**Abstract**

The effect of technological sites on the environment has been studied well, and people are aware of the problem of pollution. The possibility of an environment posing a threat to technological sites has been rarely studied. Such, events where natural forces trigger technological accidents are called as Natech accidents. In this study, the authors have observed that developing countries are aware of this emerging hazard. They have responded to it by creating various legislative frameworks for managing Natech risk. The study was done by the authors to understand the Indian perspective of the legal framework for Natech risk reduction. The Authors observed that India has an elaborate legislative framework for disaster risk identification and management. Though day to day disaster risk has been identified, the risk from natural forces is rarely considered. Apart from recognizing natural forces as a threat, no specific legislation is available for Natech risk reduction. Disaster anywhere can affect the economics of the entire world. There is a global need to create legislation and infrastructure to manage this new risk, particularly in developing countries like India.

**Keywords**

Disaster Management, Natech Risk, Indian Legislation, Safety of Hazardous Industry, Risk Reduction Measures, Climate Change

# Introduction

One disaster can cause a series of amplifying disasters through a chain of logical interaction with the built-in environment and natural environment. Such events are generally called as cascading effects. Pescaroli and Alexander, 2015 defined cascading events as, “the dynamics present in disasters, in which the impact of a physical event or the development of an initial technological or human failure generates a sequence of events in human subsystems that result in physical, social or economic disruption” [1]. There are special types of cascading events in which natural accidents can trigger one or more technological accidents. Such technological accidents which are initiated by the natural forces are called as a Natech accident. Such accidents may results in consequences like fire, explosion or release of hazardous substances in the environment. A tsunami triggered the worst nuclear disaster of Jap{Citation}an, Fukushima disaster, on March 11, 2011, which could be a suitable example of Natech. This was the worst industrial disaster in history as far as the cost of damage control and cleanup is considered from 1917 till 2011[2].

Showalter and Myers, 1992 investigated technological accidents triggered by natural forces in 28 States of America. In their research, they documented that there were, “228 accidents resulting from earthquakes, 28 from hurricanes, 16 from floods, 16 from lightning, 13 from high winds, seven from storms and six for other reasons”. They called such accidents as, “Natech,” a portmanteau of the naturally triggered technological accidents [3–9].

Recent releases of the hazardous material triggered by the earthquake in the United States are documented by the Lindell and Perry, 1996, “ 1971 San Fernando 18 releases, 1983 Coalinga 18 releases, 1987 Whittier Narrows 30 releases, 1989 Loma Prieta 50 releases and 1994 Northridge Earthquake 134 releases” [10]. Turkey earthquake occurred on August 17, 1999, can be the best example of Natech accidents. Steinberg and Cruz, 2004 studied this earthquake and found that many industrial sites were affected by the earthquake. There documented 21 hazmat release incidents associated with the earthquake [9]. Fall of the spruce-fir tree because of high wind velocities created many emergencies and blackouts in Italy on September 28, 2003. Earthquake and 1.3 Meter Tsunami resulted in tank fire at Tomakomai City on September 26, 2003 [3]. Storage tanks are vulnerable as they contain a large quantity of material. Chang and Lin, 2005 reviewed such accidents related to the storage tanks. They found that during the period from1960 to 2003 there were 242 accidents, among which 74 % were related to petroleum and 30 % of accidents are caused by lightning, a natural event [11].

Natech disaster cannot be managed by day to day disaster management system as it has following peculiarities;

1. There is a possibility of simultaneous multiple releases of the hazardous material
2. The natural event may incapacitate existing safety and mitigation measures
3. Resources required for the management of emergency and responses personnel may remain engaged in dealing with natural disaster and may not be available for management of technological accident
4. Natural disaster may hamper emergency response to the technological accident
5. Effects of a hazmat release may get exacerbated by a natural disaster
6. Stringent design standards can be exceeded by a severe disaster [12].

The research community generally considers the Natech event as a rare event and cascading effect of a natural disaster. Climate is changing, and the modern world is facing more and more stringent climatic conditions. Natech is a no longer rare event. There is a need to review the typology of disaster and acknowledge that the Natech exists [13].

There is also a need to create suitable legislation for Natech risk reduction. Developed countries have amended their laws suitably but developing countries, like India has little awareness about this relatively new hazard. In this paper, the Indian legislative framework will be studied to understand various legislations dealing with the hazardous substance and the subject of disaster management. These legislations will be evaluated for express or implied provisions related to Natech risk management.

# Scope

In this study, hazardous technology means a technology involving hazardous chemicals, 'micro-organisms and generally modified cells' or radioactive substances, which can cause harm to the nearby community or result in severe environmental pollution. Only these three industries are considered because, in case of an accident, these industries can tremendously endanger life, property, and environment of the nearby community.

# Material and Methodology

The material for the study was collected by three different methods, research papers, questionnaire survey and internet searches.

## Research Papers

The legislation created by other countries for addressing Natech disaster risk were studied mainly by referring to research papers. Research papers were searched on the internet by using keywords, “legislation for Natech risk” and “legislation for natural hazards triggering technological hazards”. Seveso III guidelines of the European Union were studied as it was important legislation known worldwide for the control of hazardous substances.

## Questionnaire Survey

The survey was conducted using a questionnaire method. The response was sought from experts from different technological systems, HSE officers (Health Safety and Environment) and members of Government Authorities.

The questionnaire contained two specific questions;

1. Name the legislation dealing with your industry for hazard and risk control.
2. Do you know any specific provision of any legislation which is related to environmental hazard posing threats to the industry? Please mention the specific name and clause of the legislation

As many of the responders have not read the legislation in detail, respondent could not through much light about the provisions for Natech, but the results were useful in knowing the names of legislation.

## Internet Search

The ‘Natech disaster’ word is composed of natural, technological and disaster, so the study was done in three parts, 1) Legislation related to Environment 2) Legislation related to risk reduction in hazardous technology and 3) Legislation related to disaster management. Legislation search was done on the internet by using the common prefix, “Act, Rules, Regulations, Notifications, and Order" for three categories, that is an environment, hazardous technologies, and disaster management. The following keywords were also used to find more specific legislation for three categories under study.

**Table 1 Keywords for Legislation Search**

|  |  |  |  |
| --- | --- | --- | --- |
| **Natech Legislation** | | | |
| **Constitution of India** | | | |
| **Domain** | **Environment** | **Hazardous Technology** | **Disaster Management** |
| Keywords | Air pollution | Explosives Safety | Disaster Management |
| Water pollution | Petroleum Safety | Emergency response |
| Environment pollution | Factory safety | Disaster guidelines |
| Hazardous substances | Dangerous goods |  |
| Hazardous chemicals | Electrical safety |  |
| Hazardous waste | Radiation safety |  |
| Biomedical waste |  |  |
| Environment impact assessment |  |  |

As a result following 30 legislations were identified for the study;

**Table 2 List of Legislation and Implementation Authority**

| Sr.  No | Name of Legislation | Authority | Government Ministry |
| --- | --- | --- | --- |
|  | The Environment Protection Act, 1986 | Central Pollution Control board  State Pollution Control board | The Ministry of Environment, Forest and Climate Change |
|  | The Environment Protection Rules, 1986 |
|  | The Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 |
|  | The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996 |
|  | The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 |
|  | The Bio-Medical Waste Management Rules, 2016 |
|  | The Manufacture, Use, Import, Export, and Storage of Hazardous Micro Organisms Genetically Engineered Organisms or Cells,1986 |
|  | The Noise Pollution (Regulation and Control) Rules,2000 | Commissioner of Police Superintendent of Police |
|  | Environment Impact Assessment Notification, 2006 | State Level Environment Impact Assessment Authority |
|  | The Public Liability Insurance Act, 1991 | District Collector |
|  | The Explosives Act, 1884 | Petroleum and Explosives Safety Organization | Department of Industrial Policy and Promotion, Ministry of Commerce and Industry |
|  | The Static and Mobile Pressure Vessels (Unfired) Rules, 2016 |
|  | The Gas Cylinder Rules, 2016 |
|  | The Petroleum Act, 1934 |
|  | The Petroleum Rules, 2002 |
|  | The Calcium Carbide Rules, 1987 |
|  | The Inflammable Substances Act, 1952 |
|  | The Indian Boilers Act, 1923 | Central Boilers Board |
|  | The Indian Boiler Regulations, 1950 |
|  | The Factories Act, 1948 | Director-General of Factory Advisory Services and Labour Institute  Director of Industrial Safety and Health | Ministry of Labour and Employment |
|  | The Maharashtra Factories (Control of Industrial Major Accident Hazard) Rules, 2003 | State Ministry of Labour and Employment |
|  | The Central Motor Vehicles Rules, 1989 | Road Traffic Officer | Ministry Of Road Transport And Highways |
|  | The Electricity Act, 2003 | Central Electricity Authority | Ministry of Power |
|  | The Central Electricity Authority Regulations, 2010 |
|  | The Atomic Energy Act, 1962 | Department of Atomic Energy | Under the direct charge of the Prime Minister |
|  | The Atomic Energy (Radiation Protection) Rules, 2004 |
|  | The Poisons Act, 1919 | Food and Drug Authority | Ministry of Health and Family Welfare. |
|  | The Petroleum and Natural Gas Regulatory Board (Codes of Practices for Emergency Response and Disaster Management Plan (ERDMP)) Regulations, 2010 | Petroleum and Natural Gas Regulatory Board | Ministry of Petroleum and Natural Gas |
|  | The Disaster Management Act, 2005 | National Disaster Management authority  District Disaster Management Authority | Ministry of Home Affairs |
|  | National Disaster Management Guidelines, Chemical Disaster (Industrial) |

After finding relevant legislations, the study was divided into four categories, constitutional perspective, environmental legislation, legislations related to hazardous technology and legislations related to disaster management. The Constitution was included in the study because it is a supermen law of the land,

Every legislation was studied to find out implied or express provision related to Natech risk management. After an in-depth study, the conclusion was drawn about whether Natech risk management has been addressed by the Indian legislation system or not.

# Legislations in Developed Countries

Article 9, Domino Effect, of Seveso III guidelines of the European Union, mandates to the Member States to, “identify all establishments where the risk or consequences of a major accident may be increased because of the geographical position, the proximity with each other, and their inventories of dangerous substances”. Once major accident hazard installation has been identified, a member state has to ensure that, “the operator of the establishment shall take in to account the nature and extent of major accident hazard in their Major Accident Prevention Plan (MAPP), safety systems, safety reports, and internal emergency plans, as appropriate”. They are also asked to keep the nearby public well informed. Further, Article 13, related to land use planning, also asks the members, “to ensure that the objectives of preventing major accidents and limiting the consequences of such accidents for human health and the environment are taken into account in their land-use policies”. Annexure-II, Safety Report, clause number four, asks for, “a detailed description of the possible major-accident scenarios”. It asks for the probability of occurring as well as the conditions under which major accidents may be triggered by the domino effects or natural causes, like earthquakes or floods. Apart from these few provisions specific Natech risk prevention was not considered [14]

Natural Risk Prevention Plans (RPP) of France, came into existence by Article L.562-1 of the Environment Code on February 2, 1995. The development of RPP results in zone maps. These zone map, a Natech risk reduction tool, is used for, “prohibitions and restrictions for the new installations, prevention, protection and safeguard general measures, special measures for existing installations”. A new law, No 2003-699 of July 30, 2003, establishes rules to give compensation for the damage caused by the Natech event. This law requires that prevention plans have to be carried out not only for natural risk but for the technological risk also [3]. Decrees 210-1254 and 2010-1255, 2010 of France created a zone system for industrial establishments which takes into account seismology of the area. Industrial establishments were divided into two risk categories for identification of the Natech risk and facilitation emergency planning: "normal risk" and "special risk". Establishments falling in the second category need to give the guarantee that their structures are mechanically strong to withstand ground acceleration, chosen by seismic zone. They have to ensure that their structures and equipment are sufficiently strong to ensure the containment of hazardous material.[7]

In Germany, the Bavarian State Department of the Interior promulgated a Decree NR. ID4-3041-C/71 (AllMBl P. 362) on April 19, 1991. This decree mandated early warning to the population for the upcoming storm. The Technical Rule on Installation Safety 310, 2012 of Germany requires that the industrial establishment which has major potential for chemical accidents should do a risk assessment for an accident that may be triggered by the flood. They are also required to consider increased flood risk because of climate change and take necessary risk reduction measures [3,7].

In Sweden, according to the EIA directive (85/337/EEG, 97/11/EG), Environmental Impact Assessments is a mandatory environment permit process for infrastructure and land use planning [3].

The United States has also recognized the Natech hazard and various precautionary measures are reflected in the legislation of different States. The specific risk reduction precautions were recommended by the Association of Bay Area Governments (ABAG). They published a guide in 1990, “Hazardous Materials Problems in Earthquakes: A Guide to their Cause and Mitigation” (ABAG, 1990). Learnings from Loma Prieta, earthquake were disseminated by creating a list of various failure modes by ABAG. They also recommended migratory measures like, “secondary containment structures, the use of seismic restraints, earthquake-resistant structural designs for tanks and pipeline support”. The California Accidental Release Program (CalARP) explicitly requires consideration for earthquake-induced hazmat release. It also considers planning for the worst-case scenario of hazmat [7,15]

In 2003, many fires were initiated by the Tokaichi-Oki earthquake, at the refinery. In response to this Natech event, Japan Government amended the law on the Prevention of Disasters in Petroleum Industrial Complexes and other Petroleum Facilities. This law considers earthquake-induced technological accidents. Accidental releases triggered by earthquakes and tsunamis are also considered in amended Japanese High-Pressure Gas Safety Law. These rules require industrial establishments to mitigate the risk of hazardous material release caused by Tsunamis and earthquakes [7].

Despite all these efforts, it seems that there is a requirement of specific legislation to address the Natech risk so that the lessons learned from past Natech events can be communicated [16].

# Study of Indian Legal Framework Related to Disaster Management

Relevant legislations have been studied in detail to find the existence of an express or implied Natech related provision. Legislations are freely available on websites of the concerned Government department of India.

## Constitutional Perspective

India believes in, ‘Constitutional Supremacy” which means the Constitution is the supreme and all legislative and administrative actions are derived from the Constitution. Though the Constitution of India does not have any explicit provision on the subject of disaster management, many provisions do have implied disaster management provisions. Article 51A of Part IVA of the Constitution imposes fundamental duties on citizens of India. Some of these duties are relevant to the broad subject of disaster management those are as follows;

1. “To protect and improve the natural environment including forests, lakes, rivers, and wildlife, and to have compassion for living creatures”;
2. “To safeguard public property and to abjure violence”;

Thus, in the true spirit, accident prevention and disaster management is also a fundamental duty of citizens of India [17].

Part IV of the constitution provides for the Directive Principles of State Policy. These principles are not enforceable, means they are not mandatory in nature. Nevertheless, they are the guiding stars in the governance of the country. Article 48A provides for, “the protection and improvement of environment and safeguarding of forest and wildlife in the country”. Any kind of accident or disaster will endanger the environment, so it is a constitutional mandate that every organization and individual should work towards efficient disaster management.

The Constitution of India, under Part III, guarantees fundamental rights that are essential for the moral, spiritual and intellectual development of every individual. Broad interpretation by the Supreme Court of Articles 21, 14 and 19 of this part, particularly Article 21, “Right to Life” has laid down various principles required for enjoying full life and freedom with the wholesome environment [18–22].

The issue of pollution as a result of technology is addressed in the Constitution but the issue of environment affecting technological sites was not expressly addressed. This is obvious because the Constitution creates only basic laws and fundamental infrastructure to govern the country. The provisions regarding disaster management were left to the wisdom of the Government and Authorities. It was expected that they would evolve appropriate policy and administrative framework required for disaster management.

## Legislation Related to Environmental Protection

The first special pollution control measure is the enactment of the Water (Prevention and Control of Pollution) Act, 1974. This Act was enacted for, “the prevention and control of water pollution and maintain and restore the wholesomeness of water”. It has created water pollution control boards at central and state level. The duty and function of the board are to set standards for water and create rules, and regulations for prevention, abatement, and control of water pollution. After the United Nations Conference on the Human Environment held in Stockholm in June 1972, the need was felt to control and abate air pollution. The Air Pollution (Prevention and Control of Pollution) Act, 1981, was enacted to control and abate increasing air pollution. The Central and State boards which were created under Section 3 and 4, respectively, of the Water Act, 1974 were also empowered to, ‘exercise the powers and perform the functions under the Air Act, 1981’ [23,24].

Till the year 1986, pollution control legislation was available only for water and air. The need was felt to protect and improve the quality of the entire environment, ensure safe handling of hazardous substances and control and reduce pollution from all sources. So, the Environment Protection Act, 1986 was passed which defines the environment as, "environment includes land, air and water, and interrelationship that exists between and among land, air and water, and plant, microorganism, animal, etc." The word "include" made this definition open-ended. The implication of this is, whatever is surrounded by us, including us, is an environment.

The Environment Protection Act, 1986 created a giant umbrella, under this visionary Act, various Rules are formed to govern almost every aspect of the environment. Some examples are; management and handling of microorganisms and genetically engineered cells, chemical accidents, hazardous chemicals, lead batteries, medical waste, municipal waste, hazardous and other waste, construction and demolition waste, plastic waste, E-waste, recycle plastic, ozone layer depletion, wetland conservation, all kind of emissions in the air, water and on land. Even noise is also considered as pollution [25]. These Rules suggest all preventive measures for safe handling of hazardous substances, accident notification to the authorities and then mitigating action by the occupier as well as authorities with the help of available resources. Responsibilities and duties to manage hazardous substances are fixed.

A total of seven Schedules are attached to the Environment Protection Rules, 1986 of which the Schedule number two is deleted. Fist schedule itself contains all emission standards for 104 different kinds of industries. Not only it provides emission standards but it also provides quality standards of air and water [26,27].

The Manufacture Storage and Import of Hazardous Chemical Rules, 1989 (MSIHC Rules) formed under the Environment Protection Act, 1986 [28]. These rules define and list hazardous chemicals. Specific definitions of flammable, toxic, explosives chemicals are given. Some chemicals are safe in low quantities but become hazardous if quantities handled are more. For such chemicals thresh hold quantities are prescribed beyond which they become hazardous. An exhaustive list of hazardous chemicals is given in Schedule one, two and three. These Rules have made detailed provisions for an onsite and offsite emergency plan for the accidents involving hazardous chemicals. Schedule 11 of MSIHC Rules provides for the onsite emergency plan, and schedule 12 provides for an offsite emergency plan. This rule covers only “hazardous chemicals” as defined in Rule 2(e) and not all “hazardous substances”. The definition of a hazardous substance is given in the Environment Protection Act, 1986. These rules also define Major Accident Hazard Installations and make provisions for the safe handling of hazardous chemicals. Under Rule number 10, the safety report is mandatory, and it has to be updated after three years under Rule number 11. A safety audit has to be carried out by an external independent expert person. Rules specify that safety report has to be prepared according to Schedule 8 but how to prepare safety audit report is not defined. Generally, auditors follow IS 14489 as a standard. Under these rules responsibilities of authorities have been fixed under schedule five. Accordingly, the chief factory inspector, now called DISH, Director of Industrial Safety and Health, is the Authority for the implementation of these Rules for factories. So these rules, with appropriate modifications, have been made mandatory under the Factories Act, 1948 by some State Governments. For example in the State of Maharashtra, the Control of Industrial Major Accident Hazard Rules, 2003 has been passed [29,30].

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was held in 1989. The provisions of the convention were made legal in India by enacting the Hazardous Waste Management Rules, 1989 under the EPA, 1986. New Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016 promoted the minimization of toxic waste generation. Recycle and reuse of waste are promoted and detailed provisions have been made for recycling and reuse of waste. Imports of certain hazardous waste mentioned in Schedule six are prohibited for example the waste containing Arsenic, Beryllium, Mercury, Selenium. Waste can be imported in India only to recycle and reuse and not for dumping. Elaborated provisions are made for the import and export of hazardous waste [31].

New Biological Waste Management Rules, 2016 divides biological wastes into four classes as against ten classes of previous Rules, which were repealed. These Rules provide for scientific management of biological waste. Many new things have been introduced like GPS (Geological Positioning System) tracking of biological waste transporting vehicles, immunization and training of workers, a website showing waste generation data for every biological waste generator and simple color-coded non-chlorinated bags [32].

Rules are also formed for the management of, “manufacture, use, import, export and storage of hazardous micro-organisms and genetically engineered organisms or cells”. “Microorganisms or genetically engineered organisms, products or cells” are classified under two major categories; ‘animal, pathogens’ and ‘plant, pests’. Different committees have been created for the management of microorganisms. The highest committee is the Recombinant DNA Advisory Committee (RDAC). This committee reviews scientific developments in biotechnology at national and international levels. The prime function of the committee is to recommend safety regulations related to the research and its application in the field. The onsite disaster management plan is the responsibility of the Institutional Biosafety Committee (IBSC) and an offsite disaster management plan is the responsibility of the District Level Committee (DLC) [33].

The Ministry of Health and Family Welfare (Department of Health), Government of India, has issued a notification under the Drugs and Cosmetics Rules, 1988. The notification was issued vide notification number GSR No. 944 (E) on September 21, 1988. This notification provides a detailed requirement for the conduct of the clinical trial, presentation of trials, import or manufacture of biotechnological and biological products. The permission is required from the drug control authorities for the marketing of any new drug manufactured in India or imported to India [34].

Indian Legislation system respected hazardous properties of the chemicals and enacted the Chemical Accident Rules, 1996. The definition of hazardous chemicals is the same as the MSIHC Rules, 1989. These Rules have created different level crisis groups, Central Crisis Group, State Crisis Group, District Crisis Group, and Local Crisis Group to manage the chemical accident. Onsite and offsite plans had to be prepared according to the MSIHC, 1989 only [35].

Prior environmental clearance is necessary before starting a new project according to the Environment Impact Assessment Notification, 2006, unless exempted. Projects are classified as category A and B. the Central Government, the Ministry of Environment and Forests is responsible for category A projects and State Level Environment Impact Assessment Authority (SEIAA) is responsible for the project category B. These Authorities give prior environmental clearances on the recommendation of the Expert Appraisal Committee (EAC) at Central Government level and State Expert Appraisal Committee (SEAC) at State level. Information about the project is required in Form number I. Form number I, part II, Activity number 8 is, “Risk of accidents during construction or operation of the project, which could affect human health or the environment”. Clause number 8.3 specifically asks, "Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudbursts, etc.)?" This shows that the Natech possibility is recognized by this notification. Apart from this question, there is no Natech risk management provision and this notification is applicable for new projects only and not to existing technological sites [36].

The Public Liability Insurance Act, 1991 provides for, “public liability insurance for immediate relief to affected people by accident involving hazardous substances”. This Act is for “hazardous substances” and not only for “hazardous chemicals”. The collector is the authority for the implementation of the Act. Though speedy financial help is possible under this Act, the relief amount provided is very less [37].

## Legislation Related to Hazardous Substances and Technological Sites

The oldest legislation dealing with hazardous substances in the Indian Explosives Act, 1884 which is still in force with necessary amendments. The Indian Explosive Act, 1884 talks about safety, reporting of accidents and licensing system. Authority to execute the Act is with PESO (Petroleum and Explosive Safety Organization) previously known as a CCOE (Chef Controller of Explosives). Now PESO is the authority for the Petroleum Act, 1934 and the Explosives Act, 1884. The functioning of the organization, procedures they have established and the way they ensure compliance is exemplary. Under the umbrella of PESO many other rules like the Static and Mobile Pressure Vessel (unfired) Rules, 2016, The Ammonium Nitrate rules, 2012, The Petroleum Rules. 2016, The Gas Cylinders Rules, 2016, The Calcium carbide Rules, 1987, The Inflammable substances Act, 1952 and many others are governed [38]. Ammonium Nitrate being an explosive governed under the Indian Explosives Act, 1884 [39]. The Gas Cylinder Rules, 2016 apply to all gas cylinders. Gas cylinder means, “any closed metal container having a volume exceeding 500 milliliters but not exceeding 1000 liters intended for the storage and transport of compressed gas, including any liquefied petroleum gas (LPG) container or compressed natural gas (CNG) cylinder fitted to a motor vehicle as its fuel tank but not including any other such container fitted to a special transport or undercarriage and includes a composite cylinder and cryogenic container, however, the water capacity of the cylinder used for storage of CNG, nitrogen, compressed air, etc., may exceed 1000 liters up to 3000 liters provided the diameter of such cylinder does not exceed 60 cm”. So, except CNG, nitrogen, and air, a metal container containing compressed gas will be considered as a gas cylinder up 1000 liters capacity, beyond which it will be covered by the Static and Mobile Pressure Vessel (unfired) (SMPV) Rules, 2016 [40]. Process plants and equipment are exempted from SMPV Rules. All piping and equipment, which do not fall under the definition of pressure vessels but having pressure more than atmospheric pressure are governed by Section 31 of the Factories Act, 1948, if they are inside the factory. Periodic testing like visual inspection, non-destructive tests, and hydrostatic tests are mandatory for pressure plants under the Factories Act [41,42].

Serious boiler explosion occurred in Calcutta in 1863 caused loss of several lives. Various province then enacted boiler laws, which were inconsistent with each other. So the Central government appointed, The Boiler Law Committee” to consolidate and create uniform law for India. As a result the Indian Boiler Act was enacted in 1923[43]. The latest definition of the boiler is the vessel more than 25 liters capacity used for generating steam by application of heat and which is at 100 degree Celsius generating more than one kg per centimeter square pressure. The boilers used for sanitization in hospitals are excluded up to 100 liters capacity. Further, the boilers used for locomotives, vessels and belonged to armed forces are excluded from the operation of the Act. The Central Boiler Board has been constituted under Section 27A of the Act, to regulate and provide for manufacturing specifications, safety operating procedures and likening etc. Under Section 18 it is necessary to report the accident within 24 hours to Boiler Inspector. The Indian Boiler Regulation, 1950 deals with the manufacturing part of the boiler. It gives detailed engineering specifications and mandates for sound engineering practices, so that the boiler should withstand maximum working pressure. Though, this Act and regulations made under it are based on sound engineering and industrial practices, Natech hazard has not been considered in the Act or corresponding regulation[44,45].

The Petroleum Act, 1934 and the Petroleum Rules, 2016 made thereunder are also governed by PESO. According to the Petroleum Act, 1934, petroleum is divided into three classes, “class A flashpoint less than twenty-three degrees centigrade, Class B flash-point of twenty-three degrees centigrade and above but below sixty-five degrees centigrade and Class C flash-point of sixty-five degrees centigrade and above but below ninety-three degrees centigrade”. All licenses, safety systems, safe distance, and electrical safety systems are governed by PESO. The Petroleum Rules, 2016 is a beautiful body of Rules, which clearly defines when a license is required for handling, storing and refining petroleum. It states all safety precautions required to be taken for the safe handling of petroleum [46,47]. Many times Acts and Rules doesn't specify conditions instead of it asks to comply with some Indian standards, like the Bureau of Indian Standard (BIS), even international standards are also accepted. The Petroleum Rules, 2016 ask for compliance of six Oil Industry Safety Directorate (OISD) Standards. Though OISD standards are only guidelines and not mandatory, these six standards, being accepted by the Petroleum Act, have a mandatory effect.

These standards are OISD 105, 116, 117, 118, 141 and 156 pertaining to Work Permit System, Fire Protection Facilities for Petroleum Refineries and Oil/Gas Processing Plants, Fire Protection Facilities for Petroleum Depots, Terminals, Pipeline Installations & Lube oil installations, Layouts for Oil and Gas Installations, Design and Construction requirements for cross country hydrocarbon pipelines and Fire Protection Facilities for Ports Handling Hydrocarbons respectively. Though calcium carbide is not petroleum, it generates acetylene gas when it comes in contact with water. Acetylene properties are similar to petroleum, so the Calcium Carbide Rules, 1987 are formed under the Petroleum Act, 1934 to manage and control the hazard of acetylene gas [48].

The Central Government may apply, by notification, any or all provision of the Petroleum Act, 1934 to any, “dangerously inflammable substance” excluding the explosives. The Inflammable Substances Act, 1952, empowers Central Government to apply the Petroleum Act to seven new “dangerously inflammable substances”. Accordingly, acetone, carbide of calcium, a cinematographic film having nitrocellulose base, ethanol, methanol, calcium phosphide, and wood naphtha will be considered as petroleum, though they are not petroleum [49].

The Poisons Act, 1919, governs poisons since 1919. The State Government may by Rules, “regulate, the possession for sale and the sale, whether wholesale or retail, of any specified poison within the whole or any part of the territories under its administration”. The Central Government may, by notification in the Official Gazette, regulate the grant of Licenses for any specified poison. The Central Government may prohibit the importation of any specified poison into India across any customs frontier defined by the Central Government, except under the conditions of a License [50].

The Central Motor Vehicles Rules, 1989 deals with the transport of dangerous goods by motor vehicles. United Nations classification number, display of Emergency Information Panel is compulsory on all vehicles involving the transport of dangerous goods. NDMA guidelines for chemical accident preventions also have elaborate provisions for the safety of hazardous goods transport. Apart from other measures driver has to undergo three days of defensive driving and chemical safety training for the transportation of dangerous goods [51].

In 1875, the first committee appointed to inquire into the conditions of the factory and create a law to ensure minimum standards. The first Factories Act was adopted in 1881. After independence, many old provisions related to laborers and factories were consolidated in the new Act, the Factories Act, 1948. This new Act touched many important aspects of life safety, disaster management, social security and welfare of the workers working in the factory. Section 12 mandates that every effluent should be treated before sending out of the factory. This is a general provision. Nevertheless, it addresses environmental pollution. This Act makes mandatory for the occupier to prepare an onsite and disaster management plan under Section 41B, but how to prepare the plans has not been explained. Every state has different factory rules prepared under The Factories Act, 1948 for example, the Gujarat Factory Rules, 1963, The Karnataka Factory Rules, 1969, etc. The Maharashtra Factories Rules, 1963 governs safety and welfare provisions in the factories in minute details as per the guiding principle is given in the Factories Act, 1948. Only implied Natech related provision under Rule 70(3) of the Maharashtra factories Rules, 1963 is, “protection against lightning” [41,52].

The Electricity Act, 2003, requires the Union Government to prepare a Tariff Policy and National Electricity Policy in consultation with the Central Electricity Authority of India (CEA) and the State Governments. The main purpose of the Act is the development of the power system based on the optimal utilization of resources. The Central Electricity Authority has been created under the Act (originally created under Section 3(1) of the repealed Electricity (Supply) Act, 1948). This authority prepares the National Plan. National, Regional and State load dispatch centers have been created for optimum scheduling and dispatch of electricity. Central, State, and Joint regulatory commissions have been established to regulate terrify and other matters [53]. The Electricity Act has created nationwide infrastructure, but detailed safety precautions regarding electricity are elaborated in the Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010. Only implied Natech related provision is found under regulation 74, “protection against lightning” [54].

In India, atomic energy is being governed by the Department of Atomic Energy (DAE) reporting directly to the Prime Minister. Under the Atomic Energy Act, 1962 Central Government has got power, “to produce, develop, use and dispose of atomic energy either by itself or through any authority or Corporation”. The Central Government under this Act can control or acquire any mining, plant dealing with fissile material. The authority for enforcement of the provisions lies with the Central Government. These authorities also include the appointment of inspecting staff and the making of rules under the Indian Mines Act, 1952 and the Factories Act, 1948. Accordingly, the mines having radioactive substances are governed by the Atomic Energy (Working of the mines, minerals, and handling of prescribed substances) Rules, 1984. The factories involving radioactive substances are governed by [Atomic Energy (Factories) Rules, 1996](http://www.dae.nic.in/writereaddata/FactoriesRules96.pdf). General radiation safety is handled by the Atomic Energy (Radiation Protection) Rules, 2004 made under the Atomic Energy Act, 1962. The Civil Liability for Nuclear Damage Act, 2010 and the Civil Liability for Nuclear Damage Rules, 2011 provides for elaborate provisions regarding civil liability arising from any accident involving radioactivity. This way, all fissile and radioactive material is directly brought under the control of the Central Government [55–58].

## Legislations Related to Disaster Management

India has a quasi-federal governing system. Though more powers are centralized at the Union level, many subjects lie within the power of State Governments. The Seventh Schedule to the Constitution of India ensures distribution of powers and function between Union Government and State Government by creating three separate lists, Union List, State List, and Concurrent List. The Concurrent list contains powers and functions common to both Union and State Government. The subject of disaster risk reduction was not listed specifically in any list of the seventh schedule. Primarily it was the responsibility of respective State Government with the assistance of the Central Government [59]. By this time need was felt to bring a paradigm shift in disaster management so, the Department of Agriculture and Cooperation, Ministry of Agriculture, along with the National Disaster Response Plan constituted a “High Power Committee” in August 1999 with the approval of the Prime Minister. Shri J. C. Pant was the chairman of the committee. The main purpose of the committee was, “to suggest measures to bring about institutional reforms in the field of disaster management”. Disaster Management Act was one of the recommendations of the Pant Committee [60].

With this background, the revolutionary Act was passed in 2005, the Disaster Management Act, 2005. There was a paradigm shift in the approach from reactive relief based approach to a proactive, holistic approach towards preparedness, prevention, mitigation, speedy response, and build back. This Act has created whole body National Disaster Management Plan, State Level Disaster Management Plan, District Level Disaster Management Plan, Government Ministries, and Department level Disaster Management Plan under the common umbrella of the NDMA (National Disaster Management Authority). The prime minister is the chairperson of NDMA. National Executive Committee (NEC) comprising secretaries of Different Ministries and Chief of Integrated Defense Staff is a member of the Executive Committee. National Disaster Response Force (NDRF) has been created comprising mainly of paramilitary forces equipped with special training and equipment for response and rescue. The financial backup plan is created by establishing a National Disaster Mitigation Fund and National Disaster Response Fund. For every district, District Emergency Authority (DEA) has been created. The responsibility to create a detailed disaster management plan lies with this Authority, generally District Collector. The responsibilities have been fixed, and resources have been identified for disaster management [61].

NDMA guidelines on chemical accidents recognize that natural forces can cause a chemical disaster. The executive summary mentions that "common causes for chemical accidents are deficiencies in safety management systems and human errors, or they may occur as a consequence of natural calamities or sabotage activities”. Clause 1.3.2 “Natural Calamities” recognizes that, “the Indian subcontinent is highly prone to natural disasters, which can also trigger chemical disasters”. As an example, guidelines give two cases, “damage to phosphoric acid sludge containment during the Orissa super cyclone in 1999 and the release of acrylonitrile at Kandla Port, during an earthquake in 2001”. Under clause 5.2 storage v (g) guidelines suggest the usage of, “lightning arrestors for gases such as hydrogen that can make an explosive mixture with air”. Further, Annexure F suggested in the element of Onsite Emergency Plan that emergency response procedures should have Hurricane Procedure for coastal areas. Guidelines are silent on what the procedure should be followed. The guidelines recognize that natural hazards can interfere with technological hazards at two-three places expressly or impliedly but apart from that these guidelines are silent on Natech risk management [62].

The Petroleum and Natural Gas Regulatory Board, Emergency Response and Disaster Management Plan Regulations(ERDMP), 2010 is the latest specific comprehensive effort by certain departments of the Government towards disaster risk reduction. These regulations are very special from a disaster management point of view. Some of the key features are as follows;

1. These regulations apply to installations involving hydrocarbons only and not for any other hazardous chemicals.
2. These regulations are currently applicable to only the petroleum industry under the Ministry of Petroleum and Natural gas.
3. ERDMP regulations are location-specific, for different areas according to natural, geological, climatic and social setting different plans will be prepared.
4. ERDMP mandates to take account of NDMA chemical guidelines while preparing a disaster management plan, indirectly making NDMA chemical guidelines mandatory.
5. Not only the cascading effect of the technological accident is considered, but offsite emergencies initiating onsite emergencies have also been considered.
6. All installations having ERDMP has to provide help to civil authorities. Any contradiction to this provision attracts a heavy penalty.
7. Identified causes for an accident include, among others, natural calamities also.
8. The uniform siren code system throughout the country.

Apart from just recognition, no specific provision for Natech risk management can be seen in the legislation [63].

# Results and Discussion

The general philosophy of accident prevention legislation in India is that the legislation identifies specific risk area, create rules for the safety of man and environment. Legislation fixes the responsibility of safe handing on a person, “who has ultimate control over the affairs” of the technological site, called an “occupier”. Enforcement of the legislation is done by some executive authority. Safe and accident-free operation is the responsibility of occupier and accident reporting is mandatory. Penalties are provided for the contravention to any provision of the legislation.

India has a good legal framework for governing hazardous substances. The Country has identified and defined specifically various hazardous substances in different categories. The country has also identified Major Accident Hazard Installations and specific laws for the safety of the technological sites are already in place. The Disaster Management Act, 2005 and The Environment Protection Act, 1986 are two important legal frameworks for the management of disaster in India. These two legislation along with ERDMP regulation, 2010, has created a world-class legal framework for effective, and efficient management of any kind of disaster.

Despite all these goods, specific provisions for Natech risk management is missing. Lightning as a natural hazard has been recognized conspicuously. New legislation like ERDMP specifically acknowledges natural forces as a cause of the disaster. The NDMA chemical guide uses word Natech only once and considers it as a rare phenomenon. Earlier the Natech might have been a rare event but with growing dependence on technology and climate change, Natech is no longer rare.

Indian legislative system has already identified hazardous substances and basic infrastructure is also available for Natech risk management. There is, therefore, a need to ensure that the existing legal framework of the safety management system is further improved and made effective and efficient. There is a need to create specific legislation to identify and reduce Natech risk for accidents involving hazardous substances. The focus should not only on technological sites handling hazardous chemicals but on other hazardous technologies like radioactive substances and hazardous microorganisms, etc.

# Conclusion

Natech, a natural hazard triggering a technological accident is a new hazard in the technology-driven world. Environmental hazards are becoming more and fiercer which can damage the human technological system, if not properly protected. The disaster anywhere in the world can affect the entire globe through the supply chain and distribution network. Hurricane Katrina is an example that affected crude oil prices and the petroleum industry throughout the world. Though, there is increased awareness in developed countries Natech legislations are scares. It is a need of time that the international community should take the call and create a specific legal infrastructure for Natech risk reduction for their Country.

India also has a very good framework for disaster prevention as well as disaster management. Despite the world-class disaster management system, specific provision for the Natech risk management is missing. As a developing and crowded country with a population density of 382 persons/sq.km, India cannot afford any kind of risk to its infrastructure. Under these circumstances, it becomes compulsory for India to consider Natech risk and manage it proactively by creating specific legislation.

# Data availability

All Acts, Rules, and Regulations mentioned in this paper are freely available on websites of the different departments or authorities of the Indian Government.

# References:

[1] G. Pescaroli, D. Alexander, A definition of cascading disasters and cascading effects: Going beyond the “toppling dominos” metaphor, Planet@Risk. 3 (2015) 58–67.

[2] E. Mihailidou, K. Antoniadis, M. Assael, The 319 Major Industrial Accidents since 1917, International Review of Chemical Engineering. Rapid Communications (I.RE.CH.E.). 4 (2012) 1–12.

[3] A.L. Arellano, A.M. Cruz, J.-P. Nordvik, F. Pisano, Analysis of Natech (Natural Hazard Triggering Technological Disasters) Disaster Management, European Commission Directorate General Joint Research Centre Institute for the Protection and Security of the Citizen, Technological and Economic Risk Management Unit, European Commission Directorate General Joint Research Centre, Ispra, Itali, 2003. https://www.preventionweb.net/files/1607\_LBNA21054ENC002.pdf.

[4] A.M. Cruz, N. Okada, Methodology for preliminary assessment of Natech risk in urban areas, Natural Hazards. 46 (2008) 199–220. https://doi.org/10.1007/s11069-007-9207-1.

[5] A. Kovacs, N. Bican-Brisan, C. Malos, Z. Török, A. Ozunu, Prerequisites of a NaTech event at a production gas well in Romania, 12 (2015) 8. http://www.ecoterra-online.ro/files/1437398884.pdf.

[6] E. Krausmann, A.M. Cruz, Impact of the 11 March 2011, Great East Japan earthquake and tsunami on the chemical industry, Natural Hazards. 67 (2013) 811–828. https://doi.org/10.1007/s11069-013-0607-0.

[7] Nuclear Energy Agency, Towards an All-Hazards Approach to Emergency Preparedness and Response, 2018. https://doi.org/10.1787/9789264289031-en.

[8] P.S. Showalter, Natural disasters as the cause of technological emergencies : a review of the decade, 1980-1989 / Pamela Sands Showalter and Mary Fran Myers, Natural Hazards Research and Applications Information Center, Institute of Behavioral Science, University of Colorado, [Boulder, Colo.], 1992.

[9] L.J. Steinberg, A.M. Cruz, When Natural and Technological Disasters Collide: Lessons from the Turkey Earthquake of August 17, 1999, Natural Hazards Review. 5 (2004) 121–130. https://doi.org/10.1061/(ASCE)1527-6988(2004)5:3(121).

[10] M.K. Lindell, R.W. Perry, Hazardous Materials Releases in the Northridge Earthquake: Implications for Seismic Risk Assessment, Risk Analysis. 17 (1997) 147–156. https://doi.org/10.1111/j.1539-6924.1997.tb00854.x.

[11] J.I. Chang, C.-C. Lin, A study of storage tank accidents, Journal of Loss Prevention in the Process Industries. 19 (2006) 51–59. https://doi.org/10.1016/j.jlp.2005.05.015.

[12] A.M. Cruz, Challenges in Natech Risk Reduction, Revista de Ingeniería 37. (2012) 79–87. http://www.scielo.org.co/pdf/ring/n37/n37a13.pdf.

[13] J.S. Picou, Katrina as a Natech Disaster: Toxic Contamination and Long-Term Risks for Residents of New Orleans, Journal of Applied Social Science. 3 (2009) 39–55. https://doi.org/10.1177/193672440900300204.

[14] The Control of Major Accident Hazards Involving Dangerous Substances, the European Council, 2012. https://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0001:0037:EN:PDF.

[15] A.M. Cruz, L.J. Steinberg, A.L. Arellano, J.-P. Nordvik, F. Pisano, State of the Art in Natech Risk Management, Ispra, Italy, 2004. https://www.preventionweb.net/files/1607\_LBNA21054ENC002.pdf.

[16] E. Krausmann, D. Baranzini, Natech risk reduction in the European Union, Journal of Risk Research. 15 (2012) 1027–1047. https://doi.org/10.1080/13669877.2012.666761.

[17] The Constitution of India, 1950. https://www.india.gov.in/sites/upload\_files/npi/files/coi\_part\_full.pdf.

[18] M C Mehta vs Union of India, 2001. https://indiankanoon.org/doc/69408974/.

[19] Maneka Gandhi Vs. Union of India, 1978. https://indiankanoon.org/doc/1766147/.

[20] M.C. Mehta vs. Union of India, 1987. https://indiankanoon.org/doc/1486949/.

[21] Rural Litigation and Entitlement Kendra vs. State, Dehradun Quarrying Case, 1988. https://indiankanoon.org/doc/1949293/.

[22] Vellore Citizens Welfare Forum vs. Union of India, 1996. https://indiankanoon.org/doc/1934103/.

[23] The Air (Prevention and Control of Pollution) Act, 1981. https://indiacode.nic.in/handle/123456789/1389?view\_type=browse&sam\_handle=123456789/1362.

[24] The Water (Prevention and Control of Pollution) Act, 1974. https://indiacode.nic.in/handle/123456789/1612?view\_type=search&sam\_handle=123456789/1362.

[25] The Noise Pollution (Regulation and Control) Rules, 2000. http://cpcbenvis.nic.in/noisepollution/noise\_rules\_2000.pdf.

[26] The Environment Protection Act, 1986. https://indiacode.nic.in/handle/123456789/4316?view\_type=browse&sam\_handle=123456789/2497.

[27] The Environment Protection Rules, 1986. http://moef.gov.in/wp-content/uploads/2017/11/Petcoke.pdf.

[28] ILO, Prevention of Major Industrial Accidents Convention, 1993. https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100\_ILO\_CODE:C174.

[29] The Maharashtra Factories (Control of Industrial Major Accident Hazard) Rules, 2003.

[30] The Manufacture Storage and Import of Hazardous Chemicals Rules, 1989. http://www.dgfasli.nic.in/docks/MSIHC\_RULES.htm.

[31] The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. http://iwma.in/HWM%20Rules.pdf.

[32] The Bio-Medical Waste Management Rules, 2016. http://mpcb.gov.in/biomedical/pdf/BMW\_Rules\_2016.pdf.

[33] The Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms Genetically Engineered Organisms or Cells, 1989. http://nbaindia.org/uploaded/Biodiversityindia/Legal/28.%20Rules%20for%20the%20manufacture,%20use%20import%20export%20and%20storage%20of%20hazardous%20microorganism%20genetically%20engineered%20organisms%20or%20cells,%201989.pdf.

[34] The Drugs and Cosmetics (Eight Amendment) Rules, 1988. https://ibkp.dbtindia.gov.in/DBT\_Content\_Test/CMS/Guidelines/20181115121725374\_drug%20and%20Cosmetics%20Rules.pdf.

[35] The Chemical Accident Rules, 1996. http://npcb.nagaland.gov.in/wp-content/uploads/2016/03/Chemical-accidnets-1996.pdf.

[36] Environment Impact Assessment Notification, 2006. http://www.environmentwb.gov.in/pdf/EIA%20Notification,%202006.pdf.

[37] The Public Liability Insurance Act, 1991. https://indiacode.nic.in/bitstream/123456789/1960/1/A1991-06.pdf.

[38] The Indian Explosive Act, 1884. https://peso.gov.in/PDF/Explosive\_%20Act\_1884.pdf.

[39] The Ammonium Nitrate Rules, 2012. https://peso.gov.in/PDF/Ammonium\_Nitrate\_Rules\_2012\_English\_Version.pdf.

[40] The Gas Cylinder Rules, 2016. https://peso.gov.in/PDF/GCR\_2016.pdf.

[41] The Factories Act, 1948. https://indiacode.nic.in/handle/123456789/1530?view\_type=browse&sam\_handle=123456789/1362.

[42] The Static and Mobile Pressure Vessel (unfired) Rules, 2016. https://peso.gov.in/PDF/SMPV\_RULES\_2016.pdf.

[43] Website of Central Boiler Board, (n.d.). https://dipp.gov.in/sites/default/files/boiler\_rules\_updated/history.htm (accessed June 7, 2020).

[44] The Boilers Act, 1923.

[45] Indian Boiler Regulation, 1950. https://dipp.gov.in/sites/default/files/boiler\_rules\_updated/contentsregulation.htm (accessed May 30, 2020).

[46] The Petroleum Act, 1934. https://peso.gov.in/Petroleum\_Act.aspx.

[47] The Petroleum Rules, 2016. https://peso.gov.in/Petroleum\_rule.aspx.

[48] The Calcium Carbide Rules, 1987. https://peso.gov.in/PDF/Calcium\_Carbide\_Rule/CHAPTER%20I.pdf.

[49] The Inflammable Substances Act, 1952. https://indiacode.nic.in/handle/123456789/2165?view\_type=browse&sam\_handle=123456789/1362.

[50] The Poisons Act, 1919. https://indiacode.nic.in/bitstream/123456789/5751/1/the\_poisons\_act%2C\_1919.pdf.

[51] The Central Motor Vehicles Rules, 1989. http://www.tn.gov.in/sta/Cmvr1989.pdf.

[52] The Maharashtra Factories Rules, 1963. https://shodhganga.inflibnet.ac.in/bitstream/10603/148703/20/11\_chapter%205.pdf.

[53] The Electricity Act, 2003. http://www.cercind.gov.in/Act-with-amendment.pdf.

[54] The Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010. http://www.cea.nic.in/cei\_rgn.html.

[55] The Atomic Energy Act, 1962. https://indiacode.nic.in/handle/123456789/1413?sam\_handle=123456789/1362.

[56] The Atomic Energy (Radiation Protection) Rules, 2004. https://www.aerb.gov.in/english/acts-regulations/rules.

[57] The Civil Liability for Nuclear Damage Act, 2010. http://www.barc.gov.in/about/10.pdf.

[58] The Civil Liability for Nuclear Damage Rules, 2011. https://dae.nic.in/writereaddata/liab\_rules.pdf.

[59] R. Pandey, Legal Framework of Disaster Management in India, The Indian Law Institute, New Delhi. (2016). http://www.ili.ac.in/pdf/p13\_rajendra.pdf.

[60] The Report of High Powered Committee on Disaster Management, National Centre for Disaster Management, New Delhi, 2001. https://nidm.gov.in/PDF/pubs/HPC\_Report.pdf.

[61] The Disaster Management Act, 2005. https://ndma.gov.in/images/ndma-pdf/DM\_act2005.pdf.

[62] National Disaster Management Guidelines, Chemical Disaster (Industrial), 2007. https://ndma.gov.in/en/ndma-guidelines.html.

[63] The Petroleum and Natural Gas Regulatory Board (Codes of Practices for Emergency Response and Disaster Management Plan (ERDMP)) Regulations, 2010. https://www.pngrb.gov.in/OurRegulation/Others-GSR39.html.