



## **Jaipur Engineering College and Research Centre**

**Department of Computer Science and Engineering**

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**Subject: Disaster Management (8TT6-60.2)**

**Unit-IV Man Made Disaster**

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## **Content (to be covered) IN Unit - IV**

- Man-Made Disasters
- Types of Man Made disaster
- Industrial Hazards
- Industrial Hazard Vulnerabilities
- What Are the Main Causes of Industrial Accidents?
- How to reduce risks
- Prevention of Industrial Accidents
- Fire Hazards
- Preparation of state and district disaster management plan  
(Beyond Curriculum)

## **Man-Made Disasters:**

Man-made disasters are the result of carelessness or human errors during technological and industrial use. The disasters are in the form of accidents, which occur all of a sudden and take a huge toll on life and property. Mostly such disasters cause injuries, diseases and casualties where they occur.

### **Man-made disasters are mainly of two types:**

#### **Local disasters:**

These are small-scale disasters such as train accidents, plane crashes and shipwrecks.

#### **Industrial Hazards**

Industrial hazards consist of four principle hazards. This is because industries employ many different processes involving a wide range of different raw materials, intermediates, waste products and final products. The hazards encountered are fire, explosion, toxic release and environmental damage.

- **Fire:** This is the most frequent of the hazards however the consequences are generally less. The effect of fire on people usually takes the form of skin burns and is usually dependant on the exposure time and the intensity of the heat. Fire can also produce toxic fumes like Acrolein, Carbon monoxide and Cyanides. Physical structures can be damaged either by the intensity of the heat or combustion. It may also have an effect on essential services like power and instrumentation which can cause an escalation of the incident
- **Explosion:** Explosions are usually heard from far away as a 'bang'. This is the result of a shock wave. This overpressure can kill people but usually the indirect effects of collapsing buildings, flying glass and debris causes far more loss of life and severe injuries. There are different types of explosions which include gas explosions and dust explosions. Gas explosions occur when a flammable gas mixes with air and is exposed to an ignition source. Dust explosions occur when flammable solids, especially metals, in the form of fine powders are intensively mixed with air and ignited.
- **Toxic/Chemical release:** Sudden releases of toxic vapours have the potential to cause death and severe injuries several miles from the release point. They are carried by water

and air. Their release into public sewage systems, rivers, canals and other water courses, either directly or through contaminated water used in fire fighting can result in serious threat to public. The number of casualties depends on the weather conditions, population density in the path of the cloud and the effectiveness of the emergency arrangements.

- **Environmental Damage:** As well as having the potential for causing injury, loss of life and damage to property, the hazards of fire, explosion and toxic releases may pose a severe threat to the environment. Release of other substances, not directly toxic to humans can cause major pollution problems. It is becoming increasingly recognized that damage to natural resources such as plant and animal life can have serious long term consequences. E.g. destruction of trees is increasing the effect of global warming and extinction of animals are severely disrupting food webs and causing an increase in pests.

## **Industrial Hazard Vulnerabilities**

### **• Improper location of Communities**

Communities like California and Couva are located too close to the Point Lisas industrial estate. If there is an explosion or chemical release, these communities will be severely affected potentially with many deaths and structural damage

### **• Poor developmental planning in Point Lisas**

Industries in Point Lisas Industrial estate are located in such a way that it is easy for one failure to cause a domino effect e.g. there is a methanol plant situated approximately 150m from a power generation plant. This power plant can produce a very easy source of ignition for any possible leak that may occur from the methanol plant.

### **• Lack of knowledge**

Many persons in the country and primarily persons close to the industrial estate are unaware of the actual dangers they face on a daily basis. Although it has been said many times, persons continue to ignore this because a disaster of catastrophic scale has not occurred before at the estate and companies boast of the low probability of such an incident. From a domestic point of view, person using everyday product like degreasers, disinfectants, bleach, lubricants (WD40, PR40), paints, thinners, acids (concrete cleaner) must be careful as most of these products affect the skin.

### • **Lack of mitigation measures**

From findings it has been proven that the mitigation measures put in place on the estate with respect to the ammonia plants are insufficient (Persad 2003). There exists no specialized medical facility to deal with industrial cases. Even though there is the Couva Medical facility nearby, this is occupied by persons from that area. Fishing villages.

### • **Lack of evacuation expertise**

It was found that the emergency response system at Point Lisas was inadequate to handle industrial emergencies as there were a lack of specialized medical personnel as well as triage equipment and facilities. (Persad, Deenesh 1996)

### • **Transportation risks**

Many chemicals, including flammable hydrocarbons are transported on the roadway alongside other vehicles and pedestrians. This poses a risk of explosion, fire, blast fragments and other harmful injury to bystanders, if an incident was to happen.

## **What Are the Main Causes of Industrial Accidents?**

There are a number of factors that can lead to industrial accidents, including everything from improper lifting techniques to mishandling hazardous materials. Below are some common causes of accidents in the workplace.

### **Environmental Causes of Accidents**

Accidents which occur from environmental causes refer to those workplace accidents that happen because of the working environment. The environmental factors can be both natural and man-made such as workplace design. Common environmental causes of accidents include:

- ❑ **Poor lighting**- Low visibility is a common cause of slips, trips, and falls.
- ❑ **Ambient temperature**-If a workplace is too hot, overheating can occur. If the workplace is too cold, frostbite or hypothermia can occur.
- ❑ **Air pollution**-Breathing issues can develop if a workplace has poor ventilation and/or air pollution.
- ❑ **Sound pollution**-The sound in a workplace can cause injury to a worker's hearing.

## Mechanical Causes of Industrial Accidents

Mechanical causes of industrial accidents are factors that refer to machine or equipment failure or breakdown. Generally, with proper maintenance and safety processes in place, these types of accidents are preventable. Common mechanical causes of accidents include:

- ❑ **Broken or damaged machine:** Parts can be easily broken or damaged if made of poor-quality metal.
- ❑ **Power failure:** Total or partial power failure can lead to serious injury.
- ❑ **Fire or explosion:** Cooling failure or a small spark can lead to a mechanical fire or explosion.
- ❑ **Fair wear or tear:** The older machine, the more wear and tear on the parts which can lead to a higher risk of mechanical accident.

## Human Factors That Cause Accidents

Accidents caused by human factors refer to incidents in which the accident is directly attributed to the worker involved in the accident. Common human factors that cause industrial accidents include:

- ❑ **Poor Housekeeping:** An unkempt work space can lead to slips, trips, and falls.
- ❑ **Fatigue:** When a body is tired, injury is more likely to occur.
- ❑ **Overexertion:** Overexertion injuries are the most common type of workplace injury.
- ❑ **Stress:** Workers who are stressed are often more distracted and of greater risk of injury.
- ❑ **Dehydration:** It is important to consume enough water to ensure you body functions properly.
- ❑ **Improper Lifting:** Lower back strains and shoulder injuries are common among workers who use improper lifting techniques.

## How to reduce risks

- **Design and Pre-modification review:** this involves proper layout, facilities and material selection. Research should be done try to substitute extremely toxic chemicals with safer ones. Less chemicals should be stored; a reduction in inventory will automatically mean less damage if an accident is to occur.

- **Chemical Risk Assessment:** Chemicals are assessed based on compatibility, flammability, toxicity, explosion hazards and storage.
- **Process Safety Management:** HAZOP studies, reliability assessment of process equipment, incorporating safety trips and interlocks, scrubbing system, etc. should be done before effecting major process changes. Management should try to develop a culture of safety in industrial organizations
- **Safety Audits:** Periodical assessment of safety procedures and practices, performance of safety systems and gadgets along with follow up measures should be carried out.
- **Emergency Planning:** A comprehensive risk analysis indicating the impact of consequences and specific written down and practiced emergency procedures along with suitable facilities should be done. This can be done by communities as well as national or regional corporation authorities
- **Training:** Proper training of employees and protective services should be done.
- **Special times and escorts for dangerous vehicles**
- **Public Cooperation on the road:** the public should cooperate with the police and any tankers and heavy duty vehicles to avoid accidents and allow for the shortest possible on road time for dangerous vehicles.
- **Public awareness:** Everyone should be aware of potential disasters and informed of protective and safety measures. MSDS sheets should be readily available to the public. Cautions must be placed to stand out on dangerous household and car care products.
- **Proper storage of hazardous Materials:** All chemicals and hazardous materials should be kept at proper storage temperature and in locked cupboards away from children and animals. Also, if reactive substances are stored, it should be stored in a watertight container.

Some of the steps for preventing industrial accidents are as follows:

1. Proper safety measures
2. Proper selection
3. Safety conscious
4. Enforcement of discipline
5. Incentives
6. Safety committees
7. Proper maintenance of machines, equipment and infrastructural facilities
8. Safety training.

### **1. Proper safety measures:**

The proper safety measures should be adopted to avoid accidents. Government also provides guidelines for enacting measures for checking accidents, these should be properly followed.

### **2. Proper selection:**

Any wrong selection of workers will create problems later on. Sometime employees are accident prone, they may not be properly suitable for the particular jobs. So the selection of employees should be on the basis of properly devised tests so that their suitability for jobs is determined.

### **Safety conscious:**

The employees should be made conscious of various safety measures to be followed. There should be proper working slogans and advises to the worker for making them conscious.

### **4. Enforcement of discipline:**

Disciplinary action should be taken against those who flout safety measures. There may be negative punishments like warnings, lay off, terminations of workers.

### **5. Incentives:**

Workers should be given various incentives for maintaining safety. There may also be safety contrasts among workers. Those who follow safety instructions properly should be given monetary and nonmonetary incentives.

### **6. Safety committees:**

Safety measures are in the interest of both employers. There should be committees consisting of representatives of workers and employees for devising and enforcing safety programmes.

### **7. Proper maintenance of machines, equipment and infrastructural facilities:**

Accidents may occur on account of the fault in machines or equipment. There should be proper maintenance of machines. These should be regularly checked and frequently inspected by engineering

### **8. Safety training:**

The workers should be given training regarding safety measures. They should know the hazards of the machines, the areas of accident proneness and the good working possible



precautions in case of some accident.

### **Prevention of Industrial Accidents**

When it comes to industrial accidents, incidents are almost always preventable when proper safety measures and employee training is in place. Tips for avoiding industrial accidents include:

- Developing an employee safety plan with feedback from all level employees
- Requiring monthly employee training and promote safety awareness with an internal safety committee
- Focusing on skill development and education of all employees
- Ensuring supervisors are monitoring and reporting on the progress of all safety measures
- Providing avenue for employees to share safety concerns and ideas for improving safety
- Establishing a planned maintenance schedule for all machines – daily, weekly, monthly based on manufacturer suggestion
- Quickly repairing and addressing all defective or broken machine parts
- Testing all equipment before use
- Creating a regular inspection schedule and put mechanisms in place to ensure it is adhered to

### **Industrial and technological disasters:**

These are much larger in scale and are the result of technology failures or industrial accidents. Such disasters affect both local population and may even cover a much larger area. Industrial disasters result due to accidental leakage of water or air pollutants. Many of the chemicals are extremely toxic and carcinogenic which affect the human population in an adverse way. Some people die instantly while others are crippled for whole life in the form of blindness, paralysis and many other chronic diseases.

### **Impact on the environment:**

Leakage of toxic chemicals from the industries and accidents in the nuclear reactors has short- term and long-term effects on the environment and human health. Short-term effects on human health relate to casualties and diseases like blindness, cancer, paralysis, heart trouble, gastric and respiratory abnormalities. Long-term effects include genetic imbalances in humans and its impact on the future generations. Soil and water sources also remain polluted for long durations of time.

**Prevention, control and mitigation:**

**Man-made disasters can be minimized to a large extent by adopting the following measures:**

1. Proper training of personnel working in the hazardous industries.
2. Proper maintenance and care of safety measures.
3. Removing human encroachments around hazardous industries.
4. Making the people aware about the first-aid methods in case of accidents.
5. Applying wet cloth over the mouth and nose in case of gas leakages minimizes the health hazards.
6. Remaining indoors in case of radioactive accidents.
7. Providing the people with proper medical care, in some cases throughout their life.
8. Providing adequate compensation to the affected people by way of money and employment.

**Bhopal Gas Tragedy (BGT):**

The most serious industrial disaster occurred on December 3, 1984 at Bhopal, India, which is known as the Bhopal Gas Tragedy (BGT). The Bhopal gas tragedy occurred due to leakage of methyl isocyanide (MIC) gas from the factory of Union Carbide of India Ltd. MIC gas is used as an ingredient in pesticides.

It leaked from the factory and formed the deadly cloud over Bhopal. People living in slums in the vicinity of the factory were the most affected and more than 5000 people were killed, half of them due to direct exposure and other half due to after effects. MIC is a colourless gas which causes severe irritation, violent coughing, swelling of the lungs, bleeding and death due to direct inhalation. It also caused loss of eye-sight in more than 1000 people. More than 50,000 people were affected with respiratory, eye, gastric, neurological and gynaecological problems

Another technological disaster is due to the potential damages of nuclear fallout. An example is the Chernobyl Nuclear Disaster.

**Chernobyl Nuclear Disaster:**

This nuclear disaster occurred at the Chernobyl Nuclear Power Plant, which was one of

the largest power plants in the Ukrainian Republic of erstwhile USSR, on April 26, 1986. It is the worst nuclear disaster recorded in a nuclear power plant. This nuclear power plant had four reactors of 1000 megawatt each for electricity generation. A sudden power surge resulted in two explosions, which destroyed the reactor core and blasted a large hole in the roof of the reactor building.

The Radioactive debris moved up through that hole to heights of 1 km. Approximately 100 to 150 million curies of radiation (radioactive isotopes of iodine and caesium) escaped into the atmosphere. To reduce emissions, the rescue team bombarded the reactor with 5,000 metric tonnes of shielding material consisting of lead, boron, sand and clay. Soviet officials placed the toll of human lives to 31.

### **Fire Hazards**

It is the most dangerous hazards in industrial point of view.

**Control of fire and explosion:** Government regulations are available for safety and fire protection Careful plant layout and judicious choice of constructional materials can reduce fire and explosion hazard. Hazardous operations should be isolated by conducting them in separate buildings.

The roof is designed to lift easily under an explosive force. Possible sources of fire are reduced by eliminating the unnecessary ignition sources the installation of sufficient fire alarms; temperature alarms Fire resistance brick-walls can limit the effects of an explosion

## Beyond Curriculum

### Preparation of state and district disaster management plan

India has integrated administrative machinery for disaster management at the National, State, District and Sub-District levels. The Federal Government supplements the State relief efforts by initiating supportive action. An elaborate procedural mechanism and the allocation of resources to facilitate emergency management operations is outlined in relief manuals and codes backed by the Contingency Action Plan. The Contingency Action Plan (CAP) facilitates the relief operations, procedures and focal roles of Central Ministers and Departments. The Crisis Management Group headed by the Cabinet Secretary and consisting of nodal ministries (particularly the Ministry of Home Affairs and Agriculture) oversee the response coordination, carry out an assessment, and make recommendations for assistance. The role of community and NGOs is not clear.

State Governments have the responsibility for undertaking rescue and relief measures in the event of a natural calamity through the State Relief Commissioner, Relief and Rehabilitation Department or the Department of Revenue.

District Coordination and Review Committee headed by the Collector involves the participation of related agencies, departments and NGOs.

**At the district level, the DM Act 2005** provides for the constitution of District Disaster Management Authorities under the chairmanship of the District Magistrate/ Collector while the elected representative of the local authority would be the co-chairperson. In those districts where Zilla Parishads exist, the Chairman would be the ex-officio cochairperson of the District Disaster Management Authority. The District Authority shall act as the planning, coordinating and implementing body for disaster management in the district and take all measures for the purposes of disaster management in the district in accordance with the guidelines laid down by National and State Authorities.

The planning process has been carried down to the sub-divisional, block and village levels. Each village in multi-hazard prone district will have a Disaster Management Plan. The Disaster Management Committee which draws up the plans consists of elected representatives at the village level, local authorities; Government functionaries including doctors/paramedics of primary health centres located in the village, primary school teachers etc. The plan encompasses prevention, mitigation and preparedness measures. The Disaster Management Teams at the village level will consist of members of youth organisations like Nehru Yuvak Kendra and other non- governmental

organisations as well as able bodied volunteers from the village. The teams are provided basic training in evacuation, search and rescue, first aid trauma counseling etc. The Disaster Management Committee will review the disaster management plan at least once in a year. It would also generate awareness among the people in the village about dos' and don'ts for specific hazards depending on the vulnerability of the village. A large number of village level Disaster Management Committees and Disaster Management Teams have already been constituted.

**Describe unique features of district under consideration** with statements on hazards and their impacts on life and property. Give / elaborate appropriate information in the following subsections:

- i. District Profile (Socio, economic, demographic, geographic, critical infrastructures, key resources)
- ii. District Administrative Set up
- iii. District Population profile

It is already recognised that it is possible to take preventive, mitigation, preparedness measures along with the capacity building of the stakeholders so that the negative impact of a disaster can be minimized. Hence, there is a need for good planning.

**Under the DM Act 2005**, it is mandatory on the part of District Disaster Management Authority (DDMA) to adopt a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary and expedient for prevention as well as mitigation of disasters. These processes are to be incorporated in the developmental plans of the different departments and preparedness to meet the disaster and relief, rescue and rehabilitation thereafter, so as to minimize the loss to be suffered by the communities and are to be documented so that it is handy and accessible to the general public.

### **Objectives and Goal of the Plan:**

**Section 31 of Disaster Management Act 2005 (DM Act)**, makes it mandatory to have a disaster management plan for every district. DDMP shall include Hazard Vulnerability Capacity and Risk Assessment (HVCRA), prevention, mitigation, preparedness measures, response plan and procedures. An indicative list with possible plan objectives is given below:

- i. To identify the areas vulnerable to major types of the hazards in the district.
- ii. To adopt proactive measures at district level by all the govt. departments to

- prevent disaster and mitigate its effects.
- iii. To define and assign the different tasks and responsibilities to stakeholders during the pre-disaster and post-disaster phases of the disaster.
  - iv. To enhance disaster resilience of the people in the district by way of capacity building.
  - v. Reduce the loss of public and private property, especially critical facilities and infrastructure, through proper planning.
  - vi. Manage future development to mitigate the effect of natural hazards in the district.
  - vii. To set up an Emergency Operations Centre at the District level to function effectively in search, rescue, response.
  - viii. To develop the standardized mechanism to respond to disaster situation to manage the disaster efficiently
  - ix. To set up an early warning system so as to prepare the community to deal with the disaster and responsive communication system based upon fail-proof proven technology.
  - x. To prepare a response plan based upon the guidelines issued in the State Disaster Management Plan so as to provide prompt relief, rescue and search support in the disaster affected areas.
  - xi. To adopt disaster resilient construction mechanism in the district by way of using Information, Education and Communication for making the community aware of the need of disaster resilient future development.
  - xii. To make the use of media in disaster management.
  - xiii. Rehabilitation plan of the affected people and reconstruction measures to be taken by different govt. departments at district level and local authority.

The District Disaster Management Plan (DDMP) is the guide for achieving the objective i.e. mitigation, preparedness, response and recovery. This Plan needs to be prepared to respond to disasters with sense of urgency in a planned way to minimize human, property and environmental loss.

**Scope of the Plan:** The scope of this plan, the entities (e.g., departments, agencies, PRIs, ULBs, private sector, NGOs, citizens) and geographic areas to which the plan applies need to be stated explicitly with identified role and responsibilities. The purpose statement need not be complex but should include enough information to establish the direction for the plan. The scope should include all disaster phases (Prevention, Preparedness, Mitigation, Response and Recovery), hazards addressed, area / district etc.

**Authority and Reference:** Mention - references that form the legal basis for actions outlined in this Plan is in accordance with Sections 31 and 32 of the DM Act 2005. Include and cite the legal and administrative basis for evolution of the Plan and implementing DDMP including: i. Laws & Statutes ii. Executive Orders / Rules iii. Regulations iv. Formal agreement (MoU) – with utility service agencies, telecom service providers, manufacturers of different emergency resources etc.

**Plan Development:** Steps in a collaborative planning process include – formation of team, understanding hazards, vulnerabilities and risk in the district, plan development (develop and analyse course of action, identify resources, identify information needs), plan preparation (write, review, approve and disseminate), plan implementation and maintenance (exercise, review, revise and maintain).

**Planning Team:** There is no fixed format / composition for planning team, but integrating Emergency Service Function agencies into planning team would be useful.

An ideal team could be as given below –

- i. District Magistrate / District Collector (Chairperson)
- ii. Elected member of the district
- iii. DEOC coordinator / Manager (nominate him/her as plan coordinator)
- iv. District Fire Chief
- v. Head of the Primary agency supervising each ESF (Telecom, Public health, Agriculture, Power, Transport, Education, PWD, Food and civil supplies, Water supply and sanitation, Law and order, Information / Media)
- vi. Representatives from central agencies located in / around the district (Army/Navy/Air Force, Coast Guard, Port and fisheries, DDK, AIR, IMD and CWC etc.)
- vii. Representatives from major places of worships
- viii. Local NGOs / Corporate / CIKR

The District Collector has the following duties:

- i. To facilitate and coordinate with local Government bodies to ensure that pre and post disaster management activities in the district are carried out.
- ii. To assist community training, awareness programmes and the installation of emergency facilities with the support of local administration, non-governmental organizations and the private sector.
- iii. To function as a leader of the team and take appropriate actions to smoothen the response and relief activities to minimize the adverse impact of disaster.
- iv. To recommend the Commissioner of Relief (CoR) and State Government for

declaration of disaster.

Local Authorities have the following duties:

- i. To provide assistance to the District Collector in disaster management activities.
- ii. To ensure training of its officers and employees and maintenance of resources so as to be readily available for use, in the event of a disaster.
- iii. To undertake capacity building measures and awareness and sensitization of the community
- iv. To ensure that all construction projects under it conform to the standards and specifications laid down.
- v. Each department of the Government in a district shall prepare a disaster management plan for the district. The local authorities need to ensure that relief, rehabilitation and reconstruction activities in the affected area, within the district, are carried out.
- vi. Trust / Organisations managing Places of Worships & Congregation a. Each establishment / organisation identified as —critical infrastructure and key resource, b. Including places of congregation in a district shall prepare —on-site and —off-site c. Disaster management plan. Carry out mitigation, response, relief, rehabilitation and d. Reconstruction activities.

Private Sector:

- i. The private sector should be encouraged to ensure their active participation in the predisaster activities in alignment with the overall plan developed by the DDMA or the Collector.
- ii. They should adhere to the relevant rules regarding prevention of disasters, as may be stipulated by relevant local authorities.
- iii. As a part of CSR, undertake DRR projects in consultation with district collector for enhancing district's resilience.

**How to use the Plan:**

- i. Section 31 of DM Act 2005 makes it mandatory for every district to prepare a disaster management plan, for the protection of life and property from the effects of hazardous events within the district.
- ii. In significant emergencies or disasters, District Magistrate or the chairperson of DDMA will have the powers of overall supervision direction and control as may be specified under State Government Rules / State Disaster Management Plan guidelines.



- iii. The district EOC will be staffed and operated as the situation dictates. When activated, operations will be supported by senior officers from line departments and central government agencies; private sector and volunteer organizations may be used to provide information, data and resources to cope with the situation.
- iv. The DDMA may recommend for action under Sec 30 of DM Act.
- v. Facilities that have been identified as vital to operation of the district government functions have been identified.
- vi. The DM or his designee will coordinate and control resources of the District.
- vii. Emergency public information will be disseminated by all available media outlets through the designated media and information officer.
- viii. Prior planning and training of personnel are prerequisites to effective emergency operations and must be considered as integral parts of disaster preparations.
- ix. Coordination with surrounding districts is essential, when an event occurs, that impacts beyond district boundaries. Procedure should be established and exercised for inter district collaboration.
- x. Departments, agencies and organizations assigned either primary or supporting responsibilities in this document must develop implementation documents in order to support this plan.
- xi. When local resources prove to be inadequate during emergency operations, request for assistance will be made to the State or higher levels of government and other agencies in accordance with set rules and procedures.
- xii. District authority will use normal channel for requesting assistance and/or resources, i.e., through the District Emergency Operations Center (DEOC) to the State EOC. If state resources have been exhausted, the state will arrange to provide the needed resources through central assistance.
- xiii. The District EOC will coordinate with the State EOC, Agencies of the Govt. of India like IMD / CWC to maintain upto-date information concerning potential flooding, cyclones etc. As appropriate, such information will be provided to the citizens of the affected areas in the district.
- xiv. Upon receipt of potential problems in these areas, DEOC / designated officials will appropriately issue alert and notify action to be taken by the residents.
- xv. Disaster occurrence could result in disruption of government functions and, therefore, all levels of local government and their departments should develop and maintain procedures to ensure continuity of Government action.