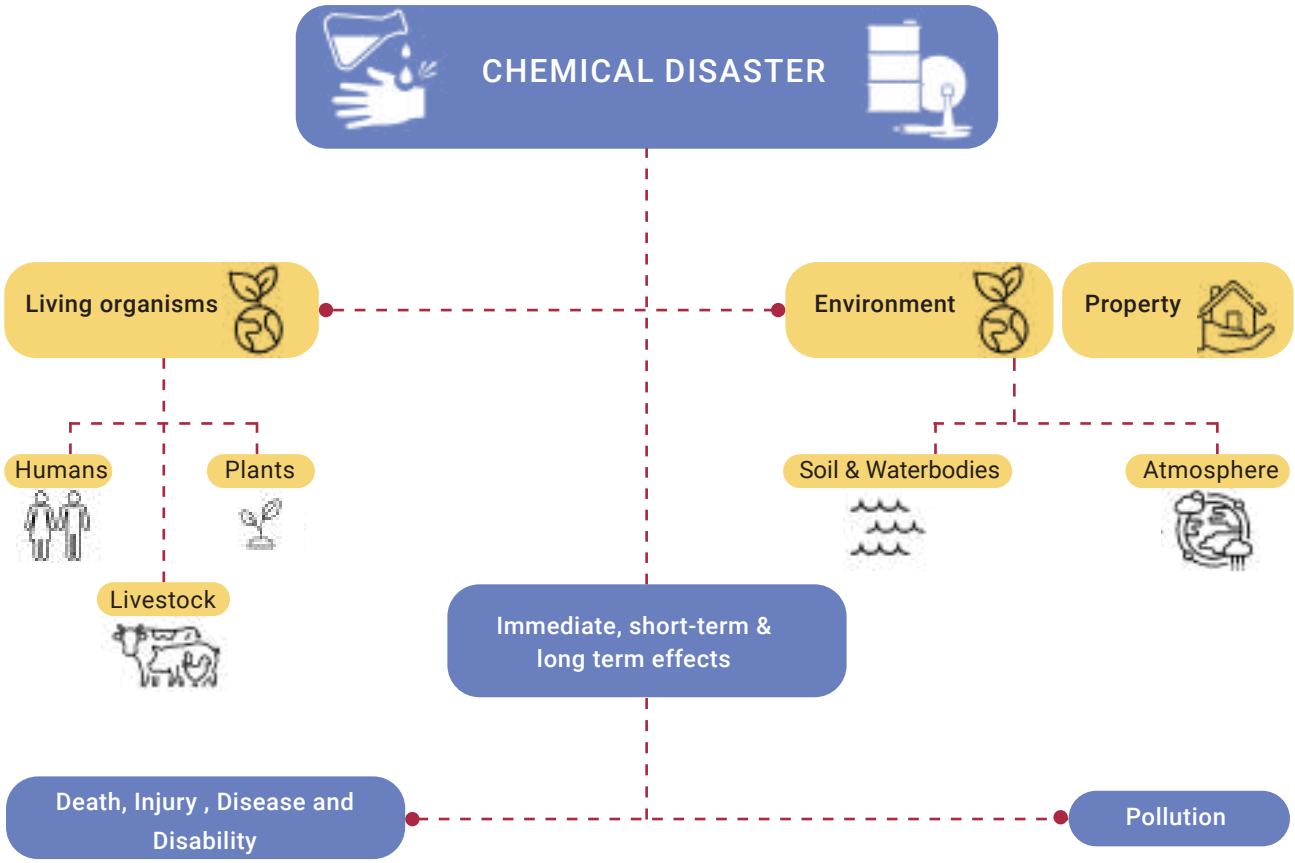


Fig.3 : Effects of Chemical Disaster

The various hazards associated with chemicals may be broadly put into three main categories-

- **Physical Hazards,** such as explosive, inflammable solid/liquid/gas, self-reactive substances; oxidizing liquid/ solid; pyro- phoric liquids/solids,etc.
- **Health Hazards,** such as acute toxicity-oral or dermal; skin corrosion/irritation; serious eye damage/eye irritation; respiratory/skin sensitization; specific target organ toxicity; germ cell mutagenicity; carcinogenicity, reproductive toxicity, aspiration hazard, secondary infections,radiotoxicity.
- **Environmental Hazards,** such as very toxic/toxic/harmful to aquatic life; adverse impact on ozone layer, etc.

1.3 Vulnerable Sites for Chemical Emergencies

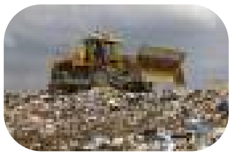
Examples of vulnerable sites and examples of the type of chemical that might be released are as follows.

Fuel storage sites, tank farms

- Kerosene
- Petroleum
- Propane
- Butane

Waste storage sites

- Oil
- Solvents
- Polychlorinated biphenyls



Gas and oil pipelines

- Natural gas (methane)
- Crude oil

Tailing Dams

- Toxic sludge
- Mine tailing containing Cyanide and Arsenic

Petroleum or Petrochemical Industries

- Ammonia
- Acrolein
- Methanol
- Organic peroxides

Acid mine drainage (abondoned mines)

- Aluminium
- Arsenic
- Cadmium
- Lead

Chemical factories

- Alkalis
- Acrolein
- Methanol
- Organic peroxides

Transport: Railways, Roads, Rivers, Sea

- Ammonia
- Chlorine
- Petroleum
- Methanol

Food processing plants

- Ammonia

Hospitals, Laboratories, Pharmacies

- Reagents
- Disinfectants
- Medicines
- Radiological materials

Pesticide storage depots

- Carbamates
- Organophosphates
- Organochlorines

Metallurgical industries

- Toxic metals
- Cyanide
- Sulfuric acid
- Ammonia

1.4 Causes of Chemical Emergencies

Chemical emergencies can occur due to different types of hazardous substances, including toxic chemicals, gases, and radioactive materials. They can be released into the environment due to various reasons, such as:

1. **Natural disasters leading to chemical emergencies** -
   Natural disasters such as floods, earthquakes, and cyclone can damage industrial facilities and release hazardous substances into the environment for Eg Sandhurst Chemical blast,Gloucestershire,UK in 2000 following floods, AKSA Acrylic Fibre Plant disaster following Earthquakes in Turkey in 1999.

2. **Manmade disasters** -
   These include accidents at industrial facilities , during transport, storage and use of Hazardous Chemicals . These accidents can lead to the release of toxic chemicals, explosions, and fires for eg:Tulglakabad Gas Leak,Delhi 2017, Fire at Indian Oil Corporation, Jaipur, 2009.

3. **Deliberate acts of terrorism** -
   Chemical emergencies can also be caused by deliberate acts of terrorism for Eg: Sarin gas attack at Tokyo subway,Japan,1995.

a) AKSA acrylic fibre plant disaster post Earthquake, Turkey, 1999

b) Indian Oil Corporation ,Jaipur fire, 2009

c) LPG tank fire at the Chiba refinery,Japan after the earthquake 2011

d) Release of nerve gas Sarin in the Tokyo subway in 1995

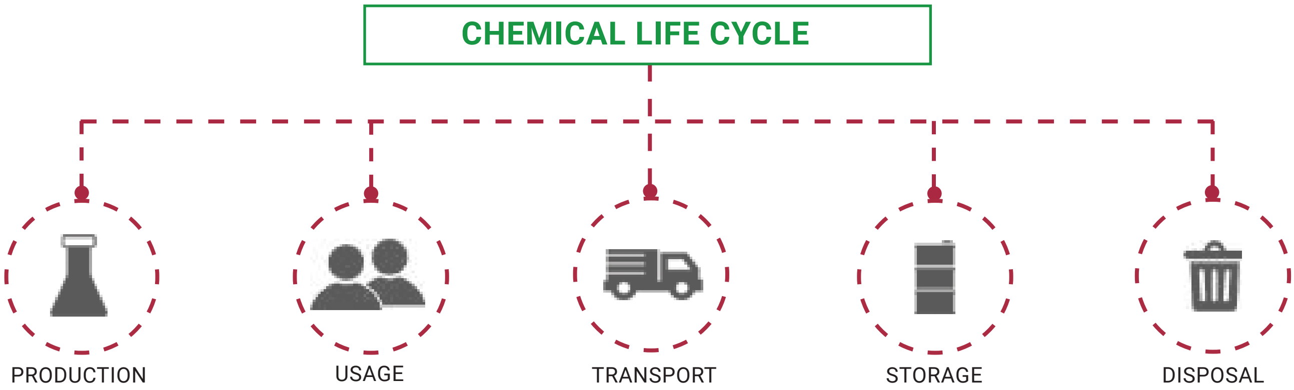


Figure 4 - Components in Chemical Disaster Management

1. Chemical Emergency during Production - Bhopal Gas Tragedy, 1984, Madhya Pradesh

2. Chemical Emergency duringUsage - Hapur Factory boiler explosion, Lucknow, 2022, Uttar Pradesh

3. Chemical Emergency during Transportation - Kanpur LPG Truck explosion, 2001,Uttar Pradesh

4. Chemical Emergency during Storage - Gas leakage in LG Polymers Visakhapatnam, 2020,Andhra Pradesh

5. Chemical Emergency during Disposal - Mumbai port trust - Sewri chlorine leak, 2010, Maharashtra

1.5 Need for management

The management of chemical emergencies is essential to protect human health, wildlife, and the environment from the harmful effects of hazardous substances. Chemical emergencies can occur due to various reasons, including accidents at industrial facilities, transportation mishaps, natural disasters, and deliberate acts of terrorism. These emergencies can have immediate and long-term impacts on the health and safety of individuals, wildlife, and ecosystems.

Effective management of chemical emergencies can help to minimize the potential damage caused by such events. Emergency planning and preparation can help to identify potential hazards and develop procedures for responding to emergencies, including notification, evacuation, and communication protocols.
The components in chemical disaster management are mentioned in figure 5.

Figure 5 - Components in Chemical Disaster Management

Bhopal Gas Disaster - Plant structure UCIL Factory, 1984

Bhopal Gas Disaster,1984.

""Failing to prepare is preparing to fail"

EXISTING REGULATORY & INSTITUTIONAL FRAMEWORKS

By the end of this chapter, you will be able to understand:

1. What are the list of laws and acts pertaining to the Management of Chemical Events
2. What are MAH Units?

2.1 List of Laws and Acts related to the Management of Chemical Emergencies in India

	NAME OF THE ACT/LAW/RULES	PROVISIONS
	The Water (Prevention and Control of Pollution)Act,1974	Provides for the prevention and control of water pollution and the establishment of boards for the prevention and control of water pollution.
	The Environment (Protection) Act, 1986	Provides for the protection and improvement of the environment and the prevention of hazards to human beings, other living creatures, plants, and property.
	The Manufacture, Storage, and Import of Hazardous Chemicals Rules, 1989	Provides for the regulation of the manufacture, storage, and import of hazardous chemicals.
	The Public Liability Insurance Act, 1991	Provides for mandatory insurance coverage for industrial units handling hazardous substances to compensate for the damages caused to third parties in case of an accident.
	The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996	Provides guidelines for emergency planning, preparedness, and response in case of a chemical accident.
	The Disaster Management Act, 2005	Provides for the management of disasters, including chemical disasters, and the establishment of institutions for disaster management.
	The Petroleum and Natural Gas Regulatory Board (Emergency Management Plan) Regulations, 2010	Provide for the establishment of emergency management plans for petroleum and natural gas installations.
	The Hazardous Waste (Management, Handling, and Transboundary Movement) Rules, 2016	Provides for the management, handling, and transboundary movement of hazardous waste in a safe and environmentally sound manner.

These laws and acts aim to ensure the safe handling, storage, transportation, and disposal of hazardous chemicals, and to prepare and respond to chemical emergencies effectively.

Amendments to Pre-Bhopal legislations including Factory Safety Act and Motor Vehicles Act.

- The Insecticides Act, 1968 (amended 2000) and The Insecticide Rules, 1971 (amended 1999).
- The Motor Vehicles Act, 1988 (amended 2001).
- The Central Motor Vehicles Rules, 1989 (amended 2005).
- The Explosives Act, 1884 (amended till 1983).
- The Gas Cylinder Rules, 2004.
- The Static and Mobile Pressure Vessels (Unfired) Rules, 1981 (amended 2002).
- The Explosives Rules, 1983 (amended 2002).

Apart from the above, legal instruments for the management of hazardous wastes include the Biomedical Wastes (Management & Handling) Rules, 1998 and the Batteries (Management & Handling) Rules, 2001(amended 2010) ,Battery Waste Management Rules 2022, Hazardous Microorganism Rules, 1989. Major responsibility for implementing these Rules is with the Central Pollution Control Board and State Pollution Control Boards (SPCBs) / Pollution Control Committees (PCCs) and also with the State Departments of Environment.

These laws and acts aim to ensure the safe handling, storage, transportation, and disposal of hazardous chemicals, and to prepare and respond to chemical emergencies effectively.

2.2 Environmental Regulations: Liability and Litigations

- Development of legislation in area of chemical disaster management owes to environmental jurisprudence and also to the lawsuits in form of public interest litigations.

- Under the Public Liability Insurance Act, 1991 as amended in 1992, all the MAH units handling chemicals in excess of the threshold quantities referred to in the Schedule, are mandated to take an insurance policy before starting their activity, on behalf of the off-site population, and deposit an equal amount in the Environment Relief Fund (ERF) to ensure immediate payment to the chemical accident victims.

- This relief shall be paid on “Principle of no fault” that is the claimant shall not be required to plead or establish that the death, injury or damage was due to any wrongful act neglect or default.

- The National Environment Tribunal Act, 1995 is enacted to setup legal institutions across the country to provide for strict liability for damages arising out of accidents occurring during the handling of hazardous substances and for establishment of National Environment Tribunal for effective and expunction disposal of cases arising from such accidents, with a view to giving relief and compensation for damages to person, property and the environment.

- Several verdicts of the Hon’ble Supreme Court of India under the Article 21, Right to Life also provided standards for the environmental jurisprudence in the country.

- A number of chemical specific codes of practices published by the Bureau of Indian Standards (BIS), the Oil Industry Safety Directorate (OISD) and guidelines brought out for chemical accident management by the Ministry of Environment, Forest and Climate Change (MoEFCC).

2.3 International Health Regulations (IHR) and Chemical Events

The chemical industry is one of the largest economic sectors worldwide. Despite the omnipresence of chemicals worldwide and their predicted increase in production and use, many countries lack adequate capacities to deal with the health aspects of chemical events and emergencies. In 2005 the WHO Member states adopted the revised IHR (2005) which included Chemical events.

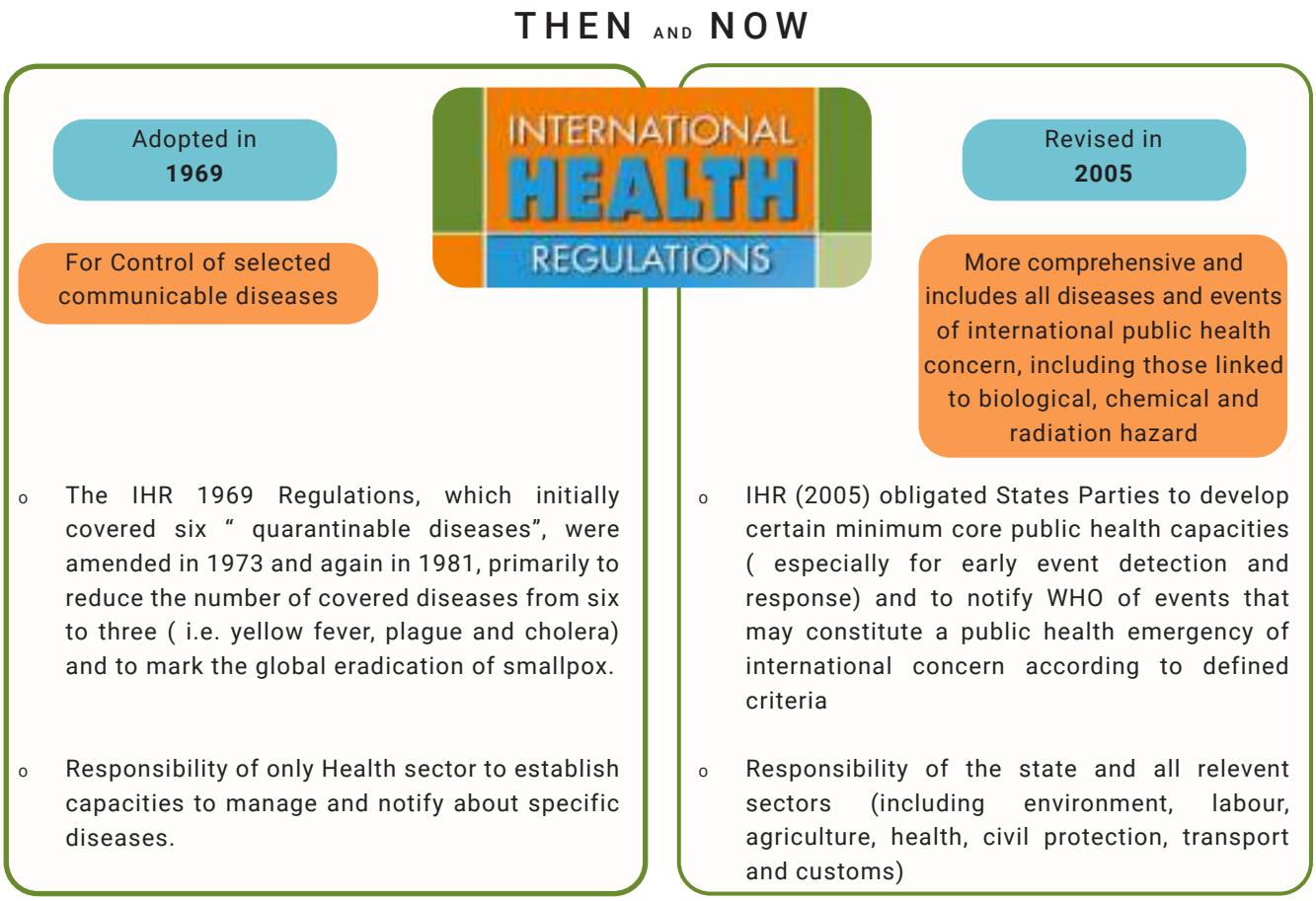


Fig.6 : IHR in 1969 vs IHR 2005

- A new fund for pandemic prevention, preparedness and response ,The revision of the International Health Regulations (IHR) are ongoing initiatives aimed at improving the international response to public health emergencies
- Pandemic Accord-Member States of the World Health Organization have agreed to a global process to draft and negotiate a convention, agreement or other international instrument under the Constitution of the World Health Organization to strengthen pandemic prevention, preparedness and response.
- Pandemic Accord, International Health Regulations Amendments and Health Emergency Preparedness and Response (HEPR) are thus the upcoming instruments that focus on concept of building and strengthening capacities and fostering coordination. The worldwide production, trade and use of chemicals are predicted to increase further, particularly in developing countries like India thus the importance of these treaties and regulations

01 POLICY PLANNING AND COORDINATION

- Capacity building of designated focal points for the IHR in all authorities i.e., health sector, labour, environment, agriculture, transport, security etc., that have important role in the management of chemical events
- Others - operators, emergency service, workers, customs, food authorities, consumer protection organizations, academia and public

02 PREPAREDNESS AND CAPACITY BUILDING

- Multi-disciplinary response requiring a range of skills and expertise.
- Training for individuals and organizations with specific responsibilities.
- Poison Centres as key sources of expertise.

03 EVENT DETECTION, VERIFICATION AND RISK ASSESSMENT

- Multi-hazard surveillance strategy
- An integrated surveillance system should link these important sources of information about chemical events together and be supported by a surveillance plan. Multiple sources of notification and alert:

1. Within health sector - Poisons Centres, hospital emergency departments, primary health-care facilities and toxicology laboratories
2. Outside health sector - agency for consumer protection and food safety, plant operators, environmental agencies (surface water, air and soil), first responders, public/community (overt release, such as an explosion, a chemical plume, contaminated drinking water, dirty surface water or dead wildlife)

04 EMERGENCY RESPONSE

- Authorities respond by evaluating risks and implementing actions based on guidelines.
- National chemical event emergency response plan is crucial.
- Consideration of existing legal and technical instruments or plans.

05 CHEMICAL EVENT SCENARIO ANALYSIS

- Technique to explore how chemical events occur and their consequences, which guides the building of surveillance and response plans and related capacities.
- Monitoring national and international chemical events to identify major impacts, and risks
- Risk mapping - inventories of major hazard sites

06 INTERNATIONAL CHEMICAL SAFETY AGREEMENTS

- Responsibility usually with ministries of environment or industry.
- Recognition of the need for a multisectoral approach.
- Sectors should be aware of and collaborate with each other.

2.4 Major Accident Hazard (MAH) units

In India, Major Accident Hazard (MAH) installations are regulated under the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989, which were amended in 2000 and 2009. MAH installations are those that handle hazardous substances in large quantities and have the potential to cause major accidents that can result in loss of life, property, and environmental damage.

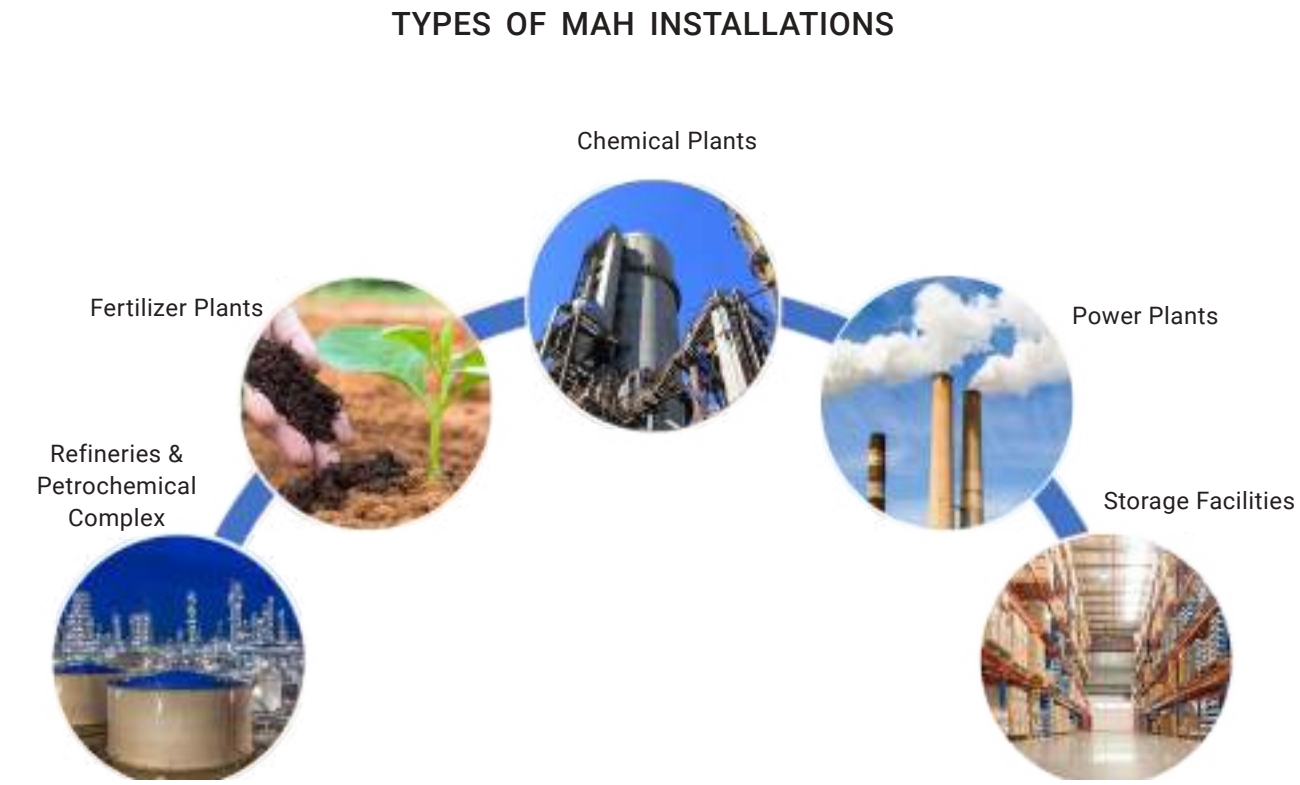


Fig.7 : Types of MAH units

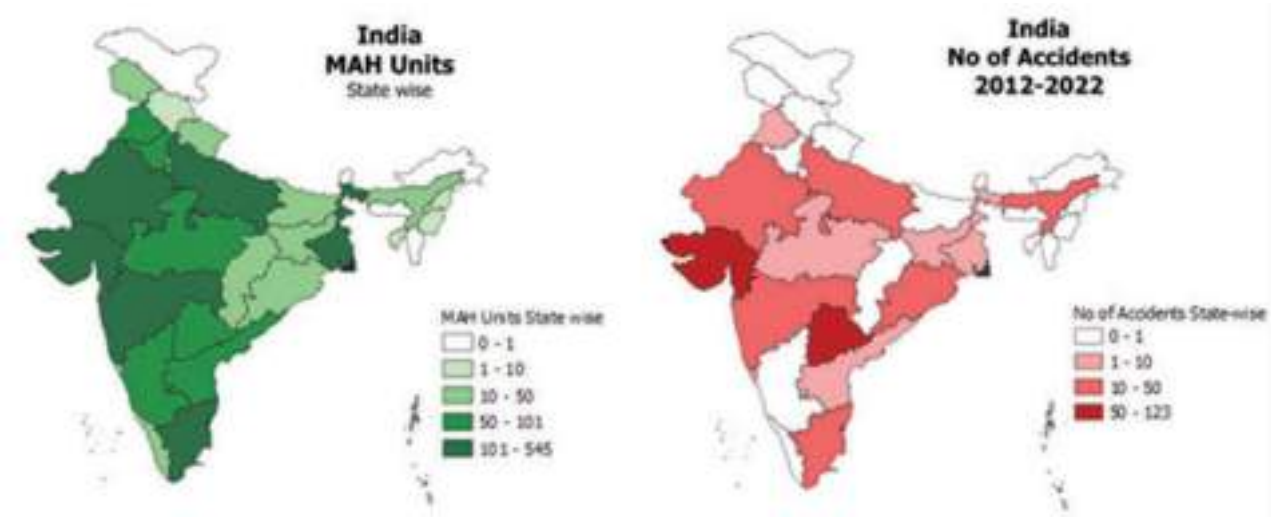


Fig. 8 : No of MAH Units state-wise. Ref: Data from MoEFCC & No of Accidents state wise in last 10 years (2012-2022)

Indian Oil depot fire, Jaipur, Rajasthan, 2009

Train containing chemicals derailed Ohio, 2023

"In times of disaster, we all play a role"

INSTITUTIONAL MECHANISMS

By the end of this chapter, you will be able to understand:

1. List of stakeholders with their roles and responsibilities in the management of chemical emergencies
2. What are Crisis Group and Directorate of Industrial Safety and Health (DISH) Centres
3. What is the role of RRT Team and Surveillance officers during chemical emergencies

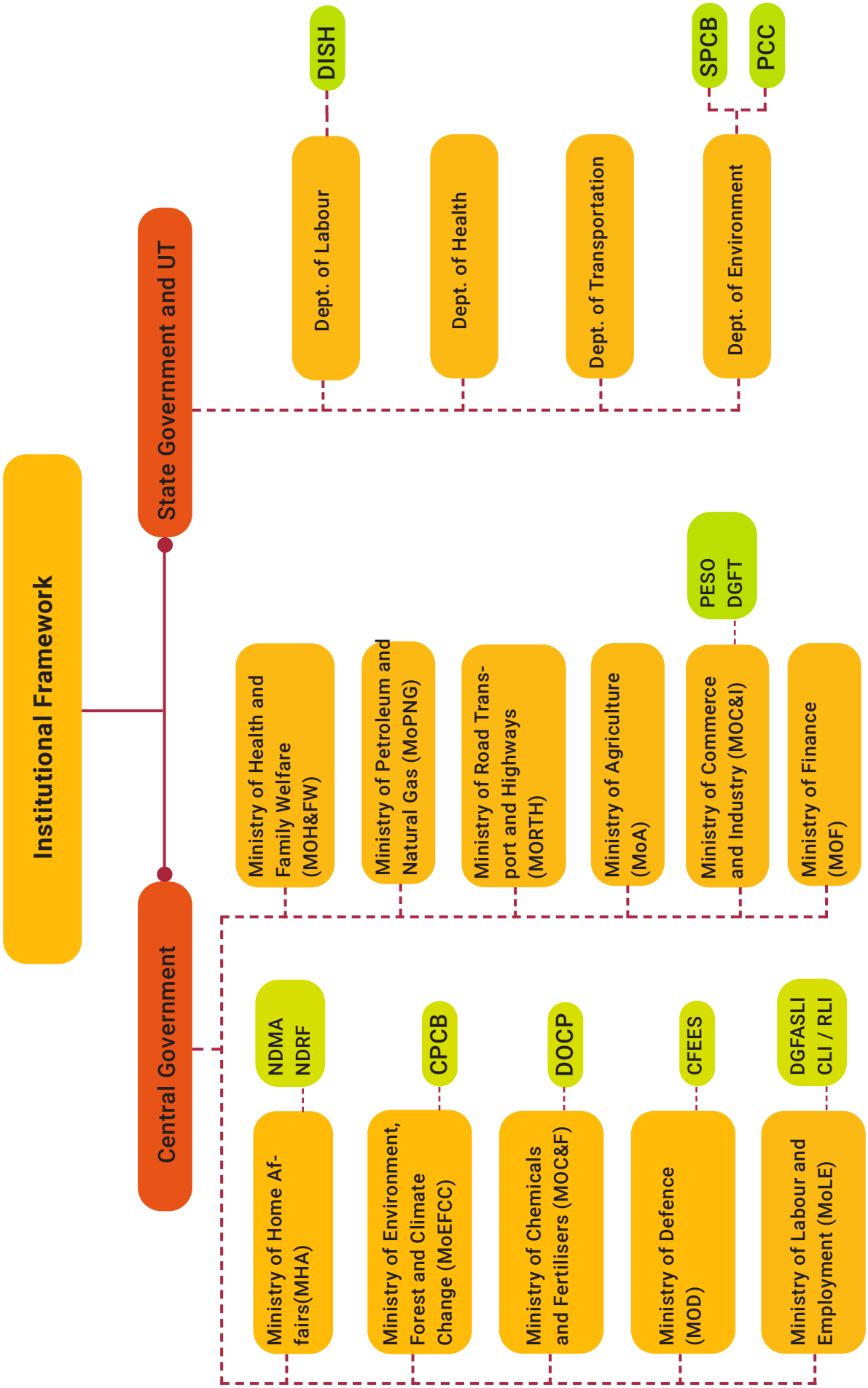


Fig.9 : Institutional Framework for chemical emergencies

* Adapted from NDMA guidelines on chemical disasters

3.1 List of stakeholders and their roles and responsibilities in the management of chemical emergency

There has been a paradigm shift from relief centric approach to pre-disaster preparedness and mitigation since the 1999 super cyclone in Odisha for disaster management in India. The Disaster Management Act (DM Act, 2005) provides for the establishment of National Disaster Management Authority,State Disaster Management Authority, District Disaster Management Authority and Local Disaster Management Authority The legal and institutional mechanism set up by the Environmental Protection Act (EPA), 1986) has been dovetailed with the DM Act, 2005. Convergence of institutional mechanisms for chemical disasters with the holistic disaster management framework is essential for achieving this goal.

In India, at the national level following ministries are involved in chemical disaster management:

- Ministry of Environment, Forests and Climate Change (Nodal Ministry)
- Ministry of Home Affairs
- Ministry of Health and Family Welfare
- Ministry of Chemicals and Fertilisers
- Ministry of Defence
- Ministry of Labour & Employment
- Ministry of Petroleum and Natural Gas
- Ministry of Commerce and Industry
- Ministry of Road Transport and Highways of India
- Ministry of Agriculture
- Ministry of Finance

Various departments related with Central level ministries include :

- **CPCB** - Central Pollution Control Board
- **NDMA** - National Disaster Managment Authority
- **NDRF -** National Disaster Response Force
- **DGFASLI** - Directorate General Factory Advice and Labour Institutes
- **CLI** - Central Labour Institute ,Mumbai,
- **DAE -** Department of Atomic Energy
- **RLI** - Regional Labour Institutes
- **CFEES** - Centre for Fire, Explosive and Environment Safety
- **DOCP** - Department of Chemicals and Petrochemicals
- **PESO** - Petroleum and Explosives Safety Organization

The other associated research institutes and organisations working in the field of chemical emergencies include - Defence R&D Establishment (DRDE) which is the nodal laboratories of Defence Research & Development Organization (DRDO) for providing technological solutions for chemical and biological defence, and National institute of disaster management (NIDM),Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad; Indian Institute of Toxicology Research (CSR-IITR), Luknow, National Environmental Engineering Research Institute (CSIR-NEERI), Nagpur; National Chemical Laboratory (NCL), Pune and National Institute of Occupational Health (NIOH), Ahmedabad, which work in the field of occupational hazard and safety. Limited facilities for the collection of environmental toxicants, released during a chemical disaster also exist in the Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR).

Following departments are responsible for the chemical disaster management at the state Level,

1. Department of Labour - DISH
2. Department of Health
3. Department of Environment - State Pollution Control Board(SPCB) and Pollution Control committees (PCC).
4. Department of Revenue and Disaster Management

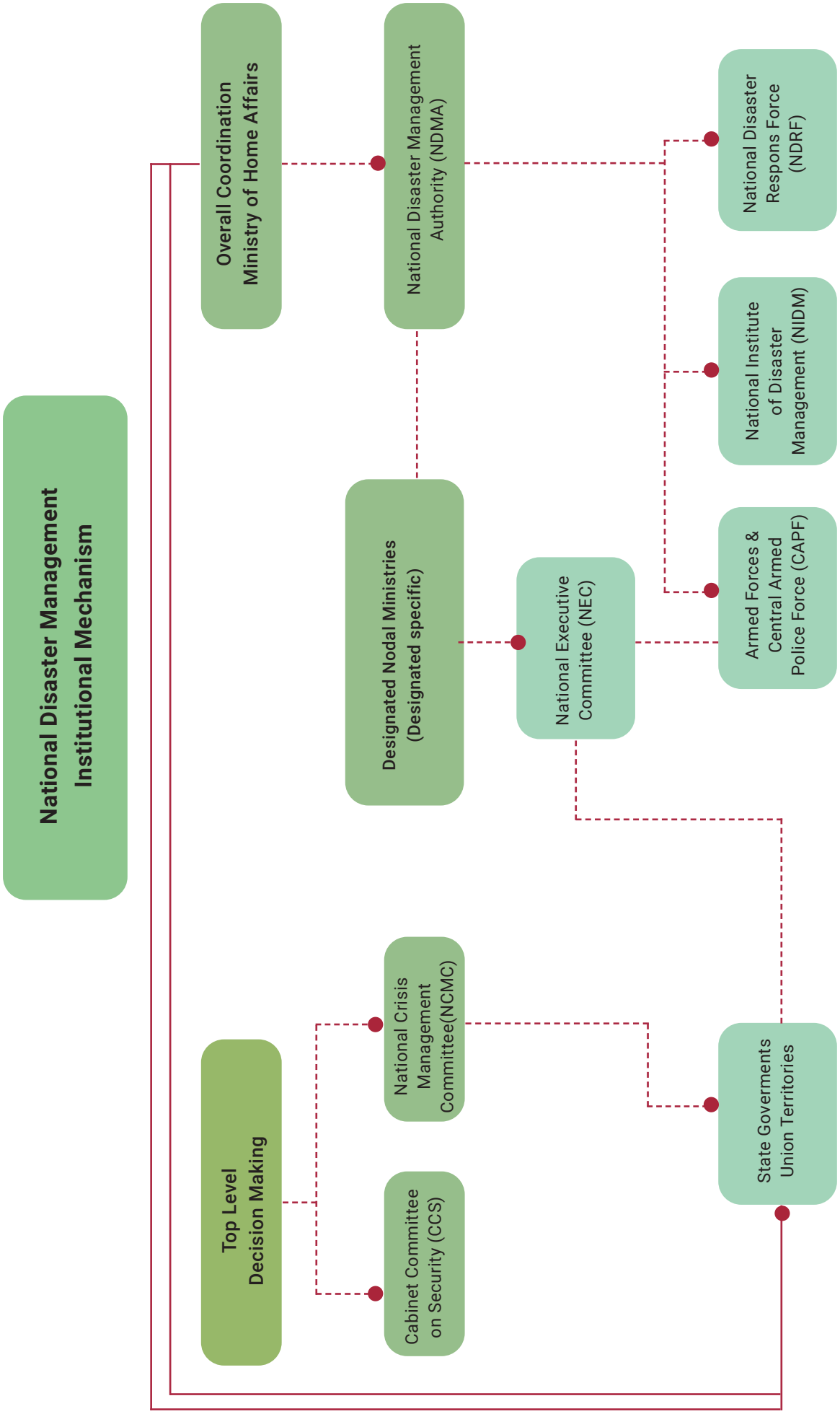


Fig.10 : Components in Chemical Disaster Management

* Adapted from NDMA guidelines on chemical disasters

3.1.1 National Disaster Management Institutional Mechanism

- Ministry of Home Affairs is the responsible Ministry for overall coordination of disaster management in the country. There are nodal ministry identified for various disasters, for example, Ministry of Environment & Forests for Chemical Disasters, Ministry of Health and Family Welfare for Biological disasters, Ministry of Atomic Energy for Nuclear Disasters, Ministry of Railways for Rail accidents, etc. Ministry of Agriculture now looks after Drought.

- For chemical disaster management in our country, many ministries are involved – Ministry of Environment and Forests, Ministry of Labour & Employment, Ministry of Agriculture, Ministry of Petroleum and Natural Gas, Ministry of Commerce and Industry, Economic Affairs & Finance, Ministry of Road Transport & Highways takes care of the aspects related to accidents during road transport of chemicals.

- There is a National Crisis Management Committee that meets at the time of a calamity but not in the pre-disaster stage. At the time of a calamity of national scale, crisis management committee under the chairmanship of the Cabinet Secretary gives policy directions and guidelines for the crisis management group where the national and international efforts are required.

- Crisis management Group at the Ministry of Home Affairs reviews the situation in Inter-ministerial meeting to coordinate various emergency support functions to the affected areas. Union Cabinet can set up the task force or committee for effective coordinate of the relief measures.

- The National Disaster Management Authority has been constituted under the Chairmanship of the Prime Minister of India. There are nine members in the authority. NDMA's role is to lay down the guidelines and plans for disaster management, development of guidelines of minimum standards of relief, providing guidelines to the state governments and relevant central ministries.

- Training and education are given significant focus and a number of workshops, training and awareness initiatives have been undertaken by NDMA and NIDM.

- It is important to note that the roles and responsibilities of these stakeholders may vary depending on the specific circumstances of the emergency and the laws and regulations in place in the affected area.(Fig. X)

3.1.2 State Level Disaster Management Coordination Mechanism

- Similarly there is a mechanism at the state level where the crisis management committee under the Chief Secretary, responsible for the emergency management at state level. This committee comprises of the state departments officers with representative of central government organisations.

- State Department of Relief has now been changed to Department of Disaster Management and will be the nodal department coordinating the relief operations and disaster preparedness at the state level. It is also proposed to rename Relief Commisioners as Disaster Management Commissioners.

- State Disaster Management Authority (SDMA) has the functions at states similar to NDMA has at national level and is chaired by Chief Minister.It provides guidelines to the state departments and the Districts.

- District Disaster Management Authority(DDMA) is chaired by the District Collector or the District Magistrate. DDMA is responsible for formulation of District Disaster Management Plan. In some states like Gujarat and Odisha the Disaster Management Authority was formed prior to the National Disaster Management Authority. So, in those states now also the chairperson in not the Chief Minister but the Relief Commissioner. This is because these authorities were formed before the enactment of the Disaster Management Act.

- Odisha Disaster Management Authority (OSDMA) was formed in 2000 and Gujarat Disaster Management Authority (GSDMA) was formed in 2001. Disaster Management Act provides the constitution of a Disaster Response Fund and now a Disaster Mitigation Fund.

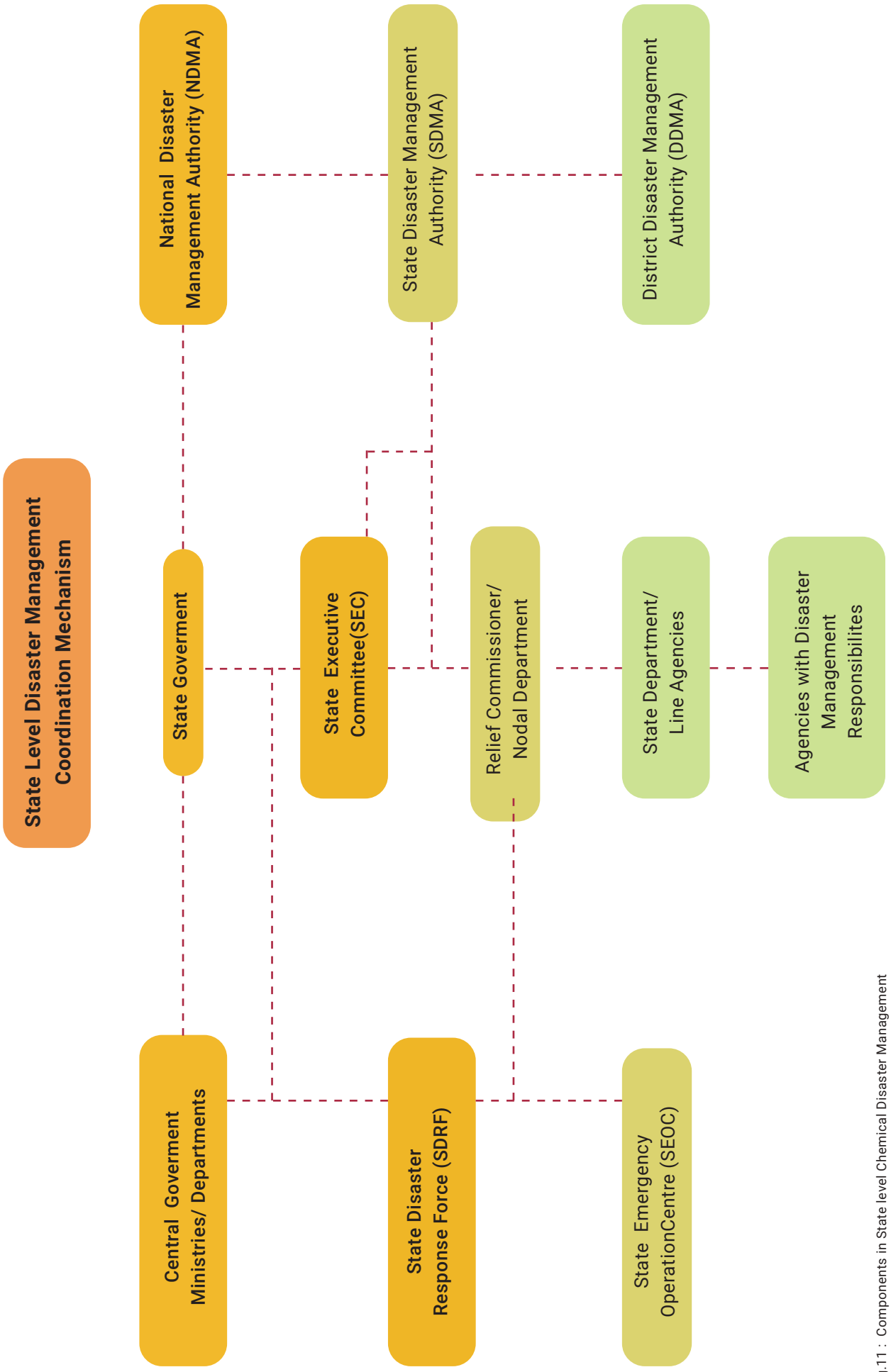


Fig.11 : Components in State level Chemical Disaster Management

* Adapted from NDMA guidlines on chemical disasters

3.2 Crisis Groups

Crisis groups are constituted at the Central, State, District and local (industrial areas) levels. They act as bodies at their respective levels, to deal with chemical accidents and provide expert guidance for handling major chemical accidents.

The Central Crisis Group shall be the apex body at Central level and its functions include

- Continuously monitor the post-accident situation arising out of a major chemical accident and suggest measures for prevention and to check recurrence of such accidents.
- Conduct post-accident analysis of such major chemical accidents and evaluate responses;
- Review district off-site emergency plans with a view to examine its adequacy in accordance with the Manufacture, Storage and Import of Hazardous Chemicals Rules, and suggest measures to reduce risks in the Industrial pockets;
- Review the progress reports submitted by the State Crisis Groups;
- Respond to queries addressed to it by the State Crisis Groups and the District Crisis Groups;
- Publish a State-wise list of experts and officials who are concerned with the handling of chemical accidents;
- Render, in the event of a chemical accident in a State, all financial and infrastructural help as may be necessary.

3.3 Directorate of Industrial Safety and Health (DISH) Centres

- The (DISH) in India is pivotal in safeguarding the health, safety, leave with wages ,work-environment, and working hours and welfare of workers across various sectors. It undertakes the enforcement of labour laws within industrial settings and construction sites, ensuring adherence to the Factories Act, the Building and other Construction Workers Act, and related labor legislations. DISH's primary focus is to foster safe working environments through regular inspections and by classifying factories into high, medium, or low risk categories, based on criteria such as the manufacturing process and workforce size.,etc.
- DISH from all the states are the members of Technical Committee on Explosives.
- Factories are assigned a risk category by DISH: high-risk for those with significant accident hazards or dangerous operations usually involving over 100 workers; medium-risk for those with hazardous operations or processes with up to 100 workers, and non-hazardous factories employing over 250 workers; and low-risk for non-hazardous factories not engaged in dangerous operations and having fewer than 250 workers.
- Additionally, DISH plays a role in labor welfare through initiatives like the Labour Welfare Fund, which supports activities for employee welfare including social education, vocational training, and recreational programs.
- Overall, DISH is essential in upholding a safe and healthy work environment in India's industrial and construction sectors by enforcing legal standards, conducting inspections, and promoting worker welfare.

3.4 Agencies in the Preparedness, Surveillance & Response to chemical emergencies

3.4.1. National Disaster Management Authority (NDMA)

NDMA has the responsibility for laying down the policies, plans and guidelines for disaster management including chemical disasters for ensuring timely and effective response in the country.NDMA provides directions to ministries, departments and state authorities for the preparation of their detailed disaster management plans and calls for a proactive, participatory, multi-disciplinary and multi-sectoral approach at various levels for chemical disaster preparedness and response.

3.4.2. National Disaster Response Force(NDRF)

It is a specialized force trained to handle various types of disasters, including chemical emergencies, and they are equipped with the necessary expertise, equipment, and resources to effectively respond to such situations.

- **Emergency Response:** They assess the situation, implement safety measures, and initiate rescue operations to protect affected individuals and mitigate the impact of the chemical incident.
- **Containment and Mitigation:** They have specialized knowledge in handling hazardous substances, implementing control measures, and mitigating the risks associated with chemical emergencies.
- **Evacuation and Rescue:** They conduct rescue operations, provide medical assistance to those injured or exposed to hazardous chemicals, and ensure their well-being during the evacuation process.
- **Decontamination:** They establish decontamination zones and follow protocols to ensure the safe removal of hazardous substances from affected individuals, equipment, and the environment.
- **Coordination and Support:** They provide support, technical expertise, and guidance to local agencies involved in the management of such incidents.

3.4.3. National Centre for Disease Control(NCDC)

NCDC is the premier organisation involved Public health activities in the country .NCDC is the International Health regulations (IHR)secretariat in the country and chemical emergencies including transboundary movement of chemicals are major risk to public health. NCDC has been assigned the job of carrying out trainings in chemical hazards prevention and it cooperates with pertinent central and state agencies in the creation of standards, guidelines, and standard operating procedures (SOPs) for chemical disaster management

3.4.4. Other agencies involved in the chemical emergencies management

- **Medical Health and safety agencies:** They are responsible for providing medical treatment to those affected by the emergency, like civil hospital, nearest health facility, specialty hospitals/designated hospitals. They are responsible for ensuring the safety and health of workers during the emergency response.
- **Public health agencies:** Agencies such as the National Centre for Disease Control (NCDC) and local health departments shall monitor and conduct investigations into the health effects of the emergency.
- **Chemical Industries:** Chemical Industries are responsible for cooperating with emergency response teams and providing information about the chemicals involved in the emergency, as well as for taking steps to prevent similar emergencies in the future. (both Big and Small)
- **Media:** The media is responsible for reporting on the emergency, providing accurate information to the public, and serving as a source of information for the public during the emergency.
- **Storage and Transportation Companies:** crucial role in ensuring the safe handling and transport of hazardous materials. They should follow best practices and comply with regulations and contribute to protecting public safety, minimizing environmental impacts, and supporting effective emergency response

3.5 Role of RRT and Surveillance Officers

The role of Rapid Response Teams (RRTs) and Surveillance Officers is critical in the effective management of chemical emergencies.

Rapid Response Teams (RRTs) are specialized teams that are trained to respond quickly and effectively to chemical emergencies. Their main role is to provide immediate assistance to affected people, contain the spread of the hazardous substance, and prevent further damage to the environment. RRTs typically consist of emergency responders, medical professionals, and hazardous materials specialists, who work together to provide a coordinated response to chemical emergencies. Some of their specific tasks include: Assessing the situation: RRTs are responsible for assessing the situation and determining the level of risk to human health and the environment.

- Containing the hazardous substance: RRTs work to contain the hazardous substance and prevent it from spreading to other areas.
- Evacuating affected people: RRTs are responsible for evacuating people who have been exposed to the hazardous substance and transporting them to medical facilities for treatment.
- Providing medical assistance: RRTs work to provide medical assistance to affected people, including administering first aid, providing oxygen, and treating injuries.
- Decontaminating affected areas: RRTs are responsible for decontaminating affected areas and ensuring that the hazardous substance is properly disposed of.

Surveillance Officers are also critical in the management of chemical emergencies. They play a key role in monitoring and identifying any potential health effects associated with exposure to hazardous substances. Some of their specific tasks include:

- **Monitoring affected areas:** Surveillance Officers monitor affected areas for any potential health effects associated with exposure to hazardous substances.
- **Conducting epidemiological investigations:** Surveillance Officers conduct epidemiological investigations to identify the source of exposure and determine the extent of the outbreak.
- **Collecting and analyzing data:** Surveillance Officers collect and analyze data on the number of cases and the severity of symptoms associated with exposure to hazardous substances.
- **Providing recommendations:** Surveillance Officers provide recommendations to emergency response teams

Massive Fire Breaks Out at Govt Hospital in Amritsar, 2022

Indian rescue personnels work at the site of an explosion at a chemical factory in Dombivli, Mumbai, 2024

"The first step in any kind of disaster management is always to be prepared"

SURVEILLANCE & MONITORING

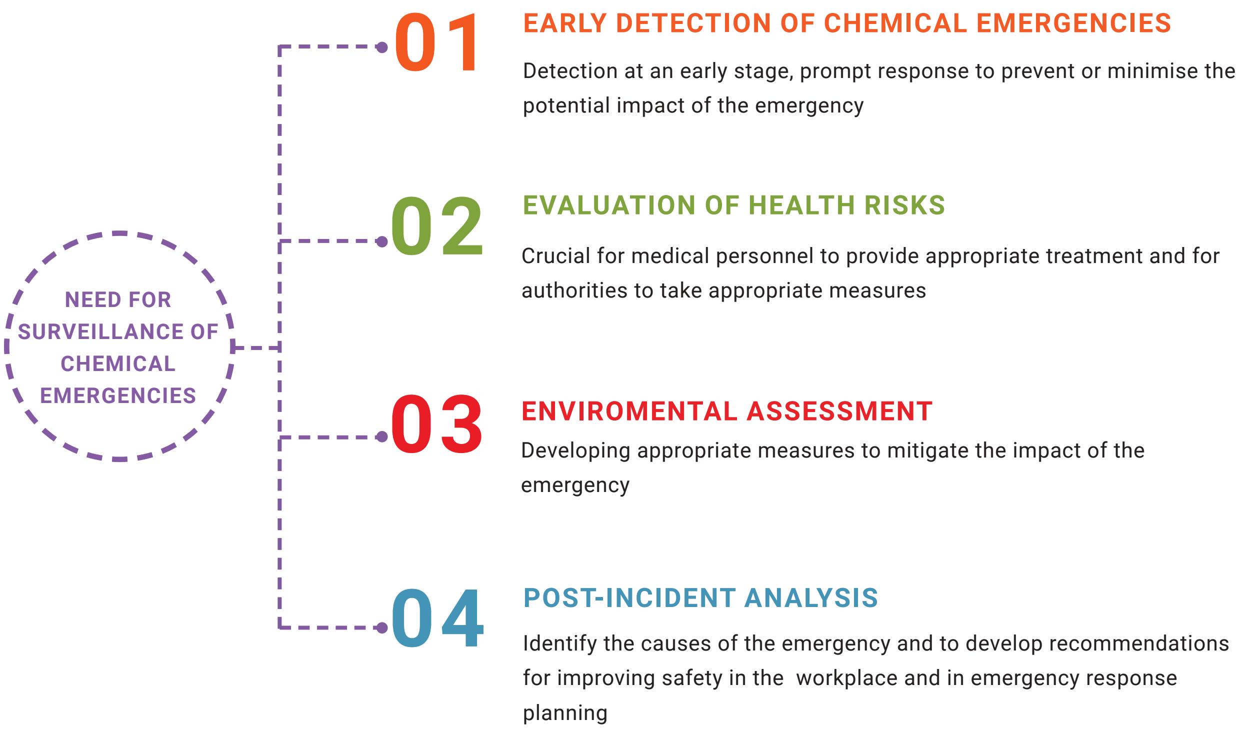
By the end of this chapter, you will be able to understand:

1. What is the need for surveillance and monitoring of chemical emergencies
2. Stages of Surveillance and reporting in IHIP
3. What is the surveillance mechanism at point of entries

4.1 Need for Surveillance and Monitoring

Surveillance is a crucial public health measure to be undertaken for raising timely alerts and early warnings. While infectious disease surveillance is well-established in India through the Integrated Disease Surveillance Programme (IDSP), chemical surveillance remains underdeveloped. Currently no mechanism for medical surveillance exists for identifying or alerting for cases with plausible chemical exposure as also highlighted in the NDMA(National Disaster Management Authority)guidelines on chemical disaster. Hence a surveillance mechanism to generate timely early warning signals for chemical incidents was perceived by integrating it into the existing IDSP program and developing mechanisms for reporting through IHIP portal. This chapter presents a structured approach to establish chemical surveillance by adapting methodologies from disease surveillance, focusing on early detection, data integration, and rapid response to chemical incidents. Chemical surveillance plays a critical role in identifying, assessing, and mitigating health risks related to chemical exposure in the population.

According to WHO, surveillance is a continuous, systematic collection, analysis and interpretation of health-related data. The data collected through surveillance serves as an early warning system for chemical incidents that could become a public health emergency. It enables monitoring and evaluation of the impact of an intervention, helps track progress towards specified goals; and monitors and clarifies the epidemiology of health problems, guiding priority-setting and planning and evaluation public health policy and strategies. An effective surveillance is essential to detect chemical incidents before it spreads, affecting more people, cost lives and become difficult to control. Chemical incidents may have both acute and chronic effects on health, environment, livestock and wildlife. The harm may be individual or, in the case of a chemical incident, may affect a few people, communities or even large populations, and the consequent human and economic costs may be considerable. In addition, chemicals may be deliberately released by disaffected individuals or terrorists and result in large-scale chemical incidents. The chemicals released may be toxic industrial chemicals and chemical warfare agents, such as organophosphate nerve agents and sulfur mustard. The other causes of chemical incidents are explosion, fire/ leak resulting in the release of an airborne plume, taining and polluting water or depositing particles on land. Timely identification of the cause requires detection and verification of clusters and a subsequent outbreak investigation.



Defining terms and establishing thresholds for alerts are essential to chemical surveillance, enabling health workers to recognize and act on potential incidents. Before proceeding let us understand some common terminologies:

1. Cluster: An unusual aggregation, real or perceived, of health events that are grouped together in time and place and that is reported to a public health department. This may suggest exposure to a chemical agent
2. Outbreak: The occurrence of cases exceeding normal levels for a given region and timeframe, prompting further investigation. The number of cases varies according to the disease-causing agent, and the size and type of previous and existing exposure to the agent.
3. Syndrome Description: The sudden occurrence of unusual events, in a geographical region, causing death or hospitalization and which does not conform with the standard case/ syndrome definitions under the existing surveillance mechanisms. Some of the symptoms may be: Convulsions. Alteration in consciousness, Breathing Difficulty, Bleeding, Paralysis and Others. The trigger here is two cases of death or hospitalisation due to an unusual symptom.

Even if a cluster is confirmed as being an outbreak and it is apparent that it is non-infectious like exposure to chemical substances, it may be difficult to establish the cause. Hence extensive investigation may be required to determine whether the outbreak is indeed due to exposure to an environmental hazard, such as a chemical substance, radiation, the physical environment or food or water contamination or adulteration.

Chemical Surveillance Scenarios:

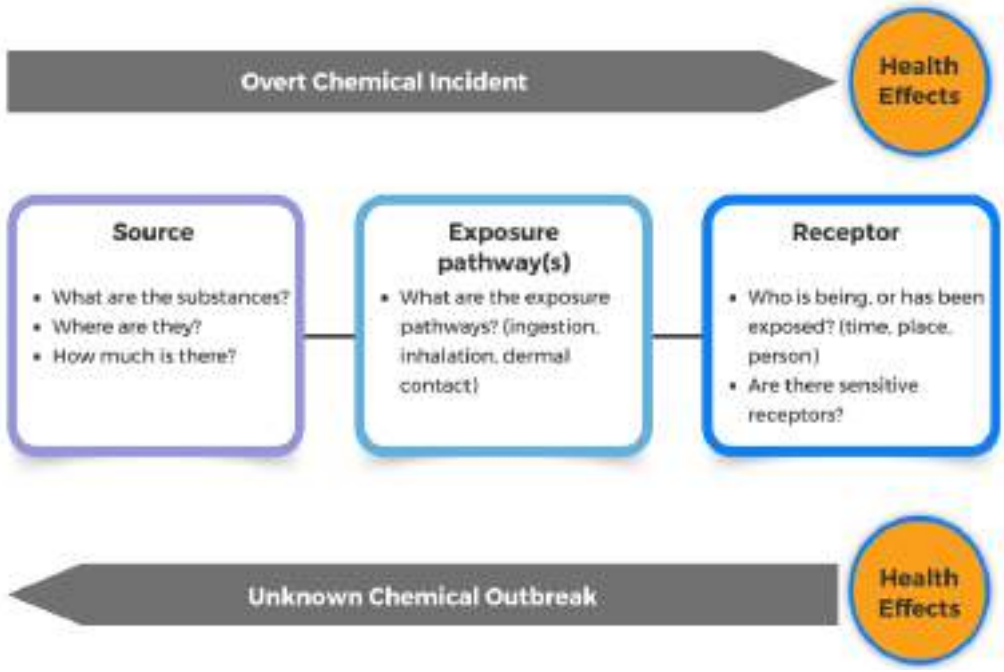
Surveillance for chemical incidents may occur under two primary scenarios, each requiring distinct methodologies and investigation strategies. The chart below shows the pathways of investigation in the given two scenarios.

Scenario 1: Overt Chemical Outbreaks

In this case the source of the outbreak is known to be a chemical including its location and quantity. The surveillance in this case follows from known source to exploring exposure pathway to understanding of the receptors who are exposed to it and its health impacts. In such case its important to confirm the source with available facts and implement control measures as soon as possible to reduce the impact of the chemical incident.

Scenario 2: Unknown chemical Outbreak

In this case the source of cases is not known, and the investigations goes retrospectively wherein the health impacts are seen and thorough investigation is required to assess the exposure pathways and confirm the source of outbreak.



Surveillance Methodologies for Chemical Exposure

Chemical surveillance can adopt disease surveillance methodologies, such as indicator-based and event-based surveillance, each tailored to detect chemical incidents. This is in lines with the types of surveillance that currently is supported under IDSP through Integrated Health Information Platform (IHIP) portal. Currently following types of surveillance is undertaken through IDSP which can be applied to chemical incidents as well.

Routine surveillance:
a. Indicator based – weekly reporting of aggregate data collected based on standard case definitions through standardised formats.

- Syndromic – (done by Multipurpose Health Worker (MPHW)/ Accredited Social Health Activist (ASHA)- Diagnosis made on the basis of clinical pattern by paramedical personnel and members of the community. (Indicator - Unusual symptoms leading to death or hospitalization that do not fit into above)
- Presumptive – (done by MOs at PHC, CHC, medical colleges, sentinel hospitals) Diagnosis made on typical history and clinical examination by Medical Officers and presumptive lab tests (D/s under presumptive surveillance – indicator - Unusual Syndromes (NOT Captured Above); D/s under lab surveillance – indicator – any other)
- Lab Confirmed – Clinical diagnosis confirmed by an appropriate confirmatory laboratory test

b. Event based surveillance – events detected through informal sources like Community informants, media, rumors etc whenever required.

Outbreak Surveillance
Weekly reporting of outbreaks based on analysis of information gathered through indicator and event based surveillance.

Special Surveillance:
For e.g. Mass Gathering, Public Health Emergency of International Concern (PHEIC)s or Post Disaster (Discussed in detailed in separate module)

4.2 Stages of Surveillance and Reporting in IHIP

Stage1: Detecting, Alerting and Reporting

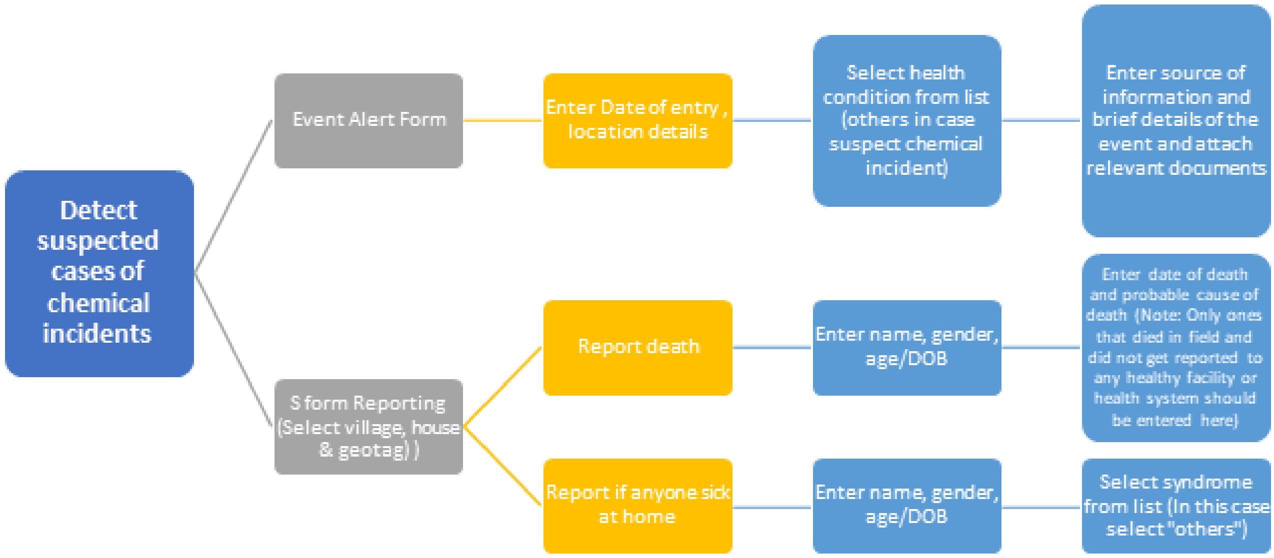
Objective: Rapidly detect cluster of cases possibly caused by Chemical(s) and to notify public health authorities in a timely manner

This includes detection of a signal, data analysis, verification, and reporting. In India, under the Integrated Disease Surveillance Programme (IDSP) surveillance activities are undertaken for epidemic prone diseases which consists of weekly surveillance data collected by reporting units which include Subcentres , PHC, CHC, government and private sector hospitals and medical colleges. These data are further analyzed by State Surveillance Unit(SSU)/ District Surveillance Unit (DSU) to identify the rising trends of illnesses. If an outbreak is confirmed, the DSU/ SSU further initiates outbreak investigation by forming the RRTs to diagnose and control the outbreak. Similar can be conducted in case of suspected outbreaks of illnesses of possible chemical etiology.

The stage 1 deals with rapid detection of cluster of cases and flagging it to the higher authorities. It can be done through the routine surveillance of “S form” and “P form” or through event alert generation in case of information received from other sources.

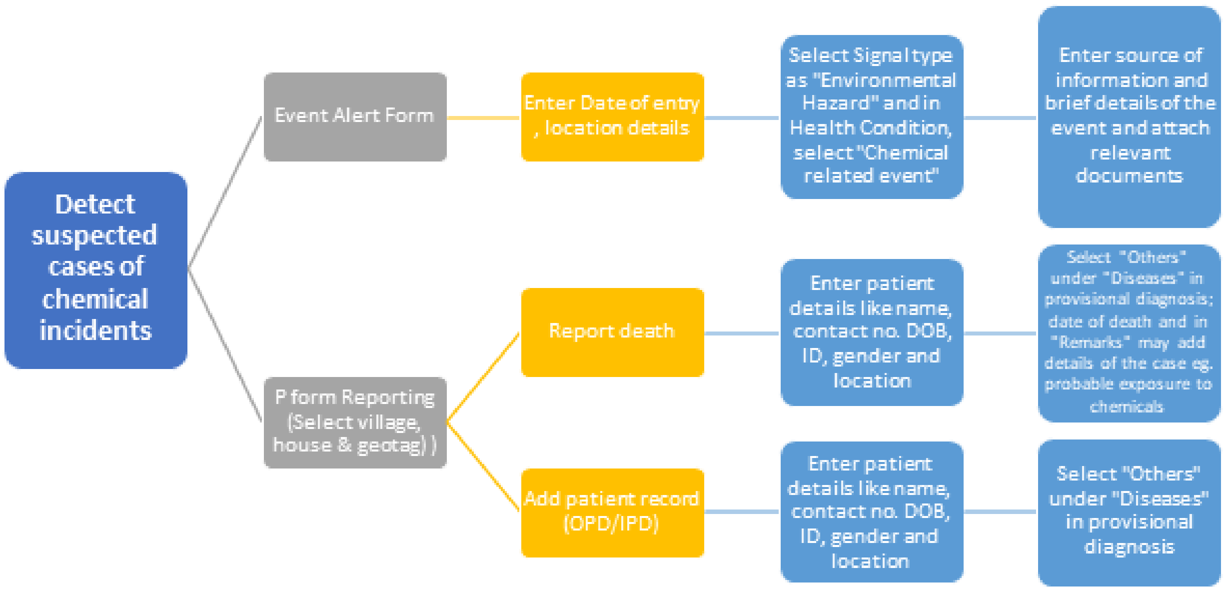
Reporting mechanism on IHIP:

S form reporting: A syndromic surveillance mechanism and event alert happens at the level of health worker. The Syndromic surveillance is done through S form reporting to report anyone suffering from any syndrome under surveillance or to report death. In case of chemical incidents, many times it happens that the workers are not able to confirm that the syndrome is caused due to chemical exposure as it can be too nonspecific and difficult to distinguish from other causes. Hence in order to ensure that even such cases get reported the health workers can select report even suspicious chemical incidents by reporting it through the S form under “Others” section.



Reporting mechanisms through IHIP mobile application at the level of health worker

P form reporting: The case based surveillance mechanism is done through P form reporting which is done by the facility level users like the medical officers at PHC, CHC, DH, SDH. In case of a suspected exposure to chemical incident a detailed clinical examination is done by the medical officers and they can report these cases through IHIP portal by filling the presumptive cases form. The health facility user has to enter the basic patient details and further enter the provisional diagnosis by selecting “others” under the “Diseases” section.



Reporting mechanisms through IHIP portal at the level of health facility user

Event Alert form: Any user of any health facility (except the Lab user) can flag an event through “Event Alert Form”. Here we will take the example of P form user (Medical Officer or IDSP Nodal Officer of the Health Facility) raising the event alert. Similarly, Health Workers can also raise an Event Alert using IHIP mobile app, District/ State/National level user can also raise an Event Alert using Event Alert form using their respective user account on IHIP-IDSP web portal.

Stage 2: Information gathering and evaluation.

Objective: To review the evidence and verify or refute the presence of an outbreak

Once an event gets alerted from the field level or facility level, the DSU/SSU needs to analyse and verify the evidence and confirm if it's an outbreak. The additional information may be obtained from formal and informal sources which may include community reporting, OPD data, emergency department or laboratory data, reports of suspected or actual chemical release or episode of environmental pollution. These data need to be thoroughly reviewed to verify its accuracy and relevancy to assess the existence of an outbreak.

Verifying that a reported cluster does indeed constitute an outbreak requires assessment of community, epidemiological, environmental, clinical, and toxicological information regarding the current situation in the affected area or population. Consequently, it may require access to routine data from primary care centers, hospital departments and laboratories, as well as environmental agencies. Information from many different sources should be cross-referenced, corroborated, and continually reviewed in order to determine its veracity and its value in guiding decisions on the next steps. Such information will help in answering various questions for verifying an outbreak as given below:

Box 1. Verify whether reported cases constitute an outbreak

- Has the reported cluster been corroborated by other sources?
- Are the reported cases linked in space and time?
- Do reported cases have the same clinical presentation, or can some be explained by another etiology?
- Is the baseline number of reported cases known?
- Has the number of cases increased above baseline?

Whether a particular event requires detailed outbreak investigations will be decided by DSO based on the local epidemiology or guidelines for initiating outbreak investigation.

Stage 3: Preliminary Investigation of etiology

Objective: To ascertain the likely cause(s) of the outbreak in a preliminary assessment and exclude scenarios that are improbable or implausible.

Once the event is alerted by the health facility user/ field staff, the DSO confirms if it's an outbreak and will also have to verify from the information received whether the outbreak is due to a potential chemical cause. For this the DSO collects further information from the MO (clinical and toxicological information), factory health officer (if the cases are epidemiologically linked to exposure to chemicals from a particular factory/industry) and also collects information regarding suspected or actual chemical release or episode of environmental pollution (Refer Annexure 2: examples of sources of environmental contamination).

Box 2. Further information required to determine the potential etiology of an outbreak

- Demographic
  - Age, sex, ethnicity, location, occupation
- Clinical
  - Signs and symptoms and their evolution (may provide clinical clues, e.g. toxidromes)
  - Time course of illness (dates of onset and recovery)
  - Severity of illness (consultation for primary care, hospital admission, death)
  - Laboratory tests undertaken
- Epidemiological
  - Numbers of affected and unaffected people, characteristics of affected people (differences and similarities with the unaffected population)
  - Period (epidemic curve)
  - Geographical area affected
  - Specific epidemiological clues (e.g. family clusters, occupational clusters, consumption of a common food or drink)
- Environmental
  - Chemicals used near the outbreak location, presence of industrial sites and other industrial activities, waste or landfill sites, evidence of contamination of air, water, soil or food

Refer annexure 4 for epidemiological clue, its interpretation that strongly suggest an etiology of chemical cause and preliminary investigation questions

Stage 4: Field Investigation / Outbreak investigation

Objective: To verify that an outbreak is due to exposure of a community to a chemical hazard and to determine the magnitude of the event.

The outbreak investigation will reflect the principal findings of stage 1 to 3 focusing on identifying obvious sources of contamination at specific sites or locations, confirming sources and environmental pathways of receptor exposure, establishing case definitions, actively seeking cases, and confirming clinical diagnoses through laboratory verification if applicable. It aims to assess the population at risk and likely causative agents through thorough epidemiological and environmental investigations, evaluate any ongoing public health risks associated with chemical exposure, and identify necessary immediate interventions along the source–pathway–receptor linkage to protect public health. Furthermore, the investigation will involve coordination with national and, if relevant, international agencies for effective response and communication with professional organizations, the media, and the public as needed

Reporting mechanism on IHIP: Responding to Event Alert
Once the DSO/ SSO confirms an event to be an outbreak with likely cause as chemical, he/ she initiates outbreak/ field investigation similar to any disease outbreak investigation. The DSO/ SSO can view the alert in outbreaks section under the event alert section. The DSO will have the "Update Action" button next to the newly generated event alert which is visible only to DSO. After clicking on "update action", a window pops up which displays the event ID , message, date of event, source of information. Further the DSO user needs to fill in the "Preliminary information" as obtained form stage 3. The DSO has to further confirm if an outbreak investigation is required. As soon as DSO selects "Yes" under "Outbreak Investigation Required", 2 more parts [RRT Details and Facility Covered] will appear and Outbreak ID will be generated having same number as "Event Alert" but ending as "O" instead of "EA". Further the DSO has to select "Others" under "Health condition" and constitute a rapid response team (RRT) to undertake the outbreak investigation at field level. DSO can select the RRT members with their date of deployment (they will receive the SMS). With "+" sign, DSO can select as many RRT members as required. DSO selects Health Facilities, the areas of which seem to be affected based on preliminary investigation. With "+" sign, multiple health facilities can be selected. When DSO clicks on "Submit" button, the select RRT members will receive an SMS for the deployment in the concerned outbreak.

RRT composition:
RRT composition has to be a multidisciplinary team in case of a potential chemical outbreak. It is suggested that the team should comprise of an epidemiologist, a clinician, a microbiologist, a veterinarian, experts in food safety or environment or entomologist etc. depending on the type of outbreak and field level health staff to assist the team in the community. In case of probable chemical outbreak, it can also include experts from clinical toxicology, behavioral science, engineering, environmental health, geology , health and safety, hydrology (in case of water contamination), occupational medicine and risk communication.

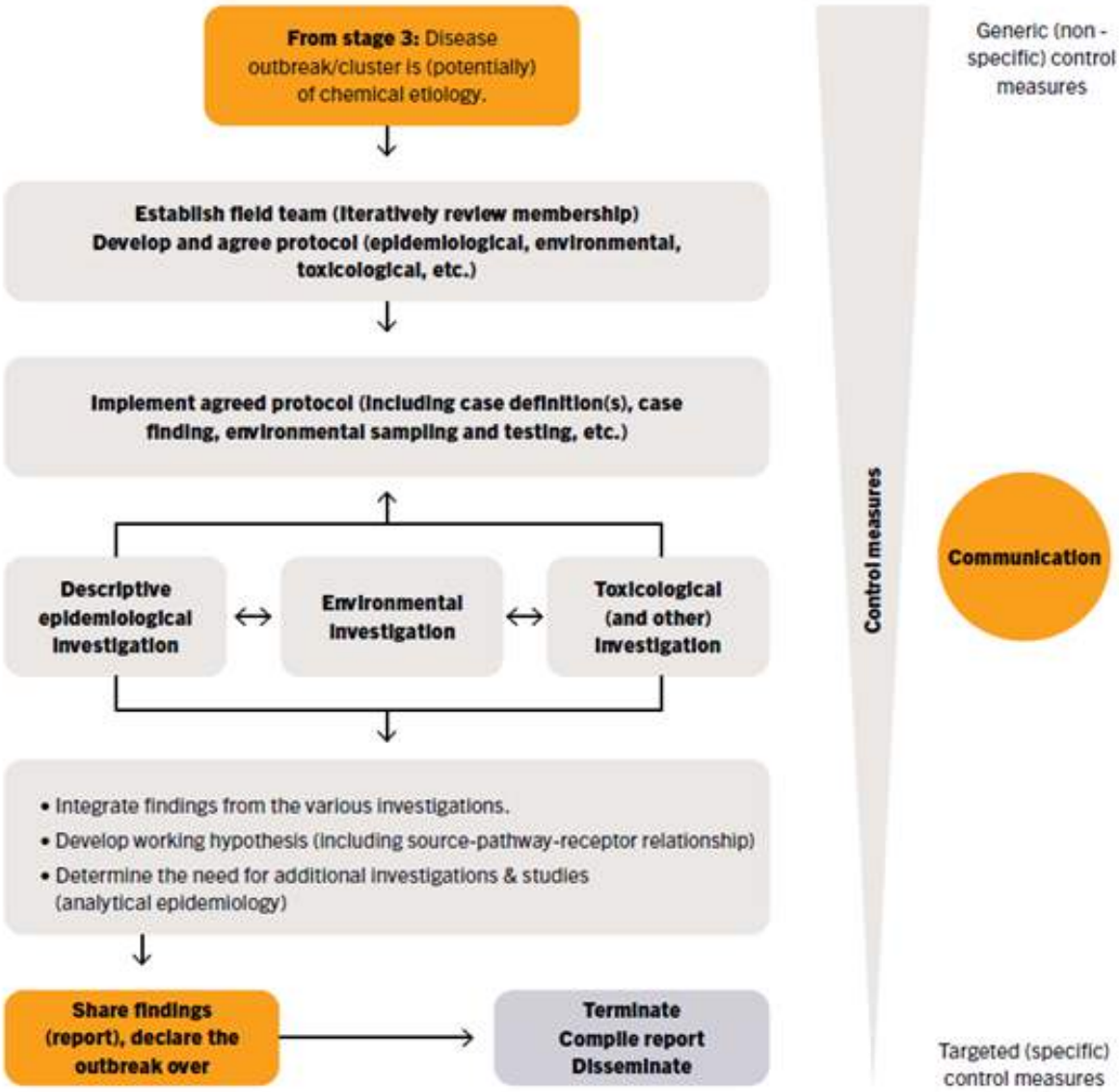
Case Definitions
Case definitions may comprise various combinations of clinical, environmental, laboratory and epidemiological criteria:

- Clinical presentation of agreed signs, symptoms and toxidromes;
- Laboratory analyses (when available or appropriate) of biomarkers of exposure and of effect;
- Chronology: the period during which identified cases can be considered part of the outbreak;
- Geography: residence in a potentially exposed area; and
- Demographics: inclusion of those most likely to be affected, e.g. by age group, occupation or gender

Cases may be classified as "suspected or possible", "probable" or "confirmed" according to the certainty of the diagnosis:

- Suspected case: person presenting with clinical features consistent with the outbreak and considered for laboratory or other diagnostic investigation
- Probable case: person presenting with clinical features consistent with the outbreak and resident in the affected area during the defined period, or person presenting with the clinical features of concern and epidemiological links to an analytically confirmed case
- Confirmed case: person presenting with clinical features consistent with the outbreak, resident in the affected area during the defined period and with laboratory or diagnostic confirmation.

Key components of field investigation:



Reporting mechanism on IHIP: Updating data of Outbreak Investigation

Once the DSO has flagged that the outbreak investigation is required then the RRT Members will go to the areas of the Health Facilities along with other staff of the health facility and will investigate the outbreak. The Health Facility (P form) user or RRT user can further update the information by navigating to “Outbreak” menu page and click a particular Outbreak ID under “EWS Outbreak Summary” to open the “Action Update” page. The upper part of this page contains basic details of the Outbreak including Preliminary Information, Details of the RRT Members selected, RRT Update. RRT Members can update their comments under RRT Update.

The lower part of “Action Update” having space for entering and seeing the Line Listing of Cases/Deaths reported under the Outbreak. The Health Facility (P form) user or RRT user can add the Outbreak cases/deaths details using “Add Affected Case” which is similar to the format of entering patient data in L form user with additional data fields like symptoms, immunization status, travel history etc. This gets accumulated in the “Line listing of Case – pending submission” and after submission, it gets reflected on the “Submitted Lise list” and “list of death cases”. Once the cases stop coming and it seems that the outbreak is contained then the DSO can close the outbreak

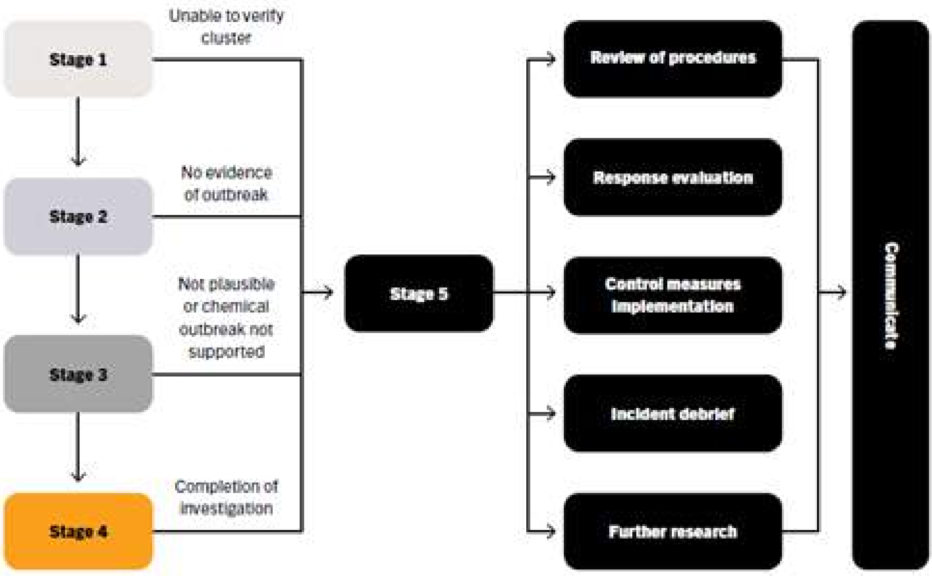
Stage 5: Completion of the investigation

Objective: To bring the investigation to a conclusion and review the outbreak response

Investigations undertaken during stages 1–3 may suggest or demonstrate that the outbreak is unlikely to be of chemical etiology, and the investigation can be concluded. In such a case, a detailed report should be written with critical analysis of the data, the conclusions drawn and recommendations, stating that a new investigation will be conducted if further evidence comes to light.

Reporting mechanism on IHIP:
When an Event Alert is converted in to Outbreak by the DSO, the Outbreak will be enlisted under EWS Outbreak Summary with the initial status of "Ongoing - Under Surveillance" with orange color background. One can click on the Outbreak ID (blue button) to see the details of the outbreak investigation as entered by the Health Facility (P form) user &/or RRT user. In the upper part of the "Action Update", one can see basic details of the outbreak, RRT Members chosen for Outbreak investigation and various comments put by RRT Members with Date. One can also click and download any document uploaded by the Health Facility (P form) user &/or RRT user in relation with the outbreak. In the lower part of the "Action Update", DSO can update IHR Risk Assessment as per IHR guidelines. If the outbreak is ongoing then one of the 2 sub statuses [Under Surveillance / Contained] can be selected.

Once the outbreak is over [i.e. no new case coming even after twice the duration of incubation period of the disease since the date of onset of last case of the outbreak], DSO can select "Completed" status. In this case, DSO will also have to select the date on which RRT completed investigation. DSO can add any important comments in "Remarks" box and can also attach any important document in relation with outbreak investigation. DSO can also view the Line-List of the Cases and Deaths. On clicking the "Save" button the details will be saved. Once the outbreak is "Completed" and the "Save" button is clicked, no changes can be made after that. When the outbreak status is selected as "Completed", the same can be seen in the EWS outbreak summary with Green color background under "Status" column.



Examples of sources of environmental contamination, pathways, exposure routes and likely human receptors

Source	Pathway (exposure route)	Receptors
Gaseous industrial emissions	Air (inhalation)	Populations downwind Susceptible individuals, including those with obstructive and restrictive airways disease
Dust from mining and grinding or particulate emissions from vehicles or industry	Air (inhalation) Deposition of dust on surfaces, clothes, food (ingestion, dermal exposure)	Workers, their families and downwind populations; commuters Susceptible individuals, including those with obstructive and restrictive airways disease
Industrial effluent	Air (inhalation of volatiles and soluble gases) Soil, water, food (ingestion; dermal contact, e.g. from bathing and washing)	Communities that receive a water supply from the polluted source; consumers of contaminated produce Susceptible individuals
Spills and leakages from containers	Water (ingestion) Soil (inhalation, ingestion and dermal contact with particles, contaminated crops and livestock) Air (inhalation of volatiles and gases)	Workers and populations living in the vicinity of the containers Communities that receive a water supply from the polluted source; consumers of contaminated produce Susceptible individuals
Deliberate or covert release of a noxious chemical(s)	Air (inhalation) Water (ingestion) Soil (inhalation, ingestion and dermal contact with particles, contaminated crops and livestock) Food (ingestion)	Communities downwind of an airborne release and people who consume contaminated water and food Susceptible individuals
Ingredients or contaminants in pharmaceuticals, food or consumer products	Food (ingestion) Water (ingestion, dermal contact) Medicines (ingestion, injection, dermal) Consumer products	People who take medicines and drugs and apply lotions and cosmetic products People who consume contaminated food Susceptible individuals

It is important to note that not all symptoms may be immediate and some symptoms may have a delayed onset, making it important to monitor symptoms and report them as soon as possible

Fig.14 : Major symptoms of chemical event

For IDSP - IHIP

Annexure 2- Step by step process of IDSP Reporting of Chemical events by users including health care workers, medical officers of healthcare facilities both private or public, administrators - Block, District, State and National, District surveillance officers , State surveillance officers, epidemiologists.

- Selecting Event Alert – Under Disease Category – Select Chemical Emergencies

Annexure 3- Community based Surveillance for IHIP-IDSP -

- In the IHIP website select the link for community reporting - fill page - attach relevant document s/images .
- Community-based surveillance is a proactive approach that involves the active participation of community members in monitoring and reporting health-related information including those involving chemical inccidents . Unlike traditional surveillance methods conducted solely by health professionals, this approach engages individuals within communities to detect, track, and report potential health threats.
- By leveraging the knowledge and observations of local residents, community-based surveillance systems can provide early warnings for chemical incidents and contribute valuable data for public health decision-making. This approach fosters a sense of ownership and responsibility among community members toward their health and well-being.
- Through the use of various tools like mobile phone, tablets or computers individuals can access the IDSP-IHIP website and can share information about unusual health event, enabling authorities to take timely actions to investigate and respond.
- Effective community-based surveillance not only enhances surveillances and response but also promotes a collaborative relationship between healthcare providers, public health agencies, and the communities they serve, ultimately leading to more resilient and healthier populations.

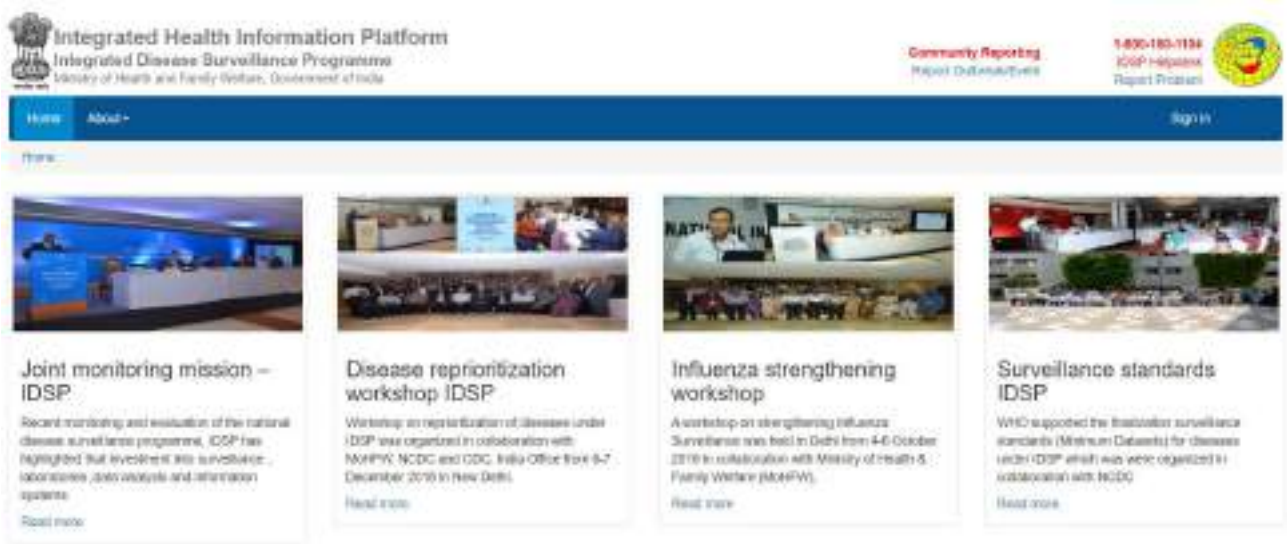


Fig.12 : IHIP Portal

The important activities envisaged under IDSP-IHIP Community Based Surveillance are:

- Active Community Participation: Community-based Disease Surveillance involves active engagement of community members in reporting outbreak-prone communicable diseases.
- Integration with IDSP: Its primary aim is to bolster the Integrated Disease Surveillance Program (IDSP) by leveraging community involvement.
- First-Line Informants: Community members serve as the initial informants, often the first to notice and report unusual illnesses within their locality.
- Reporting Mechanism: Individuals can report occurrences by completing and submitting information over internet, including their contact details for follow-up if needed.
- Evidence Submission: There's provision to submit supporting evidence, documents or images along with the report to substantiate the occurrence.
- Health Officials' Response: Concerned health officials act upon receiving reports.
  Mobile Number Verification: Users are required to provide their mobile numbers, and an OTP (OneTime Password) is necessary for submitting the information, ensuring authenticity and security of the reports

4.3 Surveillance at points of entry

Surveillance at points of entry is an important aspect of managing chemical emergencies in India. Points of entry include seaports, airports, and land borders where hazardous chemicals are imported or exported. The following are some of the ways surveillance is carried out at points of entry for chemicals in India:

- **Screening and inspection of containers:** All containers carrying hazardous chemicals are screened and inspected at the points of entry. This includes x-ray scans, physical inspections, and chemical testing to ensure that the contents are declared accurately.

- **Documentation checks:** All shipments of hazardous chemicals must have proper documentation, including safety data sheets, certificates of origin, and import/export permits. These documents are checked to ensure compliance with Indian regulations and to verify that the shipment is safe for transport.

- **Customs inspections:** Customs officials inspect all shipments of hazardous chemicals to ensure that they comply with import/export regulations and to prevent the smuggling of illegal substances.

- **Monitoring of shipments:** Once hazardous chemicals enter India, they are monitored to ensure that they are stored, handled, and transported safely. This includes regular inspections of storage facilities and transport vehicles to ensure compliance with safety regulations.

- **Coordination with other agencies:** Surveillance at points of entry involves coordination with other agencies, including the Directorate of Industrial Safety and Health (DISH), the National Disaster Management Authority (NDMA), and the Central Pollution Control Board (CPCB). These agencies work together to ensure that hazardous chemicals are managed safely and that appropriate measures are taken in the event of a chemical emergency.

Overall, surveillance at points of entry is critical for preventing chemical emergencies and ensuring that hazardous chemicals are managed safely in India. By screening and inspecting shipments, monitoring storage and transport, and coordinating with other agencies, the Indian government can help protect public health and the environment from the risks associated with hazardous chemicals.
The Chemicals movement of a country happens in large quantities as import and export at Point of Entries. They are moved in the form of Bulk, Packages, Containers, Radio nuclear, scraps. The movement of the same is greater in volume in Seaports and in small volumes through airports. The vast different varieties of the presence of Hazardous Chemicals at the same point for a period of few days to months at the same time is a very high risk factor for Chemical Accidents at Point of Entries. The chemicals are imported in ships, aircrafts or by road, rail transport in borders of a country. The 99% and above movement of cargo happens at Seaports

CASE STUDY 1 :
THE SIVAKASI FIREWORKS ACCIDENT: TAMIL NADU

The 2012 Sivakasi factory explosion in India, occurring on September 5, resulted in 40 deaths and over 70 injuries at the Om Sakthi Fireworks Industries, a facility without a valid license. The explosion transpired during chemical mixing for fireworks production, potentially exacerbated by a high ambient temperature of 69 °C (156 °F). Firefighter entry was delayed by equipment shortages, and treatment of victims was hindered by inadequate hospital facilities, with firefighting taking over five hours. The Petroleum and Explosives Safety Organization (PESO) initiated an investigation, revealing 15 major Explosives Rules 2008 violations. The cause was attributed to an inexperienced worker causing a spark while preparing fireworks, and the erratic storage of materials contributed to the explosion's magnitude. The license was subsequently canceled.
Post-incident, authorities enforced regulations, leading to the closure of 150 fireworks production units. Twelve individuals, including the factory manager, were arrested for culpable homicide, while the owner fled.

Lessons Learned:

- The results of monitoring activities, whether related to public health or the environment, should be communicated to the public and discussed with policy-makers.
- After a chemical incident, an in-depth analysis of the causes of the incident should be done in order to prevent the occurrence of similar events
- Cracked down on Illegal factories and making stringent laws to control the establishment of the high risk industries.
- Disaster management plans for High risk chemical industries.

Schoolgirls hospitalised after a gas leak from a container depot in Tughlakabad , Delhi,2017.

"Risk assessment is not about predicting the future, it's about reducing uncertainty"

RISK ASSESSMENT OF THE EVENT

By the end of this chapter, you will be able to understand:

1. Checklist required for Risk Assessment of the event.
2. What are the Tools, techniques & methodologies for rapid assessment & response
3. What is After Action Review

5.1 Checklist for risk assessment of the event

The following is a checklist for risk assessment of a chemical event:

5.2 Tools, Techniques & Methodologies for Rapid assessment & response

The chemical emergency toolkit contains materials that can quickly be modified to meet the needs of a local team performing an epidemiologic assessment, including:

- Surveys
- Consent forms
- Medical chart abstraction form
- Interviewer training manual

Surveillance and monitoring of chemical emergencies are crucial for several reasons. Some of the key reasons for the need for surveillance and monitoring in the management of chemical emergencies are shown in the figure below

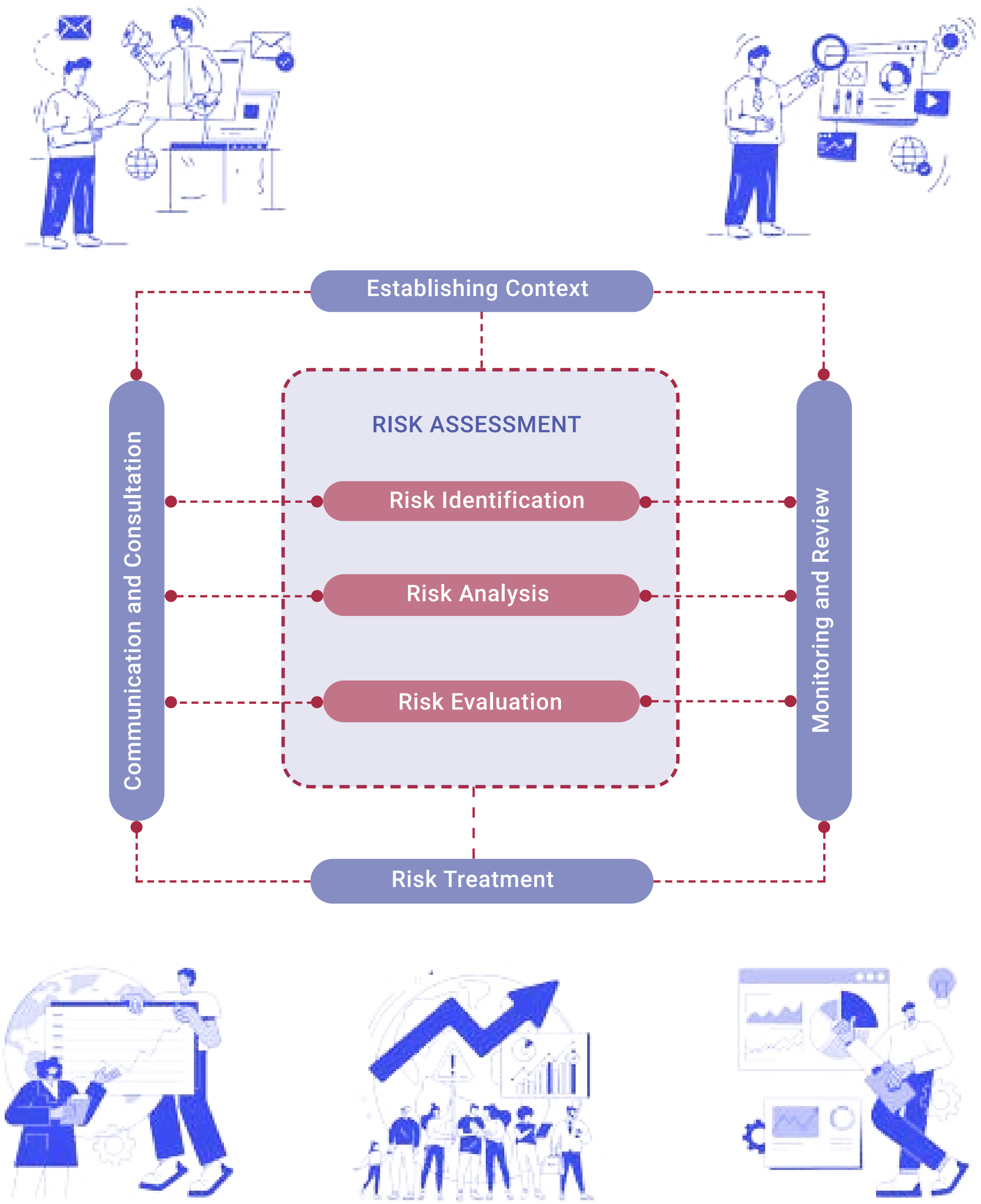


Fig.15 : Need of Risk Assessment

5.3 Steps of Chemical Emergency Investigation

A. Investigators talk with incident responders and hospital staff that treated patients to understand
- what happened
- who was exposed
- steps taken to protect public health
- communication during the response
- lessons learned during the response

B. Interview people who may have been exposed to collect detailed information on
- exposure history
- symptoms experienced
- health services used
- needs resulting from the exposure
- medical history
- how people receive information about the release

C. Collecting and analyzing clinical samples
- results are sent to participants for further treatment of the patients

Identification of vulnerable population

In any disaster the Vulnerable population is dispropotionately affected .However often the steps taken frequently neglect the unique requirements of vulnerable populations during times of disaster. Neglecting the requirements of people who are more susceptible to harm can have disastrous results. Large death tolls could befall the disadvantaged.

Vulnerable Population

- The vulnerable populations (Individuals with Disabilities, Elderly Persons, Pregnant Women, Children, Prisoners, Economically Disadvantaged Minorities, Undocumented migrants , Workers, and Individuals with Language Barriers) are most likely to die or get affected in chemical disaster.
- Members of vulnerable populations who survive could suffer permanent, debilitating injuries and become unable to work, live independently, and care for themselves. The needs of vulnerable populations should be addressed during all three phases of emergency operations i.e., pre-event planning and preparation, the event, and recovery.
- Their poor outcomes may be linked to lack of physical and emotional strength or a dearth of the social and economic resources upon which others rely during disasters. Response and recovery efforts will be optimized only if decision makers have carefully prepared for emergencies at a time when they have the leisure to contemplate options and establish responsible policies. However, planning and production of planning documents alone are not sufficient to achieve comprehensive and effective disaster readiness. Rather, at a minimum, planners must identify at-risk individuals through registries, delegate authority and responsibility to appropriate governmental officials, collect supplies, and allocate resources, among other steps.

Exposure scenario analysis (acute and long term)

Exposure scenarios (ESs) are prepared as part of a Chemical Safety Report (CSR), They are included in the substance registration dossier, as well as annexed to the Safety Data Sheet (SDS) of the hazardous substance (or the formulated product containing the substance).
The key information that an ES for communication should contain is:

- The uses and types of activities that the exposure scenario covers;
- The operational conditions (OC) and Risk Management Measures (RMM) that were assumed by the registrant when assessing the risk; and

Exposure impact assessment

Exposure assessment is "the process of estimating or measuring the magnitude, frequency, and duration of exposure to an agent, along with the number and characteristics of the population exposed. Ideally, it describes the sources, routes, pathways, and uncertainty in the assessment."
Alternatively, exposure assessments may be categorized according to exposure assessment approaches, exposure media, exposure routes, assessment tiers or types, lifestages and populations.People react differently to chemical exposures. Some people can come into contact with chemicals without harm while others maybe more sensitive and fall ill. Sometimes illness occurs only after prolonges exposure.

Many factors play a part in whether you get sick from contact with chemicals, including:

- The kind of chemical you are exposed to,
- How much of the chemical you were in contact with,
- How long the contact lasted,
- How often you were exposed,
- How it entered your body, and
- Your health.

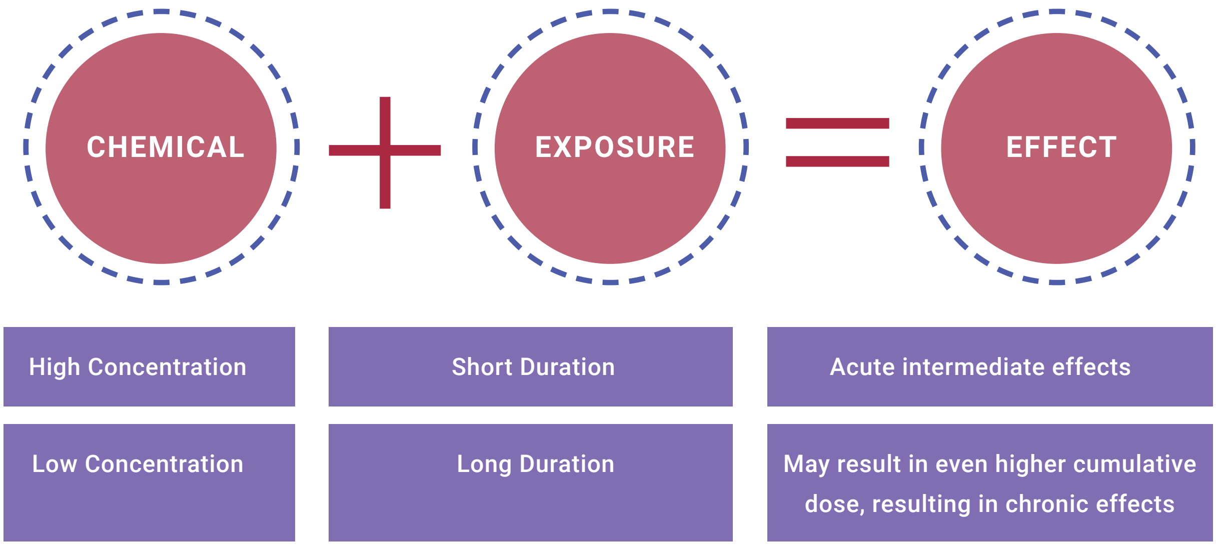


Fig.16: Factors affecting the effects following chemical exposures

Be aware of the combined effects:

- Most common situation: workers exposed to two or more chemicals.
- Challenge: the combined effects of chemicals is mostly unknown.
- Possible prevention: Avoid mixing several chemicals together. The combination may result in very dangerous effects.

5.4 After Action Review

An AAR is a qualitative review of actions taken in response to an event of public health concern including chemical emergencies. An AAR is a means of identifying and documenting best practices and challenges demonstrated by the response to the event.

An AAR seeks to identify:

- actions that need to be implemented immediately, to ensure better preparation for the next event;
- medium- and long-term actions needed to strengthen and institutionalize the necessary capabilities of the public health system.

An AAR offers participants an opportunity to translate their experiences from the response into actionable roadmaps or plans, which should then be incorporated into national planning cycles (for example, the health sector plan, the humanitarian response plan, or the national action plan for health security).

AARs should involve:

- a structured review of response activities.
- An exchange of ideas and an in-depth analysis of what happened;
- identification of what can be addressed immediately;
- identification of what can be done in longer term to improve response to the next event.

While various quantitative and qualitative evaluation methods can be used after a response, the added value of an AAR is its focus on collective learning and experience sharing, with emphasis on the knowledge of stakeholders.

AAR planning roadmap:

Objective of an AAR:

An AAR is a review of all actions taken during the response to an event. The review aims to identify capacities in place before the response, any challenges that came to light during it, the lessons identified, and any best practices observed during the response, including the development of new capacities.

There are three phases of AAR:

1. Objective observation: establish how actions were actually implemented, rather than how they would ideally have happened according to existing plans and procedures.
2. Analysis of gaps/ best practices and contributing factors: identify gaps between planning and practice; analyse what worked and what did not work, and why.
3. Identification of areas for improvement: identify actions to strengthen or improve performance and determine how to follow up on them.

When should an AAR be carried out?

AARs should be considered after a response to any event with public health significance. The ideal timing for an AAR is within three months of the official declaration of the end of the event by the concerned department/ ministries, when response stakeholders are still present and have clear memories of what happened.

The AAR approaches are more or less similar to IAR with former gives scope to deep dive into different aspects of the response pillars with three lenses viz. coordination, resources and technical aspects with specific trigger questions

Benefits of conducting AAR:

- Ensures critical thinking around the event
- Builds consensus on issues for follow-up.
- Allows documentation of lessons learned
- Allows cross-sectoral learning
- Allows advocacy for support
- Builds capacity for preparedness and response.

Team composition for AAR

The team will be composed of the people necessary to fulfil the scope, objectives and format of the planned AAR. The indicative team composition may include:

- Team Lead
- Lead Facilitator/ Interviewer
- Facilitators and interviewers
- Note Taker
- Report Writer

Structure of the final report of AAR:

The report writer should receive the notes from the note takers and begin to integrate them into a comprehensive final report. A generic report template may include:

- Executive summary
- Background on emergency under review
- Scope and objective of review
- Methods
- Findings
- Key activities
- Next steps
- Conclusions.

NDRF personnel at the site of a gas leak in Delhi's Tughlakabad,Delhi,2017.

"Preparedness is not a one-time event,it's an ongoing process"

ASSESSMENT OF PREPAREDNESS MEASURES (HR, FACILITIES, BEDS, EQUIPMENT, ANTIDOTES)

By the end of this chapter, you will be able to understand:

1. What are preparedness measures required and the checklist for the assessment

6.1 Preparedness Measures

Despite recent efforts to optimize preparedness and response to chemical emergencies, the chemical disasters keeps on getting challenging and thus, warrant urgent measures to strengthen local, state, and national preparedness. It is important to ensure the various preparedness efforts (including assessments) are grounded in risk. The various threats and hazards are simply too dynamic and it is impossible to prepare for everything equally. People, processes, and technology are constantly changing as well. Preparing for disasters is an enduring mission that requires ongoing and focused commitment, as well as some degree of ongoing financial support from the federal government to state and local governments for homeland security/ emergency management purposes, particularly if there is a desire to be able to develop, sustain, and deploy specialized response capabilities (e.g., Incident Management Teams).

One of the biggest challenges for assessing preparedness stems from the fact that preparedness means different things to different people. Additionally, how communities and organizations prepare greatly depends on what they are preparing for.

6.1.1 Assessment of Preparedness Measures to consider:

- Facility readiness, local and national chemical incident response plans (with health involvement).
- Databases on chemicals, sites, transport routes and expertise.
- Mechanism for interagency communication and public communication.
- Emergency response guidelines, including environmental protection guidelines.
- Capacity building plans- undertaking incident exercises, training, and audits.
- Capacity for chemical incident surveillance.

Public authorities should develop guidelines and standards for off-site and on-site emergency preparedness plans. They should also ensure the development, implementation, testing and updating of off-site and on-site emergency preparedness plans in coordination with relevant stakeholders.

The on-site and off-site emergency plans should give details of the technical and organizational procedures which are appropriate to reduce the effects on people, property and the environment both on-site and off-site in the event of a chemical accident.

Public authorities should give particular attention to ensure that all hazardous installations, including small and medium-sized enterprises and commercial users of hazardous substances, undertake assessments and the appropriate emergency planning. Specific assistance should be obtained, where necessary, to ensure that such enterprises and users fulfil their responsibilities in emergency planning. Emergency planning should take into account potential complicating factors which could be associated with major accidents at hazardous installations such as extreme weather conditions, natural disasters, loss of power or water supplies, etc., as well as factors which may make response more difficult, such as problems with communication and transportation systems. During the emergency planning process, there should be a realistic assessment of the capabilities and resources of those who will be involved in emergency response, and the skills and resources required. This assessment will provide insight into what additional skills and resources are needed.

6.1.2 Assessment of Human Resources and Health Facilities

- Maintaining patient triage operations, on the basis of a well-functioning mass-casualty triage protocol, is essential for the appropriate organization of patient care
- Surge capacity – defined as the ability of a health service to expand beyond normal capacity to meet increased demand for clinical care – is an important factor of hospital disaster response and should be addressed early in the planning process.
- Effective human resource management is essential to ensure adequate staff capacity and the continuity of operations during any incident that increases the demand for human resources
- Effective human resource management is essential to ensure adequate staff capacity and the continuity of operations during any incident that increases the demand for human resources.

6.1.3 Assessment of Emergency equipment, medicines and antidotes

- The types of emergency equipment needed to meet specific types of emergencies should be determined, and this equipment (for example, specially designated emergency response vehicles) obtained.
- All emergency equipment should be in working order, highly reliable, effective, and available when an emergency occurs. The best storage areas for emergency equipment should also be determined.
- The value of storing such equipment near the sites of possible emergencies should be assessed, with consideration given to ease of accessibility and protection from unauthorized use. Periodic checks need to be carried out on the equipment's adequate functioning.
- As part of emergency preparedness planning, it should be ensured that adequate medical facilities are available, including transportation facilities. In an emergency, this may mean the rapid transformation of facilities normally used for other purposes. Where suitable antidotes exist to chemicals produced by industry, industry should be required to ensure the availability locally of the antidotes if obtaining them is a problem for the health authorities.
- Essential emergency medicines, kept up to date, should be available at or near installations handling toxic chemicals for use by authorized health professionals.
- Emergency medical facilities, medical centres or hospitals in proximity to such installations or, if necessary, poisons information centres in the nearby area should also stock appropriate emergency medicines, antidotes and equipment to deal with the consequences of a major chemical accident.

FOR MAINTENANCE OF RESPIRATORY FUNCTION	FOR MAINTENANCE OF CARDIO-CIRCULATORY FUNCTION
• Laryngoscopes • Endotracheal tubes • Masks (oxygen) • Suction system (mechanical) • Self-inflatable bag • Tracheostomy set (Including tubes) • Mechanical portable ventilator	• Cardiac monitor • Defibrillator • External pacemaker • IV Line, IV Cannula, BP apparatus
FOR MAINTENANCE OF RESPIRATORY FUNCTION	**FOR DECONTAMINATION**
• Fluids (colloids and crystalloids) • Pharmaceuticals (including antidotes and electrolytes)	• Portable showers • Water supply • Soap and specific washing solutions • Eye-washing equipment (including local anesthetics)
OTHER NECESSARY ITEMS	
• Bladder catheters, glucometer • Containers for samples (chemical and biomedical) • Liquid disinfectants • Wound dressing material ,Blankets, Bed sheets, robes for pateints the following decontamination • Plastic bags (for contaminated clothing and other material) Protective equipment for emergency personal	

6.2 Checklist for the Assessment of preparedness measures

Checklist for the assessment of preparedness measures for chemical emergencies:

1.Human resources:

- Are there enough trained personnel available to respond quickly to a chemical emergency?
- Is there a plan in place to ensure that emergency responders, healthcare providers, and other staff members are available 24/7?
- Are regular training and drills conducted to ensure that response teams are prepared to handle chemical emergencies?

2. Facilities:

- Are healthcare facilities equipped with the necessary infrastructure and technology to handle chemical emergencies?
- Do hospitals, clinics, and other healthcare facilities have dedicated areas for decontamination, isolation, and treatment?
- Are emergency response centers located in strategic areas to provide quick access to affected areas?

3. Beds:

- Are there enough beds and space to accommodate patients affected by chemical emergencies?
- Does the healthcare facility have the capacity to handle a surge in patients, including those requiring critical care?

4. Equipment:

- Does the healthcare facility have the necessary equipment for decontamination, isolation, and treatment?
- Is there an adequate supply of personal protective equipment (PPE), respiratory equipment, and monitoring devices?
- Are the equipment regularly maintained and tested to ensure that they are functional?

5. Antidotes:

- Is there an adequate supply of antidotes for the most common chemical agents that may be encountered in the area?
- Are the antidotes stored appropriately and easily accessible to healthcare providers in case of an emergency?

Volunteers and rescue workers remove the body of a victim from the debris of a fallen chimney at a powerplant in Korba, 2009

"Capacity building is about creating a culture of perparedness and resilience"

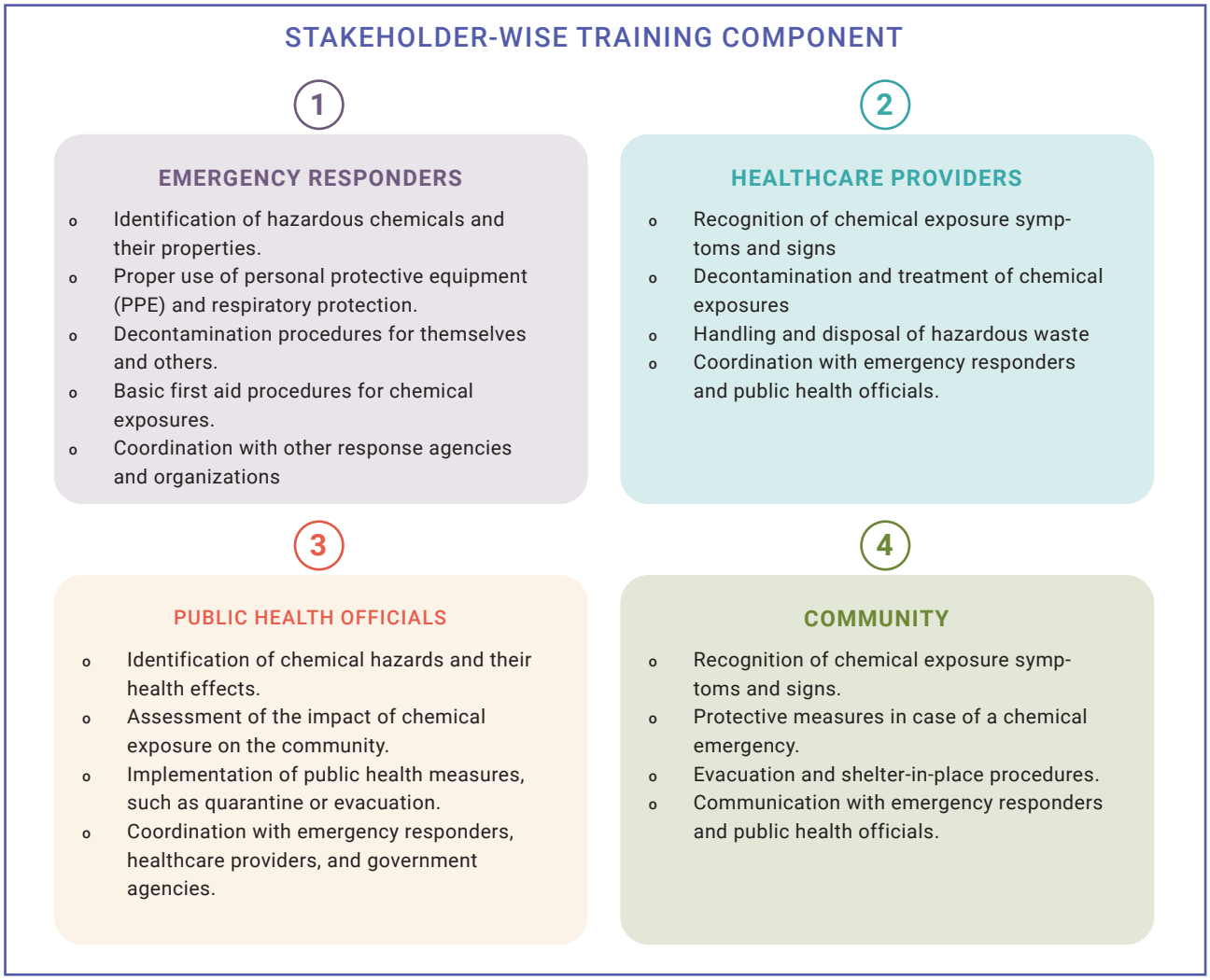
CAPACITY BUILDING PROGRAMS – TRAININGS & EXERCISES

By the end of this chapter, you will be able to understand:

1. What are the training components for various stakeholder for management of chemical emergencies?
2. What are the various methods for training & exercises?

7.1 Stakeholder-wise training component

Managing chemical emergencies requires the participation and cooperation of various stakeholders. Each stakeholder plays a unique role in responding to a chemical emergency, and it is important to provide them with appropriate training to enable them to fulfill their responsibilities effectively. Here is a stakeholder-wise training component for chemical emergencies management:



One of the biggest challenges for assessing preparedness stems from the fact that preparedness means different things to different people. Additionally, how communities and organizations prepare greatly depends on what they are preparing for.

By providing stakeholder-wise training, organizations can ensure that each stakeholder is aware of their roles and responsibilities during a chemical emergency. This will enable them to work together efficiently and effectively to mitigate the impact of a chemical emergency on the community.

7.1.1 Capacity building in Chemical Emergency

Capacity building is generally defined as either a product if the focus rests upon the term “capacity” (e.g., the requisite of resources, tools and competencies) or a process, if the focus is on the term “building” (e.g., the continuous process and action to support development of capacity).

The concept of capacity building has been defined conceptually as “the extent of existing capacity in the country to implement an effective chemical accident prevention and preparedness programme. Agenda 21 of the United Nations Conference on Environment and Development states that “the ability of a country to follow sustainable development is determined by the capacity of its people and its institutions as well as by its ecological and geographical conditions”.

The emergency preparedness includes all of the activities undertaken in an effort to ensure the effective coordination of response to an emergency event. A continuous cycle of activities includes the following steps:

Capacity building is an ongoing process that equips officials, stakeholders and the community to perform their functions in a better manner during a crisis/disaster. In the process of capacity building, focus must be there on including elements of human resource development, i.e., individual training, organizational development such as improving the functioning of groups and organizations and institutional development.

7.2 Trainings & exercises

Different types of exercises could be used in training of medical and public health staff, such as: discussion-based workshops; desktop/table-top exercises; drills; and command-post, functional and field exercises. Several national and regional training and exercise sessions that took place in 2011-2012, such as the Exercise Iridium of the European Commission (EC), confirmed the effectiveness of exercises in identifying weaknesses and gaps in planning and resources, as well as in the training of personnel in emergency-management duties. They are also useful in: verifying plans; validating systems and equipment; demonstrating operational capability; fostering cooperation and information-sharing among organizations; clarifying roles and responsibilities; improving communication, coordination, command and control; and enhancing public confidence.

There are seven types of exercises either discussion-based or operations-based. Discussions-based Exercises familiarize participants with current plans, policies, agreements and procedures, or may be used to develop new plans, policies, agreements, and procedures.

Discussion-based Exercises include the following:

1. **Seminar:** A seminar is an informal discussion, designed to orient participants to new or updated plans, policies, or procedures
2. **Workshop:** A workshop resembles a seminar, but is employed to build specific products, such as a draft plan or policy
3. **Tabletop Exercise (TTX):** it involves key personnel discussing simulated scenarios in an informal setting. TTXs can be used to assess plans, policies, and procedures.
4. **Games:** A game is a simulation of operations that often involves two or more teams, usually in a competitive environment, using rules, data, and procedure designed to depict an actual or assumed real-life situation.

Fig.17 : Mock drills at NCDC

Operations-based Exercises validate plans, policies, agreements and procedures, clarify roles and responsibilities, and identify resource gaps in an operational environment. It includes the following:

1. **Drill:** A drill is a coordinated, supervised activity usually employed to test a single, specific operation or function within a single entity (e.g., a fire department conducts a decontamination drill).
2. **Functional Exercise (FE):** A functional exercise examines and/or validates the coordination, command, and control between various multi-agency coordination centers (e.g., emergency operation center, joint field office, etc.). A functional exercise does not involve any "boots on the ground" (i.e., first responders or emergency officials responding to an incident in real time).
3. **Full-Scale Exercises (FSE):** A full-scale exercise is a multi-agency, multi-jurisdictional, multi-discipline exercise involving functional (e.g., joint field office, emergency operation centers, etc.) and "boots on the ground" response (e.g., firefighters decontaminating mock victims).

Fig.18 : Full scale state wide chemical emergency management exercises, Gujarat

4.Table-Top Exercises

Objectives of Table top exercises:

1. To help explore, validate, and deconflict the chemical emergency plans in place.
2. To focus on the healthcare aspects of the response (e.g., screening/caring for the exposed, or potentially exposed) and understand plans and existing gaps at the coalition and coordination level.
3. To review and combine agency/facility role during a chemical emergency.
4. To identify changes that need to be made in based on the roles and capabilities of the involved stakeholders.
5. To compile notes and comments, and produce an After-Action Report and Improvement Plan
6. To implement action items in the Improvement Plan and addressing any training or equipment needs

Steps to complete the exercise

1. Planning Assumptions
2. Deduce Assumptions
3. Specific response steps (Before, during and after)
4. Prepare own action items and share with your partner
5. Discuss and note any gap in the action items
6. Prepare After-Action Report
7. Merging of after action reports
8. Improvement Plan
9. Implement action items in the Improvement Plan
10. Address any training or equipment needs

S.NO.	TIME OF ACTION VIS A VIS ONSET OF CHEMICAL EMERGENCY	ACTION STEP
1	BEFORE	
2		
3	DURING	
4		
5		
6		
7		
8		
9		
10		
11	AFTER	
12		

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National Disaster Response Force (NDRF) team at the site after a gas leak incident in the Giaspura Ludhiana , 2023

"Advocacy is about creating a sense of urgency and inspiring people to take action"

ADVOCACY, RISK COMMUNICATION AND SENSITIZATION OF STAKEHOLDERS

By the end of this chapter, you will be able to understand:

1. What are the strategies for Community Awareness on Hazardous Materials
2. Who shall be for sensitized
3. What is healthcare system sensitization
4. What are the guidelines and do's and don'ts for advocacy and sensitization

8.1 Strategy for Risk Communication

Risk communication involves informing the public about probable incident scenarios, information about potential protective steps, and public participation in the licensing of facilities where chemicals are produced, used, or stored before an incident has actually taken place. Risk communication builds trust between the potentially at risk population , emergency responders and the public health department. Good risk communication establishes communication channels, fosters trust, and creates the groundwork for effective crisis communications. The fundamentals of good risk and crisis communication are speed, openness, transparency, and communication continuity , and it is a critical tool for responding agencies and public leaders to lessen the implications of the incident. Risk communication to the population covers all communication that occurs before to an incident. This may contain information about nearby risks, potential incident scenarios, authorities' preparedness, protective steps that the public can take if an incident occurs, and the construction of a communication channel.

Throughout the situation, a coordinated communication strategy is very beneficial.

During the preparedness stage

- A public crisis communication system can be developed and tested. This involves strategies, procedures, command and control, the identification of spokespersons, and standard communications for various eventualities. Guidance on crisis communication is offered.
- Individuals responsible for communication of information related to hazardous installations should be specifically trained to understand how to develop information for target audiences and how to deliver information effectively, particularly in an emergency.
- Mechanisms should be established to facilitate consultation with the public concerning the type of information it would like to receive and the information which should be made available regarding hazardous installations.
- Conducting risk discussions with stakeholders to increase public understanding and participation in decision-making. Public authorities might consider forming community groups for this aim.
- Encouraging major stakeholders like Hospitals to maintain an exclusive communication line to respond to and coordinate during an emergency.
- Industry should promote this awareness and education process by maintaining close relations with the local population, community leaders and groups, education facilities and providing information regarding hazards and need for safe practices and equipment.
- A contact number of individuals who can act as points for communication should be maintained.

8.2 Stakeholders list for sensitization

By implementing this strategy, organizations can raise community awareness on chemical hazardous materials and empower individuals to take appropriate precautions to protect themselves and their families. It is important to continuously evaluate and update the strategy to ensure that it remains effective and relevant to the community.

Associated with hazardous materials and how to respond in the event of an emergency. Here is a list of stakeholders who should be included in sensitization efforts:

- **Emergency responders:** this includes firefighters, police officers, hazardous materials teams, and emergency medical services personnel.
- **Healthcare providers:** this includes doctors, nurses, paramedics, and other healthcare professionals who may encounter patients exposed to hazardous materials.
- **Public health officials:** this includes officials from local, state, and national health departments who are responsible for monitoring and responding to public health emergencies.
- **Government officials:** this includes elected officials, policymakers, and regulators who are responsible for developing and implementing policies related to hazardous materials.

- **Environmental organizations:** this includes organizations that advocate for environmental protection and work to prevent environmental contamination.
- **Community leaders:** this includes religious leaders, business owners, and other community leaders who can help to disseminate information and educate their networks on the risks associated with hazardous materials.
- **General public:** this includes individuals and families who may be at risk of exposure to hazardous materials in their homes, workplaces, or communities.

By sensitizing these stakeholders, organizations can create a network of informed and prepared individuals who can work together to respond to chemical emergencies and protect public health and the environment. It is important to tailor sensitization efforts to the needs and priorities of each stakeholder group and to continuously evaluate and improve the effectiveness of these efforts.

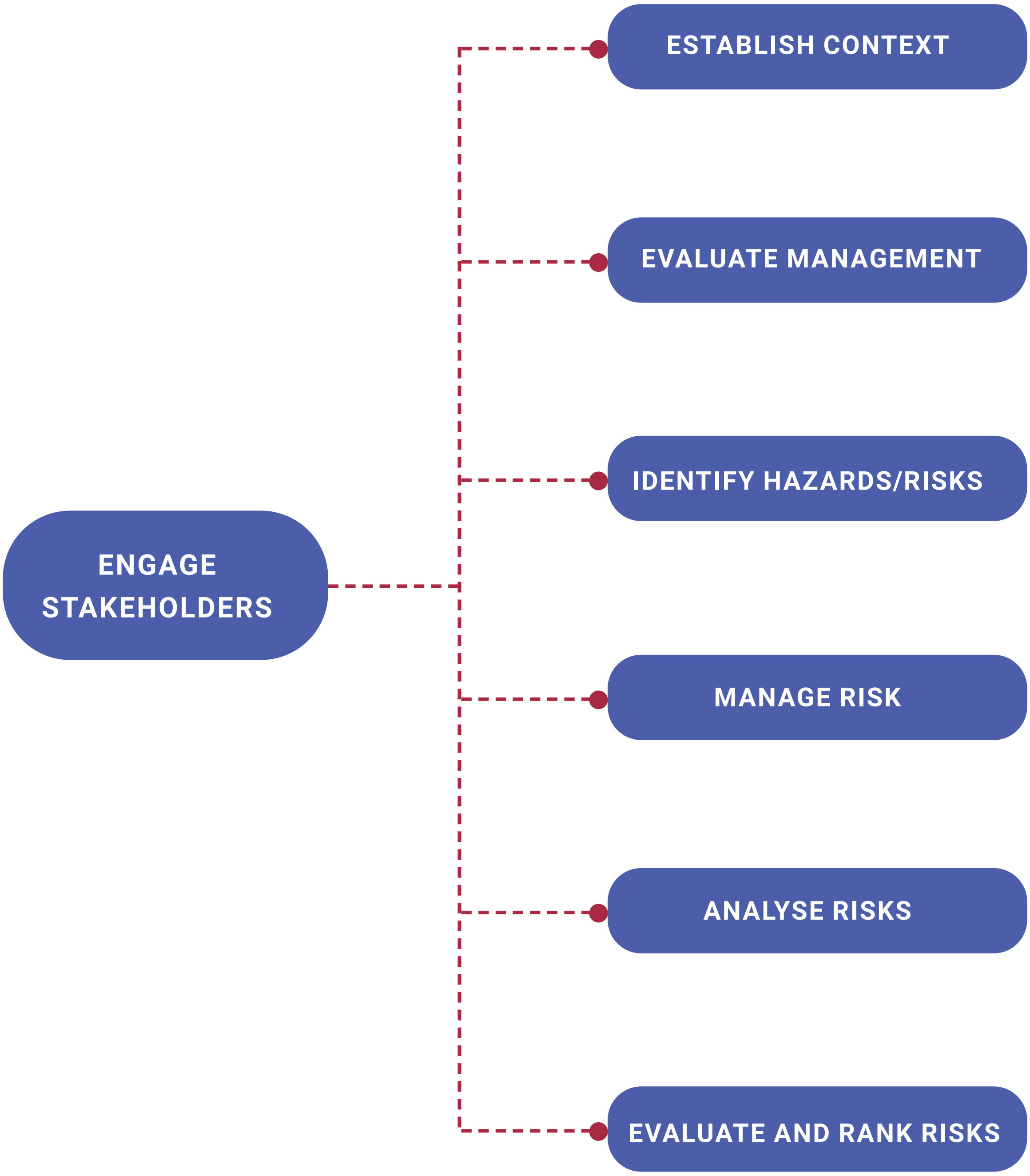


Fig 19: Stakeholder enagagment

8.3 Do's and Don'ts for advocacy and sensitization

DO'S:

- **Build awareness:** Raise awareness about the risks and impacts of chemical emergencies among stakeholders, including the general public.
- **Promote best practices:** Promote best practices for the safe storage, handling, and disposal of hazardous materials among industry stakeholders.
- **Engage the media:** Engage the media to increase public awareness about the risks and impacts of chemical emergencies, as well as the steps that stakeholders can take to prevent and respond to them.
- **Encourage community involvement:** Encourage community involvement in preparedness and response efforts, such as through the establishment of community emergency response teams.
- **Foster partnerships:** Foster partnerships among stakeholders to enhance the response to chemical emergencies, including public-private partnerships and collaborations between government agencies and civil society organizations.

DON'TS:

- **Neglect the importance of prevention:** Do not neglect the importance of prevention measures, which are critical for reducing the risk of chemical emergencies.
- **Use scare tactics:** Do not rely on scare tactics to raise awareness about the risks and impacts of chemical emergencies. Instead, provide accurate information and promote best practices.
- **Ignore cultural differences:** Do not ignore cultural differences when developing educational materials and engaging with stakeholders. Cultural sensitivity is key to building trust and fostering effective communication.
- **Overlook the needs of vulnerable populations:** Do not overlook the needs of vulnerable populations, such as low-income communities and migrant workers, who may be disproportionately affected by chemical emergencies.
- **Follow One-size-fits-all approach:** Don't assume that a one-size-fits-all approach will benefit in all contexts. Tailor advocacy and sensitization efforts to the local context and the needs of different stakeholders.

8.4 Strategy for community awareness on hazardous materials

Raising community awareness on chemical hazardous materials is crucial in enabl individuals to understand the risks associated with exposure to these materials and to take appropriate precautions to protect themselves and their families. The strategy involves

- Developing educational materials: create informative and easy-to-understand materials that educate the community on the risks associated with chemical hazardous materials. These materials can include brochures, fact sheets, videos, and posters. They should be available in multiple languages and distributed through various channels, including social media, community centers, schools, and local businesses

- Hosting community events: organize community events, such as workshops, seminars, and information sessions, to educate the public on chemical hazardous materials.These events can be led by experts in the field and should include hands-on demonstrations of proper handling and disposal of hazardous materials. Encourage attendees to ask questions and provide feedback to improve the educational materials.

- Involving community leaders: engage community leaders, such as elected officials, business owners, and religious leaders, to advocate for community awareness on chemical hazardous materials. Encourage them to promote the educational materials and events within their networks and to make the issue a priority in their communities.

CASE STUDY 2 :
CHLORINE GAS LEAK - MUMBAI PORT TRUST

On the morning of 14 July 2010, chlorine leak incidence was reported at Haji Bunder hazardous cargo warehouse in the Mumbai Port Trust (MPT), Sewri. Around 103 individuals fell ill due to inhaling chlorine gas from a leaking cylinder. The affected included college students, BPT staff, and firemen.

The emergency response involved transferring victims to multiple hospitals. Critical cases primarily suffered from respiratory issues and throat problems. This incident led to a joint investigation by BPT, police, and the Brihanmumbai Municipal Corporation. It was learnt that the chlorine cylinders have been abandoned by an importer nearly a decade ago in 1997 and MPT has been unsuccessful in selling off these cylinders

Lessons Learned

- Importance of proper hazardous material storage and disposal
- The need for robust emergency response protocols, and the significance of effective coordination among various stakeholders during a crisis.
- Critical need for regular safety audits and employee training in handling hazardous materials
- The importance of regulatory compliance and the need for continuous monitoring and maintenance of industrial equipment to prevent similar occurrences in the future.

Oil India Limited Gas well Fire,Assam India,2020

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."

OVERVIEW OF PRE-HOSPITAL MANAGEMENT OF CHEMICAL EMERGENCIES MODULE

By the end of this chapter, you will be able to understand:

1. Overview of pre-hospital management of chemical emergencies

9.1 Pre-hospital management of chemical emergencies module

The pre-hospital management of chemical emergencies is critical in preventing further harm to the affected individuals and mitigating the overall impact of the incident. Pre-hospital management during chemical emergencies involves a coordinated effort between emergency medical services (EMS), hazardous materials (hazmat) teams, and other response agencies.

The goal of pre-hospital management is to identify and assess the extent of the incident, provide medical treatment to those affected, and ensure the safety of first responders and the general public. The initial response to a chemical emergency involves the activation of the emergency response system, which includes calling the appropriate local emergency number. The dispatcher will then initiate a response from the appropriate agencies, including EMS and hazmat teams.

Upon arrival at the scene, the first responders will assess the situation and determine the appropriate course of action. This may include the establishment of a perimeter or evacuation of the affected area. The hazmat team will then identify the hazardous substance and determine the appropriate method for containment and cleanup.The medical response to a chemical emergency involves the identification and treatment of those affected by the hazardous substance. The first priority is to ensure the safety of the responders and the general public.

This may involve the use of personal protective equipment (PPE) and decontamination procedures to prevent the spread of the hazardous substance.The medical treatment of those affected will depend on the type and severity of the exposure. The first step is to provide basic life support, including airway management, breathing support, and circulation

Things to remember in the initial minutes

- Notify local, state, and nodal authorities.
- Notify nearby hospitals and specialized medical centres
- Notify Specialized response forces
- Wear appropriate protective gear for suspected or confirmed poisoning.
- Direct the people to move away from the site of a chemical disaster in a direction opposite to the direction of the prevailing wind
- Initiate decontamination as soon as possible
- The developmental and technical agencies working in the field
- Inform a Poisons Information Center

The chemical alert is to be activated if there is substantial evidence of chemical release

- Notification of a chemical release is provided by the site/industry responsible for the release
- Notification regarding visible evidence of a release by the public
- The surveillance systems show warning signals such as the occurrence of a chemical event or a sudden increase in levels of a contaminant in the environment
- Trained public health officials , medical professional

For those with significant exposures, advanced life support may be necessary. This may involve the use of antidotes or specific treatments for the specific chemical exposure. In some cases, patients may require hospitalization for further observation and treatment. Pre-hospital management during chemical emergencies also includes the management of psychological stressors. The traumatic nature of chemical emergencies can cause significant psychological distress for those involved. Responders and survivors may require counseling and other support services to help them cope with the emotional impact of the incident.

CASE STUDY 3 :
JAIPUR IOCL FIRE - RAJASTHAN,INDIA

The Jaipur IOCL fire occurred on October 29, 2009, at the Indian Oil Corporation's oil depot in Sitapura Industrial Area, Jaipur, Rajasthan. The fire broke out in a giant tank holding 8,000 kilolitres of petrol, causing 12 deaths and injuring over 300 people.

The fire raged uncontrollably for over a week, necessitating the evacuation of half a million people. The incident was attributed to the non-observance of standard safety procedures during the transfer of petrol from the depot to a pipeline, leading to a massive explosion and fire.

Lessons Learned

- Importance of Adhering to Safety Procedures: Non-compliance with safety protocols can have catastrophic consequences.
- Emergency Preparedness and Response: The lack of a disaster management plan at both the IOC and the district administration level was evident. This underscores the need for comprehensive disaster management strategies and plans, especially in high-risk areas.
- Environmental Impact: The fire caused significant air pollution in Jaipur and neighboring areas, raising concerns about environmental safeguards in industrial operations.

NDRF personnel at the site of a gas leak in Delhi's Tughlaqabad area, 2017

"Medical management is not just about treating illness or injury, it's about restoring health and well-being."

OVERVIEW OF MEDICAL MANAGEMENT OF CHEMICAL EMERGENCIES MODULE

By the end of this chapter, you will be able to understand:

1. Overview of medical management module

10.1 Medical management of Chemical Emergencies module

The medical management of victims of chemical emergencies is critical in preventing further harm to the affected individuals and mitigating the overall impact of the incident.The first step in the medical management of victims of chemical emergencies is to identify the type of exposure. This includes determining the type and quantity of the hazardous substance, the duration of exposure, and the route of exposure. This information will help healthcare professionals determine the appropriate medical treatment. The medical treatment of victims of chemical emergencies varies depending on the type of exposure. There are three main routes of exposure: inhalation, ingestion, and skin contact. Inhalation exposure occurs when a person breathes in a hazardous substance, ingestion exposure occurs when a person swallows a hazardous substance, and skin contact exposure occurs when a person's skin comes into contact with a hazardous substance.

Inhalation Exposure

Inhalation exposure to hazardous substances can cause respiratory distress, including coughing, wheezing, and shortness of breath. The medical management of inhalation exposure involves the administration of oxygen, bronchodilators, and other medications, as needed. Patients may require intubation and mechanical ventilation in severe cases.

Ingestion Exposure

Ingestion exposure to hazardous substances can cause gastrointestinal distress, including nausea, vomiting, and abdominal pain. The medical management of ingestion exposure involves the administration of activated charcoal, which can help adsorb the hazardous substance and prevent further absorption. Patients may also require intravenous fluids and other supportive care.

Skin Contact Exposure

Skin contact exposure to hazardous substances can cause chemical burns, irritation, and other dermatological problems. The medical management of skin contact exposure involves the removal of contaminated clothing and decontamination of the skin. Patients may require topical treatments, including ointments, creams, and dressings, as well as pain management and other supportive care.

In addition to the specific medical treatments for each type of exposure, victims of chemical emergencies may require psychological support. The traumatic nature of chemical emergencies can cause significant psychological distress for those affected. Healthcare professionals may provide counseling and other support services to help victims cope with the emotional impact of the incident.
Medical management of victims of chemical emergencies also involves the monitoring of long-term health effects. Some hazardous substances can cause long-term health effects, including cancer, respiratory problems, and neurological disorders. Healthcare professionals may provide follow-up care and monitoring to ensure that victims receive appropriate medical care and support

CASE STUDY 4 :
TOKYO SARIN GAS ATTACK - JAPAN

On March 20, 1995, the Tokyo Sarin Gas Attack, perpetrated by the Aum Shinrikyo cult, shocked the world. On the morning of March 20, 1995, members of Aum Shinrikyo released sarin gas in five subway cars of the Tokyo Metro system during the morning rush hour. The toxic gas quickly spread within the confined spaces, affecting thousands of commuters. This attack resulted in significant casualties, including 13 deaths and over 50 severe injuries. The motive was that the cult also sought to deflect attention from mounting legal troubles and investigations into their activities.The Tokyo Sarin Gas Attack had a profound impact on Japanese society and led to increased public awareness of the potential for domestic terrorism

Lessons learned

- Importance of Preparedness: The attack underscored the importance of preparedness and rapid response in the face of chemical and biological threats. It prompted governments to invest in training and equipment for emergency responders and healthcare professionals to handle such situations effectively.

- Public Awareness and Education: The incident demonstrated the necessity of educating the public about recognizing and responding to chemical threats. It encouraged governments to establish awareness campaigns to inform citizens about potential dangers and the appropriate actions to take during emergencies.

- International Cooperation: The Tokyo Sarin Gas Attack had international implications, as the Aum Shinrikyo cult had global connections. It emphasized the need for international cooperation in combating terrorism and sharing intelligence to prevent similar incidents.

- Emergency Response Coordination: The Tokyo Sarin Gas Attack revealed the significance of coordination between various agencies during a crisis. It led to the development of better communication and collaboration protocols among law enforcement, emergency responders, and healthcare providers.

ANNEXURE

ANNEXURE 1: List of High risk Chemicals that can cause Chemical Accidents in India

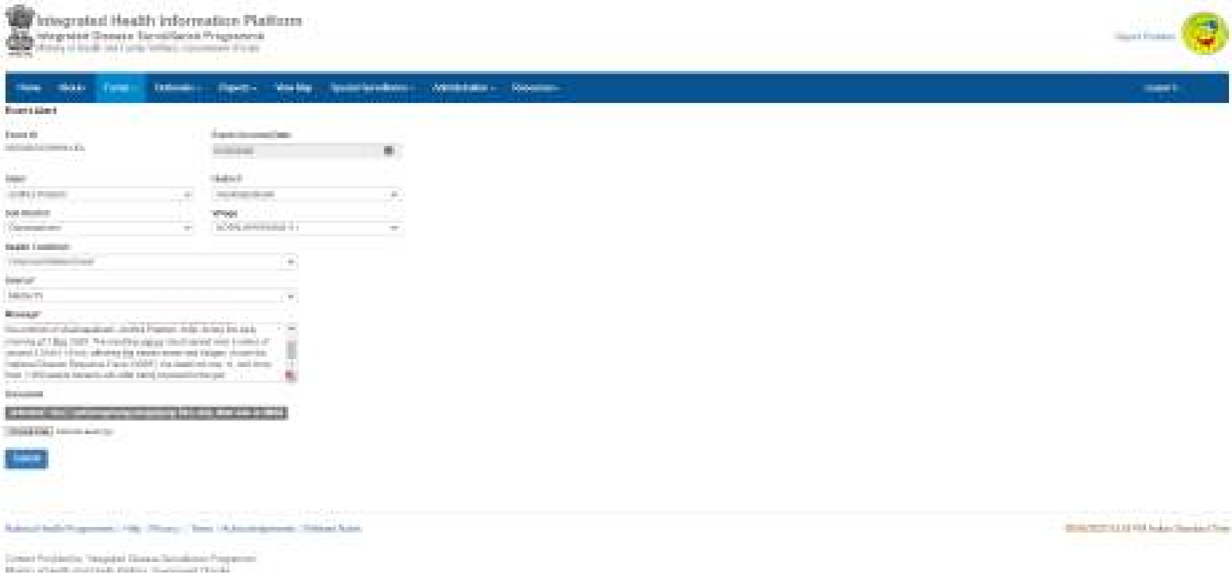
HIGH RISK CHEMICALS

- Ammonia
- Arsine
- Boron trichloride
- Boron Trifluoride
- Carbon disulphide
- Chlorine
- Diborane
- Ethylene oxide
- Fluorine
- Formaldehyde
- Hydrogen bromide
- Hydrogen chloride
- Hydrogen cyanide
- Hydrogen fluoride
- Hydrogen sulphide
- Nitric acid
- Phosgene
- Phosphorus trichloride
- Sulfur dioxide
- Sulfuric acid
- Tungsten hexafluoride

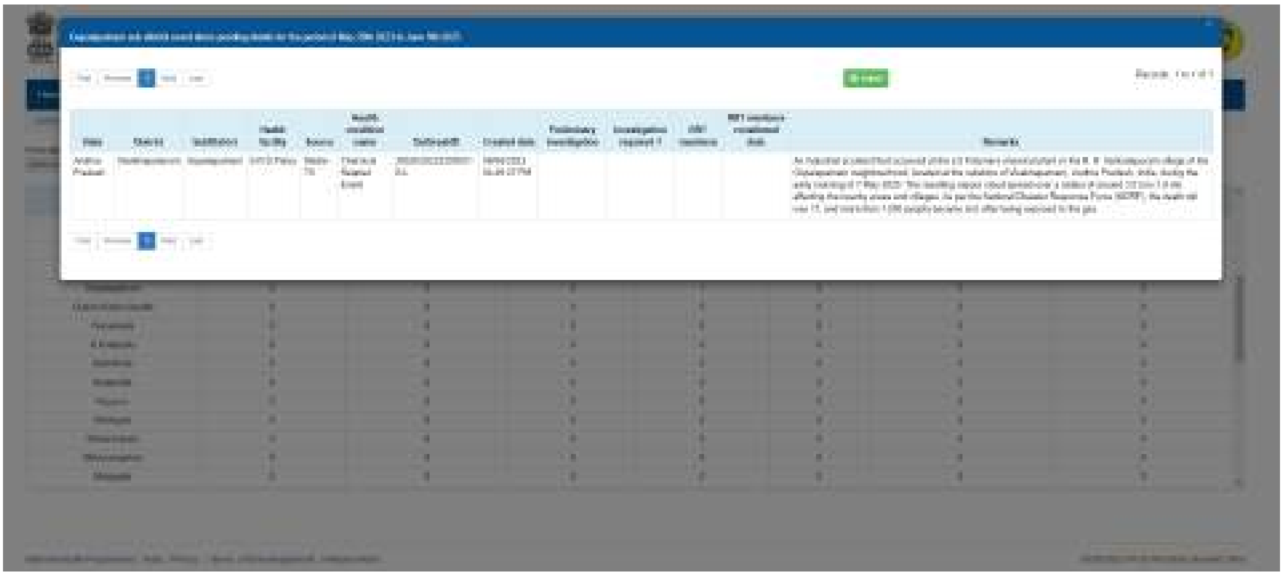
National Disaster Management Guidelines—Management of Chemical (Terrorism) Disasters, 2009.
A publication of the National Disaster Management Authority, Government of India.
ISBN 978-81-906483-9-4, June 2009, New Delhi.

ANNEXURE 2: STEP BY PROCESS OF IDSP REPORTING OF CHEMICAL EVENTS

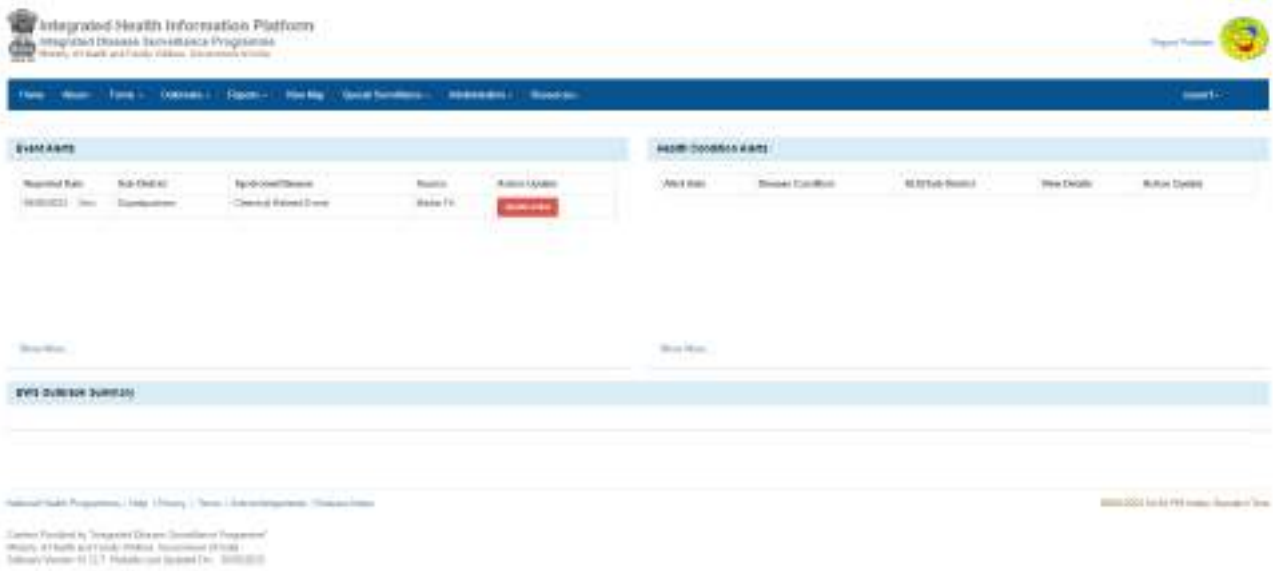
a) After Login – Go to Forms – then go to Event Alert – under Health Condition select Chemical related event and fill the form



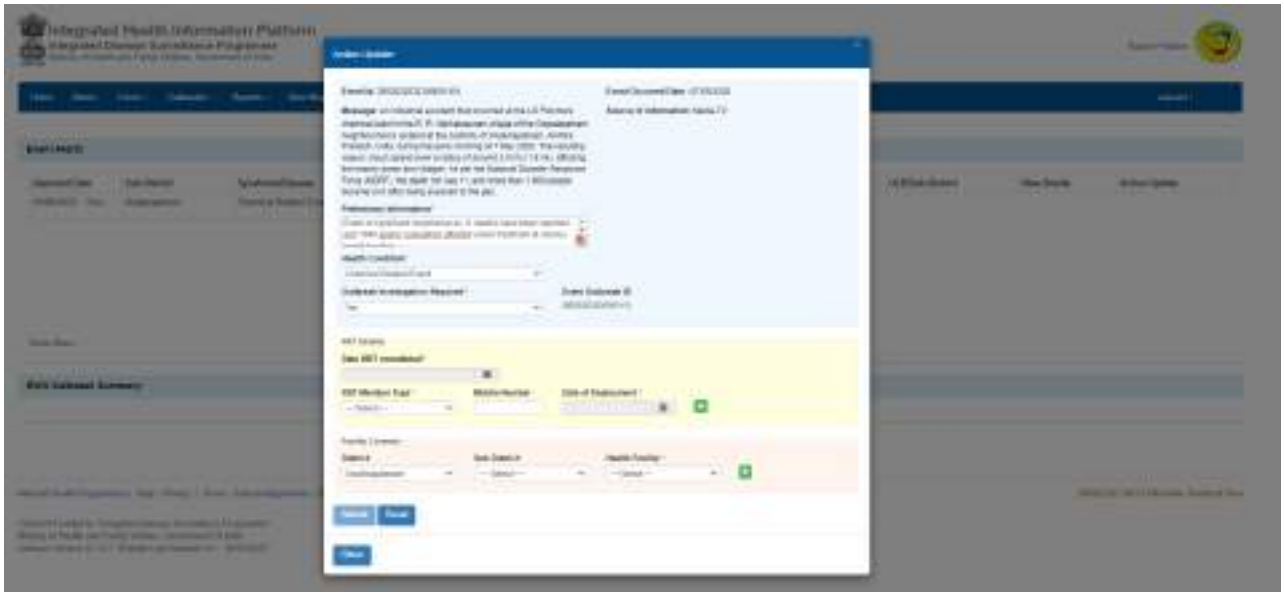
b) Event generated on the portal



c) District Surveillance Officer - Under Event alerts – Shall select action update



d) After proper investigation – the DSO shall either decide to investigate or not to

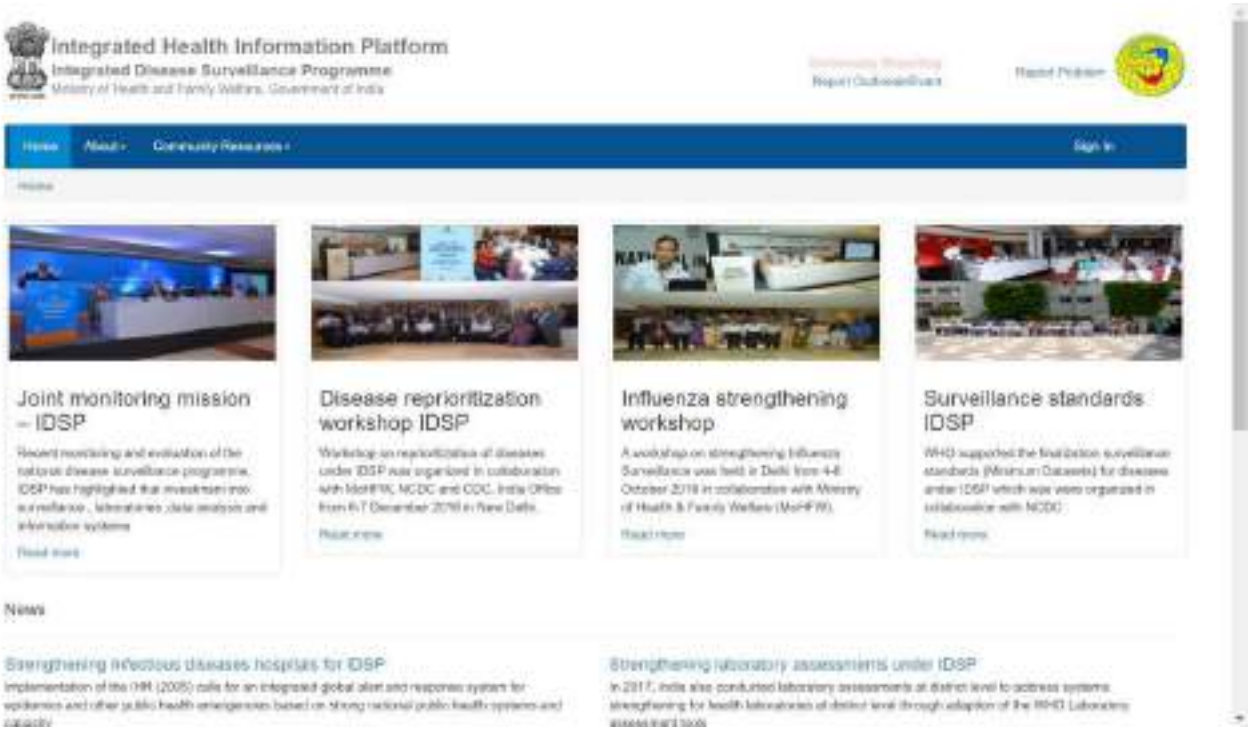


ANNEXURE 3 :

Community-based surveillance is a proactive approach that involves the active participation of community members in monitoring and reporting health-related information. Unlike traditional surveillance methods conducted solely by health professionals, this approach engages individuals within communities to detect, track, and report potential health threats.

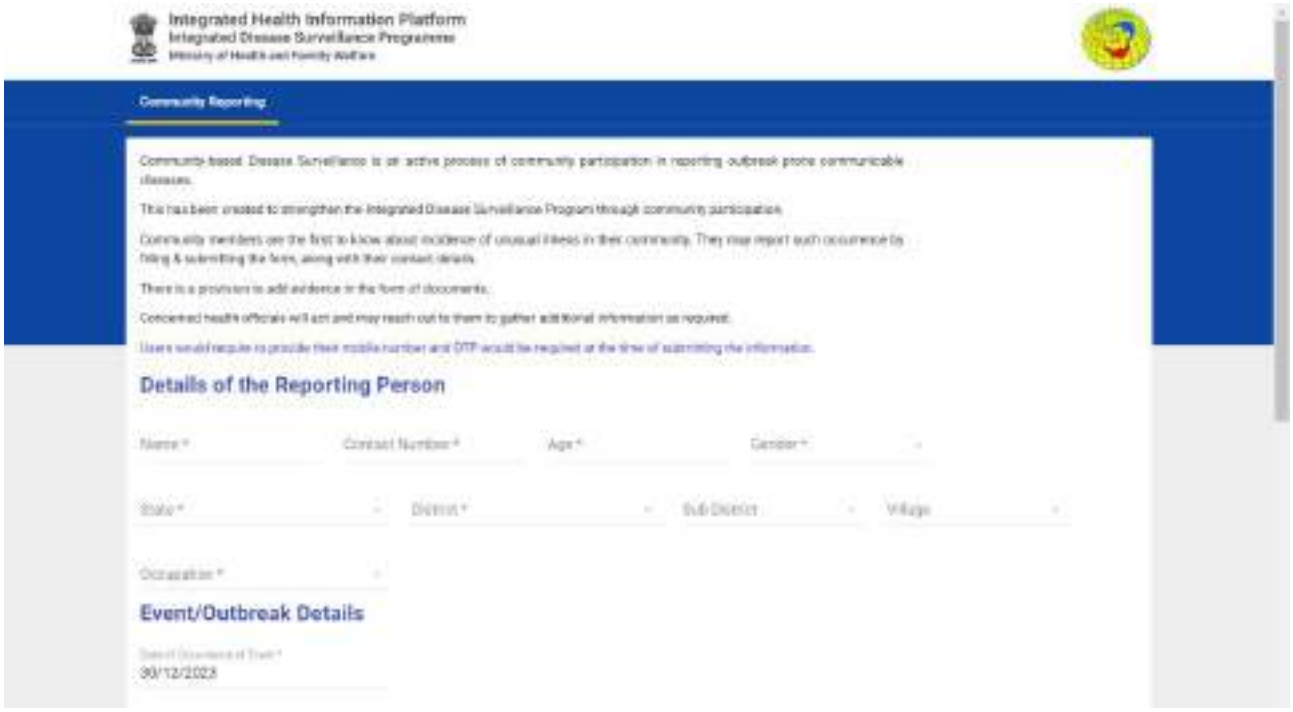
HOW TO REPORT

User has to access the IDSP-IHIP website on their mobile phone or computer https://ihip.mohfw.gov.in/idsp



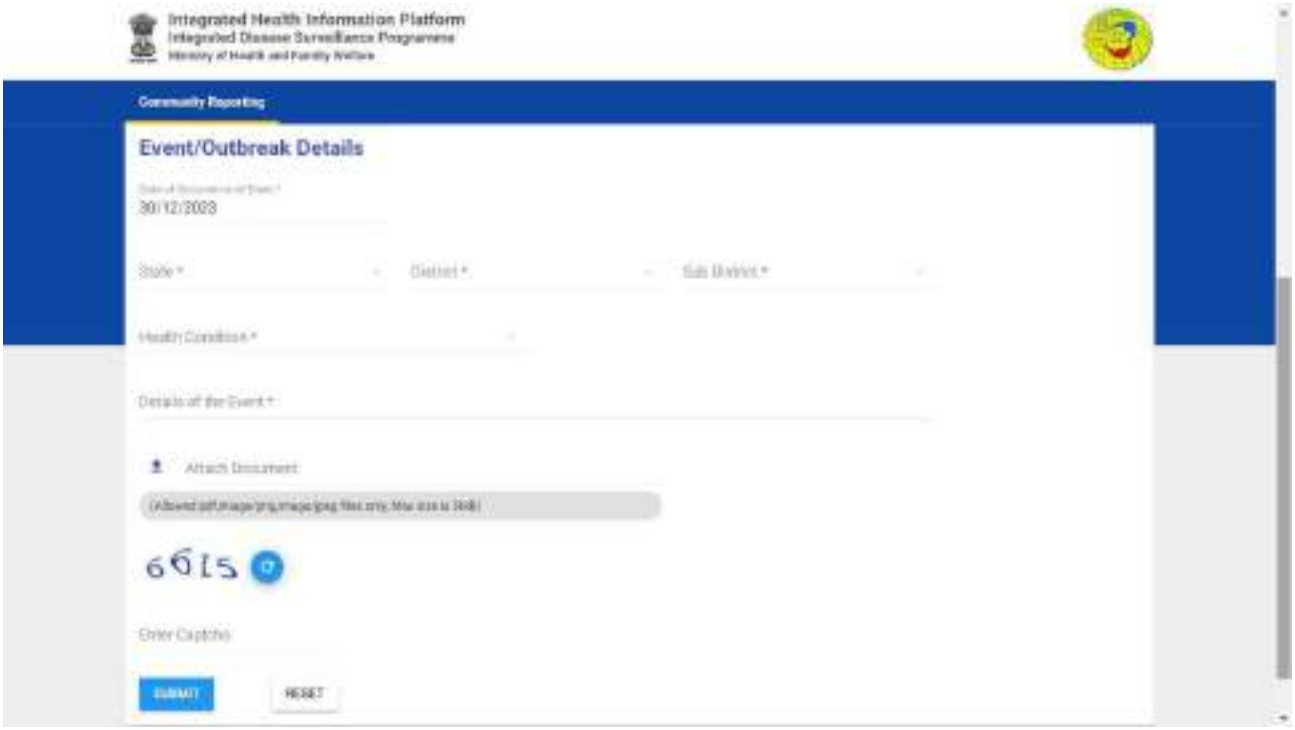
A 'Notice' will be shown, the user need to accept it to proceed further

A reporting form will be shown asking ‘Details of the Reporting Person’ and the ‘Event/Outbreak Details’

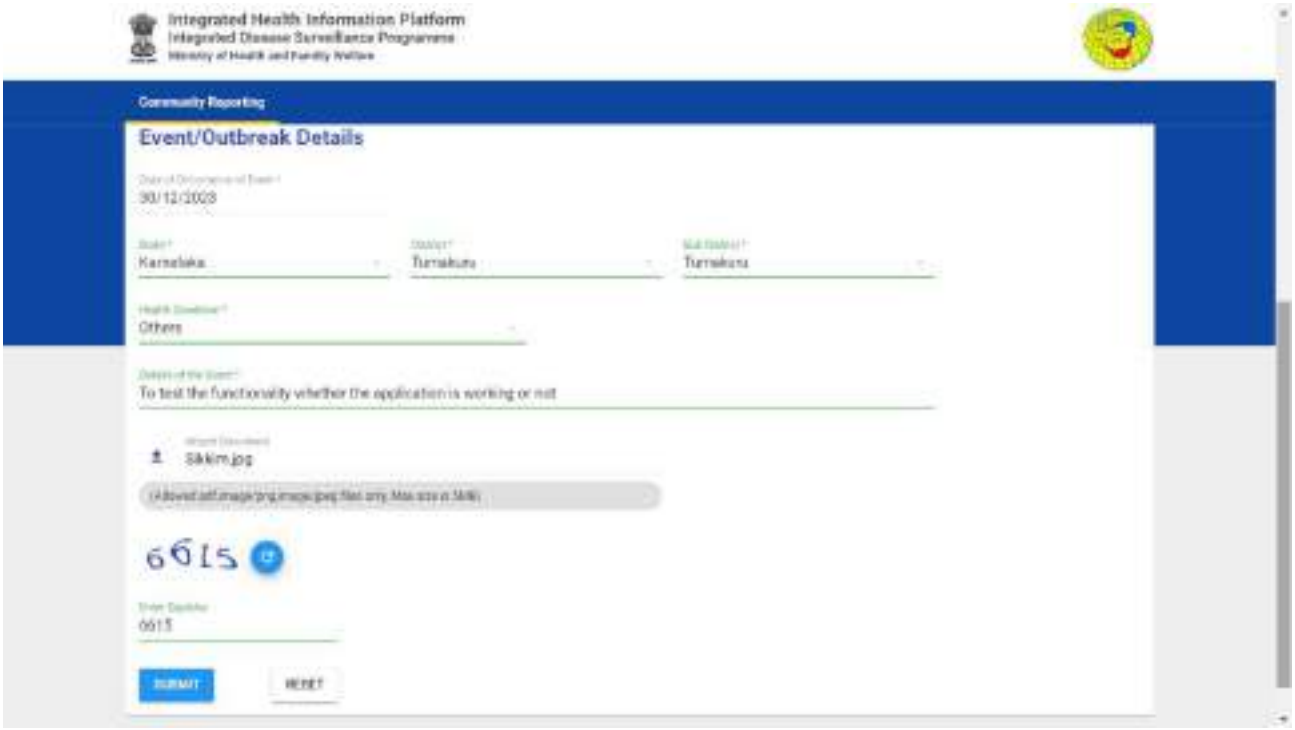


- Details of the Reporting Person – will ask for Name / Mobile Number / Age / Gender /Address and Occupation of the reporting person
- Mandatory fields are marked by *
- Correct mobile number need to be entered here because OTP will be sent on this number for verification purpose

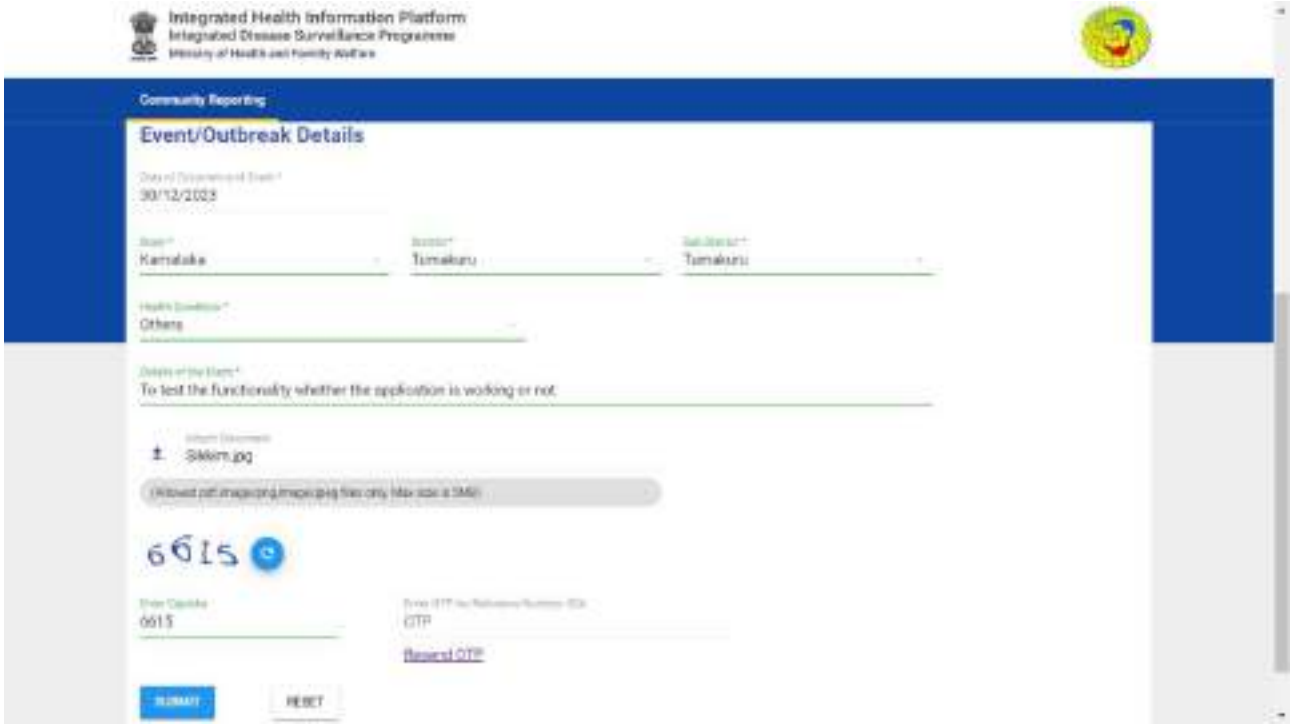
- Under 'Event/Outbreak Details' the – Date of Occurrence of event / Location / Health Condition name and its details need to provided
- If any document/photo related to the event is available, that can also be uploaded



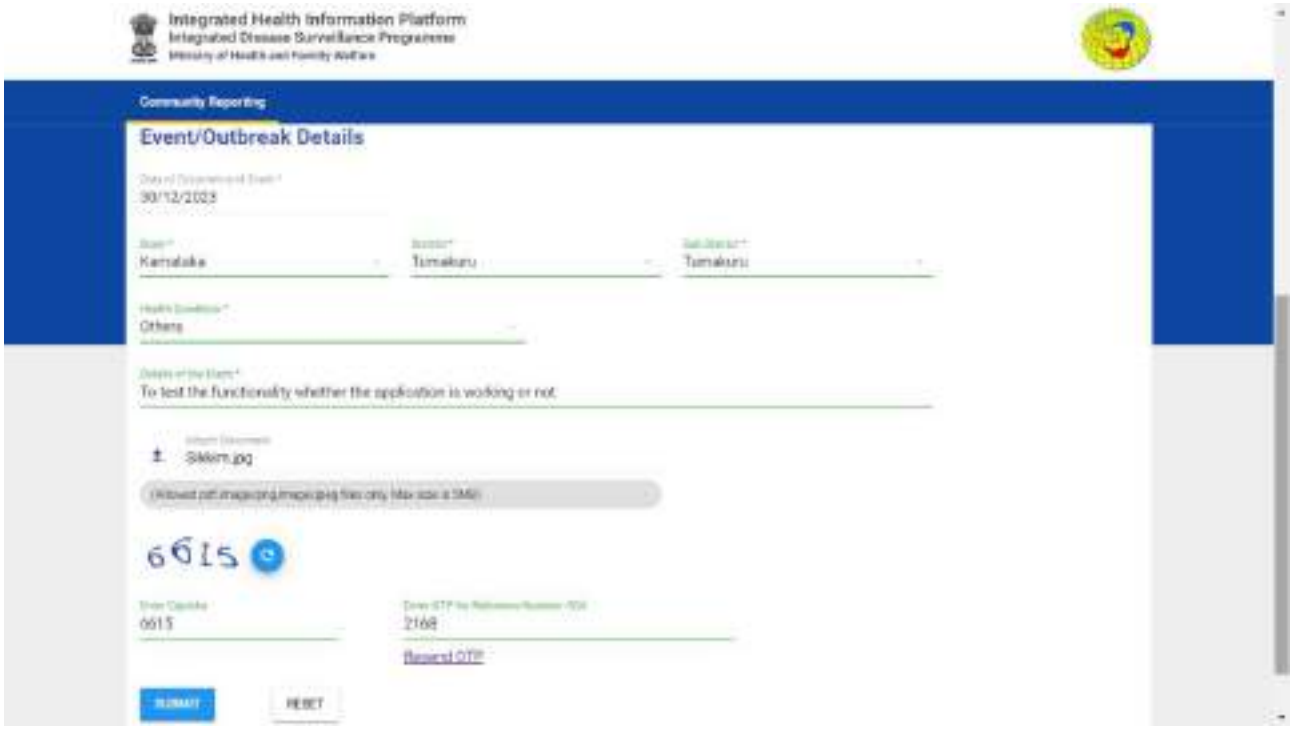
- After entering all details and shown 'Captcha' number, user has to click on 'Submit' button



- One 'OTP' with reference number will be sent to the user's mobile number.
- For chemical emergencies under the health conditions tab select others and fill the details of the event.

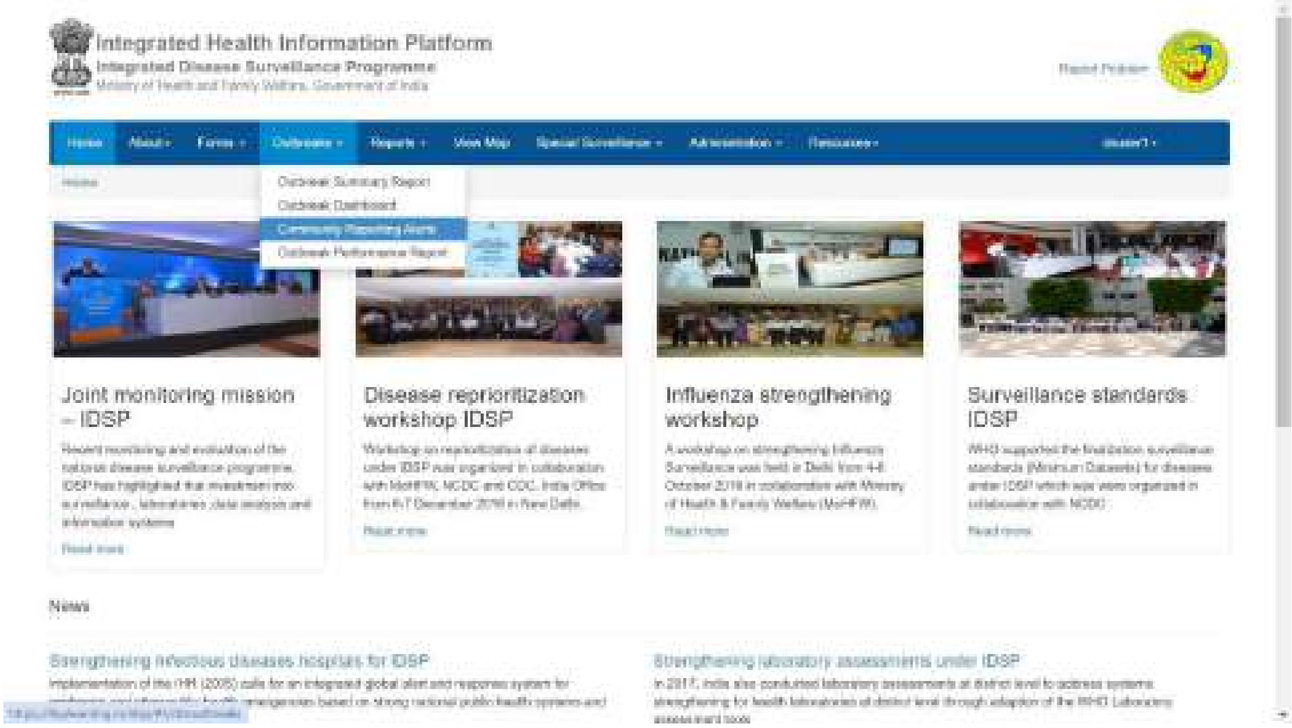


- User has to enter the OTP and click on 'Submit' again
- This will submit the event information to the authorities

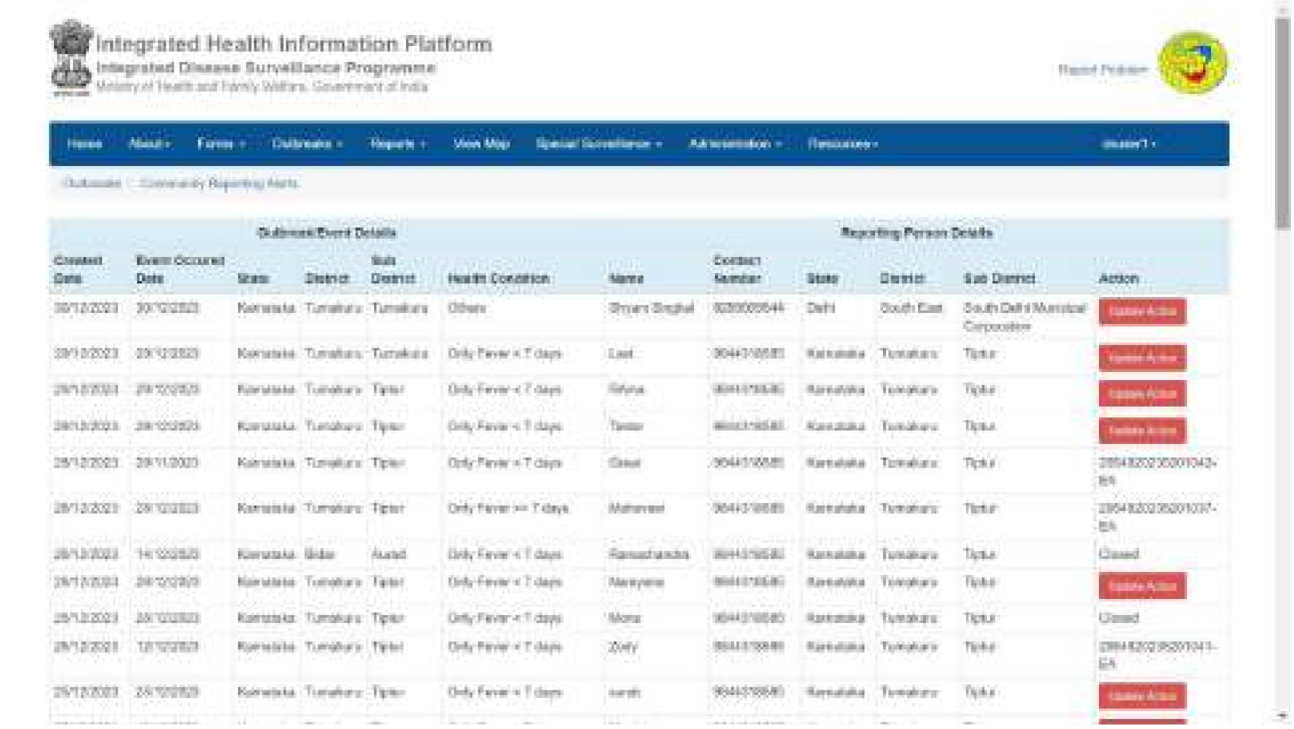


ROLE OF DISTRICT SURVEILLANCE OFFICER

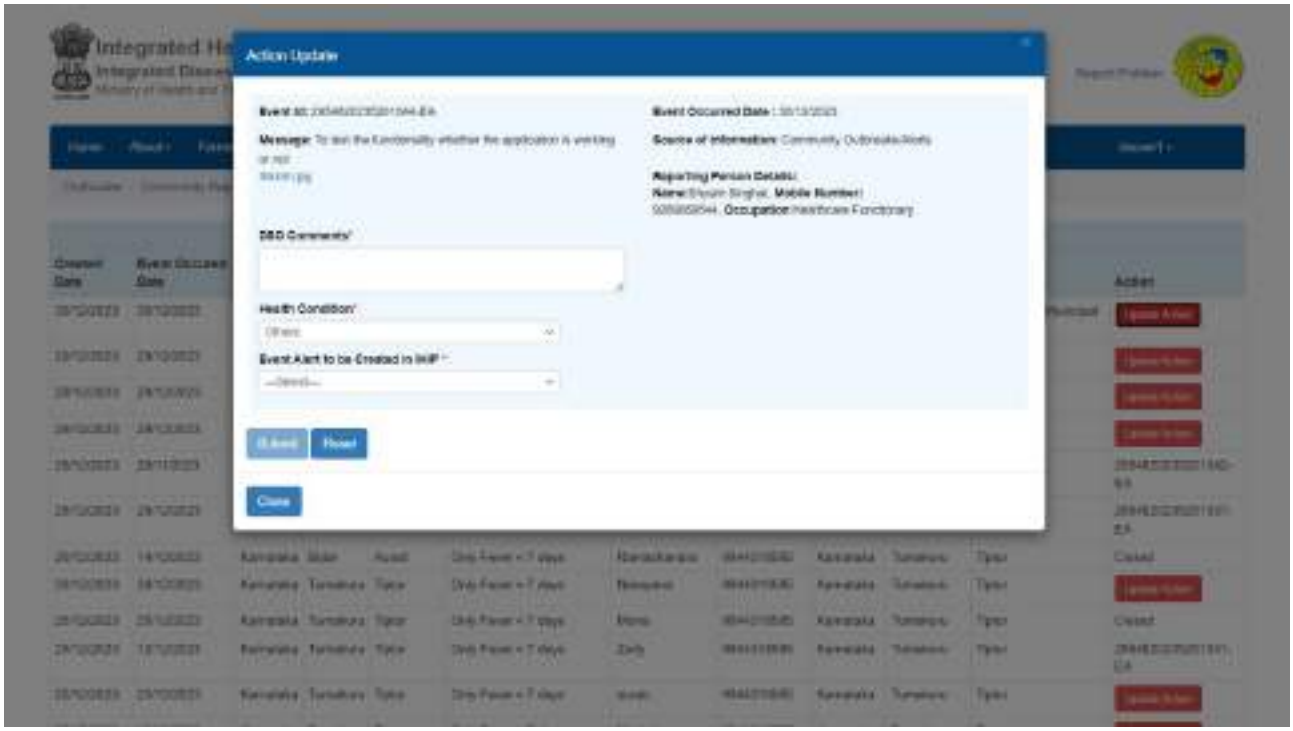
- The submitted Community Based Surveillance (CBS) alerts will get notified to DSOs on IDSP-IHIP portal on real-time basis
- DSO can access all these alerts under Outbreak – 'Community Reporting Alerts'



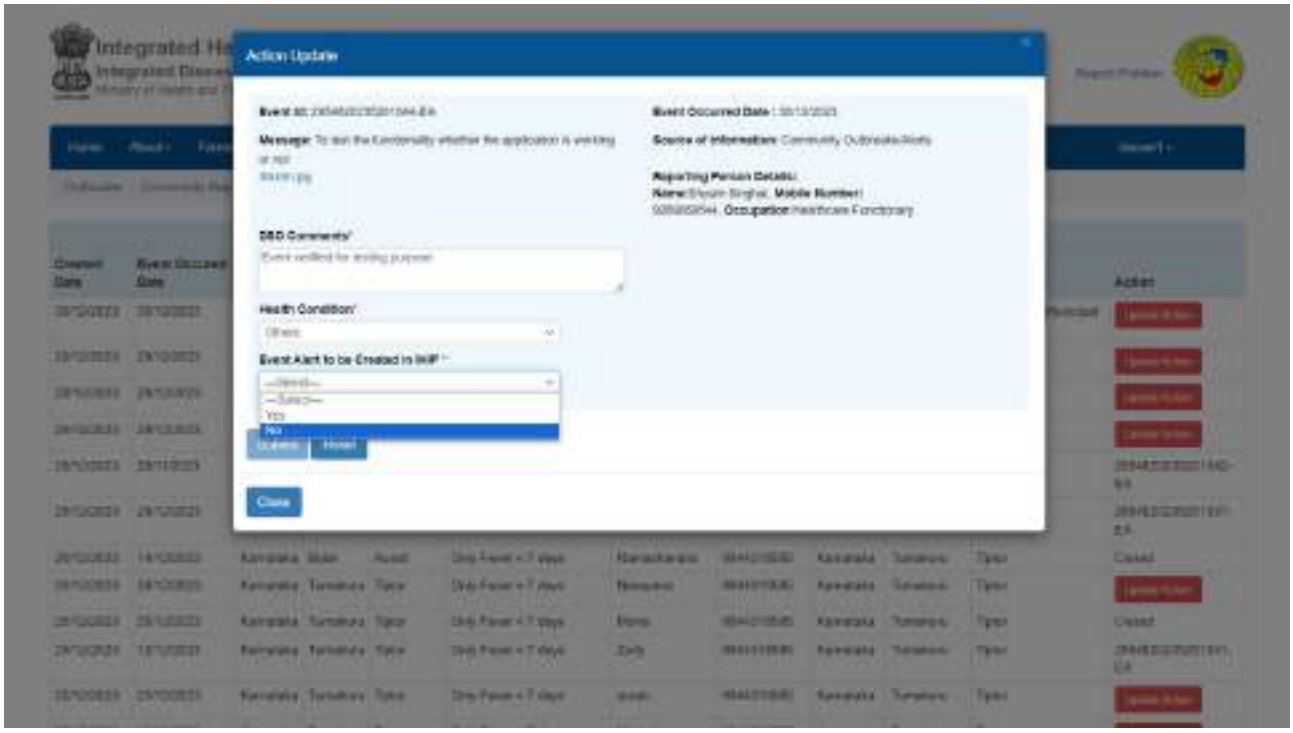
- DSO can click on ‘Update Action’ against each listed alerts to see the details



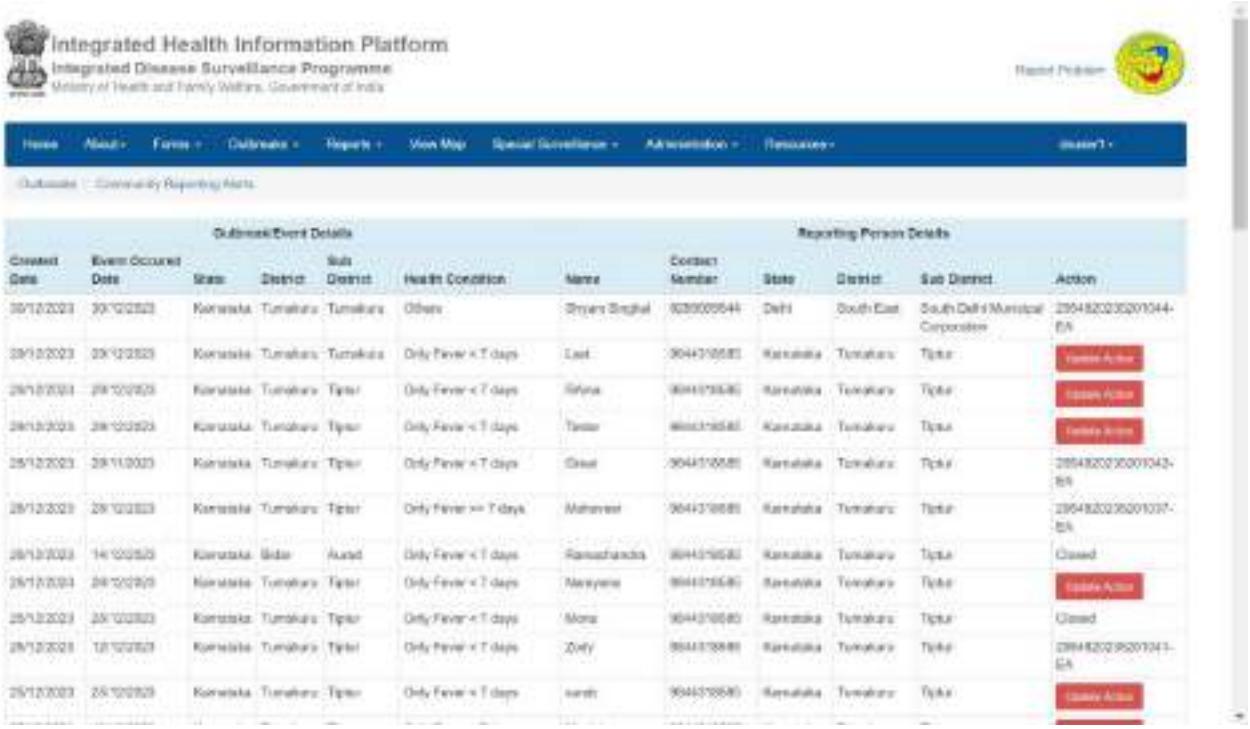
- After reviewing the provided information and documents/images the DSO need to take a decision whether this alert is significant and need further investigation
- If required DSO can contact the reporting person for seeking further information



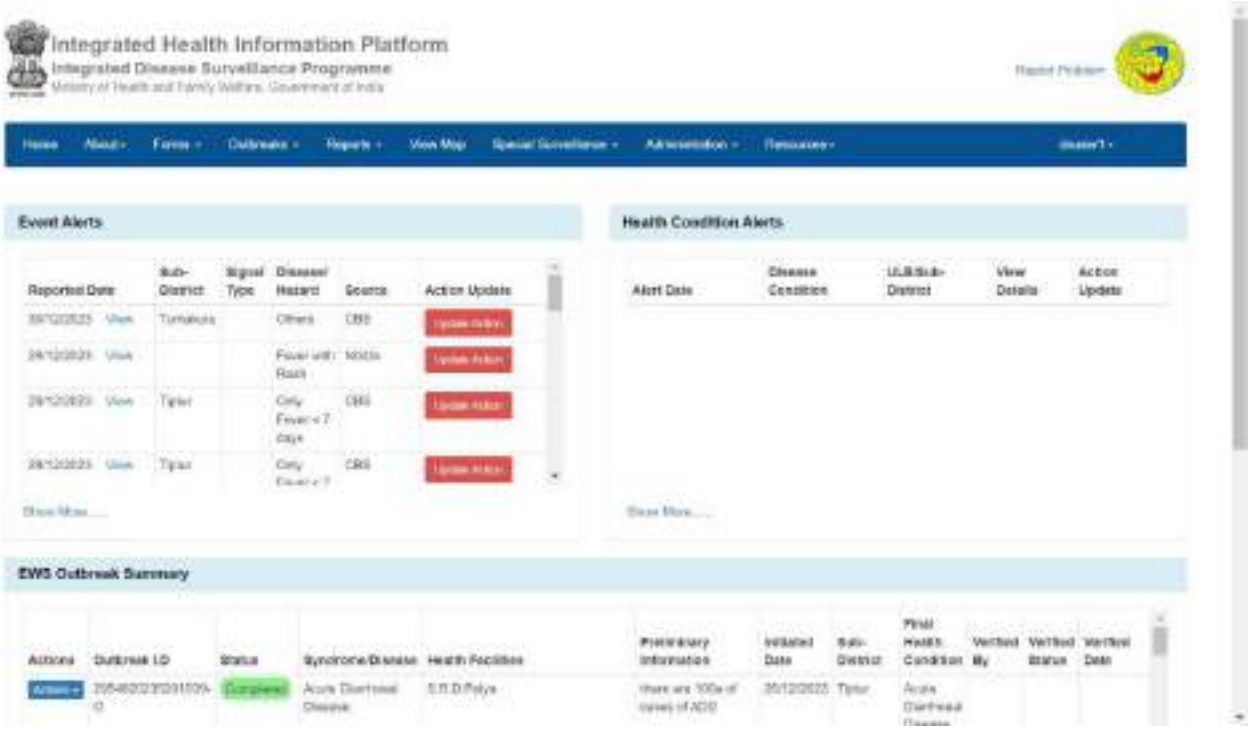
- If DSO decides that particular alert need further investigation, he/she may enter the 'Comments' and select to create an even alert on IDSP-IHIP
- DSO also need to select a health condition – this event alert belongs to



- Once a CBS Alert is converted into Event Alert on IDSP-IHIP, the 'Update Action' button will get replaced by the 'Event Alert ID'
- In case after review DSO found that alert is not significant and there is no need to create an 'Event Alert' at IDSP-IHIP he case mention so and submit
- The CBS Alert will be closed and same will be shown on the listing page



- The CBS Alert converted to 'Event Alert' will get listed under Outbreak – 'Event Alerts'
- Now, the DSO need to respond to it like other event alerts



ANNEXURE 4 :

Epidemiological clue to the possibility of a chemical-related outbreak

Epidemiological clue	Interpretation
Many people affected An unusual increase in the number of people with similar symptoms or toxidromes presenting during a short period (i.e. hours or days)	May suggest a single-source or continuing common-source exposure to a chemical agent.
Common demographic or other characteristics The affected people are from a similar age or occupational group, participated in a shared activity before the onset of illness, live in a common location or residence or used a common product (e.g. a medicine)	Clustering of affected people within defined occupational or social groups or geographical areas may indicate a shared, common, specific exposure.
No evidence of person-to-person transmission	An epidemiological pattern indicating person-to-person transmission is typical of an infectious disease outbreak. Lack of such evidence suggests a noncommunicable disease.
Geographical location Occurrence of illness or cases in a specified, defined location or outbreaks of similar illness in different geographical locations or an illness that is unusual for a given location (e.g. marine toxin poisoning in a non-coastal area)	Evidence of linkage in time and space may indicate exposure to release from a point source. Presentation of similar cases at different or unusual locations for the type of poisoning may suggest distribution of a contaminated product.
Mortality pattern – human Unexplained deaths, especially if rapid, among young and healthy members of the population	May be consistent with exposure to a toxic substance, with subsequent absorption and distribution to a target organ(s)
Mortality pattern – other organisms Unexplained and unusual pattern of deaths in plants, fish or animals (sentinel organisms)	Previously unknown contamination of the environment with subsequent ecological toxicity
Particular pattern in the onset and evolution of illness	Acute (minutes to hours) and sub-chronic (days to weeks) presentation of affected people with similar symptoms indicates a likely chemical etiology.
Rapid onset and evolution of illness	A short latency between exposure and clinical presentation is characteristic of many chemicals. The onset of toxic effects may be delayed when toxicity is due to a metabolite.
Delayed onset of illness	The latency between exposure and clinical effect may be long, e.g. carcinogens. Clinical effects may be apparent only after long exposure to low doses.

Preliminary Investigation questions

Characteristics of cases
What is the number of suspected cases?
How many deaths have there been; what is the mortality rate?
What are the age and sex characteristics of suspected cases?
How many suspected cases are there in the population?
What are the date and time of onset of cases?
What is the time course of the illness from onset to outcome (resolution or death)? In what order do clinical features appear?
What symptoms have been reported?
What signs have been observed?
Do cases require immediate medical treatment or hospitalization?
Do cases require decontamination?
What is the geographical distribution of suspected cases?
Is there any clustering of cases? Consider household, workplace, school, public place, water source, foods, consumer produce, ethnic and religious groups.
Where are cases being cared for (family, community, medical centre, other)?
Have others, such as first responders, medical staff or those caring for the suspected cases, developed symptoms?
Location
Is the area predominantly rural, urban or both?
Describe the land use or location in which cases originate (if known) e.g. camp for displaced people, residential, agricultural, commercial, industrial, educational, health care, open space, coastal area, recreational land, other
Are the dwellings temporary, permanent or other?
Are any nearby bodies of water used by those affected?
Possible sources of chemical exposure (food and water)
Did the cases eat a food in common (local, regional or imported)?
Has a particular traditional medicine or recreational substance been used by the majority of the cases?
Was a single brand of food or commodities (e.g. flour, sugar, salt, cooking oil), drink or medicine used by the majority of the cases or a range of products from a single distributor, manufacturer or market?
Is there a common source of drinking-water or recreational water?
Were any cases exposed to consumer products?

Agricultural and industrial activity
Have any unusual odours been noted in the locality?
Has there been a report of a recent chemical spill or release? What chemicals were involved? Where was the chemical released (e.g. air, water, land)? What quantity was released, approximately?
Is there visual evidence of mining in the area or any other activity that could contaminate the environment?
Is there visual evidence of current or past industrial or chemical manufacture, storage or disposal?
Are there any major industrial sites in the locality, and what do they produce?
Is there a significant trade or transport route in the vicinity?
Is chemical waste regularly imported to or exported from the area?
How and where are domestic wastes (solid and effluent) disposed or stored?
How and where is industrial or trade waste (solid and effluent) disposed or stored?
Are any unregulated domestic or industrial materials regularly recycled or sold?
Are there local cottage industries, and what are they?
Is it an agricultural area, and what are the main crops grown?
Has there been any recent pesticide application in the area? If so, which pesticide, how was it applied and for what purpose?
Are chemical fertilizers or other products applied to the land? Describe the frequency and when last used.
Military activity
Is there evidence of current or past military activity in the area?
Is the use of chemical agents known or suspected?
Other questions
What do local communities think is the cause of the illness?
Has a similar incident happened there or nearby in the past?
What are the print and broadcast media saying about the incident?
Are there any comments or speculation on social media?
Is there any reason to suspect mass psychogenic illness?
Environmental information (may not be readily available but should be collected with other data)
Have there been any unusual meteorological or extreme weather events recently (flooding, drought)?
Have there been any significant natural events that could trigger the release or mobility of a chemical?
What is the general direction of the prevailing wind?
What sources of water are used for drinking (aquifer, well, river)?
Where is drinking-water abstracted? Is it treated before use?
What water sources are used for bathing or recreational use?
Consider effluent discharges
What is the local geology (sand, clay, loam)?

Results of clinical and environmental testing
What medical investigations have been conducted? What are the results?
Have tests have been conducted on water (e.g. for heavy metals, organic solvents, pesticides)? What are the results?
Have tests have been carried out on food (e.g. for heavy metals, pesticides)? What are the results?
Have tests have been carried out on air? What are the results?
Have tests have been carried out on soil? What are the results?
Have any results been validated in quality-assured, accredited laboratories?

Factsheet : Chemical Emergencies

Key Points

PREVENTION OF CHEMICAL EMERGENCIES

SAFE LOCATION OF CHEMICAL FACILITIES

Ensure chemical facilities are situated away from residential areas.

REDUCTION OF STORED TOXIC AND FLAMMABLE CHEMICALS

Implement measures to reduce the quantity of stored toxic and flammable chemicals

TECHNICAL CONTROLS AND REDUNDANCY

Incorporate technical controls to enhance the safe use of chemicals

PREPARATION FOR MANAGEMENT OF CHEMICAL EMERGENCY

SCENARIO ANALYSES AND IMPACT ASSESSMENT

Conduct scenario analyses to identify potential chemical release scenarios

PLANNING, TRAINING, AND EXERCISING RESPONSE

Develop comprehensive emergency response plans

TRAINING AND EQUIPPING RESPONDERS

Ensure responders are well-trained to handle loss of containment situations

DETECTION AND ALERT IN CASE OF CHEMICAL EMERGENCY

EARLY RECOGNITION OF CHEMICAL EVENTS

Develop systems for early detection of chemical events

SCALING UP INCIDENT RESPONSE

Establish protocols to scale up the incident response based on the severity of the chemical event

RESPONSE IN CASE OF CHEMICAL EMERGENCY

CONTAINMENT OF CHEMICAL RELEASE

Act promptly to contain the spread of the released chemicals

DECONTAMINATION

Implement decontamination procedures for affected areas and individuals

MANAGEMENT OF HEALTH CONSEQUENCES AND RISK ASSESSMENT

Provide medical care and support for individuals affected by the chemical release

RECOVERY IN CASE OF CHEMICAL EMERGENCY

RISK AND IMPACT ASSESSMENT

Assess the overall risk and impact of the chemical release

CLEAN-UP

Execute thorough clean-up operations to remove residual chemicals and contaminants.

INVESTIGATION OF ROOT CAUSE

Investigate the root cause of the chemical release

WHY IS THIS IMPORTANT?

A chemical incident is the unexpected release of a substance that is (potentially) hazardous either to humans, other animals or the environment. Chemical releases arise from technological incidents, impact of natural hazards, and from conflict and terrorism. The management of chemical incidents requires a multi-disciplinary and multi-sectoral approach - the health sector may play a supporting or a leadership role at various stages of the management.

WHAT ARE THE HEALTH RISKS?

Chemical incidents can cause injury through four basic injury mechanisms which can also be strongly interrelated:

- Fire produces injuries through heat and exposure to toxic substances (including combustion products).6
- Explosion produces traumatic (mechanical) injuries through the resulting shockwave (blast), fragments and projectiles.
- Toxicity may result when humans come into contact with a chemical released from its containment, be it from storage or transport, or as reaction or combustion products. Toxicity can cause harm by a wide array of toxic mechanisms ranging from chemical burns to asphyxiation and neurotoxicity.

KEY FACTS: INDIA

-India has witnessed the world's worst chemical (industrial) disaster "Bhopal Gas Tragedy" in the year 1984. The Bhopal Gas tragedy was most devastating chemical accident in history, where over thousands of people died due to accidental release of toxic gas Methyl Iso Cyanate (MIC).

Only in last decade, 130 significant chemical accidents reported in India, which resulted into 259 deaths and 563 number of major injures

Following are the relevant provisions on chemical disaster management, prevailing in country:-

- Explosives Act 1884
- Factories Act 1948
- Environment Protection Act 1986
- Public Liability Insurance Act 1991
- Petroleum Act 1934
- Insecticides Act 1968
- Motor Vehicles Act 1988
- Disaster Management Act 2005

Exercise Scenarios :

BHOPAL GAS TRAGEDY

The Bhopal gas tragedy occurred on the night of December 2-3, 1984, in Bhopal, India.
Here's a timeline of events:

1. The UCIL pesticide plant in Bhopal had been operating since 1979. It was designed to produce carbaryl, a pesticide used to kill insects.
2. On the night of December 2, 1984, a large amount of water entered one of the storage tanks containing methyl isocyanate (MIC), a highly toxic gas used in the production of carbaryl.
3. The water reacted with the MIC, causing a chemical reaction that produced a large amount of heat and pressure. This led to a safety valve being activated, releasing a small amount of gas into the atmosphere.
4. Workers at the plant were not trained to deal with such emergencies, and they did not know how to contain the gas leak.
5. The gas cloud, consisting mainly of MIC and other toxic gases, quickly spread throughout the city of Bhopal. Thousands of people were exposed to the gas and many were killed instantly.
6. Panic and chaos ensued as people tried to flee the area. Many died on the streets, while others were trampled in the stampede.
7. The official death toll from the disaster is estimated to be around 3,000, but it is believed that many more died in the days and weeks following the gas leak due to the toxic effects of the gas.
8. Hundreds of thousands of people were injured, and many suffered from respiratory problems, blindness, and other health issues as a result of their exposure to the gas.
9. The disaster led to widespread outrage and calls for justice. Union Carbide Corporation, the parent company of UCIL, was criticized for its slow response to the disaster and for not taking responsibility for the tragedy. It eventually settled with the Indian government for $470 million, but many argue that this amount was not enough to compensate for the damage caused by the disaster.

INJECTS

- Do you think a proper M and E system would have helped to prevent the BGT at that time?
- How would have proper Surveillance and Monitoring played a crucial role during The Bhopal Gas Tragedy?
- How does an after-action review contribute to improving public health management in Bhopal tragedy?
- How would have training and exercises contribute to building capacity for managing Bhopal gas tragedy?
- Analyze the role of human error, technical failures, or organizational shortcomings in the incident.
- Evaluate the community engagement strategies used in the aftermath of the Bhopal Gas Traged
- Conduct a root cause analysis to identify the underlying causes of the Bhopal Gas Tragedy.

TUGHLAKABAD GAS LEAK 2017

On May 6, 2017, gas leak from one of the containers stationed near the ICD led to over 400 children being hospitalised

Here's a timeline of events

1. Crystal corp protection pvt.ltd. Nathupur, Sonipat imported two chemical container from China.
2. At 03:40 hrs both trucks leaves depot with one of them having some chemical dripping on the road. Driver had parked the dripping truck near the school wall, Tughlakabad area of Delhi, India, for some refreshments.
3. At 05:30 hrs driver of leakage trucks left for the Crystal corp protection pvt.ltd. Nathupur ,Sonipat
4. At 7:00 - students at Rani Jhansi secondary school adjoining the depot complaining about irritation of eyes, breathlessness, dizziness. Students were rushed to a nearby hospital from their school.

INJECTS

- What actions would you take immediately following a report of a gas leak in a populated area?
- How would have training and exercises contribute to building capacity for managing Tuglakabad incident?
- What strategies should be adopted for community awareness on hazardous materials?
- What may be the elements to had to be assessed   for risk assessment during Tugalkabad gas tragedy?
- What strategies should be adopted for community awareness on hazardous materials?

LG POLYMER (VISHAKHAPATNAM) GAS LEAK 2020

Here's a timeline of events

May 7, 2020:
• Around 2:30 a.m., a gas leak is reported from the LG Polymers chemical plant in the RR Venkatapuram village of Vishakhapatnam, Andhra Pradesh, India.
• The leaked gas is identified as styrene, a toxic and flammable substance used in the production of polystyrene plastics.
• The gas leak results in a strong odor and causes people in the surrounding areas to experience symptoms such as breathing difficulties, throat irritation, and vomiting.

May 7-8, 2020:
• As news of the gas leak spreads, panic ensues, and people in the affected areas begin to evacuate their homes.
• Several people, including children, collapse and lose consciousness due to exposure to the toxic gas.
• Local hospitals and medical facilities are overwhelmed with patients seeking treatment for gas-related symptoms.

May 8, 2020:
• The death toll from the gas leak rises to 12, and over 500 people are reported to be affected.
• Government authorities, including the National Disaster Response Force (NDRF) and the State Disaster Response Force (SDRF), are deployed to the site to contain the leak and provide assistance.
May 9-10, 2020:
• Rescue and relief operations continue, with efforts focused on evacuating affected people, providing medical treatment, and ensuring the safety of the surrounding areas.
• The gas leak is successfully contained by sealing the storage tanks and neutralizing the remaining chemicals at the plant.
• The affected areas are thoroughly cleaned and decontaminated to ensure the safety of residents.

May 11, 2020:
• An investigation is launched to determine the cause of the gas leak and identify any lapses in safety protocols at the LG Polymers plant.
• The plant's management is questioned, and several officials are arrested for negligence and violations of safety regulations.

May 14, 2020:
• The National Green Tribunal (NGT), an environmental court in India, imposes an interim penalty of Rs. 50 crore (approximately $7 million) on LG Polymers for the gas leak incident. The funds are directed towards providing compensation to the affected people and restoring the environment.

INJECTS

- Explain the significance of styrene and its potential risks in the context of the gas leak incident.
- Discuss the economic consequences, including the loss of livelihoods and property damage.
- Identify the root causes and contributing factors behind the gas leak incident.
- Explore the potential lapses in safety protocols, maintenance practices, or emergency response procedures at the plant.
- Analyze the role of human error, technical failures, or organizational shortcomings in the incident.
- Evaluate the effectiveness of the initial response by government authorities, emergency services, and medical facilities.

- Assess the measures taken to control the gas leak, evacuate affected areas, and provide medical treatment to the victims.
- Discuss the challenges faced during the rescue and relief operations and identify areas for improvement.
- Examine the legal actions taken against LG Polymers and its management for negligence and safety violations.
- Evaluate the adequacy of existing regulations and suggest possible improvements to enhance industrial safety standards.
- Explore the communication strategies employed during and after the incident to disseminate information to the public.

A crowd outside the LG Polymers plant. The incident took placed around 3:30 am. People woke up in horror with breathlessness and a burning sensation in their eyes. Photo: PTI

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LIST OF CONTRIBUTORS

NAME	DESIGNATION
Program Steering Committee and Editors	
Dr. Meera Dhuria	Joint Director & Head (Public Health Preparedness and NCD), NCDC
Dr. Saurabh Dalal	NPO (Emergency Preparedness & Risk Management) WHO India

EXPERTS

Dr. Senthil Nathan	CMO (SAG-IH) , MoHFW
Shri Jayant Raushan	Consultant- Chemical Disaster, Department of Chemicals (DCPC)
Dr. P Sivaperumal	Head - Chemical Science Division, ICMR-NIOH
Shri Abhishek Sharma	Senior Research Officer, NDMA
Dr. Vimlesh Bind	Adviser-NACWC
Dr. Amit Murari	CMO(SG), NDRF
Shri Nisarg Dave	Director, GIDM
Ms. Anusha Vyas	Research Associate cum Program Coordinator, GIDM
Shri BN Acharya	Scientist F, DRDE
Dr. Surya Prakash	Head CBRN, NIDM
Dr. Asit K Patra	Deputy Director, Disaster management Institute, Bhopal
Dr. Sujata Arya	ADG -IH, MoHFW
Dr. Raghvendra Kumar Vidua	Associate Professor, Forensic Medicine & Toxicology, AIIMS Bhopal
Dr. Meehir Palit	Scientist E, DRDE
Dr. Krupa George	Associate Professor and In-Charge CTU and PCC, CMC Vellore
Dr. Nishanth Hiremath	HOD - Emergency, Bhagwan Mahaveer Jain Hospital, Bangalore
Dr. Narendra Nath Jena	Director, Dept. of A & EM, Meenakshi Mission Hospital, Madurai
Dr. S Senthilkumaran	Emergency & Critical care Physician, Manian Medical Center, Erode

NCDC

Dr. (Prof) Ranjan Das	Director, NCDC
Dr. Atul Goel	Former DGHS and Director NCDC
Dr. Sujeet Kumar Singh	Former Director, NCDC
Dr. S Venkatesh	Former DGHS and Ex Director, NCDC
Dr. Himanshu Chauhan	Joint Director, HOD-IDSP, NCDC
Dr. Navin Verma	Joint Director Dte.GHS, EMR

WHO - India

Ms. Payden	WHO Representative to India (Acting)
Dr. Badri Thapa	Team Lead, WHE & CDS
Dr. George Joseph Kodickal	Health Emergencies and Disaster Risk Management Officer
Dr. Vidhya Chandramohan	Health Emergencies and Disaster Risk Management Officer
Dr. Anisur Rahman	NPO, Infection Prevention and Control, WHO India
Dr. Girish Chandra Dash	Consultant, Emergency Preparedness and Response
Mr. Amit Alok	Consultant, Emergency Preparedness and Response

National Centre for Disease Control
22 - Sham Nath Marg, Delhi - 110 054
Phone: +91-11-23971272, +91-11-23971060,
e-mail: dirnicd@nic.in
Website: www.ncdc.gov.in