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Elements of a Computer aided Emergency Management System

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Abstract : Past and recent disasters, both man made (technological) and natural (non-technological) have produced innumerable casualties and unimaginable harm to life and property. It is well documented that in case where the organization and the civil authorities were prepared to handle the situation, the losses were significantly less since these undesirable events occur suddenly and generally without immediate warning, especially the technological disasters, the result is an emergency. Though the management of factories and the authorities has responded to the challenge and has introduced number of measures to minimize the hazards, still one cannot forget the fact that accident cannot be completely eliminated. For this purpose, it is necessary to prepare an emergency preparedness plan for every administrative or industrial area by the competent authorities. Outcome of chemical accidents can be broadly categorized as fire, explosion and toxic release depending upon characteristics of a chemical involved in an accident along with other critical factors such as storage and processing characteristics, availability of ignition source, etc. Meteorological conditions such as wind speed, wind direction, height of inversion layer, stability class, etc. also play an important role by affecting the dispersion pattern of toxic gas cloud. With the help of computer simulation models, knowledge of chemicals'; it's behavior and availability of input data, it is possible to predict the area affected under different emergency scenarios. Further to assess the damage and carry out emergency planning and response exercise, it is essential to overlay the outcome on a map having features such as other industries, residential areas, schools, markets, road, rail, etc. Also the resources required such as fire and spill control, medical aid, etc. to combat the emergency situation arising out of chemical accident, their location and access to site of accident can also be plotted. Keeping in view the plotting requirement along with linkages of various databases, it has been considered appropriate to use Computer Aided Emergency Management System for effective mitigation and response during an industrial disaster. This paper proposes a basic composition of a Computer Aided Emergency Management System.
Keywords : Industrial disaster, Emergency Preparedness, Computer Aided Emergency Management System.

1. Introduction

The emergency planning for major accident hazardous installations across the world is essential due to rapid industrialization has increased usage of chemicals. This leads to increased storage, production, transportation and handling resulting in number of serious chemical accidents affecting surrounding communities in a very short span of time and mostly without any warning[1], [2].

India, although developing, is one of the highly industrialized countries in the world.The rapid growth in large number of hazardous chemicals has significantly increased the potential of accident involving such chemicals. In past, many of these accidents have led to large scale loss oflife, damage to environment and property[3].

Disasters have always posed a serious threat to human life and it has been a matter of great concern for eminent scientists, technocrats and decision makers. Disasters can be divided into two major categories - natural disasters such as earthquakes, cyclones, floods, etc. and manmade disasters such as chemical accidents, terrorism, chemical/biological war, etc. With technological advancement, substantial efforts are being made to predict the occurrence of natural disasters, assess the damage potential and to take precautionary measures to mitigate their effects. However, on other hand, technological advancements have also increased the occurrence of manmade disasters[4].

For instance, Bhopal Gas tragedy is still fresh in our memories wherein couple of hours over 3000 people died due to accidental release of toxic Methyl Isocyanate (MIC). Therefore, it is pressing need of time to understand the potential of chemical emergencies and develop tools for emergency planning and response to minimize the damage in case of any eventuality. One such tool that could be employed in the present era of advanced computation and simulation is a computer aided emergency management system[5]. This paper enumerates the basic elements and requisites of a computer aided emergency management system.

2. Emergency Preparedness Plan

The Emergency Preparedness Plan, which is prepared by a competent authority, to specify the coordinated response of agencies to an emergency on the site which has adverse effects to health, safety and environment[6].

The following are the basic elements of an emergency preparedness [7],

- Identification of hazardous chemicals, processes and operations.
- Release scenarios, consequences in terms of heat radiation, overpressure and intoxication.
- Preparation of plot and site plan incorporating the damage contours.
- Identification of vulnerable zones. An example of a vulnerable zone is shown in Fig. 1.
- Classification of unit(s) which have the potential for creating an off-site emergency.
- Requirements of various departments for coping with emergency situations.

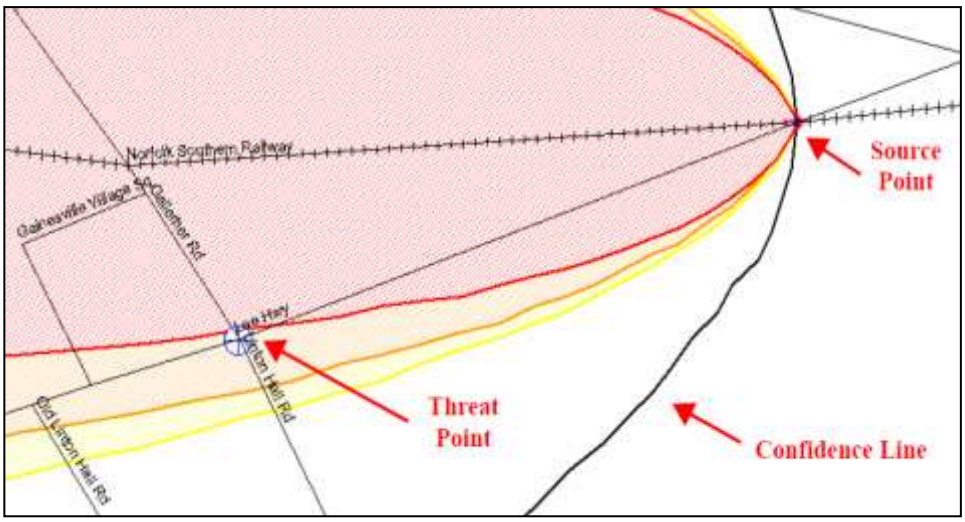

Fig. 1A sample representation of vulnerable zone during an emergency

Basic emergency management planning usually includes establishing a chain of command, an alarm system, medical treatment plans, communication system, shutdown and evacuation procedures, and auxiliary power systems[8]

Advanced emergency management planning is the best way to minimize potential loss from natural or human caused disasters and accidents. Emergency planning must provide for the safety of employees and the public, protect property and the environment, and establish methods to restore operations to normal as soon as possible[8].

Organizations can use a variety of government and private sources to find out what types of hazards are most likely to occur in their area. Once the initial background work has been done, the next step is to develop a working emergency management plan[8].

Thus, this section envisages the need and features of an emergency preparedness plan. The next section deals with the elements that may create a viable and efficient computer aided emergency management system.

3. Computer Aided Emergency Management System

In the present era of modern computation and simulation any methods and procedures shall be managed through the application of computers and programs[9], [10].

All phases of emergency management depend on data from a variety of sources. The appropriate data has to be gathered, organized, and displayed logically to determine the size and scope of emergency management program(s). During an actual emergency it is critical to have the right data at the right time displayed logically to respond and take appropriate action. Emergencies can impact all or a number of government departments. Emergency personnel often need detailed information concerning pipelines, building layout, electrical distribution, sewer systems, and so forth. By utilizing a computer aided system, all departments can share information through databases on computer-generated maps in one location. The elements for a computer aided emergency management system are proposed and enumerated in this section.

The software suite should be a collection of software programs designed to assist first responders and emergency planners to:

- Access chemical property and response information.
- Model potential chemical releases.
- Display key locations and release predictions on a map.
- Manage planning data.

3.1 Anatomy of the Software for Computer Aided Emergency Management System

Each module in the software is a database, which is an organized collection of information. The different modules of Emergency Management software and their required details are provided in the following sub-sections.

3.1.1 Facility / Industry

The Facility or Industry module of the emergency management software consists of all the details related to the industry or the facility. It gives the overall view of any facility that is subjected to emergency management. It also gives the brief description about the facility/industry. The following are the details that are to be included in the facility module and the following fields are required.

- Facility / Industry Name
- Physical Site Location
- Address
- Facility Phones
- Contacts
- Inventory of Chemicals or Hazardous Materials
- General Site Plan

- Number of Employees
- Map Data

3.1.2 Inventory

The Inventory module of the emergency management software consists of all the details related to the goods and materials, or those goods and materials themselves, held available in stock by an industry or the facility. It gives the brief description about the various chemicals and its details in an industry or facility. The following are the details that are to be included in the inventory module and the following fields are required.

- Chemical datasheet with response recommendations and physical properties based on the Chemical Abstracts Service (CAS) number and chemical name.
- Name of the chemical.
- CAS number for the chemical.
- Material Safety Data Sheet (MSDS) number for the chemical (provided by manufacturer)
- Amount of the chemical stored or transported.
- Letter code for the type of chemical storage.
- Number code for the storage pressure of the chemical.
- Number code for the storage temperature of the chemical.
- Indicates that the chemical is either in pure form or that it's a mixture.
- Physical state(s) of the stored (or transported) chemical.
- Indication if the chemical is a fire hazard (for example, flammables, combustible liquids, and oxidizers).
- Indication if the chemical is a "sudden release of pressure" hazard (for example, explosives and compressed gases).
- Indication if the chemical is a reactive hazard (for example, water reactive, unstable reactive and organic peroxides).
- Indication if the chemical poses either acute (immediate) or chronic (delayed) health risks. Maximum amount of the chemical stored or transported.
- Average amount of the chemical stored or transported.
- Maximum amount of the chemical in a single container or in interconnected vessels.

3.1.3 Incidents

The Incidents module of the emergency management software consists of all the details related to the incidents that took place in the above said facility / industry. It gives the brief description about the previous incidents that took place and its details in an industry or facility. The following are the details that are to be included in the incidents module and the following fields are required.

- Description of the location of an incident, including the county and fire district, route or waterway, and milepost where the incident occurred.
- Date and time when the incident happened.
- Date and time when the incident was discovered.
- Date and time when the incident was reported to the authorities.
- Source categories (such as underground tank, bullet tank, cylinders) to indicate the source(s) of the spill.
- Identification or license number, if a vehicle was the source of the spill.
- Number of tanks involved in the release.
- Weight or volume of each tank.
- Type of material that has been released.
- Name of the spilled chemical. If a mixture spilled, use a separate line to describe each hazardous component of the mixture.
- Amount of the chemical that was released into the environment.
- Amount of the chemical that was released into water.
- Type of medium or media (such as air or groundwater) into which the chemical was released.
- Cause(s) of the incident.

- Short description of the cause(s) of the incident.
- Short description of the initial action taken to respond to the incident.
- List of the agencies involved in the response to the incident.
- Brief description of the response to the incident, and the evaluation of the incident.
- Number of people injured by the incident.
- Number of people killed by the incident
- Indicates the property damages.

3.1.4 Emergency Routes

The Emergency Routes module of the emergency management software consists of all the details related to the emergency routes to and from the facility / industry. It gives the brief description about the escape routes in an industry or facility. The following are the details that are to be included in the Emergency Routes module and the following fields are required.

- Name of the route.
- Route type (for example, county road, railroad, river, or canal).
- Types of vehicles common on the route or used to transport hazardous materials along the route.
- Indication that the route is designated as an evacuation route during chemical emergencies.
- Indication that the route is designated for vehicles carrying hazardous materials (HAZMAT).
- Indication that the route is designated for mass transit (for example, a bus route).
- Starting and ending points of the route or route segment of concern.
- District or other political unit through which the route passes.
- Fire district through which the route passes
- Average number of vehicles traveling the route each day.
- This record is linked to an object on a map. Not editable.

3.1.5 Scenarios

The Scenarios module of the emergency management software consists of all the possible scenarios including the worst case scenarios in the above said facility / industry. It gives the description about the possible scenarios and its details in an industry or facility. The following are the details that are to be included in the Scenarios module and the following fields are required.

- Amount of chemical released, in pounds.
- Concentration of the chemical, in weight percent.
- Duration of the chemical release (in minutes).
- Chemical's physical state (solid, liquid, or gas) at 68°F.
- Area within the dike (in square feet).
- Atmospheric concentration of the chemical on which to base threat zone calculations (in grams per cubic meter).
- Wind speed in miles per hour.
- Direction from which the wind is blowing, in degrees true north.
- A measure of the size of the obstacles on the ground that a dispersing chemical cloud must pass over.
- Atmospheric stability class depends on wind speed and cloud cover.
- The likelihood, consequences, and overall risk of a release of a chemical.
- Distance from the release point beyond which the predicted concentration of the airborne pollutant is expected to be below the LOC. At locations closer to the release point and directly downwind, concentrations are predicted to exceed the LOC. Because wind direction is not taken into account when this distance is calculated, a threat zone around a release point always forms a circle.
- To estimate the threat zone radius.
- The associated Facilities or Routes record has been linked to a map object, the facility/route and threat zone on a map.

3.1.6 Locations

The Locations module of the emergency management software consists of all the possible locations likely to be affected during all cases of emergency. It gives the description about the affected locations and its details in an industry or facility. The following are the details that are to be included in the Locations module and the following fields are required.

- Time periods during the day when people are present at the location.
- Season of the year when the largest number of people are present at the location.
- Average number of people at the location during its hours of operation on typical days.
- Average age of the people at the location.
- Minimum and maximum number of people at the location during a day.
- Minimum and maximum number of people at the location during a season.

3.1.7 Contacts

The Contacts module of the emergency management software consists of contacts of responding persons and organizations during an emergency. The following are the details that are to be included in the Contacts module and the following fields are required.

- Type of phone number (such as 24-hour, emergency, or office).
- Phone number for the location.
- Name of the contact who is associated with the location.
- Job title or position of the contact who is associated with the location.
- Organization with which this contact is affiliated.
- Description of up to four of the contact's primary functions (such as compliance officer).

This section provides a comprehensive view of the modules and data required for developing a computer aided emergency management system. This section may also appended be or modified to suit specific purposes of emergency management.

4. Conclusion

Emergency management programs are planned, implemented, and modified based on volume of business or reaction to emergencies as they occur. Computer Aided Emergency Management System allows risks and consequences to be identified prior to an incident. Disaster events, such as wildfire spread, tsunami impacts, floods, earthquakes, hurricanes, epidemic spread, chemical cloud dispersion, oil spills, and so forth, can be modeled and displayed in Computer Aided Emergency Management System[11].

Emergency management personnel can use these modeling for training, for actual tactical deployment during a disaster, or to analyze the consequences of a possible disaster. The use of this technology takes emergency management planning information "off the shelf" for utilization by response personnel for real-world operations. In short, the thoughtful application of a Computer Aided Emergency Management System can ease the Preparedness, Response and Recovery of emergencies.

References

1. B Ruj, I Rehman and A K Bandyopadhya (2006), Off-site emergency scenario, a case study from a LPG Bottling Plant, Journal of Loss prevention in Process industries, Vol. 19, pp. 645-647.
2. P A Bragatto, S M Ansaldi and P Agnello (2015), Small enterprises and major hazards: How to develop an appropriate safety management system, Journal of Loss Prevention in the Process Industries, Vol. 33, pp. 232-244.
3. N D A Majid, A M Shariff and S M Loqman (2016), Ensuring emergency planning & response meet the minimum Process Safety Management (PSM) standards requirements, Journal of Loss Prevention in the Process Industries, Vol. 40, pp. 248-258.

4. B V Ramabrahmam and G Swaminathan (2000), Disaster management plan for chemical process industries. Casestudy: investigation of release of chlorine to atmosphere, Journal of Loss prevention in Process industries, Vol. 13, pp. 57-62.
5. MT O'Mahony, D Doolan, A O'Sullivan and M Hession (2008), Emergency planning and the Control of Major Accident Hazards: An approach to determine the public safety zone for toxic cloud releases, Journal of Hazardous Materials, Vol. 154 No. 1-3, pp. 355-365.
6. J Mustajoki, R P Hämäläinen and K Sinkko (2007), Interactive computer support in decision conferencing: Two cases on Off-Site nuclear emergency management, Journal of Decision Support Systems, Vol. 42 No. 4, pp. 2247-2260.
7. B V Ramabrahmam, B Sreenivasulu and M Mallikarjunan (1996), Model on-site emergency plan. Case study: toxic gas release from an ammonia storage terminal, Journal of Loss prevention in Process industries, Vol. 9 No. 4, pp. 259-265.
8. Accident Prevention Manual for Business and Industry (APM) (2001), National Safety Council, Itasca, Illinois, 12th Edition.
9. P H Martin, E J LeBoeuf, E B Daniel, J P Dobbins and M D Abkowitz (2004), Development of a GIS – based Spill Management Information System, Journal of Hazardous Materials, Vol. 112 No. 3, pp. 239-252.
10. F Dusse, P SimõesJr, A T Alves, R Novais, V Vieira and M Mendonça (2016), Information visualization for emergency management: A systematic mapping study, Expert Systems with Applications, Vol. 45, pp. 424-437.
11. J M Tseng, M Y Liu, R H Chang, J L Su and C M Shu (2008), Emergency response plan of chlorine gas for process plants in Taiwan, Journal of Loss prevention in Process industries, Vol. 21, pp. 393-399.

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