OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

15329

Distr.
LIMITED

UNIDO/IS.598
21 August 1985

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ENGLISH

INDUSTRIAL EMERGENCY CONTINGENCY PLANNING

Prepared by the
Division for Industrial Studies

Piero Armenante

V.85-30127
2627T (0402T)

Explanatory notes

The designations employed and the presentation of the material in the present document do not imply the expression of any opinion whatsoever on the part of the United Nations Industrial Development Organization concerning the legal status of any State, territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries. Mention of names of firms and commercial products does not imply endorsement by UNIDO. This study is based largely on the work of Piero Armenante (Ph.D.), consultant.

CONTENTS

Tables

Figures

GLOSSARY OF TERMS

BLEVE. Acronym for Boiling Liquid Expanding Vapour Explosion. It occurs when the pressure vessel containing liquid is heated up so that the metal loses strength and ruptures.

Bund. Embankment provided all around some types of liquid storage tanks in order to retain tank liquid spills in case of tank failure.

Cargo manifest. A shipping paper listing all of the contents being carried by a transporting vehicle or vessel.

Fault tree analysis. Methodology used in quantitative risk assessment. It consists of identifying the sequences of events leading to an accident and assigning probabilities to the occurrence of each sequence. The probability of the accident occurrence can then be calculated.

Fire extinguishing agents

Water. The most widely used agent. It cannot be utilized in electric fires.

Foam. A substance added to water to improve its fire-fighting characteristics. Several types exist: aqueous film forming, fluoroprotein, synthetic and chemical. They extinguish fire by forming an inert blanket and are mainly used in fires involving flammable liquids.

Vapourizing liquids. Substances which interfere with the chemical reactions occurring during the combustion process. They can be used in electrical fires.

Dry powders. Certain salts used because of their blanketing action. They are recommended in electrical fires.

Inert gases. Gases (such as carbon dioxide or nitrogen) which render the atmosphere nonflammable by displacing oxygen. They are recommended in electrical fires.

Flash point. The lowest temperature at which a liquid will give off sufficient flammable vapour for ignition to occur.

Flame arrester. Device used to prevent the passage of flames along a pipe or duct.

Hazardous material. A substance or material in a quantity or form that may pose an unreasonable risk to health and safety or property when stored, transported, or used in commerce.

Ignition temperature. The minimum temperature required to ignite gas or vapour without a spark or flame being present.

Major accident. An industrial accident which may result in serious injuries, loss of life, extensive damage to the plant and/or to the environment and which requires the intervention of resources outside the plant in order to be handled effectively.

Oxidizer; organic peroxide. A substance, such as an organic peroxide, which in itself is not necessarily combustible but may give off oxygen and contribute to the combustion of other materials. Organic peroxides are thermally unstable and may undergo exothermic, self-accelerating decomposition.

Rupture disc. A pressure relief device mounted on closed containers. It consists of a disc fitted on the container in such a way that an increase of the internal pressure produces the rupture of the disc with consequent release of material from the container and decrease of the internal pressure.

Safety audit. A detailed examination of all the facets of a particular industrial activity and/or establishment conducted by professionals with the objective of minimizing loss.

Safety or relief valve. A valve mounted on a closed container which opens when a predetermined overpressure is reached in the container, releasing material from it, and allowing the internal pressure to decrease.

Spontaneously combustible material. A substance which is liable to catch fire on contact with air.

VCM. Acronym for Vinyl Chloride Monomer, a chemical substance having substantial health hazards. Used in the production of polyvinyl chloride (PVC).

Water fog. A finely divided mist produced by a special nozzle fitted on a water hose. It is used for knocking down flames and cooling hot surfaces.

Waybill. The shipping paper prepared by the railroad from a bill of lading.

WACAF region. The West and Central African region. In this study, the 20 countries of the region are divided into the following zones:

Zone I. Mauritania, Cape Verde, Senegal, Gambia, Guinea-Bissau

Zone II. Guinea, Sierra Leone, Liberia

Zone III. Ivory Coast, Ghana, Togo, Benin

Zone IV. Nigeria, Cameroon, Equatorial Guinea, Sao Tomé and Principe, Gabon

Zone V. Congo, Zaire, Angola.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study offers guidelines for the preparation of national and plant-level contingency plans for industrial accidents in the West and Central African (WACAF) region as well as a generalized procedure for conducting an industrial hazard analysis. Information on the current state of preparedness and intervention capability in case of major industrial accidents was collected during field missions to two countries, referred to in the text as countries A and B. A regional industrial risk assessment was carried out, based on the calculation of relative (a) fire and explosion risk and (b) environmental risk in the major industrial sectors and the five geographical zones which make up the WACAF region. (The countries forming these zones are listed in the "Glossary of terms".)

Conclusions

In general:

1. Contingency plans for industrial emergencies can be prepared at four different levels: national, provincial, municipal and plant. The first three are responsibilities of the Government or governmental agencies and organizations; the last should be developed by industry. Checklists and safety audits are the most important means of hazard identification in industrial plants.

2. The first step in the planning process is to conduct a hazard analysis. This consists of identifying potential hazards and the vulnerable points and risks associated with them.

3. The second step is to identify resources (such as equipment, people and agencies) that might be used in dealing with hazards. The functions and responsibilities of different persons or groups should also be clarified at this point.

4. The identification of the authorities in charge of an emergency, the chain of command, and the procedures for shifting authority to higher levels as the accident escalates, are vital elements in any plan, and especially in national contingency plans.

5. A system of contingency plans, developed by industry at the individual plant level, is the basic building block of the response capability of a city, province or country to industrial emergencies. Municipal, provincial or national contingency plans are needed to integrate plant contingency plans in case of major emergencies.

6. Appropriate general legislation pertaining to plant safety and accident prevention is a necessary complement to the preparation of national contingency plans.

7. An efficient and well equipped corps of fire fighters is the backbone of any national, provincial or municipal response capability.

On the basis of the country missions, it appears that:

8. Larger industries are, in general, relatively well equipped and better prepared than smaller ones to combat industrial accidents.

9. Fire is the most common industrial hazard, but its consequences generally are limited to the industrial facility. Transport accidents involving hazardous materials are the major industry-related hazard faced by the population in the WACAF region, especially in those countries where no regulations exist for the transport of hazardous materials. An accident which could result in the release of poisonous gases into the atmosphere would pose the greatest hazard to the population.

10. The vulnerability of the population to industrial accidents is, generally speaking, rather low, because of the limited level of industrialization in most countries of the region.

11. This vulnerability can increase, however, if zoning regulations do not carefully define the areas assigned to industrial development and human settlements.

The results of the regional risk assessment show that:

12. Zones I and IV of the WACAF region have the highest risk of fire, explosion or environmental damage as a result of an industrial accident. Zone II has the smallest risk.

13. The highest risks in the region appear to be associated with petroleum refineries and food-manufacturing industries. Individual food-processing plants present a low risk, but because there is a large number of these plants they offer a cumulatively high risk. Other high-risk industrial sectors identified in the analysis are plastic- and textile-manufacturing industries and oil storage.

Recommendations

It is recommended that Governments in the region undertake the following activities in order to establish and implement industrial contingency plans:

1. Make a census of existing industrial establishments in order to collect all available information by means of which possible accidents can be identified. The information should cover flammable and other hazardous materials present at the installations.

2. Classify industries according to the relative hazards they pose to man and the environment.

3. Draw up regulations governing design, operation and maintenance for specific classes of hazardous industries.

4. Establish standards and codes of practice for handling, storing or transporting hazardous materials.

5. Establish procedures for licensing and inspecting industrial installations, and designate a Government agency to enforce these procedures.

6. Require manufacturers to show that they have identified the major hazards existing at their plants, and adopted appropriate safety measures, including the preparations of contingency plans.

7. Require manufacturers of especially hazardous installations to prepare contingency plans also for major emergencies. These plans should

be flexible enough to be integrated with other municipal or provincial response plans.

8. Require that even industrial establishments located in areas covered by Government contingency plans develop their own plans, so as not to rely solely on public resources in case of an emergency.

9. Require manufacturers to notify the authorities of all serious industrial accidents.

10. Draw up legislation governing the transport of hazardous materials.

11. Assign established agencies the tasks of preparing national, provincial and/or municipal contingency plans.

12. Provide fire departments and other action-response groups with the equipment, manpower and training needed to combat major industrial accidents.

13. The Governments of the countries identified in the high-risk Zones (I and IV) should carry out a more detailed study, country-by-country, in order to evaluate more accurately the extent and sources of industrial risk.

I. INTRODUCTION

At Abidjan, in March 1981, the Conference of Plenipotentiaries on Co-operation in the Protection and Development of the Marine and Coastal Environment of the West African Region adopted an Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the West and Central African Region [1]. Guidance was provided by subsequent intergovernmental meetings, in particular:

(a) Meeting of the Steering Committee for the Marine Environment of West and Central Africa, Abidjan, 20-22 July 1981 [2];

(b) Meeting of the National Authorities for the Action Plan for the West and Central African Region, Geneva, 19-21 April 1982 [3];

(c) Second Meeting of the Steering Committee for the Marine Environment of West and Central Africa, Geneva, 22-23 April 1982 [4].

Support for the implementation of the Action Plan was the main purpose of UNIDO's work on industrial emergency planning in the WACAF region.

The objective of the present study is to provide guidelines for the preparation of contingency plans to deal with emergencies arising from catastrophic failures of industrial plants or the breakdown of industrial waste disposal systems. Plans for responding to spillages of toxic substances occurring during handling or transportation are also developed. Means of incorporating the methodology to cope with these emergencies into national contingency plans are presented.

The hazards considered in this study are fire, explosion, and release of hazardous materials in the environment. A hazardous material is defined as any substance that is explosive, flammable, corrosive, poisonous, toxic, infectious, radioactive or generally dangerous, and which may have detrimental effects on operating and emergency personnel, the public, equipment and/or the environment.

Particularly relevant to the study are the results of the UNIDO/UNEP survey of industrial pollution of the marine environment from land-based sources (project FP/0503-79-18) which resulted in the UNIDO/UNEP publication: Survey of Marine Pollutants from Industrial Sources in the West and Central African Region [5]. The information contained in the survey helped identify industrial establishments in the WACAF region associated with the highest risk of industrial accidents. The results of the present study should assist Governments to:

(a) Identify zones and industrial sectors exposed to the greatest risk of industrial catastrophies;

(b) Focus the attention of responsible local officials on the problems of industrial accident prevention and contingency planning;

(c) Develop national contingency plans for industrial emergencies;

(d) Co-ordinate national contingency plans in cases of main regional emergencies.

II. THE PLANNING PROCESS

Contingency plans for industrial emergencies can be prepared at several levels of sophistication, depending on the degree of completeness required, as well as on the purpose of the plan itself. The instructions for a machine operator in the case of fire in an industrial plant will differ significantly from those governing the co-ordination of different ministries or agencies in the case of a national disaster, even though both sets of instructions are referred to as contingency plans. All contingency plans have three elements in common:

(a) Analysis of the hazards;

(b) Identification of resources;

(c) Description of actions for the mobilization of personnel and equipment, and duties, in case of emergency.

These elements need not appear as specific sections of the plan, but should be logical phases of its preparation. Section A of this chapter lists and describes the most common types of contingency plans, indicating which type is most appropriate to a given planning purpose. Hazard analysis and resource identification are dealt with in sections B and C. Actions and duties are described in Chapters III-V, according to the purpose of the contingency plan.

A. Types of plans

Contingency plans can be classified according to their content and form, which are directly related to the purpose the plans should serve. Contingency plans may be grouped in four categories [6]:

(a) Lists of resources and equipment, and telephone rosters;

(b) Action guides and checklists;

(c) Response plans;

(d) Co-ordination plans.

This classification does not imply that a plan will fall into just one category, since a comprehensive plan can display features of two or even more categories.

Lists of resources and equipment, and telephone rosters

This simplest of all contingency plans comprises lists of possible resources and equipment for use in an emergency, together with their locations and/or the way the resources can be alerted (if people) or obtained (if material). In the most common case, using a telephone offers the quickest and easiest way of mobilizing some of the resources, but alternative means, such as radio transmitters or alarm systems, can also be used. Usually, a plan of this kind does not contain a hazard analysis section, even though the planner must have considered possible hazards at the time of preparation. Similarly, it does not describe subsequent actions to be taken. It should only be used by "action-response people", such as a fire department, who know the action to be taken.

The resource and equipment lists maintained by the "action-response people" usually describe the resources available within their own organizations (e.g. fire or public works departments). Lists of technical experts from local companies and universities may be useful. A list may also be prepared of volunteer groups which could undertake hard work, such as preparing and laying sand bags. These volunteer groups could be organized by action-response personnel on a city or province basis. The industrial community can provide a wide range of equipment, sometimes on a voluntary, sometimes on a direct-hire, basis. Even when a community is covered by an active province or city contingency plan, it should know the extent of its local capabilities so that the relevant information can be made available to whomever takes charge in cases of emergency.

Because of its characteristics, this kind of plan is most suitable for local communities, small industrial plants and local response organizations. Its main advantage lies in its simplicity and the little preparatory work attached to it. It presupposes, however, the availability of skilled personnel who know what to do with it.

Action guides and checklists

This kind of plan generally consists of a few pages or cards, preferably of a convenient size, carried by people who are most likely to encounter an emergency (such as a truck driver transporting hazardous chemicals or an emergency squad in an industrial plant). The plan may also be posted at key points throughout the plant.

Action guides and checklists are generally subsidiary to more comprehensive plans. They are designed to ensure that a few basic actions are taken, such as shutting down machines or other pieces of industrial equipment, extinguishing small fires at the very outset, containing spills of hazardous materials before they spread, or preventing access to dangerous areas. They should never be relied on as the sole response to an emergency. They should serve only as reminders to persons who have had more comprehensive training, or as a means of activating a more comprehensive response. An action guide may be all that plant personnel need for handling a small emergency. However, an active response plan covering the particular plant will be necessary to deal with a large-scale emergency.

Response plans

A response plan provides instructions on handling one or more emergency situations. Its orientation derives from the persons responsible for preparing and using it. One prepared by a designated response agency, such as a fire department, civil defence unit, or the control centre of a large industrial plant, may include specific, detailed field techniques. A city or province plan will define the responsibilities and capabilities of various community response agencies and indicate how to activate those agencies.

A response plan will contain information on who to notify in the case of an accident and how to notify them. It may also indicate the initial actions to be taken. (These are described, in a more explicit and specific form, in the guides to be used by the "action-response people".) A response plan will also describe the responsible response organization and its procedures. Its most vital element is the description of the chain of command during an emergency. The plan must clearly state at what stage on-scene authority shifts to another level and which official assumes the new responsibility. A hazard analysis section will be generally included. The plan should also indicate the

vulnerable areas and include detailed maps of the region. If it is to be effective, it must contain provisions for its own updating and upgrading (e.g. by audit). It should also list the types and times of exercises and training sessions available. Section F of Chapter III contains a brief description of hospital contingency planning [7].

Co-ordination plans

A co-ordination plan is generally aimed at defining the responsibilities of various agencies, groups, or individuals under various emergency-response conditions. Co-ordination plans tend to be rather comprehensive, and are mainly used at the national or provincial level or in very large cities [8, 9]. National disaster plans prepared by civil defence organizations are often primarily co-ordination plans and may cover technological disasters as part of a matrix showing who does what during different kinds of disasters. Some elements of response plans are found in co-ordination plans.

A co-ordination plan indicates the administrative procedures that should be followed in cases of emergency. It specifies the chain of command both within and between each of the agencies or groups involved in the emergency response operations. It co-ordinates the actions of those agencies or groups and defines their responsibilities from a legal standpoint.

B. Hazard analysis

Basic to emergency planning, no matter how simple, is an understanding of the problems that might arise. Hence, hazard analysis should always be carried out, and should be the first step in planning. It should also be included as part of a response or co-ordination plan, or carried out prior to preparing simple plans. It should be documented in the accompanying letter when the plans are distributed. In general terms, hazard analysis may be broken down into: identification of hazards; identification of vulnerable areas; and assessment of risk [6].

Identification of hazards. A hazard is any situation that has the potential to damage life, property and/or the environment. When preparing a hazard identification related to industrial accidents, the following questions should be answered: What types of hazardous materials and/or industrial processes exist, and where?

Identification of vulnerable areas. Vulnerability is the susceptibility of life, property and/or the environment to damage if a hazard manifests its potential. The question to be answered in this phase is: What can the identified hazards affect, and how?

Assessment of risk. Risk is the probability that damage to life, property and/or the environment will occur if a hazard manifests itself. The question to be answered is: What is the likelihood that the hazard will occur and affect the vulnerable areas? The methodologies used in risk assessment fall broadly into two categories: qualitative and quantitative. The first includes methodologies such as estimations based on professional judgement, e.g. the Dow Chemical Company Fire and Explosive Index Hazard Classification Guide [10], the Mond Fire Explosion and Toxicity Index [11] and the Hazard and Operability (HAZOP) study [12]. The second category comprises methods such as Fault Tree Analysis [13, 14], Event Analysis [14, 15] and Human Error Prediction Studies [16, 17]. Quantitative evaluation of risk may be very complex. The corresponding methodologies should only be used when a really comprehensive hazard analysis is required.

Hazard analysis for national, provincial or municipal contingency plans

The following recommended procedure should be completed [6]:

(a) Identify possible sources of hazardous materials, e.g. oil and chemical manufacturers, users, storers and transporters. Table 1 lists such possible sources;

(b) Contact the officials in charge of the industries concerned (or departments within the industries) and interview them, in person and/or through a written questionnaire, about their activities. The questionnaire should aim to identify:

(i) Hazardous materials used and their trade names;
(ii) Hazardous properties of the materials;
(iii) Product safety information and emergency guidelines available;
(iv) Types of storage/shipping containers employed;
(v) Transportation routes used and frequency of use;
(vi) Persons to contact for technical assistance;
(vii) Company accident plans, and possibility of interfacing with community plans;

(c) Identify particularly vulnerable or sensitive areas, in terms of personnel, property and environment. Fire and police departments are good sources of information when planning at the provincial or municipal level or when planning to deal with large industrial accidents which could spread beyond the plant or facility. Vulnerable areas outside the plant might include the following:

(i) Sensitive public health concerns. (Drinking water intakes; vulnerable population centres; hospital locations; schools and playgrounds);

(ii) Sensitive environmental areas. (Coastal areas; wildlife habitats; parks and recreational areas; wild and scenic rivers; historical sites; and archeological areas);

(d) Map the sources of hazardous materials, important transportation routes, and sensitive areas, using different colours for each. In so doing, use both street maps (to show where population is affected) and topographical maps (to identify flow and drainage patterns). Maps of this type may already have been prepared by the fire department as part of its pre-fire planning [18];

(e) Consult records (newspapers as well as police/fire department and civil defence records) for actual industrial or industry-related accidents (no matter how small) and mark their locations on the map;

(f) Make a written description of what the map reveals, paying attention to any obvious pattern, such as areas of concentration of known accidents, clusters of industrial use or production, and storage. This description should also include the results of (g), (h), and (i) below;

(g) Try to estimate the probability of industrial accidents. This is the most difficult part of the whole analysis. Even very sophisticated techniques based on approaches such as "fault-trees" and "event-trees" [14] can lead to controversial results. When numerical approaches are too complicated or too time-consuming to be applied, accident probability can also

be estimated in terms of qualitative categories such as low-, medium-, or high-risk. Examples of high-risk factors are:

(i) Past accidents;
(ii) Major transportation routes;
(iii) Major industrial concentrations;
(iv) Transportation routes in urban areas;
(v) Drinking water intakes close to major transportation routes or hazardous material facilities;
(vi) Chemical storage, production facilities or pipelines located in flood plains, near earthquake zones or in other areas subject to recurring natural disasters;

(h) Decide what would happen in the event of a disastrous industrial accident. Two things have to be considered: (i) all the complications of a really large accident, and (ii) the effects of a natural disaster (fire, flood, earthquake) on the ability to cope with the accident. Secondary effects (traffic jams, business closure, reduced availability of manpower for emergency squads etc.) should also be considered, as well as the direct problem of accident handling and control.

Table 1. Sources of hazardous materials

Farm and related industry	**Chemical industry**
Crop dusting	Manufacturers
Fertilizers	Processors
Pesticides	Distributors
	Recycling plants
Petroleum industry	**Other manufacturers (chemical users)**
Bulk consumers	Rubber
Producers	Paint
Oil fields	Plastics
Refineries	Textiles
Storage facilities	Soap/detergents
Waste disposers	Tanneries
Refueling facilities	
Bulk terminals	
Transporters	**Waste disposal**
Airway	Sanitary wastes
Highway	Hazardous wastes
Waterway	
Pipeline	
Railway	

Time and resources will probably dictate the depth and extent to which a hazard analysis is conducted. At one end of the spectrum will be the case where the fire/police team simply gives an assessment based on whatever knowledge they already have. At the other end, one might conduct an industry

survey, develop a picture of local transortation patterns with shippers, and go through a set of "what if" scenarios, to assess plant vulnerability. Once completed, the hazard analysis should help decide: (a) the type of contingency plan required; (b) the degree of detail needed; (c) the types of response to emphasize; (d) the location of response and clean-up resources; and (e) the type of help needed if resources available are not enough.

Hazard analysis for industrial plant contingency plans

No single, ideal, hazard identification system exists. Systems vary as industries and processes vary. Thus, a firm involved in the batch manufacture of a large number of organic chemicals is much more likely to be interested in techniques for screening and testing chemicals and reactions than, say, an ethylene plant.

An important principle in hazard identification is utilizing past experience. The use of standards and codes helps avoid hazards of which people may not even be aware. As far as hazard identification is concerned, however, the principal means of transmitting this experience in a readily usable form is the checklist. A very general example of such a checklist is given in the appendix to this chapter (appendix II.A) [19]. Many examples of checklists are available in the technical literature, however [14, 20, 21], and these should be followed when applicable. Dow's Fire and Explosion Index Hazard Identification Guide [10] is another example of a checklist for the process design; it is widely used and accepted. The Dow methodology also gives a relative measure of the risk involved with different industrial operations.

Another tool frequently used in hazard identification at the plant level is the safety audit [22]. This consists of a critical, detailed examination of all facets of a particular industrial activity with the objective of minimizing loss. It is usually carried out by a team of professionals who produce a formal report and action plan. A safety audit may encompass complex technical operations, emergency procedures, clearance passes governing access to dangerous areas, general housekeeping procedures, and management attitudes. During the audit, the examining team often uses checklists such as the one shown in the appendix.

C. Identification of resources

After the hazard analysis, the next step is to identify the resources, in terms of equipment, personnel and agencies that should be made available to combat possible accidents. The functions and responsibilities of the different response groups should be defined. The resources to be identified for the two simplest contingency plans - resource lists and telephone rosters, and action guides and checklists - are not considered separately.

Response planning: identifying resources and functions of emergency response or support groups

When planning at the plant level, the greatest source of information is to be found in the scientific and technical literature available for each class of industry. Standards and regulations already exist for many types of plant, such as refineries [23, 24, 25, 26]. They may be used at all stages, from equipment design to plant erection, operation, maintenance and shutdown [27, 28, 29, 30, 31]. These standards have been conceived and refined with time, specific attention being devoted to the safety of personnel, property and the environment. Whenever possible, plans should always be examined in

order to ascertain the appropriate resources required to face the most typical industrial emergencies. When planning at the provincial or municipal level, or for accidents spreading beyond the plant boundary, all organizations capable of providing immediate active and material support in the event of an accident should be identified. As a starting point, the planner should contact the organizations at his own level and the next highest level listed in table 2. These sources can either provide direct information or refer him to other sources. The accident response capabilities of the various sources can be determined by asking questions concerning:

(a) The person in charge;

(b) Personnel assigned (training and skills);

(c) Equipment available;

(d) Existing environmental emergency response plans and activities;

(e) Defined responsibilities and duties;

(f) Existing mutual aid or interagency agreements;

(g) Internal chain of command.

Table 2. Contingency planning information sources

National agencies	**Industry**
Ministry of industry	Chemical plants and petroleum refineries, as well as users, transporters, storage facilities
Ministry of interior	Spill clean-up contractors
Ministry of transportation	Trade associations
Ministry of labour	Professional/technical societies
Ministry of energy	
Ministry of public works	
Environmental protection agency	
Armed forces	
Coastguard	
Provincial agencies	**Voluntary organizations**
Provincial environmental protection agency	Red Crescent
Provincial police	Red Cross
Provincial fire marshal	Local citizens associations
Provincial department of transportation	Service groups
Civil defence	
Municipal agencies	**United Nations organizations**
Mayor/City council/City administrator	United Nations Development Programme
Civil defence	United Nations Disaster Relief Organization
Fire department	United Nations Environment Programme
Public works department	World Health Organization (especially the International Programme on Chemical Safety)
Roads	
Water supply	
Sanitation	United Nations Industrial Development Organization
Flood control	

Once this survey has been completed, the data should be organized in a table or some other convenient form. This will facilitate an overall assessment of the area's accident response capabilities. Once these capabilities are known, assignment of further tasks can commence.

Co-ordination planning: identifying comprehensive emergency responsibilities

The main objective of a co-ordination plan is to establish clearly who is in charge and how responsibility shifts, and to whom, as more and more resources come into play. If a network of contingency plans exists at different levels, and planning is being undertaken at the municipal level, one should determine how the municipal plan will fit into the network. One should know, therefore, exactly how far the available resources will stretch, and when and for what reason additional support will be required.

Certain governmental agencies may have legal responsibility, jurisdictional authority, a charter, an interagency agreement, or they may have been delegated a response role in an emergency situation in some other manner. Therefore, when planning tasks are being assigned, care must be taken to ensure that assignments accord with legally mandated responsibilities, so that contradictions or unnecessary overlapping of duties will be avoided.

The various necessary emergency response functions should be assigned to those agencies most logically capable of dealing with them. Some assignments will be obvious, such as law enforcement and fire protection. Others, however, such as transportation or emergency public information services, may require deeper searching in order to determine which agency (or agencies) is best equipped to handle the situation. A suggested list of emergency responsiblities is given in table 3.

A basic rule should be observed when assigning tasks in preparation for an emergency: all the tasks that need to be completed before, during and after the emergency (not just the response tasks) should be listed first. Under those tasks, one should list the agency or agencies that can accomplish them. Listing the agencies first, and then assigning the most appropriate tasks, may result in some task being left unattended.

Each task should be assigned to a particular lead agency. Other groups can be added to offer support. The lead agency should be able to provide for insertion into any plan a list of general actions for which it will be responsible during emergencies. A compilation of these actions for all agencies constitutes the plan. The lead agency may also have generated, for its own internal use, a phone roster and an action guide/checklist describing in detail the procedures governing its response to emergencies.

Table 3. Emergency responsibilities

Law enforcement services	**Damage assessment**
City chief of police	Tax assessor
Provincial police representative	Records department
Army representative	Ministry of public works
Fire protection services	**Transportation services**
City fire chief	Ministry of transportation
Volunteer fire chief	Fleet supervisors
Province fire marshal	Parks department
Communications and warning	**Emergency public information**
Provincial civil defence	Chief executive
National army	Mayor/city manager
Parks department	Province executive
Local and province police	Public relations officer
Weather bureau	
Public works engineering services	**Legal services**
City/province engineer	Province/city attorney
Public works director	Attorney general
Utilities	**Rescue services**
Public utilities representative	Fire department
Private utilities representative	Police department
	National army
Health and medical services	**Hazardous Materials**
City/province health officer	Civil defence
State health official	Fire department
Nursing administrator	Environmental protection office
Hospital administrator	Ministry of public works
	Ministry of transportation
Welfare Services	**Personnel and financial services**
City/province welfare offical	Personnel director
State welfare official	Finance director

Appendix II.A

HAZARD ANALYSIS CHECKLIST

Plant site

(a) Is plant well situated with regard to topography and adequate drainage?

(b) Will the climate or natural disasters (earthquake, floods, fog, hurricane, lightning, smog, snow, tornados, high or very low temperatures) materially affect plant operations?

(c) Will toxic fumes from fire, explosion, or other accidents at the plant affect the surrounding community?

(d) Are there major highways, airports or congested areas near the plant site? Can emergency equipment get through traffic at all times of the day?

(e) Are utilities (water, gas, electricity) adequate?

(f) Does the community provide adequate fire-fighting personnel and equipment?

(g) Does the community provide adequate ambulance, hospital and police services?

Plant layout

(a) Is the plant area enclosed by adequate fences and gates?

(b) Is there a safe distance from the boundary to the nearest plant unit?

(c) Are process areas separated from utilities, storage, offices, laboratory areas, and sources?

(d) Are hazardous units separated from all critical areas such as control rooms or process computer installations?

(e) Does spacing of equipment allow for the nature of the materials, the quantities, the operating conditions, equipment sensitivity and requirements for combating fires?

(f) Are loading areas on the periphery of the plant and away from sources of ignition?

(g) Are administrative buildings and warehouses on the periphery of the plant?

(h) Are storage tanks away from the periphery, not too closely spaced, and diked or buried?

(i) Are waste-disposal systems downwind from personnel concentration?

(j) Are there adequate roadways for vehicles to enter and exit in the event of an emergency?

Structures

(a) Do all buildings conform to the national building code (if any)?

(b) Are foundations and subsoil adequate for all loadings?

(c) Are all buildings constructed with nonflammable insultation?

(d) Have factors which could contribute to fire spreading (openings in floors, walls, elevator shafts, air conditioning and ventilation ducts) been minimized?

(e) Are hazardous process areas separated by fire walls?

(f) Are all buildings properly ventilated to limit accumulation of toxic and flammable substances?

(g) Are there sufficient and clearly marked exits in all buildings?

(h) Do electrical installations conform to the national electrical code?

(i) Are drainage facilities in buildings adequate?

Materials

(a) Have the types and quantities of materials in all stages of handling and storage and all physical states been considered? Are any materials flammable, explosive, toxic or corrosive?

(b) Are the pertinent physical properties of each material (melting point, boiling point, vapour pressure, particle size) known?

(c) Have the chemical properties of each material been classified?

(d) Have the hazards of each material been classified? Have highly hazardous materials been identified and their location in the plant determined?

(e) Have the stability hazards of materials (reactivity, spontaneous combustion, polymerization) been determined?

(f) Have the effects of impurities been taken into account as related to fire and explosion, toxicity, corrosivity and stability of the material?

(g) Are materials properly packaged and labelled according to national, or international regulations (if any), as well as industry and insurance company recommendations?

Chemical process evaluation

(a) Have the primary hazards of the process been identified?

(b) Is it a batch or continuous process?

(c) Has the process been properly described and examined through reaction equations and flow sheets?

(d) Are normal process conditions adequately described?

(e) Have provisions been made to prevent:

(i) Abnormal temperatures;

(ii) Abnormal pressures;

(iii) Abnormal rates of reaction;

(iv) Improper addition of reactants;

(v) Material flow stoppage;

(vi) Equipment leaks or spills;

(f) Are emergency measures prepared in the event that the developments cited in the previous question occur?

(g) Have potentially unstable reactions been detected?

(h) Have process health hazards been identified and control measures installed?

Unit operations, transport and storage

(a) Have the potential hazards of all materials involved been evaluated?

(b) Are precautionary measures taken to guard against accidental release of flammable or toxic liquids, gases or combustible dusts?

(c) Are unstable chemicals handled in such a way as to minimize exposure to heat, pressure and shock?

(d) Are the unit operation facilities (distillation columns, adsorbers, strippers) properly designed, instrumented and controlled to minimize losses?

(e) Have all heat-transfer operations been properly evaluated for hazards?

(f) Have all transport operations been checked?

(g) Are shipments of chemicals from the plant packaged, labelled and transported in accordance with current regulations or best industrial practice?

(h) Are waste disposal and air pollution problems handled in accordance with current regulations or best industrial practice?

Operator practices and training

(a) Has an adequate "Standard Operating Procedure" manual been prepared? Is it reviewed periodically and when process changes are made?

(b) Have adequate employee training programmes been instituted? Do they cover both supervisory and operating personnel?

(c) Have adequate start-up and shut-down programmes been initiated?

(d) Does the plant have a permit system for operations on hazardous jobs? Is it enforced?

(e) Are employees trained to recognize potential process malfunctions?

(f) Are employees trained to handle emergency situations? Is co-operation with other public and private fire departments organized?

(g) Are operators trained in the utilization of protective equipment?

Equipment

(a) Does each major piece of equipment have its own detailed checklist?

(b) Are recognized standards required in the purchase of equipment?

(c) Is equipment designed with adequate safety control? Over-pressure? Over-temperature?

(d) Has equipment been properly constructed and installed? Was it thoroughly checked before operating?

(e) Is equipment reliable and easy to operate?

(f) Is equipment designed for ease in inspection and maintenance?

(g) Are all instruments and controls fail-safe?

(h) Is the maintenance and inspection programme adequate?

(i) Are spare parts and equipment repair crews ready?

(j) Is the safety equipment adequate for the hazards?

III. NATIONAL CONTINGENCY PLANNING

Industrial accidents are an unavoidable by-product of industrialization. In the vast majority of cases, these accidents are limited to the facility and/or its workers, because either the types of activities at the plant do not pose any large-scale threat or the accident is successfully controlled before it spreads outside the plant. Unfortunately, for certain types of industrial establishments, such as refineries or explosives-manufacturing companies, the possibility exists, even if extremely remote, that an accident will develop into a large-scale disaster. As an example, in September 1977, lightning ignited an 8-million-gallon tank of diesel fuel at a major oil refinery in the United States. Subsequently, two additional tanks containing 2 million and 5 million gallons of gasoline, respectively, ignited. The situation was brought under control after two days of fire fighting and the use of 20,000 gallons of a foam-concentrate extinguishing agent. Eighteen fire departments were involved in the operation [32]. In this, as in many other cases, the population was unaffected by the disaster. But the size of such an accident requires the intervention of external resources and manpower. In addition, the economic loss may be staggering.

National contingency planning is the only effective way to combat large-scale industrial accidents. It requires the mobilization of national resources and a co-ordination effort at a level higher than any private company can provide: it requires the direct intervention of the Government authority. Therefore, national contingency planning is a governmental responsibility. Many public structures, from ministries to fire departments, may be involved in its development, elaboration and implementation.

The reasons for establishing a national contingency plan are threefold: to protect workers and the public, the industrial resources of the country, and the environment, from the consequences of industrial accidents. In greater detail, a well-conceived national contingency plan will:

(a) Limit the consequences of an industrial accident, in terms of human lives and economic losses;

(b) Enable the country to organize and utilize properly the national emergency teams and resources in case of industrial disaster;

(c) Co-ordinate emergency response actions between the plant and the local response teams;

(d) Make available to individual industries emergency resources that they would not otherwise be able to obtain;

(e) Promote co-ordination activities between local intervention teams;

(f) Instil confidence within the industry and the public;

(g) Define the authority of the Government in industrial safety and emergency response.

A. Preliminary planning steps

National contingency plans are mainly co-ordination plans. Therefore, their focus should be on the distribution of responsibilities and tasks among the parties involved, rather than on the description of specific actions to be taken in case of a major accident. A hazard analysis is the first step in the

planning process, followed by identification of the comprehensive emergency responsibilities of the different ministries and agencies. (These two steps were introduced in Chapter II.) The Government should designate a ministry or agency to take the initiative in commencing the planning process. The representatives of the other interested ministries or agencies should then be brought together to develop the plan. The sequence might be as follows.

The first meeting makes clear the need for such a plan and how everybody may be called upon to meet expected needs. The participants are asked how they can assist during an emergency. Some of those present will have capabilities not previously known. They are then requested to indicate, in writing, where they can best help. After the meeting, participants are divided into working committees, based on the information they have provided.

At the second meeting, command organization is discussed. The committees or working groups then endeavour to identify all agencies, groups or organizations that could provide assistance to their command staff assignment. A list is developed of the resources available from each agency; how the resources can be obtained (day and night), how they can be used, and the approximate amount of time required for them to become operational. The committee sends a questionnaire to representatives of groups not in attendance in order that the disaster plan inventory may be completed. The resource lists are collected, edited and compiled.

At the third meeting, the preparation of the contingency plan is initiated. Each committee develops a particular section of the plan, detailing how the participants and equipment designated in the resource inventory can best be used.

The national contingency plan should include a section for each committee function, such as evacuation or safety, and outline the specific duties of each participant group and of the various divisions and units within that group. For example, the police group may contain municipal, provincial, national and auxiliary personnel. The role of each is designated, as well as the responsibilities of specific units within the group, such as traffic, special services and communications.

Once each functional group has developed a section of the plan detailing responsibilities and duties, the sections are reviewed for any areas of overlap, or tasks that have been omitted. Each agency must know its role in the command organization and overall operations and where it will be expected to assist.

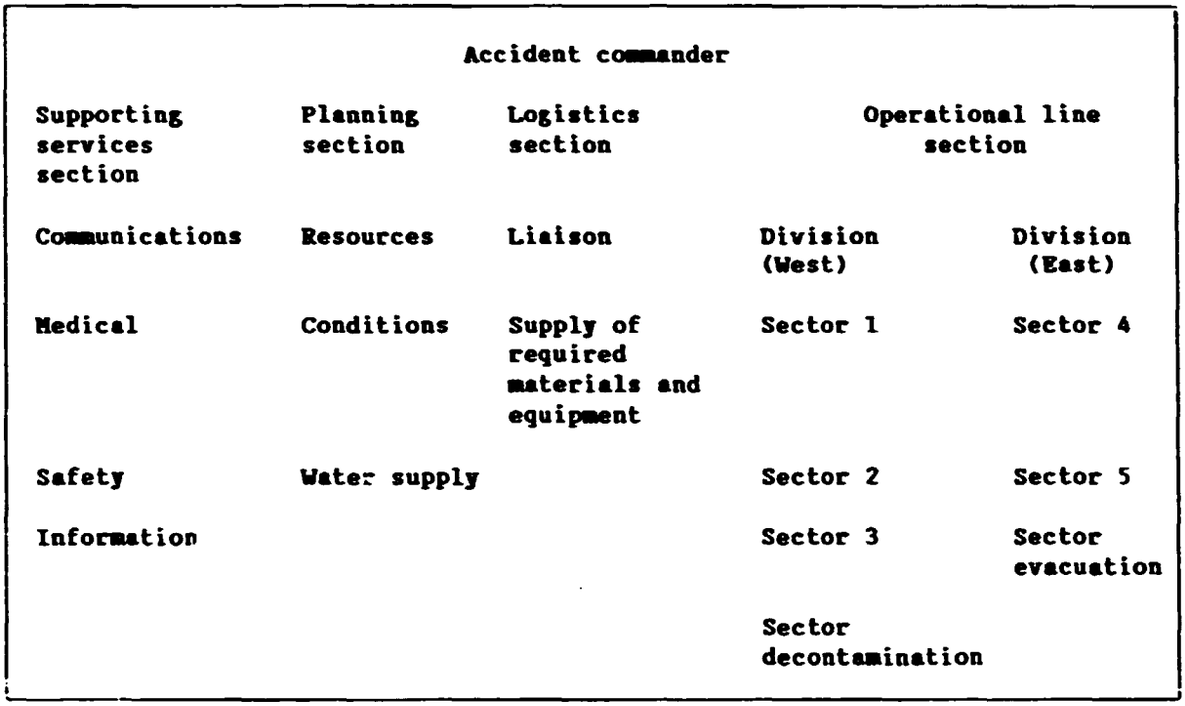
B. Command and service structures

Two of the main objectives of a national contingency plan are to define the command structure and to organize the different response teams into that structure so that the numerous necessary operations can be carried out during large-scale accidents. A possible organization chart of the command structure is shown in figure I.

Accident commander

The accident commander is responsible for managing all emergency scene operations. He should direct the operations from a command post appropriate to the magnitude and nature of the incident. From this post he can obtain expert advice and co-ordinate the actions of the operational forces, using an

Figure I. Organization chart of the command structure



emergency communications system if necessary. The commander must also co-ordinate fire-fighting tactics with other actions, such as process or pipeline shutdown, and seek advice from plant or carrier personnel having knowledge or specialized training in handling the products involved. He must oversee planning for personnel, equipment, and other outside assistance or support. Moreover, he must be prepared to apply the tactical operations necessary to confine and control the emergency.

The accident commander has three primary means of appraising the emergency. The first is by visual observation of the emergency scene. If the command post is not adjacent to the scene, someone else may make a visual check of the scene and report to the commander. The third method consists of using the pre-planning information that should be available at the command post. If it becomes necessary for the accident commander to leave the command post, authority should be delegated to another officer. The commander, however, should remain in constant radio contact with this officer.

Overall command structure

The accident commander should delegate authority and responsibility at any large, complex accident to line and staff officers. He is then free to develop overall strategy and make tactical decisions. The line officers are responsible for achieving the objectives of the accident commander's strategy, such as fighting a fire or evacuating an area. The operational line is headed by the line commander. A divisional officer may be responsible for each front of the emergency.

The staff officers provide technical assistance and support. The administrative section relieves the commander of performing detailed work associated with the accident. The planning section develops alternative strategies and

tactical approaches for the commander's review. The logistics section co-ordinates and acquires needed supplies, equipment and personnel. Such an organization may be necessary in hazardous-material accidents where many operations are involved.

Line operations

The operation line commander is the on-site tactical commander and has immediate responsibility for removing injured or exposed persons and limiting the spread of the fire or hazardous material. He reports to the accident commander. His subsequent responsibilities include decisions concerning:

(a) The type of operation: control, attack, or withdraw;

(b) Resources needed by each group to carry out these operations;

(c) Escape routes to safe areas, and appropriate retreat signals;

(d) Handling unexpected hazardous situations;

(e) How long personnel are to stay in action before rotation or being relieved.

Operations at large accidents can be divided into geographical areas of appropriate size, with division commanders. Sector commanders (figure I) can be assigned to these geographical areas or to specific functions (e.g. evacuation or decontamination).

The responsibility of a line command officer should be to supervise the crew and co-ordinate its actions with those of other companies so that they do not work against each other. The crew must function as a team; the officer should be concerned at all times with its safety and with protecting it against exposure to toxic fume inhalation, poison ingestion or absorption, pressure vessel rupture, corrosive action, or explosion.

Supporting services section

The supporting services section includes (a) a communications officer; (b) a medical officer; (c) a safety officer; and (d) an information officer. These assist the accident commander in handling the details associated with an emergency accident. This section directs radio land-line communications (including those to other agencies), treats the injured, maintains overall safety, and deals with the media.

Communications officer. The communications officer must establish communications with all units responding and on the scene, outside agencies and technical information sources. He handles all transmissions to and from the command post. The operation line commander must provide constant, specific and timely feedback to him. The communications officer should obtain a complete list of telephone numbers of local people (such as MDs) and outside agencies which may have to be called. In many cases, technical assistance may have to be requested from emergency response centres, as described in Chapter V. The communications officer should also know where to obtain additional equipment such as power megaphones, portable radios, power antennae, mobile telephones, or an emergency switchboard.

Medical officer. The medical officer is responsible for providing first aid to those rescued and making sure that they are promptly transported for

treatment. He may have to establish an aid station to take care of victims or injuries. For major accidents, it may be necessary to set up a complete field hospital. If necessary, he will request the supply officer to obtain medical supplies, resuscitators, oxygen and ambulances. He should have complete knowledge of local hospitals and notify them accordingly so that one is not overcrowded while another awaits casualties. The medical officer must also co-ordinate with a coroner on identification procedures, removing bodies and establishing a temporary morgue. In situations of less magnitude, the duties of the safety officer and the medical officer may be combined.

Safety officer. The safety officer is responsible for the safety of emergency response personnel at the scene; the public in the area; and spectators. He must ascertain whether there is a potential risk from hazardous materials. Other duties are: informing the accident commander of safety problems; assisting in strategic and tactical planning; and reviewing all sector status reports in order to identify danger. The safety officer must have the authority to halt unsafe operations immediately, if he deems necessary. He should make sure that special protective clothing is worn when necessary. He may also have to establish crowd-control lines or decontamination procedures, along with monitoring the health condition of everyone working on the scene. The safety officer liaises with law enforcement officials in order to block off the area, re-route traffic and restrict access to the accident scene and the command post.

Information officer. The information officer is responsible for working with the news media and seeing that correct information is given out. He should provide accurate information so that erroneous or embarrassing statements are not placed on the news wires. He should decide where the Press will be allowed to go. It may be advisable to hold news conferences if the emergency continues. Adequate telephone lines, in addition to those for the command post, should be established for the media.

Planning section

The planning staff consists of the resources officer, conditions officer and water supply officer. These are responsible for assisting the accident commander by developing alternative strategies and tactical operations. The planning is done in co-ordination with the commanders of the logistics and operation line sections. The planning section must also consider and present alternatives on how the operation line section can be divided into divisions and sectors; what equipment and personnel should be held in reserve; the location of the staging area (where the reserve equipment is kept); possible accident spread; safety, and special problems; co-ordination of planning with liaison, logistics, and operation line sections; and plans for the safe location of the command post.

Resources officer. The resources officer determines the number of companies that have responded or are en route to the scene of the accident. His duties are: recording arriving companies; keeping track of their assignments; and supplying the accident commander with current resources, including the companies actually available for assignment. He also maintains a chart of the command post staff assignments.

Conditions officer. The conditions officer keeps a record of what is happening on the scene and prepares progress reports of the situation for the accident commander. These reports should cover: the area involved; the possibility and direction of spread; progress of the operation line forces; and any special factors, such as rerouting of traffic, arrival of special

extinguishing agents, or evacuation procedures. The conditions officer should maintain an overall tactical control chart detailing the location of companies at the scene and their assignment. This chart would also show the sectioning of the accident fronts, the positioning of apparatus, and attack positions. A variety of records must be kept at the command post during a hazardous materials situation, and a record system should be pre-established. Records of all decisions should be clear, establishing who made them, and why. Records will assist in planning for the next accident and point to areas in need of improvement. They will also serve as a justification for funds spent during the accident.

Water supply officer. The vast majority of industrial accidents include fires. In such cases, a staff officer should be assigned the task of making available to the response teams the most common fire-extinguishing agent: water. The water supply officer performs numerous functions, such as determining the location, accessibility and quantities of water available from all usable sources; evaluating the accident water requirements or quantity needed for the planned operations; and initiating water supply operations to overcome deficiencies. He should obtain maps indicating storage capacities, mains sizes, hydrant locations, and flows available in various areas. He will need to be familiar with apparatus capacities, locations, number of lines in operation, pressure drops, residual pressures, available hose, and discharge ports. His duties overlap those of line operations.

Logistics section

The logistics section consists of the liaison and supply officers. This section is responsible for providing personnel and material for the time needed to control the hazardous-material emergency.

Liaison officer. The liaison officer co-ordinates the actions of the outside agencies which can offer assistance to the emergency-response team. He should know who represents the various agencies and where and how to contact them. Some of the agencies with which liaison will be maintained include law enforcement bodies; rescue or emergency medical services; local government bodies; utility companies (especially water, sewer, telephone and electrical); health, hospital, and ambulance services; the city lawyer's office (for legal advice, if necessary); local environmental agencies; local contractors (for heavy equipment); service groups (for facilities if evacuation of large numbers is necessary); and manufacturers' or trade associations which can provide technical assistance. Because of the number of agencies involved, the liaison officer will be in charge of any evacuation operations necessary.

Supply officer. The supply officer maintains the staging area where the rescue equipment is kept. He acquires, stores, and records all resources. The supply officer sends tools, equipment, personnel and apparatus to the line sections at the scene of the accident, on orders of the accident commander. He then informs the resource officer of the assignments. The supply officer must keep an inventory of equipment and make sure that supplies are maintained. Equipment and material that might be needed during an emergency include: breathing apparatus; generators and lights for night-time operations; special protective clothing; ample supplies of extinguishing agents; equipment for damming and diking (such as dump trucks, front loaders and bulldozers); extra supplies of hose; cranes and tow trucks; floating booms or absorbing materials (for oil or chemical spills); decontamination or neutralizing materials (for corrosives, poisons or pesticides - these may include lime, soda ash and chlorine bleach, to name only a few); and adequate supplies of gasoline, diesel fuel and oil.

C. Actions under the national contingency plan

National contingency plans are comprehensive plans geared towards organization of the emergency resources rather than a description of specific actions to be taken. More detailed guidelines can be found in response plans developed by emergency response teams or industries (see Chapter IV). Only general indications can be given on how to handle a major emergency. Some of these are listed below under the headings (a) activation of the plan; (b) establishment of the command post; (c) development and implementation of response strategy; (d) evacuation; and (e) restoration of services.

Activation of the plan

The sequence of events which culminates in the implementation of the national contingency plan is, in general, the following:

(a) The first alarm is communicated to an emergency response team (such as police or fire fighters) which arrives at the scene of the accident and begins the response operations;

(b) The commander of the response team decides that resources are not sufficient to bring the accident under control. He asks for reinforcement from, for example, other fire departments in the same area;

(c) The joint response team still cannot control the accident. The accident commander alerts the authority in charge of activating the national contingency plan;

(d) An emergency is declared and implementation of the plan begins.

Of course, the accident commander can alert the authority who has the power to activate the plan and ask for its implementation in any phase of this sequence. The person with authority to activate the plan will be, in general, a high-ranking officer of the administration, most likely in the ministry of the interior or its equivalent. Alternatively, this authority can be delegated to the representatives of this ministry at the provincial level, in order to accelerate the whole procedure. In any event, the person authorized to activate the plan is also the person in charge of operations. This command responsibility may be delegated to another officer especially designated for the job.

Establishment of the command post

The command post is the operating centre from which definite control of the accident is exercised and maintained. All intelligence, feedback and information will be directed to this one place. In order to co-ordinate the actions of the response teams at the accident location, an advance command post can also be established and placed under the authority of the operation line commander. All division or sector commanders should give periodic progress reports to the advance command post. These reports should cover the current accident situation and control probability, rescue or evacuation procedures, safety concerns, the condition of the area affected by the accident, any further resource requirements, and any special developments in the hazardous situation. The feedback provided by the operation line commander and by the officers in charge of the different sections is then channelled to the accident commander.

Development and implementation of response strategy

On the basis of all the information obtained, the accident commander will develop the accident-response strategy. Generally speaking, he has three options: control the accident, attack it (e.g. a fire), or withdraw. The actual strategy may be a combination of these three elements. The response actions are likely to be rather complex and co-ordinated activities carried out by the response teams. A detailed account is therefore impossible.

Many problems arise in the decision-making process during an accident. Most of them are attributable to lack of information (or lack of correct information) and communication problems. Examples are unidentified products, places that cannot be seen or easily reached (a train may be a mile long, or more), allowing responding units to become committed before being given a definite assignment, difficulties in co-ordinating multiple companies, multi-department or multi-agency operations, and hesitation in decision-making.

Evacuation

Evacuation is considered to be the removal of all private citizens - including public officials, Press, non-essential employees or officials, and all non-working emergency response personnel - from the immediate area of danger. If explosive chemicals are involved in the accident, then a safe separation distance should be established between the material and any essential and non-essential personnel, including the emergency teams. Safety distances are sometimes listed in the literature for the particular chemical involved. Lacking any specific information, the safety distance formula used by the United States Army Explosive Ordinance Disposal may be used: distance in feet = $325\sqrt[3]{}$ pounds of material. For example, 1,000 pounds of an explosive material would compute to 3,250 feet safety distance. Cloud cover, low temperatures and terrain configurations could cause damage, such as broken windows, beyond this distance. Overhead cover should also be used in case of flying debris.

Evacuation may be necessary downwind for gases and vapours, downgrade for liquids or high vapour density gases, or in a circular area for products that polymerize, rupture or explode. A simple rule of thumb is to initiate evacuation for at least 1.5 km. In larger metropolitan areas, evacuation in all directions for 1.5 km would be a major undertaking, requiring a considerable amount of time to accomplish. Evacuation, especially when dealing with large numbers of people, immediately develops numerous difficulties and problems. Many questions must be answered in the planning stage by establishing procedures or strategies to meet these problems. Some of the questions are:

(a) How to alert the people effectively?

(b) How to handle persons who will not want to move unless they can see the imminent danger?

(c) How will large groups be moved? (For example, Chicago once had to evacuate 16,000 persons from a silicone tetrachloride cloud.) [32]

(d) How will persons in the area be moved if they cannot drive because of poor visibility?

(e) How will the public be moved, if it is necessary, through a vapour cloud? (Both this and the routing recommended under the circumstances may need consideration before evacuation is initiated.)

(f) How will the final check be made to see that everyone has left the danger area, especially at night?

(g) Where will sufficient personnel be drawn from, in a minimum of time, to perform an adequate evacuation?

(h) How will they be trained for search and evacuation?

Finding the personnel to do evacuation work may be a critical factor. In many situations, the fire service will be concentrating on controlling the accident and will only be able to complete evacuation in its immediate vicinity. Police lines should be set up at the designated perimeter and no one allowed into the area. In most instances, the police should also take care of the evacuation procedure.

Restoration of services

The accident commander may also be required to co-ordinate the restoration of services. A number of vital services could be impaired by the accident, thereby creating minor emergencies of their own. Examples are contamination of the ground-water table supplying wells or the water source for a community's water filtration plant. Auxiliary water supplies will have to be provided for the population. This could possibly involve fire department operations. Another example would be the restoration of electrical power. The fire department may have to supply emergency light or power for vital operations while awaiting the intervention of the power company. Numerous other services requiring the assistance of the fire department and co-ordination of the accident commander might be necessary to bring the accident control to a successful completion.

D. Legislation and standards

The existence and enforcement of a proper legislation on industrial plant safety and accident prevention is a necessary prerequisite for the preparation of national contingency plans. In order to have a clear picture of the industrial situation, the Government could make a census of the country's industries [33]. Questionnaires and plant inspections by Government technical representatives could be utilized in order to obtain information relating to:

(a) The installations, such as:

(i) Type of industrial activities;

(ii) Geographical location of the installation, predominant meteorological conditions, and sources of danger arising from the location;

(iii) Number of persons working on the site, and particularly number of persons exposed to the hazard;

(iv) General description of the technological processes;

(v) Description of those sections of the establishment which are important from the safety point of view, the sources of hazard and the conditions under which a major accident could occur, together with a description of the preventive measures planned;

(vi) Arrangements made to ensure that the technical means necessary for the safe operation of plant, and to deal with any malfunctions that might arise, are available at all times;

(b) The substances present at the installations, such as:

(i) Substances stored or used in connection with the industrial activities;

(ii) Final products, by-products and residues;

(iii) Data on substance identification (i.e. chemical and trade names, empirical formula, composition and degree of purity);

(iv) The stage of the activity in which the substances are involved or may be involved;

(v) The quantity (order of magnitude);

(vi) The chemical and/or physical behaviour under normal conditions of use during the process;

(vii) The forms in which the substances may occur or into which they may be transformed in the case of abnormal, but foreseeable conditions;

(viii) If necessary, other dangerous substances whose presence could have an effect on the potential hazard presented by the relevant industrial activity;

(ix) Detection methods available at the installation;

(x) Methods available at the installation for rendering the substance harmless;

(xi) Indication on hazards to man and the environment;

(c) Possible major accident situations, that is to say:

(i) Emergency measures laid down by the manufacturer in the event of accidental dispersion of the dangerous substances mentioned in item (b);

(ii) Emergency plans, including safety equipment, alarm systems and resources available for use inside the establishment in dealing with a major accident;

(iii) Any information necessary to enable the competent authorities to prepare emergency plans for use outside the establishment;

(iv) The names of the person and his deputies (or the qualified body) responsible for safety and authorized to set the emergency plans in motion and to alert the competent authorities.

The Government could also require that serious industrial accidents be promptly notified so that steps can be taken to alleviate the consequences (including long-term) and prevent recurrence. Examples of serious accidents are:

(a) Any accident which causes death or results in disablement for more than a given time (e.g. 3 days);

(b) Fires or explosions due to vapour, gas or dust which result in damages to the workroom or equipment and which cause more than a fixed down-time to the plant (e.g. 5 hours);

(c) Release of toxic substances in the plant or the environment beyond limits determined for each substance.

Information on the accident should be supplied by the manufacturers to an appropriately delegated agency and should be concerned with:

(a) Type of accident (explosion, fire, toxic release);

(b) Description of the circumstances of the accident;

(c) Dangerous substances involved;

(d) Nature and extent of damage to private property and the environment, both inside and outside the plant;

(e) Causes of the accident;

(f) Data available for assessing the effects on man and the environment.

Certain industrial activities are more liable than others to cause major accidents. The Government could recognize this by means of a legislative act classifying industries according to the threat they pose to man and the environment. This classification could divide industrial activities into broad groups (e.g. chemical industries) or narrow ones (e.g. explosives-manufacturing industries). Regulations could then be established for the proper design, operation and maintenance of the plants. In particular, regulations should deal with subjects such as plant spacing and layout, ventilation of noxious processes, control of dust, sources of ignition, pressure relief equipment, entry into vessels, first-aid equipment, training, and dangerous practices. Requirements could also be established for specific processes such as manufacturing sulphuric acid or caustic soda.

Standards and codes of practice could also be defined for handling, storing or transporting certain classes of dangerous materials, such as petroleum products. Licencing of new industrial establishments and related planning activities should be the competence of governmental or local agencies. Periodic inspection of existing plants should also be carried out.

The manufacturers could be required by law to prove to an established, competent agency, at any time, that they have identified existing major accident hazards, adopted the appropriate safety measures, and provided the workers on the site with information, training and equipment in order to ensure their safety. The preparation of plant contingency plans could be considered part of these protective measures and be required for at least some especially dangerous industrial establishments.

Specialized governmental agencies or ministries could also be mandated by law to prepare municipal, provincial or national contingency plans. In this case, the procedure described in section A could be followed. The ministry of civil defence (or an equivalent governmental agency) will most likely be put in charge of establishing contingency plans for major industrial accidents, as part of a general scheme concerning assistance to populations affected by natural or man-made disasters.

Legislation on the transport of hazardous materials deserves special attention because of the possible international implications. If not previously agreed upon, each country may require that dangerous goods arriving at its frontiers be properly packed, labelled and carried according to its own national regulations. International agreements should therefore be established concerning:

(a) The list of substances prohibited for transport by road or by any other means;

(b) Special measures to be adopted when transporting certain classes of material;

(c) Special requirements for the construction of the carrier vehicles, train cars, or barges;

(d) Labelling, placarding and packaging systems for hazardous materials transport.

The regulations adopted by the member States of the European Economic Community [34] represent a good example of international legislative agreement on this subject.

E. Provincial and municipal contingency planning

A national contingency plan, as described in this chapter, should be utilized only in case of a major disaster. For smaller-scale major accidents, municipal or provincial resources might be enough to bring the accident under control [35]. Contingency plans could also be drawn up at these levels. The authorities or agencies in charge of preparing and implementing them should then be the appropriate ones operating at the provincial or municipal level. The procedures for preparing, organizing and implementing the plans are nevertheless similar to those for a national plan, with self-evident modifications. This chapter, therefore, can also be utilized for this purpose.

F. Hospital contingency planning

The number of casualties caused by a major emergency may be so high that local hospitals will be overburdened. Each hospital administration, therefore, should also develop a contingency plan to ensure that all available resources are mobilized and properly used in such events. Although a detailed presentation is beyond the scope of this study, a hospital contingency plan should include a telephone roster of all medical personnel, listed according to the proximity of their residence to the hospital. For example, the University Hospital in Ghent, Belgium, has a 13-page emergency admittance plan bound with a red cover [7]. This plan is updated annually. In recent years, the plan has been activated five times due to the emergency admittance of 15 or more persons following an accident. One accident involved 17 injured persons resulting from the transport accident of a truck carrying flammable industrial gas. In another accident, 33 persons were admitted after inhaling chlorine gas released during an accident at an industrial plant. An example of a hospital emergency admittance plan is presented in the appendix to this chapter (appendix III.A).

G. Summary of the main objectives of a national contingency plan

In summary, the objectives of a national contingency plan should be:

(a) To co-ordinate and unify the actions of different governmental ministries and agencies in case of a major industrial accident;

(b) To establish the authority(ies) responsible to declare a major emergency;

(c) To identify the responsibilities of the different ministries or agencies involved;

(d) To identify the resources that could be mobilized if necessary;

(e) To establish how responsibilities shift as more resources are brought in to combat the accident;

(f) To establish how provincial, municipal and plant contingency plans are going to fit into the national plan;

(g) To identify and organize the different services or sections in charge of implementing the plan (e.g. the supporting services and the logistic and planning sections);

(h) To define the procedure to be followed to update the plan and carry out training exercises;

(i) To identify the funds available to cover the expenses incurred as a result of the emergency operations.

Appendix III.A

EXAMPLE OF A HOSPITAL EMERGENCY ADMITTANCE PLAN

I. Emergency admittance during normal working hours

1. For the telephone office

As soon as the emergency response centre announces an emergency situation, inform:

(a) Office of the Director — Tel. ...

(b) Person in charge of:

(i) Emergency admittance — Tel. ...
(ii) Intensive care — Tel. ...
(iii) Operating theatre — Tel. ...
(iv) Social service — Tel. ...
(v) Central reception — Tel. ...
(vi) Patients' transportation — Tel. ...
(vii) Equipment and furnishing — Tel. ...

(c) Doctors on duty and stand-by:

(i) Administrative doctor responsible for emergency admittance;
(ii) Surgical department;
(iii) Anaesthetical department;
(iv) Internal department;
(v) Orthopaedic department;
(vi) Radiological department;
(vii) Clinical biologist on duty.

All further incoming messages should immediately be transferred to the Office of the Director (Tel. ...).

Telephone requests for information on incoming patients should immediately be transferred to Tel. ... or Tel. ....

2. For the emergency admittance

Prepare, immediately, everything necessary to receive casualties. Make sure that there are enough stretchers available to clear the ambulances as quickly as possible.

3. For the nursing department

Choose one nurse of the following services and call her to come to the emergency admittance with a stretcher equipped with:

(a) Sheets (exact number to be established);

(b) Big pillows (exact number to be established);

(c) Impermeable blankets (exact number to be established);

(d) Under blankets (exact number to be established);

Available services:

Ward 1, 1st floor	Tel. ...
Ward 2, 1st floo	Tel. ...
Ward 1, 2nd floor	Tel. ...
Ward 2, 2nd floor	Tel. ...
Ward 3, 2nd floor	Tel. ...

4. For the social service and reception service

After having been informed by the telephone centre:

(a) One or more social nurses join the personnel in the reception (building No. ...). These are responsible for the first contact with the family or other interested persons.

(b) One or more social nurses join the emergency admittance in order to start, together with the responsible personnel at the spot, an inventory of incoming patients. They try to collect as much information as possible on the patients' physical state. They are also responsible for the safe deposit of valuables. All information is regularly transmitted to the central reception.

(c) One or more social nurses go to the person in charge, or his/her replacement in the central reception. This team collects all incoming information. This is kept available for requests on Tel. ....

(d) The telephone centre immediately transfers all outside requests for information on patients to the above team, on Tel. ....

(e) The person in charge at the central reception or his/her replacement supervises the transfer of patients to the various floors.

5. For the person responsible for furnishings

He/she calls on the services of:

(a) Manual workers;

(b) Painters;

(c) Carpenters;

(d) Electricians;

(e) Metal workers.

With the help of this personnel, spare beds and equipment are moved from the basement and installed in:

- Ward 1, 1st floor
  Day room in front of central elevator: 6 beds

- Ward 2, 1st floor
  Day room at the end of the building: 6 beds
  Space in front of reception: 6 beds

  Total number of beds to be placed: 60 beds

II. Emergency admittance during nights, weekends and holidays

1. For the telephone office

As soon as the emergency response centre call comes in, inform:

(a) The persons responsible for:

(i) Emergency admittance;
(ii) Intensive care;
(iii) Operating theatre;

(b) The assistant head nurse on duty;

(c) The doctors on duty and stand-by in the following departments:

(i) Anaesthetical;
(ii) Surgical;
(iii) Internal;
(iv) Ophthalmological;
(v) Orthopaedic;
(vi) Radiological;
(vii) Clinical biological;

(d) The administrative doctor responsible for emergency admittance;

(e) The head medical officer;

(f) The head nurse;

(g) The head secretary;

(h) The person in charge of central heating as well as the electrician on duty.

Once all the above announcements are made, all further incoming notices are recorded and transmitted to the head secretary as soon as they come in.

2. For the emergency admittance

Prepare immediately everything necessary to receive victims. Make sure that there are enough stretchers available to clear the ambulances as quickly as possible.

3. For the assistant head nurse on duty

Go immediately to the reception assembly point. Call one nurse from the following services to come to the emergency admittance with a stretcher equipped with:

(a) Sheets (exact number to be established);

(b) Big pillows (exact number to be established);

(c) Impermeable blankets (exact number to be established);

(d) Under blankets (exact number to be established).

Available services (See emergency procedure during working hours, section 3)

Send one student nurse to each floor of which one nurse has been called to the emergency admittance. The student nurses are sent by the school to the reception, where they must present themselves to the assistant head nurse on duty.

Order the central-heating operator and the electrician on duty to take beds and mattresses out of the reserve stock.

Ensure that all administrative information concerning patients is registered.

Register each patient's clothes and valuables separately.

If necessary, help may be sought in the reception, from the social service, and specifically from the following persons:

Mr. ...	Tel. ...
Ms. ...	Tel. ...

4. For the central-heating operator and the electrician on duty

Both, in co-operation, help in collecting and placing reserve beds and equipment. (For distribution, see emergency procedure during normal working hours, section 5.)

5. For the nursing school

Ten student nurses (third year) are sent to the reception where they present themselves to the assistant head nurse on duty.

The assistant head nurse sends the students to all floors where a nurse had been called away to the emergency admittance.

A certain number of students (to be established by the person responsible for the emergency admittance) are sent to the emergency admittance to give assistance in preparing beds, removing clothes, washing patients etc.

IV. PLANNING AT THE PLANT LEVEL

No matter how carefully designed and properly operated, every industrial installation will have a finite probability - maybe exceedingly small - of running into an emergency, as a consequence of mechanical failure or human error. The establishment of an emergency plan is in the very best interest of a company. Plant contingency planning is that part of the loss prevention system designed to minimize the effects of an industrial accident before it spreads outside the plant itself. A sound system of industrial emergency contingency plans, developed by the industry people at the individual plant level, is the building block of the response capability of a city, province or country to industrial emergency situations.

In many countries, companies are under no legal requirement to establish and maintain an emergency contingency plan, even though some health and safety aspects of the manufacturing process, which may well be considered an integral part of emergency planning, could be covered by specific legislation. Regulations concerning the number and location of fire extinguishers are just one example.

Industrial emergencies can be classified in two broad categories: the first consists of emergencies which can be handled by means of personnel and material resources available at the plant; the second consists of major emergencies that may affect several departments of a plant and cause serious injuries, loss of life, and extensive damage to property. Outside resources are needed to bring such major emergencies under control.

The reasons for and the objectives of plant contingency planning are discussed in section A below. The other sections are devoted to the identification of the preliminary steps in the planning process, command structure during emergencies, and emergency procedures for industrial accidents of different gravity.

A. Motivations and objectives

Companies may develop their own contingency plans, not only in order to establish a safer environment for the workers and population living nearby (who could be involved in an industrial accident spreading outside the facility), but also in order to meet certain economic considerations. A well-rehearsed emergency plan will:

(a) Familiarize personnel with the plant, layout, fire-fighting equipment, and special tasks to be performed during an emergency;

(b) Instil confidence and reduce panic when an emergency occurs;

(c) Reduce casualties among plant workers and/or members of the public;

(d) Reduce liability compensation due to casualties and/or outside damages;

(e) Limit damage to the plant;

(f) Help identify existing hazardous processes, materials or procedures;

(g) Suggest new methods of reducing hazards (e.g. introducing new safety devices, working devices or procedures);

(h) Help reduce insurance premiums.

The objective of any industrial emergency plan should be to make maximum use of the combined resources of the plant and outside services (in case of major accidents) in order to [22]:

(a) Rescue and treat casualties;

(b) Safeguard other people;

(c) Minimize damage to property and the environment;

(d) Contain and control the incident;

(e) Identify any dead;

(f) Provide for the needs of relatives;

(g) Provide authoritative information to the news media;

(h) Rehabilitate affected areas;

(i) Preserve relevant records and equipment for any subsequent enquiry into the cause and circumstances of the emergency.

B. Preliminary planning steps

Before preparing the detailed plant contingency plan, management will first need to carry out a hazard analysis of the plant, followed by the identification of the resources available or necessary to fight hazards. Details on both points were given in chapter II. The use of checklists is probably the most widespread and easiest way of conducting a hazard analysis (see appendix II.A). However, even the most appropriate and accurate checklist will not be effective in identifying hazards in the plant unless: (a) it is used (and not left on a shelf), and (b) used properly so as to ensure that nothing has been neglected and that all reasonable hazards have been identified. There is no substitute for the inquisitive mind of a planner searching for hazards. In addition, plant officials who are thoroughly familiar with their equipment are probably more aware than anybody else of some of the hazards already present in their plant. Safety audits can be an effective way to identify hazards in industrial plants (previously described in chapter II).

An examination of the facilities, procedures and operating history of a manufacturing plant is therefore essential in determining how a potential industrial accident can be prevented or detected and controlled. Nevertheless, previous experience has shown that certain equipment and procedures are systematically more hazardous than others. Examples are [36]:

(a) Transfer, loading and unloading facilities, including procedures for moving chemicals to and from storage tanks, trucks and rail cars;

(b) Sources of process upsets, and process start-up, shutdown and clean-up procedures;

(c) Equipment and storage tank diking, surface drainage routing, and sewer system layout;

(d) Past history of individual departments with spillages.

Proper personnel training and orientation may also reduce accidents. A study on the subject [36] has revealed that 58 per cent of all the spill accidents occurring in a large company were caused by human error and the remainder by mechanical failure. A more detailed study of the mechanical failures, carried out by the same authors, revealed that about half could be attributed indirectly to human error, such as faulty design, wrong construction materials, and improper maintenance. Thus, human failure of some sort was probably responsible for up to 80 per cent of the spills reported.

The preliminary hazard analysis should also assess the potential for loss and damage outside the plant, and take account of:

(a) Population densities in the areas likely to be affected;

(b) Location of the incident in relation to built-up areas and other sources of hazard, such as neighbouring plants or tank farms;

(c) Prevailing winds;

(d) Possible contamination of drains, crops and water supplies;

(e) Possible effects of the collapse of tall structures.

As a result of these preliminary steps, management should then be able to answer the following questions:

(a) Where, within the plant, is there the potential for a major emergency, e.g. as the result of fire, explosion or large-scale release of hazardous material?

(b) Given the potential, what are the possible consequences in terms of risk to people and spread of damage?

(c) How adequate are existing resources and arrangements to handle the most serious foreseeable emergency?

(d) What further provision or action is needed?

Only after a satisfactory answer to each of these questions has been obtained can preparation of the contingency plan commence.

C. Key personnel and command structure

Essential to the proper functioning of a contingency plan is a clear definition of who does what, when, and how, in case of an emergency. Even more essential is the definition of who is authorized to take important decisions, such as declaring a major emergency which requires the intervention of a response team from outside the plant. For reasons of simplicity, assignment to posts in a contingency plan should follow the normal chain of command in the plant. The plant manager should head the emergency organization [37].

Adhering to this practice will minimize the training necessary to ensure competent leadership during the emergency. Decisions and authority will be accepted more readily by the plant's personnel because they have always operated under this authority. This recognized leadership will instil confidence and prevent panic.

In emergency situations, decisions will almost certainly have to be taken which may affect the whole or a substantial part of the plant, and, in a major emergency, places outside. In the latter case, many of the decisions will be taken by the plant manager in conjunction with senior officers of the response services, such as police or fire brigade.

The contingency plan should also provide for the presence of a person who is in charge of the emergency until the plant manager arrives at the scene of the accident. Since this person may be called on to take decisions involving the whole plant, it is necessary that he have a thorough knowledge of the plant situation. The shift manager is probably the best person to direct the emergency operations at the first stage of the emergency. Thus, round-the-clock coverage of the command post is achieved.

Deputies should also be appointed to provide cover for any occasion when the plant or shift managers may be away on holiday, sick leave, or other business. Deputies should also be able to take charge should managers become incapacitated as a result of the emergency [22].

Other plant personnel will also have key roles in providing advice to, and implementing the decisions made by, the senior manager in the light of information received. The key personnel will include the senior managers responsible for production, engineering, technical services (including laboratories), personnel (including medical services), transport, safety and security. As necessary, they will decide on the actions needed to shut down plants, fight fires, evacuate personnel, carry out emergency engineering work, arrange for supplies of equipment, carry out atmospheric tests and liaise with police.

There must also be depth of personnel in all positions in the plan so as to ensure that each position is manned. Enough people must be assigned to each position so that at least one person is at that position at any given time and that sufficient manpower is available to cover a prolonged emergency.

A plant should have one or more emergency squads composed of personnel from operations, maintenance, line management and guard force, all of whom are specifically selected and trained in emergency control techniques and equipment. The exact number of employees on an emergency squad varies in relation to the potential hazards and their size.

Emergency-squad members must be thoroughly trained in comprehensive first-aid treatment, handling of breathing apparatus, and emergency rescue procedures. They must be familiar with station and ambulances first-aid equipment. They must also learn to recognize the different types of fires, available extinguishing agents, the proper protective clothing for fire fighting, and be familiar with fire-fighting equipment, including hoses, nozzles, portable extinguishers, wheel units, fire trucks, and the plant's fire-protection systems [37].

In sections of the plant affected or likely to be affected by the accident, the emergency squad, under the guidance of a shift superintendent, will attempt to fight fires, isolate equipment from which flammable or toxic material is leaking, plug leaks of hazardous material and, in general, try to bring the situation under control. Meanwhile, in those parts of the plant not immediately affected or deemed to be at risk, other essential personnel must be ready to carry out an emergency shut-down. Individual plant procedures should detail the actions to be taken for an emergency shut-down and the

personnel needed to perform it. Any special protective equipment which may be needed, such as clothing or breathing apparatus, should be readily available [22].

If need be, other workers will have to be delegated to carry out essential work which may include:

(a) Providing extra first-aid services to deal with casualties;

(b) Performing emergency engineering work, such as providing extra or replacement lighting and temporary by-pass lines, and isolating equipment;

(c) Transporting equipment to the scene of the accident from other parts of the works;

(d) Moving tankers or other vehicles from areas of risk;

(e) Acting as runners in case of communication difficulties.

In affected and vulnerable sections of the plant, all non-essential workers should be evacuated from the area and assembled at specified assembly points. The need to evacuate non-essential workers from areas not immediately affected will be determined by the size of the plant and the rate at which the incident may escalate.

In medium-sized or large plants, provision should be made to establish an emergency control centre from which emergency operations are directed and co-ordinated [22]. It will be manned by the plant managers, key personnel, and also senior officers of the outside services, in case of a major emergency. The centre should be sited in an area of minimum risk, insofar as this is possible, and close to a road, to permit ready access by a radio-equipped vehicle for use if other systems fail or extra communication facilities are needed. If necessary, the police will assist in setting up an emergency control centre. This centre should be equipped with adequate means of communication to areas inside and outside the works together with relevant data and equipment which will enable those manning it to plan accordingly.

An emergency control centre should therefore contain:

(a) An adequate number of telephones;

(b) An adequate number of internal plant telephones;

(c) Radio equipment;

(d) A layout of the plant showing:

(i) Areas where there are large inventories of hazardous materials, such as tanks, reactors or drums, as well as the location of compressed-gas cylinders;

(ii) Sources of safety equipment;

(iii) Fire-water system and alternative sources of water;

(iv) Stocks of other fire-extinguishing media;

(v) Works entrances and road system, updated at the time of the emergency to indicate any road which is impassable;

(vi) Assembly points and casualty treatment centres;

(vii) Location of the plant in relation to surrounding community;

(e) Additional copies of the plant layout on which the following may be illustrated, during an emergency:

(i) Areas affected or endangered;

(ii) Deployment of emergency vehicles and personnel;

(iii) Problem areas such as fractured pipe-lines;

(iv) Areas evacuated;

(v) Other relevant information;

(f) Note pads, pens, and pencils to record messages received and any instructions for delivery by runner;

(g) Nominal roll of employees;

(h) List of key personnel, addresses and telephone numbers.

D. General emergency procedures

Requirements for individual plant procedures will vary according to circumstances and will take account of:

(a) Size and complexity of the plant;

(b) Number of employees;

(c) Materials handled;

(d) Nature of the process;

(e) Location of the plant;

(f) Availability of physical resources.

Because of the wide variation in these factors among industrial plants, it is not possible to set out a detailed procedure applicable to all. An emergency plan must be tailored to the needs and capabilities of a particular plant. Therefore, only plant officials and personnel can really design it. Despite the many types of accidents and disasters that may occur, the premise upon which an emergency plan must be built is that of simplicity. The more complicated and detailed the plan is, the less likely its success during an emergency.

Other elements often useful in plant contingency plans are outlined below. In combining these elements into a co-ordinated plan, account should be taken of the shift structure of the plant personnel to ensure that, in the initial stages, people nominated to take immediate measures are always present. The final procedures should be sufficiently flexible to allow for the widely differing circumstances accompanying an emergency [38].

The plan should also take into account the possibility of a major emergency being declared, with the intervention of outside resources, material and personnel. Hence, the plan must be flexible enough to be integrated with other municipal or provincial response plans. The sequences involved are: raising the alarm; implementing response actions; declaring a major emergency; making the emergency known; taking action at the plant in case of a major emergency; taking action outside the plant in case of a major emergency; and rehabilitating the plant. These sequences are outlined below.

Raising the alarm

It is the practice at many plants that any employee can raise, or cause to be raised, an emergency alarm [22]. This has the advantage of permitting the earliest possible action to be taken to control the situation which, in turn, may avoid the development of a major emergency. It also provides, where appropriate, for early notification of the emergency to the outside emergency services.

The choice of a suitable alarm system will depend on local circumstances and will be influenced by the size of the plant, variety of hazard, interdependence of plant sections, and the existence of other alarms. Essential requirements are that there should be an adequate number of readily identifiable points from which the alarm may be raised directly or indirectly (e.g. by telephone to the plant emergency control centre) and that the alarm should be audible throughout the plant. In areas where there is a high level of noise, it may be necessary to supplement the acoustic alarm by other systems, e.g. flashing lights.

The alarm should do more than just warn: it should also instruct. It should tell anyone who hears it what to do. People with specific assignments should go to their duty stations. Those who do not have assignments should go to assembly points where they will be given further instructions. If the alarm and its message are kept simple, people will tend to react calmly rather than panic [37].

Implementing response actions

Once the alarm has been raised, the emergency squads should rapidly reach the scene of the accident and implement the emergency response action. In so doing, they may utilize some action guides (as described in chapter II) which should have been included as a part of the general response plan covering the plant. The actions will vary, depending on the nature of the hazard, but in most cases they will consist of fighting a fire or controlling a material spill. Fire is by far the most common hazard, and any emergency plan must provide for fire protection, rescue and first-aid services. These services should be based on the organizations that already exist for handling less serious emergencies. Almost all plants have some provision for fire protection. Whatever the arrangement, the emergency squad should make up the core of the emergency group. They would answer the alarm for a major emergency in much the same way they would for a small one, with which they are more familiar.

If the hazard is fire, the emergency squads may choose to intervene, if properly trained and equipped. After evaluating the situation, the squads may choose to do one of two things: fight the fire until it is brought under control or ask for help through the emergency control centre, and begin rescuing the injured if any. If the problem consists, instead, of controlling a hazardous material spill, the squads would have to take the proper containment

action, depending on the type of spill and the characteristics of the hazardous materials involved, and according to the response plan already worked out for such events. (A possible procedure to control the spill is presented later.)

Declaring a major emergency

If the emergency squads have reported that they are unable to control the accident, the control centre will declare a major emergency. Given the scale of activity following the declaration of a major emergency, it is advisable to restrict the authority to declare it. However, it may not be necessary to limit the authority to the shift manager and his appointed deputy. The need is to have as early a declaration as possible. Other responsible persons, particularly in large plants, may be closer to the accident when it occurs and capable of making the necessary judgement. It may be advisable, therefore, to invest the authority to declare a major emergency in a limited but appropriate number of people selected on the basis of their knowledge and experience to recognize a major emergency or its potential.

Making the emergency known

Making it known inside the plant

It is important for everyone to know that a major emergency exists, and consideration needs to be given as to how this information may best be communicated. For example, in many cases the declaration of a major emergency will follow the sounding of an emergency alarm. Where this has sounded only in the affected area, it may be appropriate to signal the fact of a major emergency by sounding the same alarm site-wide. In cases where the initial alarm sounds over the whole plant, the major emergency may be made known to everyone by sounding the alarm again, over an extended period. Alternatively, it may be considered that a separate major emergency alarm, having a signal readily distinguishable from other alarms, is required, though this is not common practice [22].

At the same time, consideration should be given to the need to provide separate alarms to warn of different types of emergency, such as fire and explosion or toxic gas escape. Where such provision is condidered, care must be taken to avoid a multiplicity of alarms to the confusion of the people on site.

As an alternative to an extra alarm to denote the major emergency, the plant emergency procedures may provide for it to be made known by other methods, and many plants adopt this approach. In such cases, a site-wide alarm activates the emergency procedures whereby:

(a) All members of the work force return to their normal place of work, provided it is safe for them to do so;

(b) Those in charge of plants and departments, and who are not nominated as key personnel, go to their usual offices to await instructions from the plant emergency control centre;

(c) Senior managers nominated as key personnel report to the plant emergency control centre from where, acting on advice received from the shift managers, they communicate instructions to individual plant sections and areas, using as appropriate, telephone, tannoy or messenger.

In all cases, once the major emergency is made known, all personnel should be ready to carry out the appropriate emergency action.

Making the emergency known to the outside emergency services

Once the declaration is made, it is essential that the outside emergency services, if they have not already been called in, are informed in the shortest possible time. Liaison at local level will help to determine the best means of achieving this, for example, by direct line or automatic alarm to the fire fighters.

In a high-risk plant where there is no full-time plant-emergency team, it may be advisable to provide for the outside emergency services to be informed on all occasions when the emergency alarm is raised. Discussion with these outside services will help decide this matter, but it should be borne in mind that it is better for the emergency services to arrive to find a situation already under control than to find one out of hand due to delay in call-in.

Making the emergency known to key personnel outside normal working hours

A major emergency may arise at any time and plant emergency procedures need to take account of this fact. They should ensure, first of all, that the nominated people having immediate tasks to perform, e.g. shift manager and plant emergency team, are always present on site, i.e. they should be selected from the shift force. Secondly, they should provide for the call-in of other key personnel.

To satisfy the latter provision, it will be necessary to maintain an up-dated list of key personnel and their deputies, their home addresses, and their telephone numbers. The list should be kept in the emergency control centre and (if located elsewhere) the communications centre from which the call-in will be made. Liaison with the police will help to establish means whereby personnel called in can be allowed to proceed through any road blocks set up as part of the traffic control arrangements.

Making the emergency known to neighbouring firms

A major emergency may affect areas outside the plant. When alerted, the police will undertake any necessary action to safeguard members of the public. In the case of other nearby industrial concerns, consideration should be given to the need for direct notification to them of the major emergency. This can serve a dual purpose in that it will enable them to take prompt action to protect their own employees and to take whatever measures may be possible to prevent further escalation of the emergency due to effects on their own installations. At the same time, they may be able to provide assistance as part of a pre-arranged mutual aid plan. In the major emergency situation, resources over and above those available at the plant will be needed. In areas remote from centres of population, the build-up of fire-fighting reinforcements will be relatively slower. There may be, therefore, requirements for additional sources of fire-fighting equipment, hoses, monitors, foam, breathing apparatus, specialized equipment, medical supplies and manpower. In locations where there are a number of industrial concerns, it can be beneficial to set up a mutual aid programme which will assist, on the one hand, to secure additional supplies when needed and, on the other, to alert neighbouring concerns to the fact of the major emergency in case they, too, need to take action to protect personnel and property.

Taking action at the plant in case of a major emergency

Fighting and controlling the accident

At this phase of the emergency, outside resources should also intervene. The actions taken by the joint response teams are likely to be similar, in principle, to those already described above for the plant response team. The larger number of people involved and tasks to take care of require, however, a higher degree of co-ordination. The effective handling of such an emergency depends on the decisions taken at the time, and it is impossible to predict every action that should be taken. An example of the recommended procedure to fight a storage tank fire is given at the end of this chapter.

Evacuation

In a major emergency, it will almost certainly be necessary to evacuate personnel from affected areas and, as a precautionary measure, to further evacuate non-essential workers from areas likely to be affected should the emergency escalate. At small plants, or plants where rapid escalation is foreseeable, it may be advisable to effect a progressive, total evacuation, i.e. non-essential workers and those from affected areas first, followed by the remainder, when emergency shut-down plant sectors have been affected.

Consideration should be given to the provision of a separate evacuation alarm, preferably of a selective type, but the possibility of confusion if too many alarm signals are provided should be borne in mind. On evacuation, employees should be directed to pre-determined assembly points. These must be sited in a safe place well away from areas of risk. More than one assembly point is needed:

(a) To ensure that employees do not have to pass through the danger zone to reach the assembly point;

(b) In case any assembly point lies in the path of wind-blown harmful materials, e.g. toxic gas.

Each assembly point should be clearly marked by a conspicuous notice and provided with an identification number or letter, e.g. ASSEMBLY POINT A.

In certain circumstances, e.g. where an emergency has involved the release of toxic substances, it may be necessary for people to pass through an affected area to reach a safe assembly point. Where this can occur, a sufficient supply of a suitable respirator - capable of providing protection for the short space of time needed to escape from the affected area - should be available.

Taking action outside the plant in case of a major emergency

A major emergency may affect areas outside the plant. Explosions can scatter debris over wide areas; the effects of blast can cover considerable distances; wind can spread burning brands or toxic gases. In some cases, e.g. as the result of an explosion, outside damage will be immediate and part of the available resources of the emergency services may need to be deployed in the affected areas. In any event, the possibility of further damage may remain, e.g. as the result of further explosion or the effect of wind spreading burning brands or hazardous materials.

Perhaps the most significant risk to outside areas is that associated with a large release of toxic vapours. Managements will usually need expert advice

in drawing up plans so that if such a release occurs, they will be able to collaborate with emergency services in estimating, as far as practicable, which downwind areas are at risk. It may be necessary to prepare in advance simple charts or tables showing the likely spread of the vapour cloud, taking into account its expected buoyancy, local topography, and all possible weather conditions during the time of release. It may also be desirable to install instruments indicating wind speed and direction.

The fact of a major emergency, and the spread or potential spread of its effects outside the works, may require that road and rail traffic past the plant be halted or diverted. Responsibility for controlling road traffic flow rests with the police, who should take into account the advice of the plant manager. The problem is almost always exacerbated by members of the public driving to the scene to view the situation. The net effect can be to cause problems to those who have a real need to get to the plant, including the key personnel who will have been called out. Liaison at local level will help to devise a means whereby key personnel can readily identify themselves to the police controllers.

Rehabilitating the plant

The fire fighter's chief will not signal the end of the emergency until he is satisfied that all fires are extinguished and there is no risk of re-ignition. In the case of gas escapes, the emergency will be declared ended only when the source of emission has been effectively isolated and gas clouds dispersed. Even when the "All Clear" has been given, great care is needed when re-entering affected areas, and no work in connection with salvage, collection of evidence or start-up should be put in hand until a thorough examination of the area has been carried out. It is particularly important to avoid the introduction of possible sources of ignition, such as diesel engines, hand- or power-operated tools, or flame-cutting equipment, until it has been established that no flammable materials remain where they could be ignited.

E. Special considerations for controlling a hazardous material spill accident

The following procedures should be followed in case of a spill of hazardous materials [39]:

General safety precautions

(a) Always approach a spill from upwind, continuing to monitor for any sudden changes;

(b) Do not touch the material, and avoid any indirect contact with it;

(c) Do not smoke. Remove all possible ignition sources;

(d) Restrict access to the area by utilizing security personnel;

(e) Do not touch any container unless you have full knowledge of the hazards involved;

(f) If unidentified fuming liquids or gases are present, do not approach;

(g) When the threat of respirator exposures is unclear, use, as a minimum precaution, a gas mask with appropriate canister(s). A five-minute escape capsule should be kept by each person at all times for immediate donning;

(h) Consider the possibility of toxic gases accumulating in topographic depressions;

(i) Consider the possibility of an explosion.

Work site control

One of the most important aspects of toxic operations is that of contamination control. The following are suggestions for organizing a work area for the evacuation and removal/or containment of hazardous wastes:

(a) Establish an exclusion area boundary that defines the outer edges of the hazard area. Inside the line, it is considered unsafe or contaminated. Outside the line, it is considered uncontaminated or safe;

(b) Access control points should be used to control entry and exit. Equipment is contaminated before exiting the exclusion area. Boot-washing facilities, as well as clothing and equipment drops, should be available at the access points to prevent contamination being carried out of the exclusion area. People entering the area should be checked for proper equipment.

Protective equipment

All protective devices have limitations, and these limitations must be understood and respected in order to ensure the safety of response personnel. Emergency response personnel are responsible for the fitting, inspection, and repair of their protective equipment. Equipment should be thoroughly inspected after each use. Equipment used infrequently should be inspected at least every three months.

Protective masks

Various types of breathing apparatus are available for protection in contaminated atmospheres. The two main classes are: air purifying; atmospheric supplying. All personnel utilizing self contained breathing apparatus should handle the apparatus at least once every two months. This includes a full check-out of the equipment, donning, and utilizing it for at least five minutes. All personnel should schedule and keep a log of this activity. It is imperative that response personnel be familiar with and properly trained in the use of their particular equipment before actually using it. The following are some basic rules concerning the use of respiratory equipment:

(a) Choose atmospheric supplying equipment for initial entry to a highly contaminated site when the identification of the contaminants is undetermined;

(b) Use atmospheric supplying equipment in all cases when the concentration of oxygen is less than 19.5 per cent;

(c) When using the air supplying units, it is mandatory that the user test the equipment before use, by going through an appropriate checklist inspection;

(d) Air purifying units should be fit-tested to the wearer

(e) The proper cartridge should be used for the type of contaminant present. Be familiar with the user and limitations of the various gas-mask canisters or cartridges as per manufacturer's instructions;

(f) Consider gas and particulate protection before donning any gas-mask unit. Combination cartridges are available for simultaneous gas and particulate protecting;

(g) When using either the air purifying or atmospheric supplying equipment, ensure that a tight face seal is achieved before entering the contaminated area;

(h) Ensure that materials of construction of the units are compatible with the contaminant (ozone attacks rubber hose, certain chemical vapours may pass through rubber etc.). This is especially important for prolonged periods in a contaminated area;

(i) When the threat of exposure is unclear, the response person should, as a minimum percaution, keep a mask and suitable canister on his/her person at all times;

(j) Respirators should not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses;

(k) Each response team member should have a combination respirator for gases and particulates, including the full family of approved canisters available for the mask;

(l) Mask canisters should be changed:

(i) After each incident in which the mask is used;

(ii) After each 8-hour work shift during prolonged operations;

(iii) If the canister is immersed in water;

(iv) If breathing pressure increases, indicating possible blockage of canister;

(v) If canister is dented;

(vi) If there is any detection of odour or effect on personnel;

(vii) If the canister is damaged in such a way as to prevent a proper seal between mask and filter;

(viii) If the canister expiration date has passed.

Protective clothing and equipment

The selection of protective clothing requires an assessment of the dangers present. Eye, skin, inhalation and physical injury represent four main areas of possible injury. Eye protection is provided by mask and/or safety goggles. Skin protection is provided by coveralls, gloves and boots for minor surface contamination. Aprons may be needed for heavy splash protection for the torso. Physical injury protection is provided by hard hats and safety boots.

Protective clothing is not complete protection. It is intended to take the initial brunt of contamination and provide a minimal time of penetration. In the case of a heavy splash of contamination, the penetration time may be very short. The protection, in this case, is the shielding of protective

clothing, then rapid flushing. Total reliance must never be placed on protective clothing. Protective clothing damaged, destroyed or worn out must be replaced as required.

First aid

Each member of the emergency response team should receive first aid training, with refresher training scheduled at six-month intervals. Response teams should carry a first aid kit in their vehicles on all responses. Additional first aid items should be added to the kit when applicable.

Additional considerations

Prolonged operations

Prolonged operations in a toxic environment require special procedures and considerations. Heat loads associated with protective clothing and breathing restrictions imposed by protective masks increase the rate and amount of fatigue in people. Generally, this increases the number of people and time required to do the job. Provisions should be made for rotations of personnel or frequent rest periods if operations involving potential exposure to chemicals require the use of masks or heavy protective clothing for periods exceeding a few hours.

High-temperature operations

Operations during hot weather and high humidity carry the risk of heat stroke or prostration. Work parties should be briefed on the symptoms of and the treatment for these problems. Increased rest periods and/or increased rotation of personnel will reduce the probability of heat prostration. The correct amount of salts, plus drinking water or some other liquid replacement, should be made available. In operations above 30°, consideration should be given to suspending operations or rescheduling them to a cooler part of the day.

Cold weather operations

Cold weather brings the risk of frostbite. This is especially true in operations near water. Warming stations should be provided for the use of the work parties. If conditions are such that personnel are getting wet, frequent changes of clothing may be required. The valves of protective equipment such as masks may freeze because of breath condensation, or rubber parts may crack because of the cold. Supervisors should schedule frequent equipment checks. As a minimum, all equipment should be checked during work breaks.

Decontamination

Personnel decontamination

Personnel should consider the need for decontamination before being allowed to enter administrative vehicles or areas. This is especially important to prevent contaminating vehicles, fellow workers, or others. Decontamination may involve controlled bathing and a change of clothing for personnel.

Equipment decontamination

Equipment may have to be decontaminated before it is removed from the work site. Decontamination operations should be conducted in a specified area under

controlled conditions to minimize the spread of contamination. In special circumstances, equipment should be tested for completeness of decontamination during swipe tests, vapour tests, or other approved tests. Equipment that cannot be decontaminated on site should be double-bagged before being removed from the site. It can then be transported to a decontamination or disposal site, as appropriate.

Contaminated clothing

All disposable items of clothing should be left at a site where the appropriate personnel can ensure their proper disposal. When this procedure is not feasible, all contaminated material should be placed in plastic bags, secured, and sent to the disposal area. All contaminated, but reusable, garments should be put into plastic bags and returned to the caged area. Large trash barrels with appropriate signs affixed should be designated as an interim storage area for the contaminated clothing.

Medical requirements

Each new member of the response team should be given a complete medical examination within a short time of assuming response duties. This examination will establish a base line medical profile on the individual. A frequency should be established for repeat medical examinations. Medical examinations should also be made in cases of exposure to hazardous substances, especially if the individual displays symptoms. An individual should request a medical examination if he suspects he may have been harmed by exposure to a hazardous substance. A follow-up examination, following significant exposure to a hazardous substance, is recommended. An individual should be required to undergo medical examinations in any circumstances in which special medical hazards may be present.

F. Example of a response action: handling a storage tank fire [32, 40]

Phase I: Information gathering

Step 1. Identify the product which created the incident. Information must be obtained from plant personnel because it is possible that the same tank is used for a variety of products.

Step 2. Determine whether more than one product is stored in the tank. (Is it compartmented?)

Step 3. Check the various reference sources to determine the hazards and physical properties of the identified product. Identify appropriate extinguishing methods and agents, inlcuding agents or effective cover which will reduce hazardous vapours. Determine the product's:

(a) Effect on humans (special protective equipment needed? Evacuation?);

(b) Effect on the environment (streams, gound water, air);

(c) Specific gravity;

(d) Water solubility;

(e) Water reactivity;

(f) Flash point;

(g) Reactivity problems;

(h) Explosive limits;

(i) Polymerization.

Step 4. Check location of the tanks in reference to the exposures. Exposures include buildings, other tanks, and overhead electric lines.

Step 5. Identify the types of storage tanks used, their safety features, shut-off valves and dike drain valves.

Step 6. Check availability of resources (personnel, equipment, water, extinguishing agents).

Step 7. Consider weather conditions that may affect the fire fighting (wind direction and speed, rain, temperature).

Phase II: Decision-making and emergency procedures

Three alternative actions might be taken: attack the fire; contain the fire and let it burn up the fuel; withdraw emergency response personnel.

Alternative 1: Attack the fire

If the information obtained during phase I indicates that an attack is warranted, the attack must begin immediately. However, as the attack continues, and new information is gathered, the strategy should be revised if necessary.

Step 1. Evacuate the area downwind of the vapour cloud.

Step 2. Have all personnel approach from upwind. Make sure all are equipped with the appropriate protective equipment.

Step 3. Keep all unnecessary personnel, as well as spectators, at least one mile away.

Step 4. If there is a gas leak without a fire, use hose streams to disperse the vapour. Then, under cover of the streams, go in and shut off the control valves. Make sure a backup hose line from a separate water source is available. If the flow cannot be shut down, the vapour cloud must be dispersed with hose streams. Use caution, however, in case the combination of product and water forms a hazardous substance. In that case, runoff must be contained by diking. Remember to keep personnel and apparatus away from the vapour cloud.

Step 5. If there is a leak with fire, do not extinguish the fire until the leakage is stopped. Using the cover of hose streams, with a back-up line, the control valve should be shut down. Keep the exposures cool at the point of flame impingement. At large fires, radiant heat is also a problem, and water must be applied directly to the exposures to keep it cool. Remember to approach horizontal tanks from the sides.

Step 6. Listen for the operation of the relief valve. As pressure increases, the pitch of the noise also increases. This should be an indication that withdrawal is necessary.

Step 7. Large tank storage fires will require protection of the exposures, particularly other tanks, with large quantities of water. Unmanned monitor streams can be used to great advantage under these conditions.

Step 8. Extinguishment can be tried using special agents and techniques. Accident commanders will probably need to set up a supplemental source of supply of the extinguishing agent. Dikes will have to be kept from overflowing.

Step 9. The attack will vary according to the type of construction of the tanks. Care must be exercised not to compound the problem by failing to take this into account.

Alternative 2: Contain the fire and let it burn up the fuel

Step 1. Open-container and spill fires in a large quantity of high-pressure vapour products, such as those carried in spheroids, cannot be extinguished by any fire-fighting agent or device now known. Furthermore, if such fires could be extinguished, in most cases extinguishing them would create greater hazards than the fires themselves since the unburned vapour might accumulate at other locations. Therefore, the most effective way to control fires in these products is to use plenty of water, keep exposed property cool, and shut off the flow of product to the fire.

Step 2. Play as much water on the container, above liquid level, as possible. Even if water spray or other means of water application is fixed, play heavy streams of water on exposed steel, above liquid level, if this can be done without depleting the water supply.

Step 3. If a vent or broken line is playing a blow-torch flame on steel above liquid level, direct the streams of water onto this spot. If this cannot be done quickly, stay clear of the container, which is almost sure to rupture from heat-weakening of the steel. Water is very effective in cooling steel in such cases.

Step 4. Use every means to protect the container above liquid level.

Step 5. In the case of a broken line or other such leak, do not extinguish the fire except by shutting off the flow. It is sometimes feasible to extinguish the fire and then shut off the flow. Fires of considerable size can be extinguished by use of dry chemical extinguishers. On fires of this kind, water fog of spray should be used to protect the approach and cool the steel, or to extinguish wood and rubbish fires and prevent re-ignition of the gas before the source of flare or gas can be cut off. If the flow is not cut off, vapours or gas may accumulate and then, when re-ignited, the flow will travel back to its source.

Alternative 3: Withdraw emergency response personnel

In this case, the situation is too dangerous for response personnel. Keep monitoring the situation at a safe distance until it is possible to use one of the other alternatives.

V. PREPAREDNESS FOR HAZARDOUS MATERIAL TRANSPORT ACCIDENTS

A transport contingency plan must be sufficiently flexible to be adapted to the different circumstances in which the accident may occur. Transport accidents involving hazardous material may well occur in a built-up area. This greatly enhances the chance that members of the population will be involved in or directly affected by the accident. Consequently, measures to keep people away from the scene, divert traffic, maintain access for emergency vehicles and possibly evacuate the population assume particular importance. On the other hand, a railway accident could occur along a rural route where vehicles must travel overland to reach the site.

Another peculiarity of transport accidents is that, in general, the first emergency response teams to reach the scene will be the police or the city fire fighters, i.e. response teams which may not necessarily be prepared to fight accidents involving industrial hazardous materials in the same way a response team in an industrial plant can. In some instances, the response teams may not even be aware of the hazards, as in some road accidents where the driver is unable to give information on the content of the cargo and the vehicle is not provided with proper identification placards.

Therefore, contingency planning for transport accidents involving hazardous materials should be concerned with:

(a) Raising the alarm;

(b) Identification of the hazardous materials involved in the accident;

(c) Immediate actions to be taken at the scene of the accident;

(d) Accident information and control network;

(e) Direction of emergency operations;

(f) Emergency teams and procedures.

Each of these points will be discussed below in greater detail.

A. Raising the alarm

Almost anybody can raise the alarm in case of transport accidents. If the vehicle driver or train engineers are not dead or seriously injured, they will most likely do it. In many other instances a member of the public will raise the alarm. Therefore, a 24-hour emergency telephone number should be available. The city police or fire department telephone number could well serve the purpose, provided these departments can contact other emergency response teams at higher level (provincial, national) or from industry, if the necessity arises.

B. Identification of hazardous materials: placards and labels for transport and shipment of hazardous materials

When emergency response personnel arrive on the scene of a hazardous material accident, one of the first things to be determined is the material involved. The first way to guess, roughly, the type of material transported is by inspecting the type of container in which the material is contained. Figure II (end of this chapter) shows the various containers that are used to transport hazardous materials according to different hazard classes [41].

This identification can be more easily accomplished if the transporting vehicle or train car is provided with placards affixed on all four sides. Labels, on the other hand, only need to be attached to one side of the container holding the material. The major reasons for placing labels and placards on packages and vehicles are:

(a) To provide an immediate warning of potential danger;

(b) To inform the emergency response personnel of the nature of the hazard;

(c) To indicate any required protective action;

(d) To minimize possible injurious effects if exposure to the product does occur.

In order to be effective, placarding and labelling should be:

(a) Mandatory, i.e. imposed by law at national or international level, and codified according to the materials and their hazards; and

(b) Standardized, i.e. the type, form, size and shape of the symbols used for placards and labels should be determined and used consistently so as to represent correctly the material being transported and its hazard.

Several placarding and labelling systems already exist in many countries, and continuous efforts are being made to standardize some of them at the international level. The United Nations system is the most widely used and serves as a basis for other more comprehensive systems used in several countries [42]. Some of these systems are described below.

1. United Nations classification system

The United Nations has established a standardized class number system for hazardous materials [42]. Some countries have adopted the system and require that all imported goods be properly labelled. The system divides hazardous materials into nine classes, each identified by a number. Some classes are further subdivided into divisions, identified by another number following the class number.

The classification is based on the type of risk involved and has been conceived to minimize interference with existing regulations. The order in which classes are listed is not that of degree of danger. The classes are:

Class 1. Explosives

Class 2. Gases: compressed liquefied, dissolved under pressure or deeply refrigerated

Class 3. Flammable liquids

Class 4. Flammable solids; substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases

Class 5. Oxidizing substances; organic peroxides

Class 6. Poisonous (toxic) and infectious substances

Class 7. Radioactive substances

Class 8. Corrosives

Class 9. Miscellaneous dangerous substances

Labels for use on packages, and placards to be placed on the railway car or truck, are described below. Labels and placards should be placed on a background of contrasting colour. Figure III (end of chapter) shows the recommended specimen labels corresponding to each class. The labels are all diamond-shaped, with minimum dimensions of 100 mm by 100 mm. The colours of each label are specified in the figure. The labels are divided into halves. The upper half of the label is reserved for the pictorial symbol and the lower half of the class number.

The United Nations placarding system is very similar to the labelling system. The major differences consist in the minimum size of the placard (250 mm by 250 mm) and the display of the United Nations identification number (except for goods of Class 1). (For more details, see reference 42. The United Nations identification numbers for an extensive list of hazardous materials can be found there. The hazard class and division number (sub-class) are also listed.)

2. Federal Department of Transportation System (United States)

This placarding and labelling system [32] closely resembles the United Nations one. The class system is substantially the same, even though some difference exists concerning class divisions (such as those for explosives and poisons). With few exceptions, the placards and labels are identical to those of the United Nations system, the only difference being an inscription in English (such as "Corrosive", "Flammable" or "Explosive") appearing within the Federal Department's placard.

3. HAZCHEM scheme (United Kingdom)

This is a rather comprehensive system currently used in the United Kingdom [14, 43]. An example of a placard is given in figure IV. With reference to this figure, each placard is divided into four main sections containing the HAZCHEM action code (2YE), the United Nations classification number (1089), the telephone number of a source of specialist advice to call in case of emergency, and the diamond shaped hazard warning sign. (The United Nations symbols are used for this purpose.) A fifth section may be used to show the manufacturer's or company name or symbol.

The HAZCHEM action code contains information on the actions to be taken by the emergency squads in case of accident. The key to the code is contained on a pocket card carried by each member of the emergency squad. Figure V shows this card. The number appearing in the HAZCHEM action code refers to the fire-fighting method to be used. The first letter refers to the spillage action to be taken. The second letter, E, is added when there is need to consider evacuation of the area.

4. ADR/RID system (Europe)

This system, which has been recognized by 18 European countries, is also based on the Untied Nations system. Two placards are used instead of one. The first placard consists of one of the diamond-shaped United Nations hazard

symbols. The second placard is orange and contains two numbers, one above the other. The bottom one is the United Nations material identification number. The top number is made up of two digits, the first representing the United Nations class and the second an additional hazard index if the material presents more than one hazard [34].

5. National Fire Protection Association system (United States [44])

This association has developed a standard system for identifying the hazards of all chemicals. The system is basically a voluntary one for use by industry. However, some local Governments have adopted the system as a requirement for identifying all hazardous chemicals stored in their area of responsibility. The system identifies the hazard in terms of three categories:

(a) Health;

(b) Flammability;

(c) Reactivity (instability).

The severity of the hazard is indicated by a numerical designation, from 0 to 4. The designations graduate from 0 for a product that has no special hazard, to a 4, which indicates a severe hazard.

The label system uses a diamond shape, which is divided into four sections. The box to the left of the diamond is for the health hazard; the top box is for the flammability hazard; and the right box is for the reactivity hazard. The bottom box is used to indicate any special hazard such as reactivity to water (W), radioactivity (represented by a trefoil), an oxidizing agent (OXY), or polymerization (P).

In addition to the physical locations of the boxes within the diamond, each box is colour-coded for easier identification, as follows:

(a) Health - blue background;

(b) Flammability - red background;

(c) Reactivity - yellow background;

(d) Special hazards - white background.

The degree of hazard indicated by each numerical rating is summarized in figure VI.

6. Colour coding

Pipes carrying process or utility fluids (both liquid and gases) within a production plant (e.g. steam, cooling water, nitrogen) are often colour-coded for easy identification in case of leaks or maintenance intervention. Every country and sometimes every company has its own systems. Colour codes are also used to facilitate identification of the content of compressed gas cylinders, and sometimes of drums. As an example, the system used in the Unied States employs the following colour-code for gas cylinders:

Compressed gases - medical

Colour	Gas content
Green	Oxygen
Brown	Helium
Grey	Carbon dioxide
Green/grey	Oxygen/carbon dioxide
Blue	Nitrous oxide
Black	Hydrogen
Red/orange	Nitrogen
Silver/orange	Prepared nitrogen

Compressed gases - commercial

Colour	Gas content
Green/orange/silver	Argon - 75%, CO_2 25%
Silver/orange	Argon - 100%
Black	Acetylene
Orange	Oxygen - 100%

C. Immediate actions to be taken at the scene of the accident: action guides and information cards

In many transport accidents the vehicle driver or the train engineers will be the first responsible personnel to take action at the scene of the accident. Therefore, the following three points should be considered at the planning stage, in order to ensure maximum immediate response effectiveness:

(a) Drivers and engineers should be adequately protected;

(b) Appropriate emergency equipment should be carried on board;

(c) Simple and adequate emergency instructions should be carried on board and be easily accessible.

Certain requirements for the construction of motor vehicles or train cars will help ensure driver safety. For example, in a tank-truck there should be a fireproof screen between the tank and the driver's cab. The exhaust should be in front of the screen. The voltage of the lighting current should not exceed 24V, and it should be possible to cut the battery off with an adjacent double-pole switch [14]. The vehicle should carry a tool kit, emergency lighting and first-aid equipment. Protective clothing and breathing equipment should also be carried. The fire extinguisher should be large enough, and the right type, to put out a fire in the cargo.

The driver or the train engineers should be required to carry with them action guide cards containing instructions for the most typical emergency situations involving the material transported. This system has been adopted in the United Kingdom where the TREMCARD (Transport Emergency Cards) system was originally developed [14, 43]. These cards have been prepared for a large number of hazardous materials. Each card contains information concerning the name of the material transported, the nature of the hazard, safety equipment necessary to handle the material, emergency measures to be taken in case of fire, spillage or release, and first-aid in case of exposure to the material. An example of such a card is given in figure VII.

Similar cards (Chem-Cards) were also developed by the United States Department of Transportation. Figures VIII and IX show the front and back of the card for acrolein. It is worth noting that these cards even contain an evacuation table, readily usable once a few parameters (such as size of spill and wind direction) are determined.

If the immediate action taken by the truck driver or train engineers is not sufficient to keep the accident under control, then external response teams must intervene. The placard or label system may greatly help these teams to identify the hazards, but this system only indicates a broad category of dangerous materials. In some instances, much more detailed information is needed, and the name and amount of the specific product being transported must be determined. This can be more easily accomplished if the vehicle or train is equipped with shipping papers. The papers can include a shipping order, bill of lading, manifest or waybill. As a general rule, all of the shipping papers will contain:

(a) Shipper's name and address;

(b) Consignee's name and address;

(c) Proper shipping name;

(d) Proper classification of the shipment;

(e) Total quantity by weight or volume;

(f) A certification by the shipper that the shipment has been properly prepared.

The United Nations has also developed a system for documenting the shipment of dangerous goods [42]. Accordingly, the basic items of information considered necessary for the identification of a dangerous substance, transported by any mode, are:

(a) The proper shipping name;

(b) The class or, when assigned, the division of the goods (see also reference 42. For substances of Class 2 possessing subsidiary inflammable or poisonous properties, the class should be further amplified by adding the word "inflammable" or "poisonous" as appropriate;

(c) The United Nations serial number assigned to the substance or article;

(d) The total quantity of dangerous goods covered by the description (by volume, weight or net explosive content, as appropriate).

In addition, other elements of information deemed necessary by national authorities or international organizations may also be shown (e.g. flash point or flash point range). An example of the United Nations dangerous goods declaration form is given in figure X.

The shipping papers should be kept in the driver's cab. On trains, the conductor should keep all the papers. They may therefore be found in the caboose or the engine, depending on the location of the conductor. For shipment by rail, there should be a freight waybill for each car in the train. The conductor hould have these waybills generally arranged in

sequence, starting with the first car behind the engine, which would be the first waybill. At a derailment, one could determine the last car at both ends which remained upright. Once the waybills for the last upright cars are located, those papers in between represent the derailed cars. A quick search of the papers will indicate if there are any hazardous commodities on board.

All the measures described in this section will be effective in preventing, controlling or fighting a transport accident involving hazardous materials, only if they are codified at national or international level by some kind of legislative act, and then properly enforced.

D. Accident control network

Another way of providing assistance to emergency response personnel in handling a hazardous accident is by creating a network system made up of several centres in different parts of the country and able to provide information on chemicals transported or to contact emergency teams provided by manufacturers. Examples of such systems are the American CHEMTREC [6] and the British CHEMSAFE [45, 46].

These centres are set up to accomplish two important functions. First, if the product has been identified, information will be provided to the emergency response personnel on how to handle the situation. Second, if the product is unknown, but other facts such as shipper, manufacturer or trade name are known, the centre should be able to tap many other sources to obtain information. Once the manufacturer of the product is known, he will be contacted directly for expert information. In addition, if the accident is severe enough, the manufacturer will be asked to send expert help directly to the scene. The shipper is also notified so that he, too, can provide on-the-scene assistance. In order to reach these centres, 24-hour telephone numbers should be available. The caller should then be able to provide the centre with information such as:

(a) Name of caller;

(b) Means of maintaining the contact;

(c) Place and time of accident;

(d) Shipper;

(e) Manufacturer;

(f) Container type;

(g) Rail car or truck number;

(h) Materials involved;

(i) Type of problem;

(j) Injuries or deaths;

(k) Surrounding area (open);

(l) Weather conditions;

(m) Assistance available (police, fire fighters).

If the responsible personnel cannot locate the shipping papers, and the identity of the materials is unknown, the centres could still utilize the name of shipper or manufacturer and rail car or truck number to trace the cargo back to its point of origin. Another important function of the centres would be to identify the chemicals. In order to accomplish all these tasks, the centres should be equipped with a data bank concerning chemical products and their trade names, manufacturers, traders, importers and transporters. An alternative to a network of centres is the establishment of just one centre, either nationally or regionally, provided that a good telephone network exists at such levels.

An example of the type of information required by the existing CHEMTREC system is given in the next section.

E. Guidelines for calling CHEMTREC (United States)

Telephone number: 800-424-933 or (202) 483-7616 outside continental United States.

Reasons for calling:

(a) Unfamiliar materials;

(b) Unidentified materials;

(c) Unidentified shipper;

(d) Verification of technical information;

(e) Incident of significant proportions - property and/or life.

Information required by CHEMTREC:

(a) Name of the product(s):

(i) Quantity;
(ii) Container type;
(iii) Mixed or single load;

(b) Problem:

(i) Type of accident;
(ii) Time accident occurred;
(iii) Number and types of injury or injuries;
(iv) Threat to environment;

(c) Contact information:

(i) Caller name and organization;
(ii) Call back number and location;

(d) Location:

(i) Weather and temperature conditions;
(ii) Rail car number;
(iii) Truck trailer number (license number);
(iv) Being sent to (consignee);
(v) Being sent from (origin);
(vi) Bill of lading or waybill number;

(e) Other. When shipper or hazardous material is unknown, provide information on:

(i) Any labels or placards;
(ii) Any identifying markings, container shapes, names or numbers on containers.

F. Direction of emergency operations

Of major concern at hazardous material accidents is the question of who is in charge. This is especially true when the scene of the emergency is outside an industrial facility or on a highway or railroad right-of-way. The majority of transport accidents fall into these categories. Police officers, officials of the environmental protection agency, water resources, civil defense, and the carrier, may be present. Generally, the fire department should be in charge where there is a fire and/or spill, especially if there is a threat to life or property. The highest ranking fire officer would therefore be the officer in charge of the accident. However, law enforcement personnel may feel they are in charge of a highway accident when hazardous commodities are involved. Railroad officials who own the right-of-way may want to take charge.

Lines of authority should be established in advance so that it will be immediately apparent who is in charge and responsible. This should be determined after legal authorities have checked national, provincial and municipal laws covering the subject. If necessary, an agreement should be drawn up which specifically designates the responsibility and authority of the various agencies that can be involved, even at minor accidents. At the actual time of an accident, the agency in charge should co-operate, as necessary, with the railroad administration, highway administration, or personnel of other agencies.

Decisions on evacuation fall under the jurisdiction of the officer in charge of the accidents and are often particularly difficult, as the Glendora accident shows [47, 48]. In this accident, a train consisting of 157 cars, 8 of which contained vinyl chloride monomer (VCM), derailed near the town of Glendora, Mississipi. One of the VCM tanks ruptured and started leaking, forming a heavy fog of VCM. After seven hours, the leak ignited, creating the hazard that phosgene, a deadly gas, could be formed as a result of the high flame temperature. In spite of the extremely low probability that phosgene could be formed under the physical conditions at the accident, the official in charge felt that the nearby population had to be evacuated. Some 30,000 people were reported to have been evacuated. No one died or was injured as a result of the accident. A subsequent judgement of the accident revealed that the phosgene poisoning risk actually run by the population was marginal.

G. Decision-making process during hazardous material accidents

The emergency personnel arriving at the scene of the accident must be prepared to analyze rapidly the situation and take the proper actions. Although it is impossible to examine all the foreseeable types of accidents and be trained to cope with them, it is feasible to develop and teach a rational approach to be followed by the emergency personnel. One such approach has been developed by the National Fire Protection Association [41].

Figure XI shows the type of logic behind it. At each stage of the accident, the response team must be able to collect and elaborate information (input box), make decisions based on them (decision box), implement them

(output box), and then observe the impact of the action taken on the situation (feedback box) which should be used to start the cycle again. The same figure shows this feedback system as it is applied to the accident situation.

The box labelled "Make size-up of incident factors" refers to rapidly analysing the following:

(a) Problems;

(b) Modifying conditions;

(c) Potential losses and exposures;

(d) Control measures and resources.

Each of these can in turn be broken down and classified as shown in figures XII, XIII and XIV. After this analysis has been concluded, the decision phase follows. In essence, any decision will fall into one of the following categories:

(a) Corrective: What will I do to correct the problem?

(b) Protective: What will I do to prevent the problem from going further?

This first part of the decision process is summarized in figure XV. At this point, the emergency team must decide what kind of tactics will be used to control the accident. Different tactics can be applied, depending on the objectives of the interventions. Six main objectives may be identified:

(a) Rescue injured or endangered persons;

(b) Prevent container failure;

(c) Contain or neutralize the hazard;

(d) Extinguish ignited materials;

(e) Protect all exposures;

(f) Use additional resources.

Several of these objectives can be pursued at the same time. Each should be pursued, however, using the proper tactic(s), which are summarized in figures XVI, XVII, XVIII, XIX, XX and XXI. Of course, the details of the implementation of the tactics must be decided on a case basis, depending on the results of the previous analysis of the incident factors. Some examples are discussed later on.

H. Emergency teams and procedures

Unless the police and city fire fighters are properly informed as to the nature of the hazard, and equipped to fight it, their role should be limited to evacuation of the population (if necessary) and containment of spills and/or fires. These teams should, nevertheless, have some basic knowledge of hazardous material behaviour and the possible consequences of unconventional fires. Table 4 provides an example of how hazardous materials in different states can spread in the environment, and table 5 gives some information on gasoline burning rates and

explosion hazards [41]. Other information is available in reference [49].

Table 4. Spreading of hazardous materials

Physical state	How it spreads
Gas	1. Escapes under pressure 2. Forms clouds and fills available space 3. Travels along ground 4. Is carried by wind
Liquid	1. Flows along ground 2. Vaporizes and acts like gas 3. Seeps into ground
Solid	1. Scatters 2. Forms dust clouds 3. Sticks to surface

A more specialized emergency team should intervene in any other case. This team (which could also be provided by the manufacturer of the hazardous material) should be thoroughly familiar with the chemical, and trained to handle accidents. In addition to the general incident control measures, the emergency team should be expert in dealing with leaks and fires and in emptying damaged containers and clearing up. A moderate leak may often be plugged with wood or special materials [47]. If a leak has ignited, the best policy may be to let it continue burning. The danger of putting out a fire without eliminating the leak is that the amount of flammables may build up and, if re-ignited, cause a more serious fire or explosion. If other containers are present, as is typically the case in rail incidents, it may be necessary to cool these with water to prevent their overheating.

The equipment carried by an emergency team varies according to the chemical involved, but may include items such as:

(a) Chemical data;

(b) Protective clothing;

(c) Breathing apparatus;

(d) Safety harness and line;

(e) General tools and flashlights;

(f) Leak plugging equipment (e.g. wood plugs);

(g) Analytical equipment;

(h) Floodlights with generators;

(i) First aid kit.

Table 5. Basic information on fires and explosives

Burning rate for a spill of gasoline (depends on terrain) [50]:

One gallon per minute will cover 0.7 m^2. (Spill area will stabilize because gasoline will burn as fast as it is released.)

Liquid-to-vapour expansion ratios of liquefied flammable gases [50]:

One volume of liquid = 250 to 800 volumes of gas;
250 to 800 volumes of gas = 20 to 70 (x 250 to 800) volumes of flammable gas/air mixtures.

BLEVE a/ hazards known. (These are not necessarily maximum possible distances [50]):

(a) Flying missile hazard:

(i) 208.1 litre drum or cylinders - up to 60.9 m;
(ii) Gasoline tank vehicles - 45.7 m (stopped by embankment);
(iii) Liquefied gas tank cars and cargo tank vehicles - up to 762 m;

(b) Ground Flash and Fireball (potential burn areas):

(i) 208.1 litre drum or cylinders - up to 60.9 m;
(ii) Cylinder - up to 121.9 m in diameter;
(iii) Railroad tank car - up to 304.8 m;

(c) BLEVE time (time between flame contact with vapour space and BLEVE):

(i) Cylinders - less than 10 minutes;
(ii) Cargo tank vehicles and tank cars - between 10 and 30 minutes.

a/ Boiling liquid expanding vapour explosion.

Emergency procedures have been developed to fight accidents involving many hazardous materials or classes of hazardous materials. The emergency procedures designed for some general classes of materials are given below [32].

1. Guidelines for handling oxidizer accidents

Emergency response personnel must approach an oxidizer incident in the same manner as they would approach an accident involving explosive materials. Caution must be exercised at all times. The following procedures are suggested:

(a) Evacuate personnel from surrounding areas;

(b) Try to identify the product involved. Use reference sources to determine hazard;

(c) Position personnel and apparatus upwind from spill or leak. Make sure there is a path for escape for both personnel and apparatus;

(d) Use full protective equipment and breathing apparatus;

(e) If possible, contain the leak with the use of natural or contrived barriers. Try to divert flow from exposures, mixing with other chemicals, or from entering the sewage system;

(f) Attempt to close or stop the leak. Personnel making this attempt should be protected from the fumes and from possible ignition of the vapours;

(g) If the oxidizer is burning, use the extinguishing method suggested by the reference sources. In most cases, water is effective in extinguishing the fire;

(h) Most oxidizers are soluble in water, so solutions of the material can be absorbed in many places. These include wood floors, merchandise and other combustibles. As the material dries out, it can ignite spontaneously. Overhaul, therefore, is extremely important after extinguishment is accomplished.

2. Guidelines for handling flammable gas accidents

Flammable gas emergency incidents will involve a gas leak that is either ignited or not. General procedures for handling such incidents are given below.

Unignited leak

(a) Evacuate personnel downwind from the leak. Remember, when approaching the scene, do not drive apparatus through the vapour cloud. Keep spectators and unnecessary emergency response personnel away from the scene;

(b) Identify the material which is leaking;

(c) Determine best method of attack. For example, if the gas is water-soluble, fog streams produced by water jets sprayed through special nozzles can be used;

(d) Begin the attack from upwind and out of the vapour cloud;

(e) If possible, close valves to stop flow of gas.

Ignited leak

(a) As a general rule, a gas leak that has ignited should not be extinguished unless the leakage can be stopped immediately. This must be carefully followed because the vapours from an unignited leak can travel over a wide area, ignite from a remote source, and cause extensive injury and property damage;

(b) Any surfaces that are exposed to the gas fire must be kept cool. If the exposure is a pressurized container, then a BLEVE (i.e. a boiling liquid expanding vapour explosion) is possible. Large quantities of water are necessary to cool the vessel;

(c) Under the cover of protective streams, attempt to shut off the fuel supply;

(d) If the valve cannot be closed, consideration should be given to controlled burning to allow the fuel to be consumed.

3. Guidelines for handling flammable liquid accidents

Flammable liquid incidents can involve a leak with or without ignition. The following general procedures are given for handling the incident:

Unignited leak

(a) Evacuate personnel downwind and downhill from the leak. Use caution in locating the positioning apparatus and personnel. Keep sightseers and non-required emergency-response personnel away from the scene;

(b) Identify the leaking product;

(c) If possible, attempt to contain the leak within natural or artificial barriers. Try to divert flow from exposures. Try to prevent liquid from entering sewer system;

(d) Eliminate possible ignition sources;

(e) Attempt to close valves or stop the leak. Personnel making the attempt should be protected from a possible ignition of the vapours. If possible, the spill should be covered with a foam to reduce vapour production. Special devices can be used to attempt to close the hole or leak.

Ignited leak

(a) Keep personnel and apparatus upwind and on higher ground than the liquid;

(b) Identify the leaking product;

(c) If possible, attempt to contain the leak as in procedure (c) given for unignited leaks;

(d) Attempt to stop the leak as in procedure (e) given for unignited leaks;

(e) Use water streams to keep storage tanks cool to prevent a BLEVE. Flush burning liquids out from under storage tanks. Remember, unmanned master streams can be used to cool tanks;

(f) Stay away from the ends of the storage tanks. Since the tank can swivel in event of a BLEVE, an area 30° from the horizontal should also be kept clear. It is important to note that this does not imply that an attack from the sides is safe. Tanks have been known to swivel 90° and overrun side positions. Use unmanned streams wherever possible;

(g) Co-ordinate use of fog streams. One crew should not try to flush product out from under the tank while the other crew pushes it back;

(h) The change in pitch of the escaping gas from the relief valve can indicate a buildup of pressure. Move personnel back should this occur;

(i) Protect the steel supports of storage tanks to prevent weakening and collapse due to heat;

(j) Apply correct extinguishing agent for product involved;

(k) Always keep personnel safety in mind. Make sure an escape path is always available. Keep backup lines ready. Keep apparatus headed in direction of escape.

I. Guidelines for rescue and emergency medical treatment during hazardous material emergencies

The emergency teams arriving at the scene of the accident will often have to rescue and then administer first aid to the victims. The following material was extracted from reference [41] and contains guidelines on what should, and what should not, be done in case of some of the most common types of hazardous material accidents. Additional material can be found in reference [51].

1. Corrosives: acid (sulfuric, hydrochloric, nitric etc.)

Rescuer

(a) Wear protective clothing to prevent inhalation or skin exposure;

(b) Avoid breathing vapours;

(c) Wash immediately any area of skin exposed;

(d) Remove contaminated clothing;

(e) Flush eyes with water for 15 minutes.

Victim

(a) Assisted forced pressure ventilation may be necessary due to spasm of vocal cords. Tracheotomy may be necessary;

(b) Decontamination of skin should be done as soon as practical with water and then with soap and water. If this is not done, the victim may develop second or third degree burns;

(c) Keep all clothing at the scene, wash victim, and keep victim warm;

(d) Flush eyes with running water from a pitcher or hose - not with an eye dropper;

(e) If swallowed, give victim as much water or milk as possible; get victim to a hospital.

2. Corrosives: alkaline (chlorine, ammonia, sodium hydroxide etc.)

Rescuer

(a) Same protective clothing as for acids must be worn;

(b) Breathing apparatus must be worn.

Victim

(a) Assisted ventilation with pressure may be necessary. Chlorine, for example, reacts in the airway to make hydrochloric acid. Since it is distributed through the lungs, this is more of a problem than swallowed hydrochloric acid;

(b) Wash off contaminated areas of skin with water in large amounts;

(c) Eyes must be flushed for longer than in the case of acid - at least 15 minutes with water. Do not instill acid to "neutralize" the alkali;

(d) If swallowed, give large amounts of water or milk immediately and get to a hospital;

(e) Do not use acids to neutralize. They will react with the base and create heat that will burn the victim. Do not use oils. Although they are supposed to "soothe" the victim, they actually interfere with the care of burns.

3. Poisons: class A (arsine, mustard gas etc.)

Rescuer

(a) Wear protective clothing and breathing apparatus.

Victim

(a) Arsine. Arsine may be produced when substances such as arsenic trioxide react with galvanized steel or may be transported in bulk. The victims may seem well after exposure, but within a few hours will develop vomiting and/or diarrhoea and collapse. They must be taken to a hospital and treated, regardless of how they look or feel. Without proper medical attention, victims so exposed may die;

(b) Mustard gas. This agent is extremely poisonous to skin and will raise blisters wherever it contacts. Decontamination of skin and clothing should be carried out immediately. Victim should then be transported to a hospital.

4. Poisons: class B (organophosphates - parathion, malathion, "nerve gas" etc.)

Rescuer

(a) Protective clothing (occlusive and positive pressure breathing apparatus);

(b) Immediate decontamination with soap and water for any skin contact;

(c) Removal and destruction of all contaminated clothing and shoes;

(d) Atropine and 2-PAM treatment, as below.

Victim

(a) Assisted ventilation with clearing of mucous and saliva from airway. These victims may have enormous amounts of secretions;

(b) Atropine. Treatment should occur following known exposure or any of the following symptoms occurring together: salivation; urination; slow heart (under 60); lacrimation; defecation; pinpoint pupils. Initial dose should be 2 milligrams, intravenous or intramuscular. If victim develops a fast heart, wide pupils or dryness, no further Atropine should be given. If the preceding symptoms do not improve, more Atropine should be given until salivation stops. This may take up to 2,000 mg.;

(c) 2-PAM (potopam, pralidoxime). This antidote will need to be administered, but can usually wait until victim gets to the hospital. If the hospital is not close, or is unavailable, then the dose is one gram intravenously over two minutes in an adult, or 250 mg in a child;

(d) If poison has been swallowed, vomiting should be induced unless it has already taken place spontaneously.

5. Poisons: class B (continued)

Victim

(a) Carbamates. All of the insecticides in this class can be treated as organophosphates, except for SEVIN (carbaryl) for which 2-PAM should not be used;

(b) Chlorinated hydrocarbons. (Endrin, Dieldrin, Aldrin etc.). Decontamination as for other insecticides, with soap and water. The victims are rarely ill at the scene, unless they have swallowed some of the material. They should be transported to the hospital after decontamination. Convulsions are the most frequent major sysmptom. It is important to ensure unobstructed breathing passage for victim;

(c) Herbicides. (Paraquat, Bladex, Planavin etc.). Decontamination as for insecticides. Paraquat should not be washed down the street as it will stay active. Instead, it must be gathered up and put on a field or mixed with other dirt to destroy it. Paraquat is the most poisonous of all herbicides. One drop on the tip of the tongue can kill an adult. Of 44 victims exposed to paraquat, 42 have died. Symptoms are usually delayed and not acute. Decontaminate and transport to the hopital. Other herbicides are of a low level of toxicity, unless exposure is massive.

6. Irritants: tear gas, pepper gas etc.

Rescuer

(a) Should wear breathing apparatus.

Victim

(a) Usually little treatment is required, and symptoms disappear by themselves;

(b) Eyes should be flushed with clear water, not soap, and clothes should be removed and cleaned;

(c) Victim should bathe in soapy water.

J. Hazardous material accident report

Accident follow-up consists of the preparation of the accident report. The purpose of this is twofold. On the one hand, this report might have legal implications, or at least help determine the responsibilities of the parties involved in the accident, including those who brought or were supposed to bring it under control. On the other hand, this and other similar documents may serve the purpose of "educating", in a broad sense, responsible officials and emergency personnel in how to handle such accidents in the future, and how to plan accordingly.

The following items of information can be used to prepare an accident report [41]. The term "immediate" used below refers to information gathered at the scene of the accident, whereas "later" refers to information gathered at a later stage.

Incident documentation (physical scene of disaster)

Immediate

(a) Photos (far away and close-up; include time relationships between photos, if pertinent);

(b) Sketches (position of vehicles and debris before and after);

(c) Measurements (distance, weight, and size, especially of flying debris).

Later

(a) Describe characteristics of damaged shipping containers.

Problem

Immediate

(a) Stage of the incident (fire, leak, spill);

(b) Harmful nature of material (include name and amount of material(s) involved;

(c) Type, condition, and behaviour of shipping container (highway accident, derailment).

Later

(a) Name and address of carrier;

(b) Name and address of shipper;

(c) Name and address of consignee.

Modifying conditions

Immediate

(a) Location;

(b) Time;

(c) Weather.

Later

(a) What problems did you encounter in reaching the scene of the incident?

(b) How long did it take for any special equipment to reach the scene?

(c) What limitations did the scene place on any operations?

(d) What limitations did the weather place on any operations?

Exposures

(a) What losses occurred?

(b) What were the number and cause of any deaths or injuries before arrival of emergency forces? During control stages? After stabilization of the incident?

Resources

Immediate or available

(a) Personnel involved in control procedures;

(b) Equipment involved in control procedures.

Supportive

(a) Where did you look for technical advice? (Persons, agencies, HM guides);

(b) What technical information did you receive? (Identify sources.)

Objectives and tactics

(a) Were rescue measures necessary?

(b) What steps were taken to control the incident?

(c) What agent was used to control the incident?

(d) What measures were taken to protect emergency service personnel from injury?

(e) What steps were taken to effectively terminate the incident?

Statements of witnesses

The following are some questions that should be asked of witnesses. (Witnesses include bystanders, people involved, and first emergency service personnel on the scene.) Make sure they tell what they saw about the incident.

(a) What did you see happen?

(b) Describe characteristics of any burning, spilled or leaking material;

(c) How did you know there were hazardous materials involved?

(d) When did you arrive on the scene?

(e) Were there any identifying markings, labels, or placards?

(f) Were they visible?

(g) What was the condition and behaviour of the shipping container(s)?

(h) Did you notice anything unusual?

(i) What was observed?

(j) Did you hear any sounds?

Figure II. Shipping containers

Container	Hazard Class										
	Explosive	Compressed gas	Flammable & Combustible liquid	Flammable solid	Oxidizer	Organic peroxide	Poisonous material	Etiologic agent	Radioactive material	Corrosive material	Other regulated material
Pail			X	X	X	X	X				
Glass carboy in plywood drum or box										X	
Fiberboard box a/	X		X	X	X	X		X	X	X	X
Wooden box a/	X		X	X	X	X	X	X	X	X	X
Mailing tubes b/	X			X	X	X	X	X			
Wooden barrel											X
Bag	X			X	X	X	X				X
Cylinder		X	X				X		X	X	
Fiberboard drum	X		X	X	X	X	X		X	X	
Metal drum	X		X	X	X	X	X		X	X	X
Metal keg	X									X	
Polystyrene case a/										X	
Lead-shielded container a/									X		
Portable tank		X	X		X	X	X			X	
Tank truck	X	X	X		X	X	X			X	X
Tank car	X	X	X	X	X		X			X	X
Tanker		X	X		X		X			X	
Barge		X	X	X	X		X			X	
Regional											
Regional											

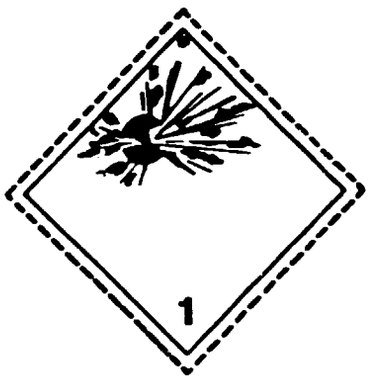
Note: An "X" at an intersection of vertical and horizontal columns means that the hazard class is shipped in that container.

a/ Indicates outside package for inside containers.

b/ Indicates shape of package only. These are not used to ship hazardous materials through the mail.

Figure III. Specimen labels (United Nations system)

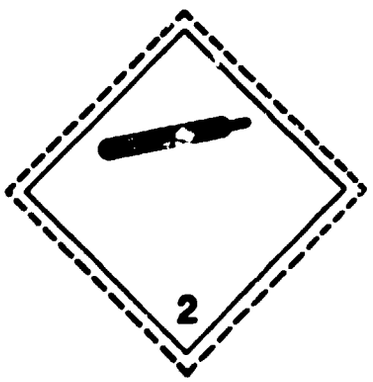
Class 1



Explosives

Divisions 1.1, 1.2 and 1.3
Symbol (exploding bomb): black; Background: orange

Class 2



Non-inflammable gases
Symbol (gas cylinder): black or white; Background: green

continued

Figure III. (continued)

Class 2

Inflammable gases
Symbol (flame): black or white
Background: red

Poison (toxic) gases
Symbol (skull and crossbones): black
Background: white

Class 3

Inflammable liquids
Symbol (flame): black or white; Background: red

continued

Figure III. (continued)

Class 4

Division 4.1

Inflammable solids
Symbol (flame): black;
Background: white with vertical red stripes

Division 4.2

Substances liable to spontaneous combustion
Symbol (flame): black;
Background: upper half white; lower half red

Division 4.3

Substances which, in contact with water, emit inflammable gases
Symbol (flame): black or white; Background: blue

Class 5

Division 5.1

Oxidizing substances

Division 5.2

Organic peroxides

Symbol (flame over circle): black; Background: yellow

continued

Figure III. (continued)

Class 6

Division 6.1

Poisonous (toxic) substances
Packing Groups: I and II
Symbol (skull and crossbones): black; Background: white

Division 6.1

Poisonous (toxic) substances
Packing Group: III
The bottom half of the label should bear the inscriptions:
HARMFUL
Stow away from foodstuffs
Symbol (St. Andrew's Cross over an ear of wheat): black; Background: white

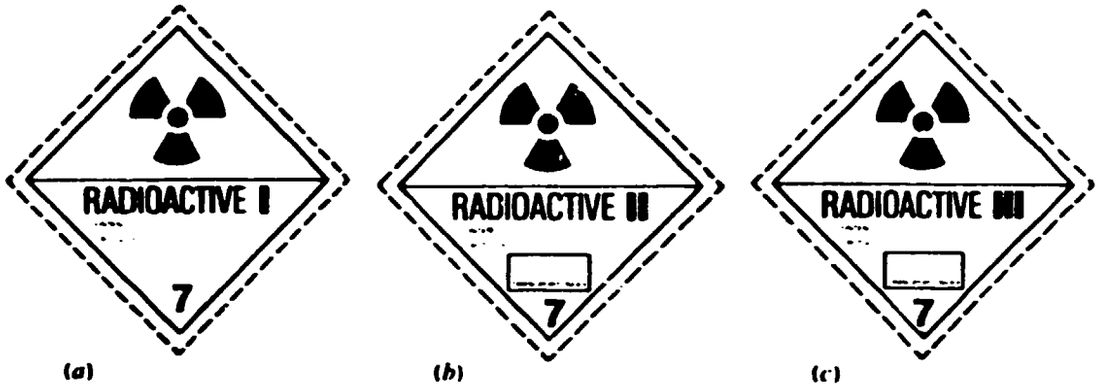
Division 6.2

Infectious substances
The bottom half of the label should bear: Infectious Substance (Optional) and the Inscription: "In case of damage or leakage immediately notify Public Health authority" (optional); Symbol (three crescents superimposed on a circle) and Inscription: black; Background: white

continued

Figure III. (continued)

Class 7



(*a*) (*b*) (*c*)

Radioactive substances

(*a*) **Category I—White**; Symbol (trefoil): black; Background: white; Text (mandatory) black in bottom half of label: **"Radioactive"**; **"Contents . . . "**; **"Activity . . . "**. One red vertical stripe must follow the word "Radioactive".

(*b*) **Category II—Yellow**; Symbol (trefoil): black; Background: top half yellow, bottom half white; Text (mandatory) black in bottom half of label: **"Radioactive"**; **"Contents . . . "**; **"Activity . . . "**; in a black outlined box—**"Transport Index"**. Two red vertical stripes must follow the word "Radioactive".

(*c*) **Category III—Yellow**; Symbol (trefoil): black; Background: top half yellow, bottom half white; Text (mandatory) black in bottom half of label: **"Radioactive"**; **"Contents . . . "**; **"Activity . . . "**; in a black outlined box—**"Transport Index"**. Three red vertical stripes must follow the word "Radioactive".

Class 8

Corrosives

Symbol (liquids, spilling from two glass vessels and attacking a hand and a metal): black; Background upper half white, lower half black with white border

Figure IV. HAZCHEM placarding system (United Kingdom)

The panel illustrated is for acetaldehyde

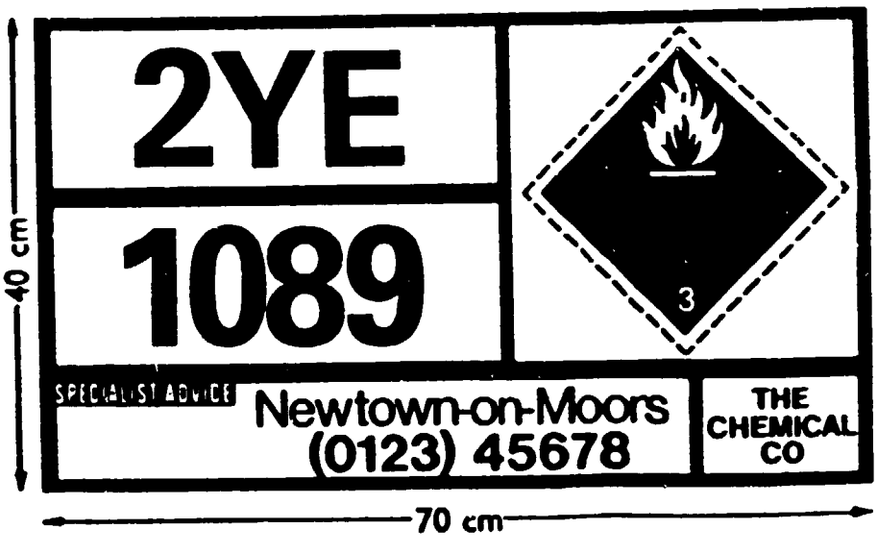
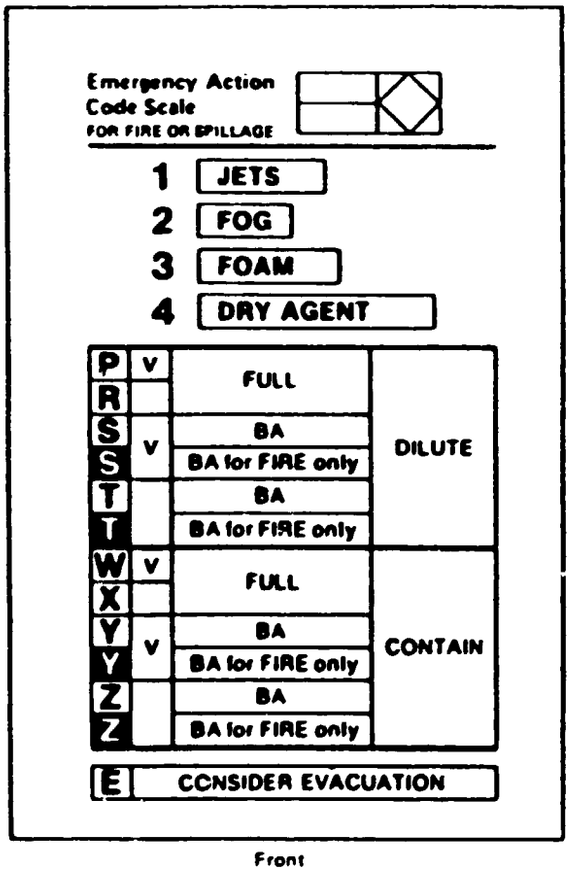
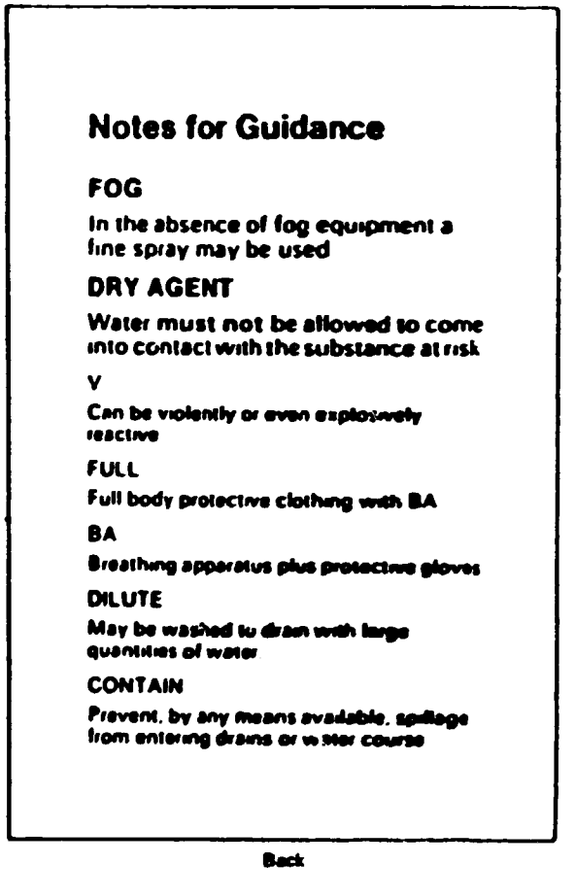


Figure V. HAZCHEM card (United Kingdom)



Front

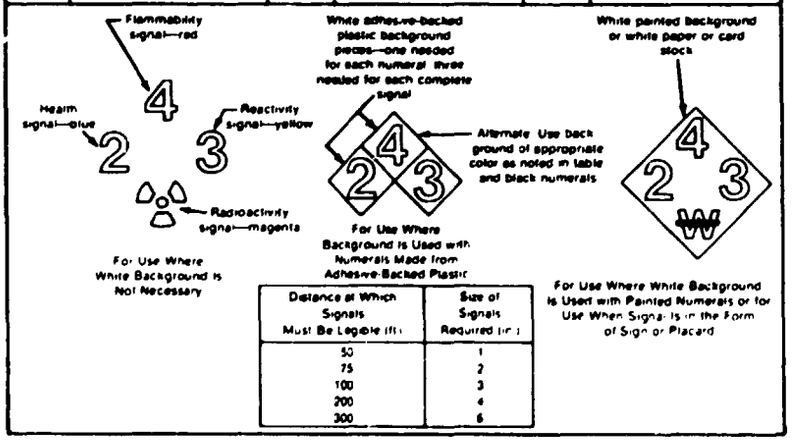


Back

Figure VI. Chart used in the classification of the hazards of materials (as recommended in NFPA Handbook No. 704M)

IDENTIFICATION OF THE FIRE HAZARDS OF MATERIALS

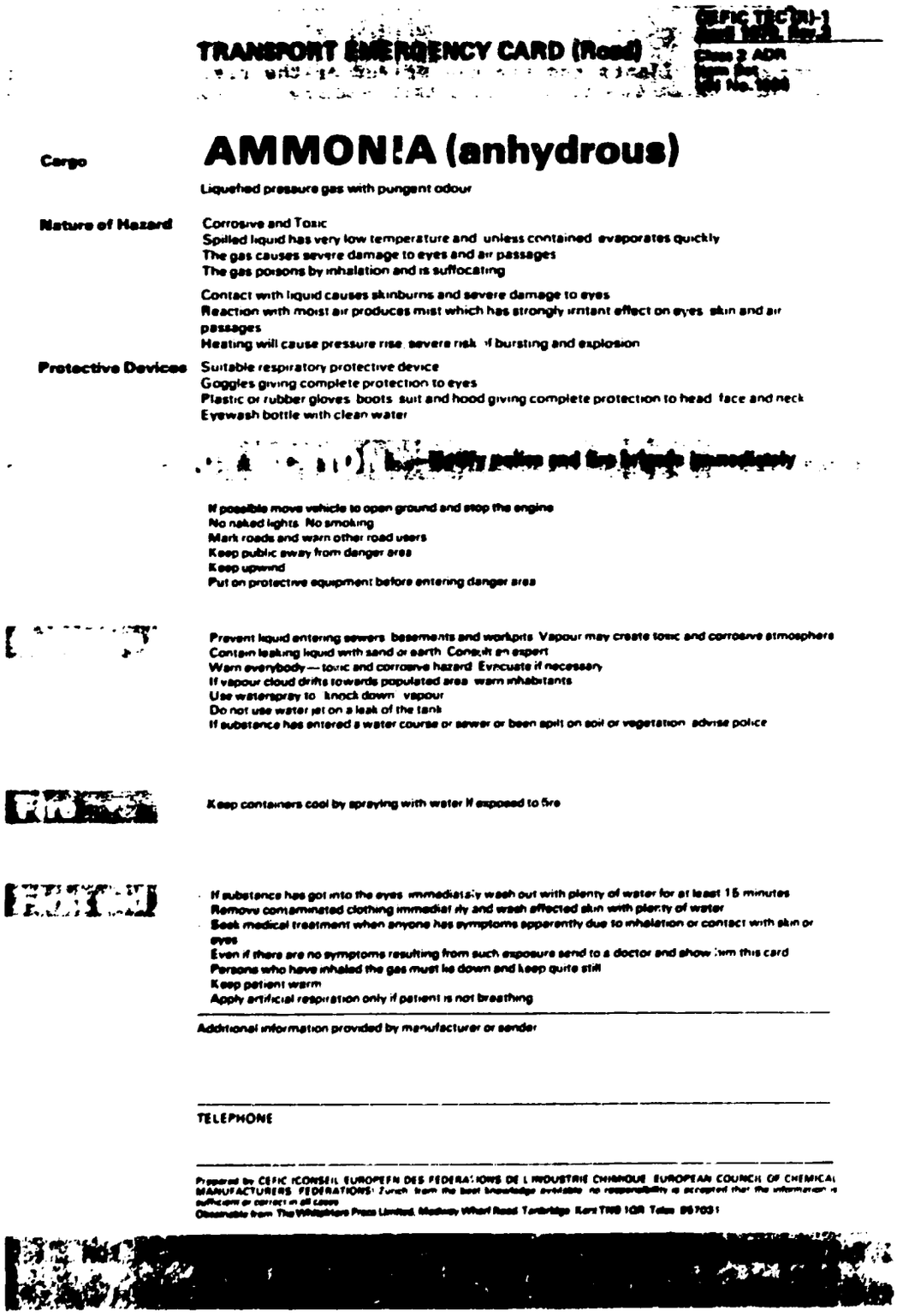
DEGREE OF HAZARD					
Identification of Health Hazard Color Code BLUE		Identification of Flammability Color Code RED		Identification of Reactivity (Stability) Color Code YELLOW	
Type of Possible Injury		Susceptibility to Release of Energy		Susceptibility of Materials to Burning	
Signal		Signal		Signal	
4	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment were given	4	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or which are readily dispersed in air and which will burn readily	4	Materials which are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures
3	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment were given	3	Liquids and solids that can be ignited under almost all ambient temperature conditions	3	Materials which are capable of detonation but require a strong initiating source and which must be heated under confinement before initiation
2	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given	2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur	2	Materials which readily undergo violent chemical change
1	Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given	1	Materials that must be preheated before ignition can occur	1	Materials which are normally stable but which can become unstable in combination with other common materials or at elevated temperatures and pressures
0	Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material	0	Materials that will not burn	0	Materials which are normally stable



Distance at Which Signals Must Be Legible (ft)	Size of Signals Required (in.)
50	1
75	2
100	3
200	4
300	6

Courtesy of the National Fire Protection Association.

Figure VII. TREMCARD system



TRANSPORT EMERGENCY CARD (Road)

Class 2 ADR

Cargo

AMMONIA (anhydrous)

Liquefied pressure gas with pungent odour

Nature of Hazard

Corrosive and Toxic
Spilled liquid has very low temperature and unless contained evaporates quickly
The gas causes severe damage to eyes and air passages
The gas poisons by inhalation and is suffocating

Contact with liquid causes skinburns and severe damage to eyes
Reaction with moist air produces mist which has strongly irritant effect on eyes skin and air passages
Heating will cause pressure rise severe risk of bursting and explosion

Protective Devices

Suitable respiratory protective device
Goggles giving complete protection to eyes
Plastic or rubber gloves boots suit and hood giving complete protection to head face and neck
Eyewash bottle with clean water

[illegible] police and fire brigade immediately

If possible move vehicle to open ground and stop the engine
No naked lights No smoking
Mark roads and warn other road users
Keep public away from danger area
Keep upwind
Put on protective equipment before entering danger area

[illegible]

Prevent liquid entering sewers basements and workpits Vapour may create toxic and corrosive atmosphere
Contain leaking liquid with sand or earth Consult an expert
Warn everybody — toxic and corrosive hazard Evacuate if necessary
If vapour cloud drifts towards populated area warn inhabitants
Use waterspray to knock down vapour
Do not use water jet on a leak of the tank
If substance has entered a water course or sewer or been spilt on soil or vegetation advise police

[illegible]

Keep containers cool by spraying with water if exposed to fire

[illegible]

If substance has got into the eyes immediately wash out with plenty of water for at least 15 minutes
Remove contaminated clothing immediately and wash affected skin with plenty of water
Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes
Even if there are no symptoms resulting from such exposure send to a doctor and show him this card
Persons who have inhaled the gas must lie down and keep quite still
Keep patient warm
Apply artificial respiration only if patient is not breathing

Additional information provided by manufacturer or sender

TELEPHONE

Prepared by CEFIC (CONSEIL EUROPEEN DES FEDERATIONS DE L'INDUSTRIE CHIMIQUE EUROPEAN COUNCIL OF CHEMICAL MANUFACTURERS FEDERATIONS) Zurich from the best knowledge available no responsibility is accepted that the information is sufficient or correct in all cases
Obtainable from The Whitefriars Press Limited, Medway Wharf Road Tonbridge Kent TN9 1QR Telex 957031

[illegible]

Figure VIII. Action guide card for acrolein (front of card)

Acrolein

(Flammable, Thermally Unstable, Poisonous)

Potential Hazards

Fire: —May be ignited by heat, sparks, flames.
—Flammable vapors may spread from spill.

Explosion. —Container may explode due to heat of fire.
—Runoff may create fire or explosion hazard in sewer system.

Health: —Vapors extremely irritating. Contact may cause burns to skin and eyes.
—Fire may produce irritating or poisonous gases.
—*Vapors may be fatal if inhaled.*
—Runoff may pollute water supply.

Immediate Action

—Get helper and notify local authorities.
—If possible, wear self-contained breathing apparatus and full protective clothing.
—Eliminate all open flames. No smoking. No flares. Keep internal combustion engines *at least* 20 yards away.
—Keep up wind and estimate *Immediate Danger Area.*
—Evacuate according to *Evacuation Table.*

Immediate Follow-up Action

Fire: —**Small Fire:** Dry Chemical or CO_2.
—**Large Fire:** Water spray or fog.
—Move containers from fire area if without risk.
—Cool containers with water from *maximum distance* until well after fire is out.
—For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
—Stay away from ends of tanks.
—Withdraw immediately in case of rising sound from venting safety device.

Spill or Leak: —Do not touch spilled liquid.
—Stop leak if without risk.
—Use water spray to reduce vapors.
—**Large Spills:** Dike for later disposal.
—**Small Spills:** Take up with sand, earth or other noncombustible, absorbent material.

First Aid: —Remove victim to fresh air. Call for emergency medical care. *Effects of contact or inhalation may be delayed.*
—If victim is not breathing, give artificial respiration. If breathing is difficult, give oxygen.
—If victim contacted material, immediately flush skin or eyes with running water *for at least 15 minutes.*
—Remove contaminated clothes.
—Keep victim warm and quiet.

DEPARTMENT OF TRANSPORTATION
EMERGENCY ACTION GUIDE
FOR SELECTED HAZARDOUS MATERIALS (1978 Edition)

Figure IX. Action guide card for acrolein (back of card)

For Assistance Call Chemtrec toll free (800) 424-9300

In the District of Columbia, the Virgin Islands, Guam, Samoa, Puerto Rico and Alaska, call (202) 483-7616.

Additional Follow-up Action

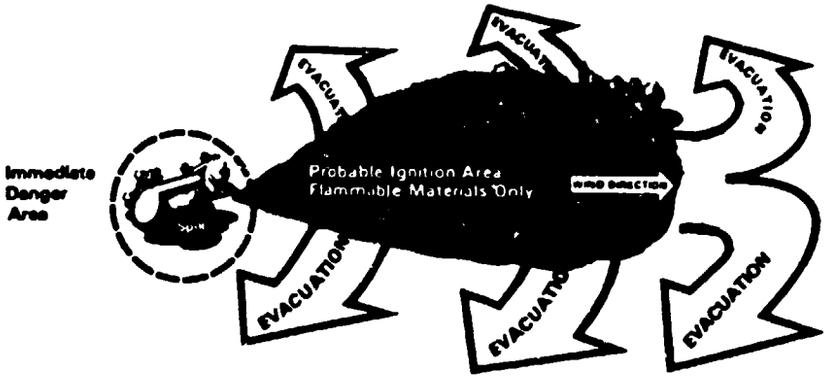
—For more detailed assistance in controlling the hazard, call Chemtrec (Chemical Transportation Emergency Center) toll free (800) 424-9300. You will be asked for the following information:

- Your location and phone number.
- Location of the accident.
- Name of product and shipper, if known.
- The color and number on any labels on the carrier or cargo.
- Weather conditions.
- Type of environment (populated, rural, business, etc.)
- Availability of water supply.

—Adjust evacuation area according to wind changes and observed effect on population.

Water Pollution Control

—Prevent runoff from fire control or dilution water from entering streams or drinking water supply. Dike for later disposal. Notify Coast Guard or Environmental Protection Agency of the situation through Chemtrec or your local authorities.



Evacuation Table — Based on Prevailing Wind of 6-12 mph.

Approximate Size of Spill	Distance to Evacuate From Immediate Danger Area	For Maximum Safety, Downwind Evacuation Area Should Be
200 square feet	360 yards (432 paces)	2 miles long, 1 mile wide
400 square feet	530 yards (636 paces)	3 miles long, 2 miles wide
600 square feet	650 yards (780 paces)	4 miles long, 2 1/2 miles wide
800 square feet	760 yards (912 paces)	5 miles long, 3 miles wide
In the event of an explosion, the minimum safe distance from flying fragments is 2,000 feet in all directions		

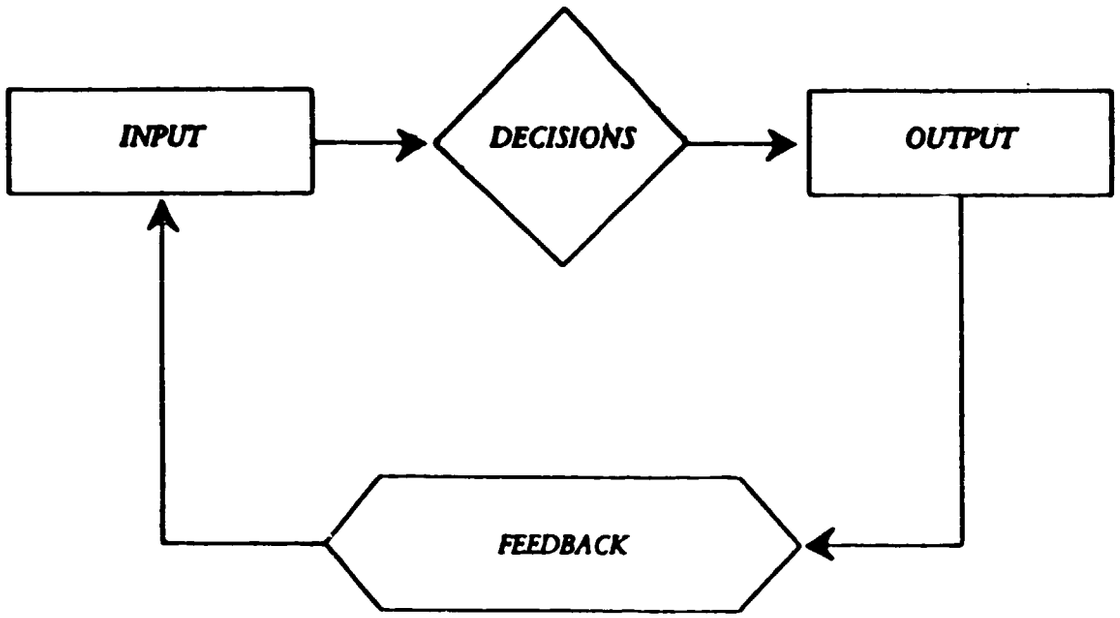
DEPARTMENT OF TRANSPORTATION
EMERGENCY ACTION GUIDE
FOR SELECTED HAZARDOUS MATERIALS (1978 Edition)

Figure X. United Nations dangerous goods declaration

Page size: "A4" (210 x 297 mm or 8.27 x 11.69 inches)

Shipper (Name & Address)	Reference number(s)
(Reserved for text, instructions or other matter)	Name of carrier (or his agent)
Name/means of transport / Port/place of departure	(Reserved for text, instructions or other matter)
Port/place of destination	
Marks & numbers; Number & kind of packages; Description of goods* INDICATE: HAZARD CLASS/DIV.; UN NUMBER; FLASHPOINT (in °C) (when required)	Gross weight (kg) / Net quantity (when required)
*PROPER SHIPPING NAME: proprietary names alone are not sufficient	
Additional information Special information is required for (a) Dangerous Goods in Limited Quantities, and (b) Radioactive substances (Class 7). In certain circumstances, (c) a weathering certificate, or (d) a Container/Trailer Packing Certificate is required.	
DECLARATION	Name/status of signatory Place and date Signature on behalf of Shipper

Figure XI. Feedback system



ANY FEEDBACK SYSTEM

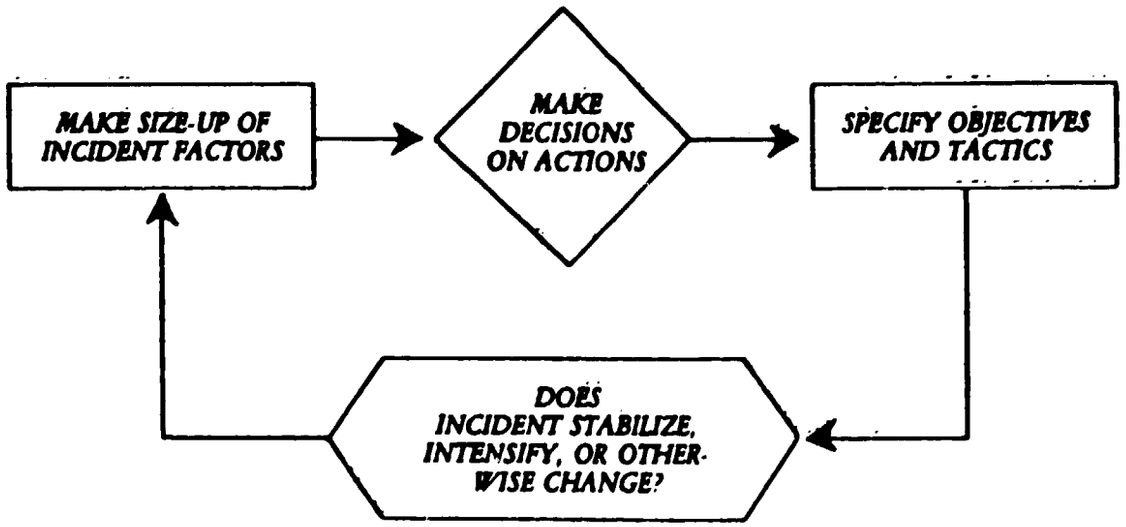


Figure XII. Incident factors for size up

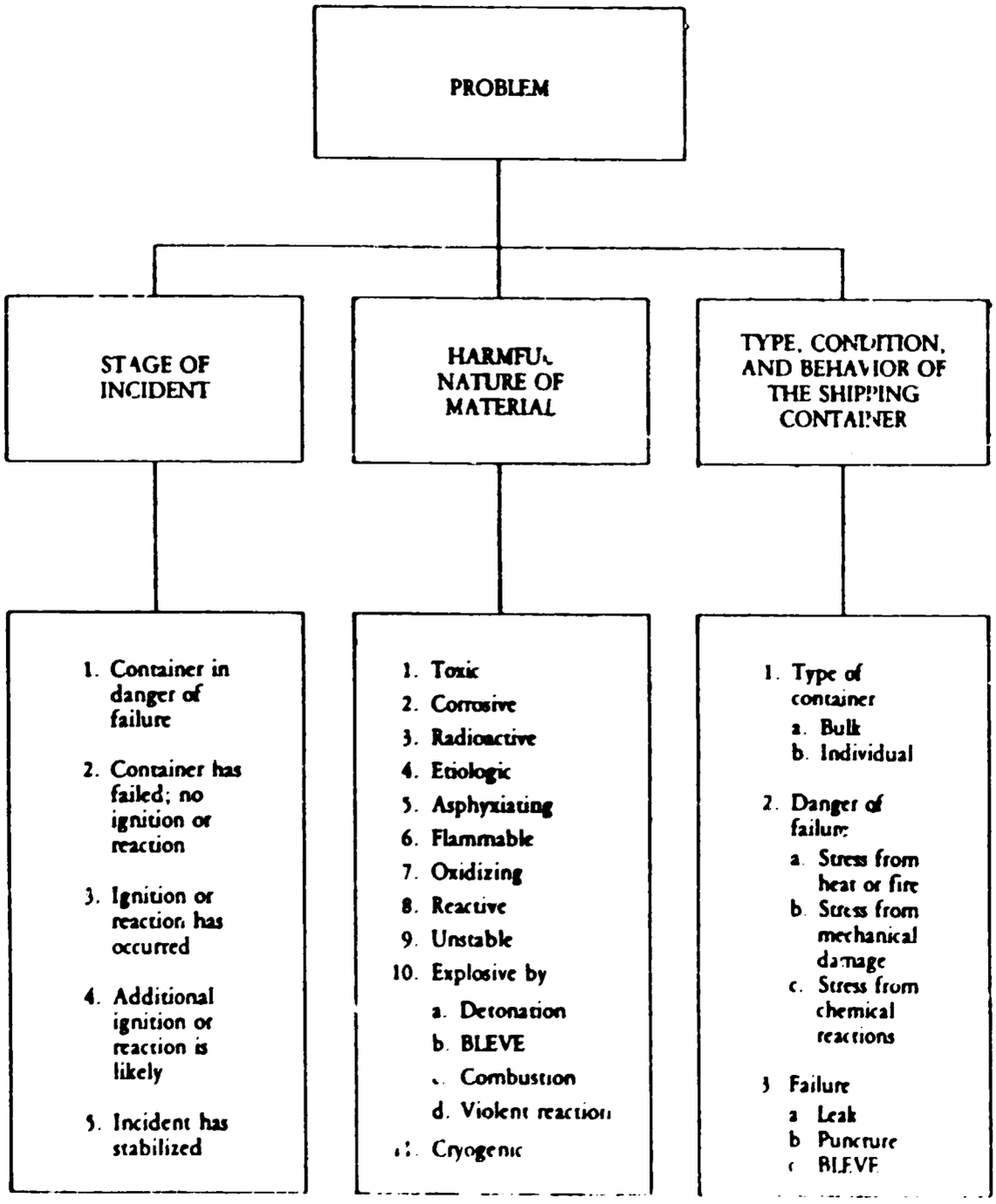


Figure XIII. Incident factors for size up

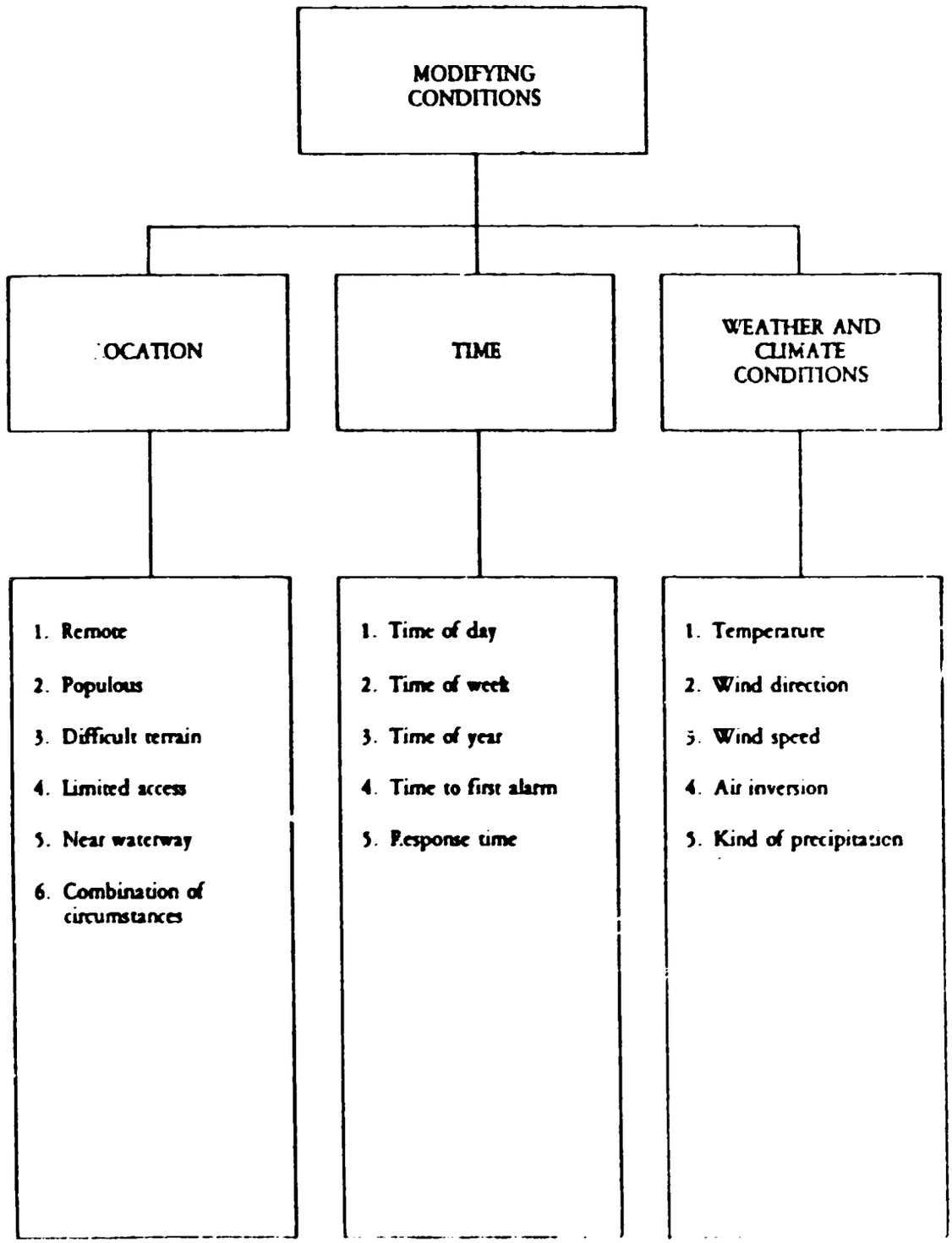


Figure XIV. Incident factors for size-up

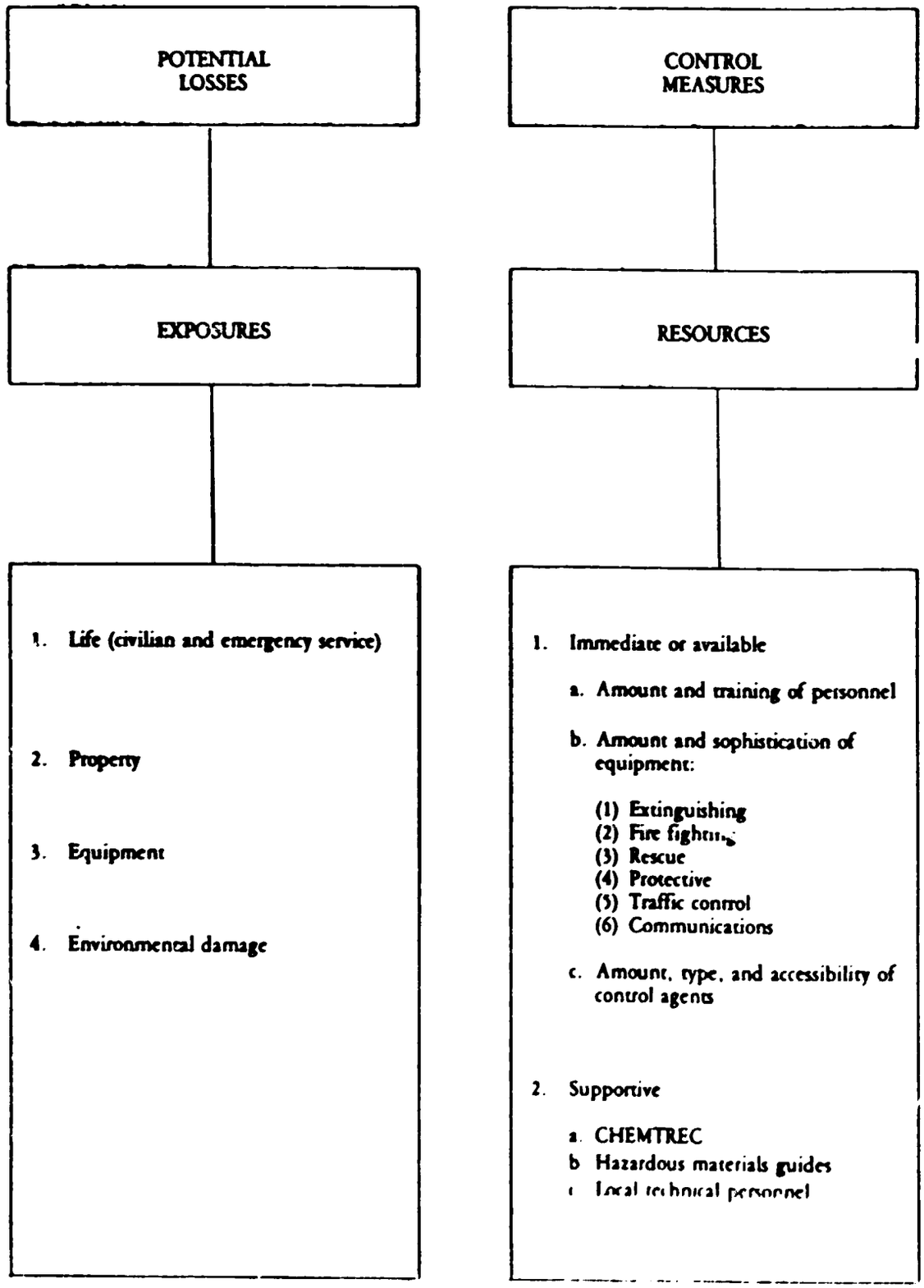


Figure XV. First part of decision process

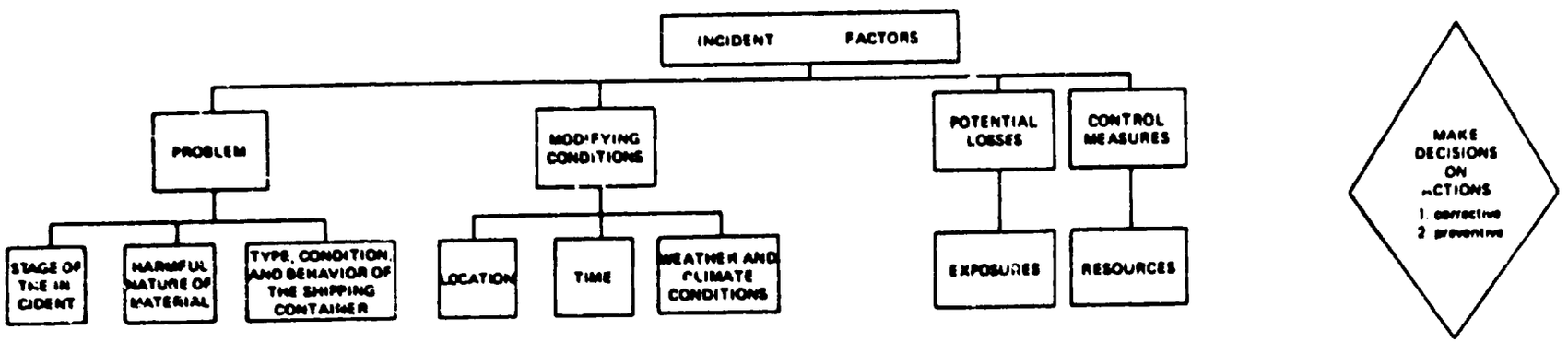


Figure XVI. Accident intervention

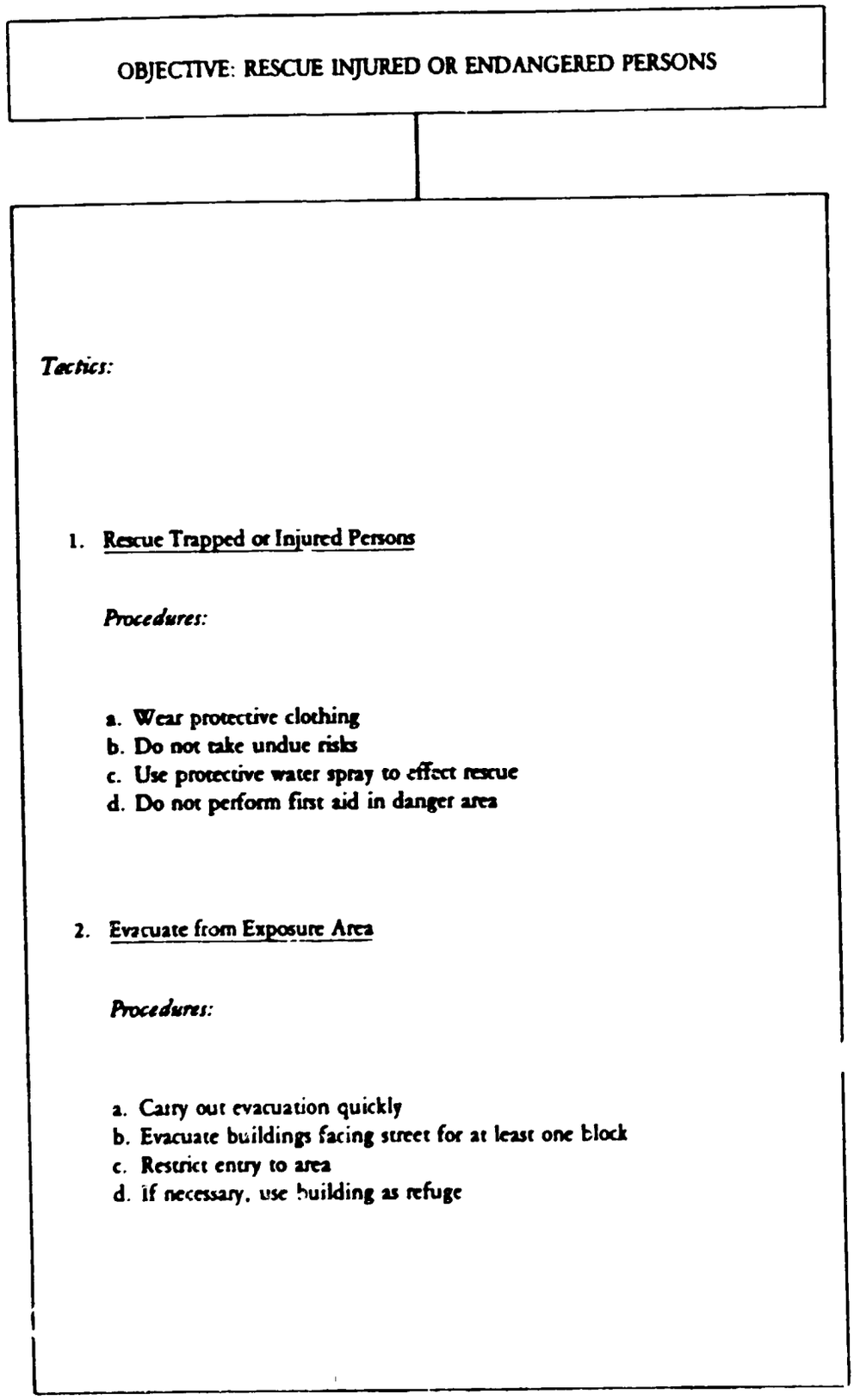


Figure XVII. Accident intervention

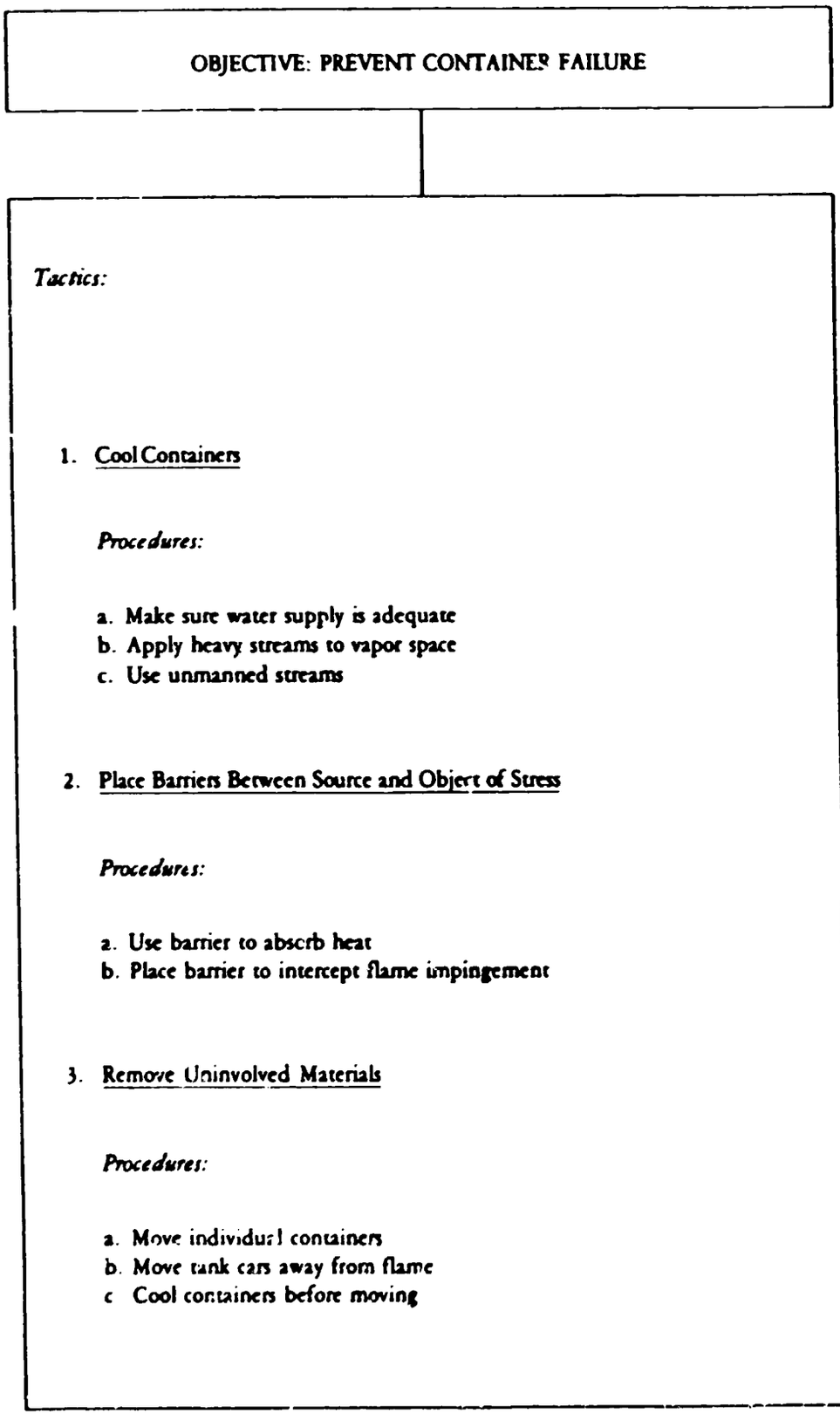


Figure XVIII. Accident intervention

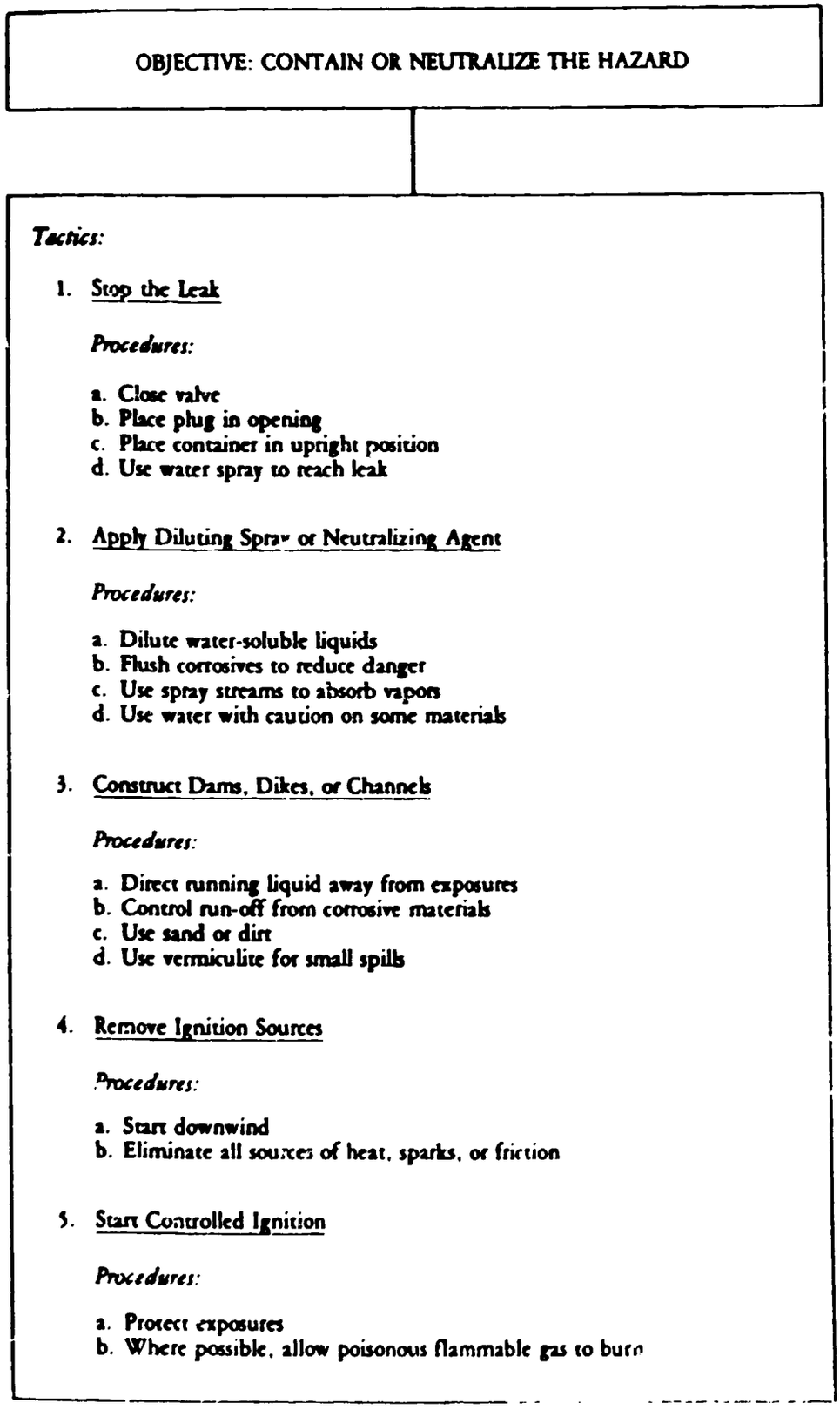


Figure XIX. Accident intervention

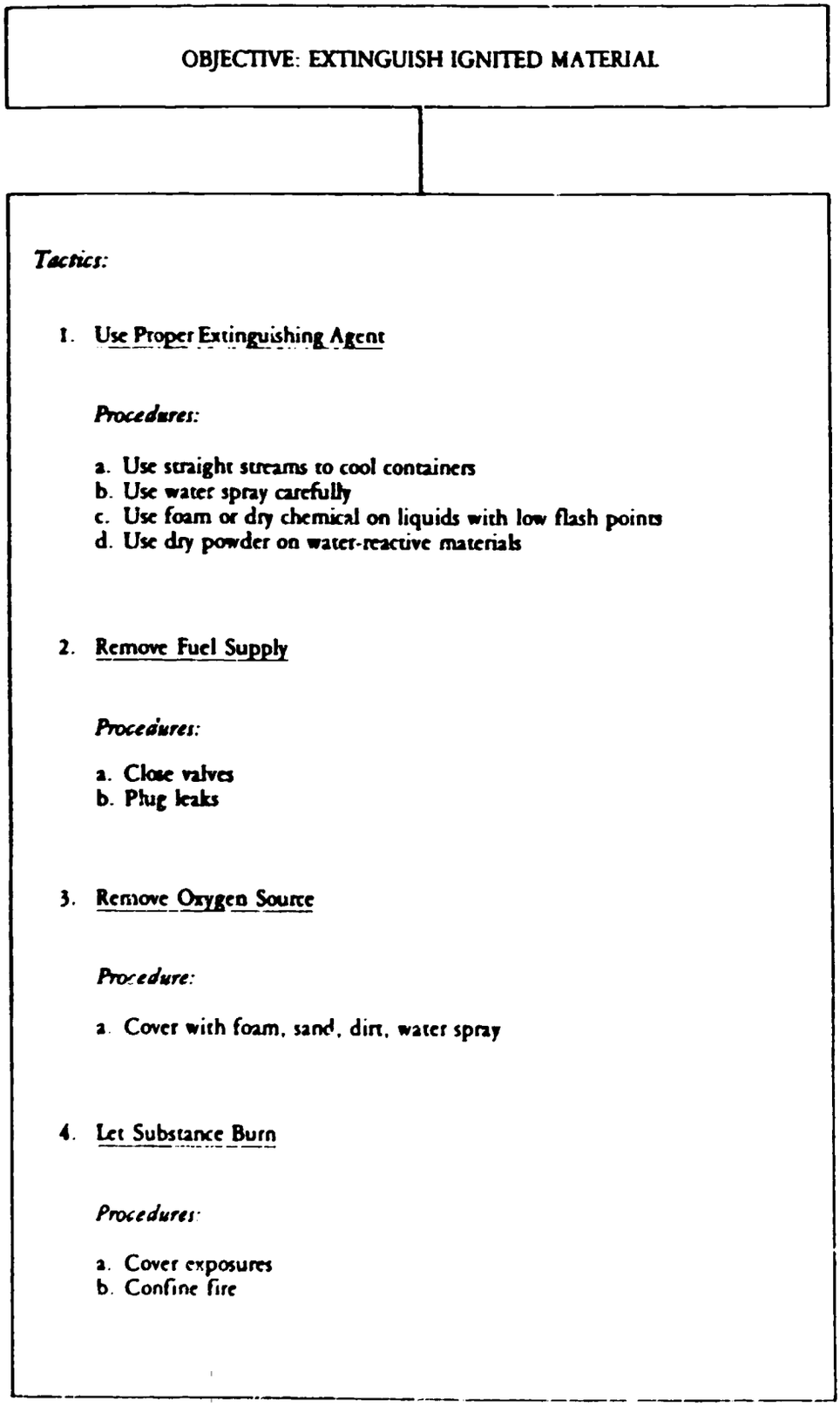


Figure XX. Accident intervention

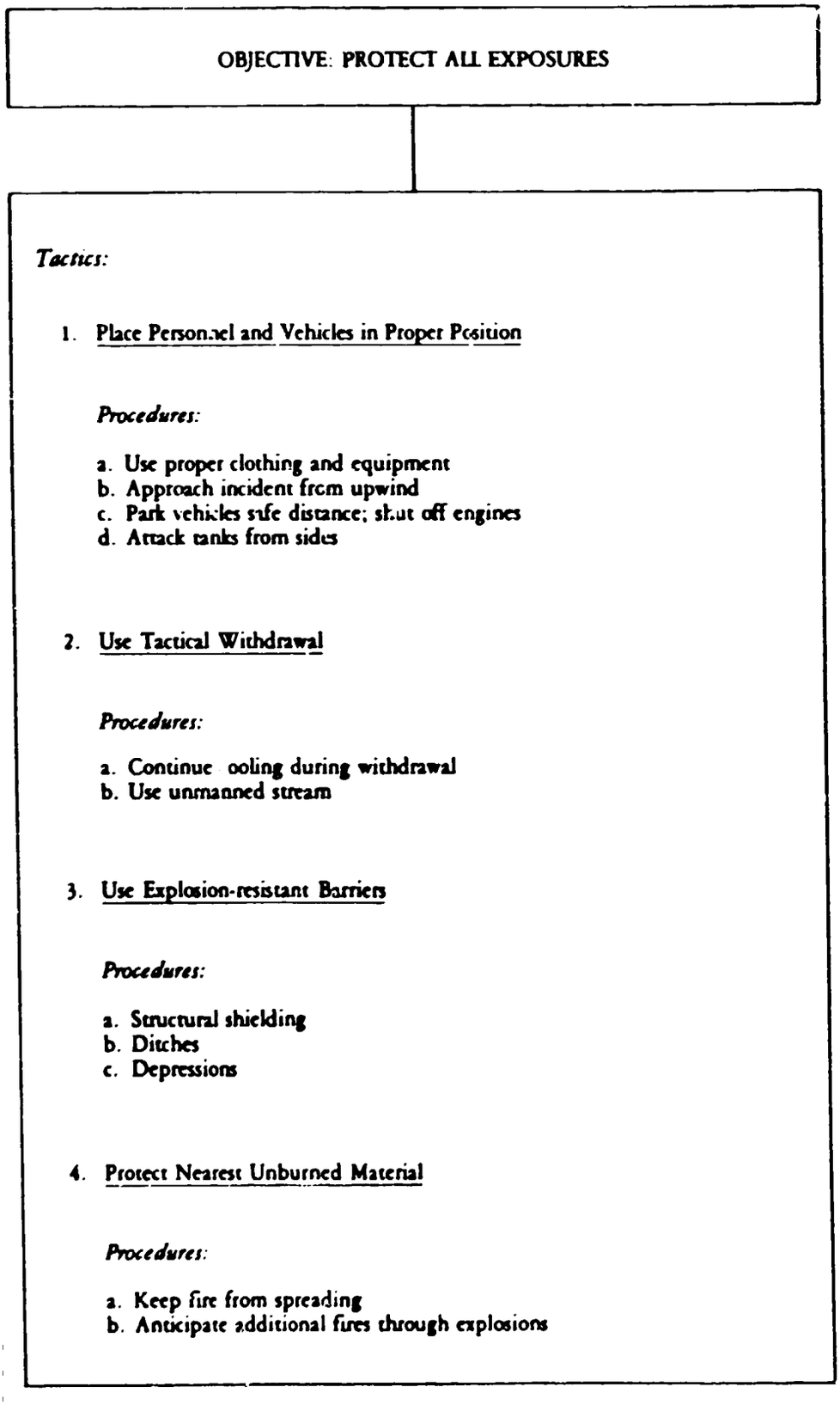
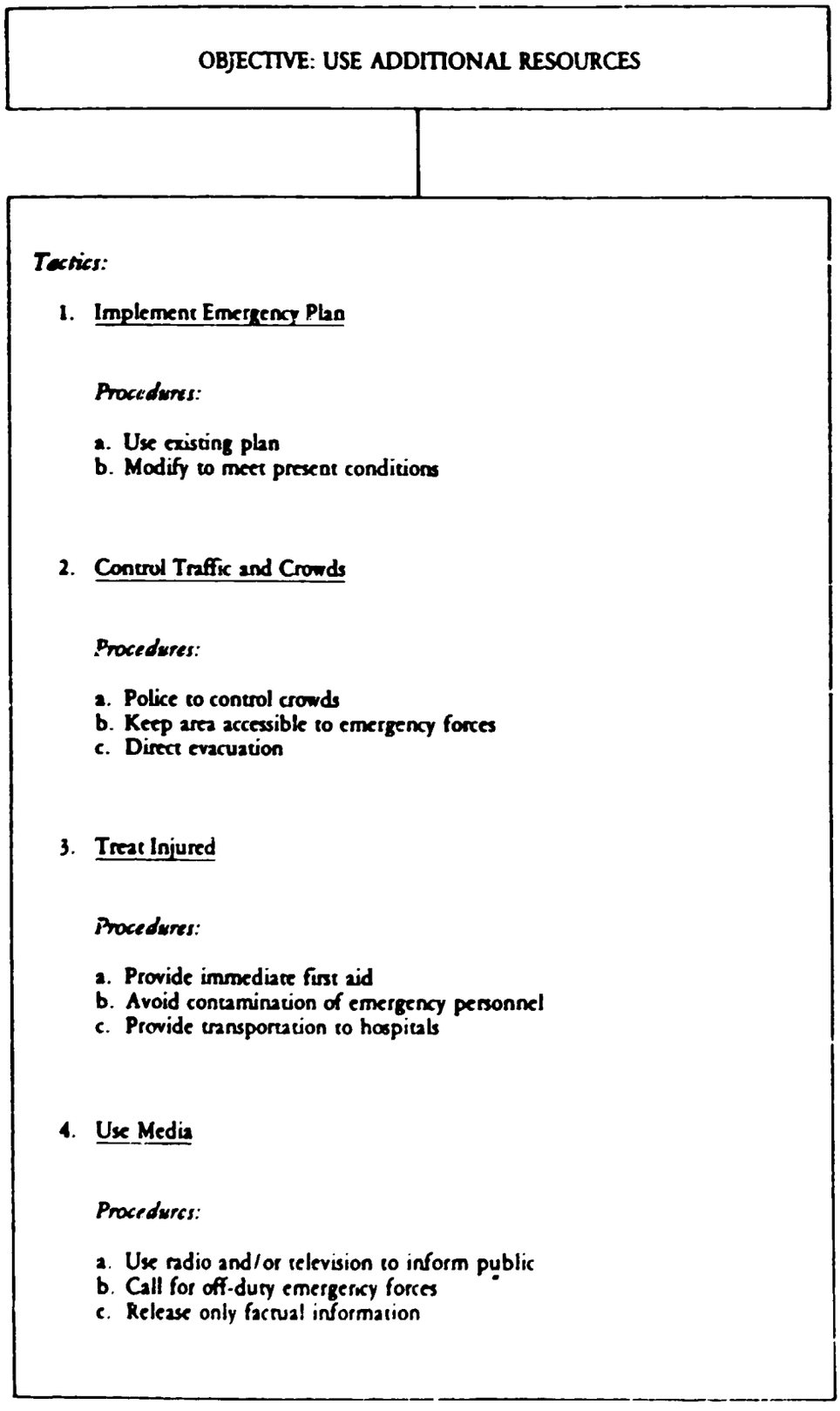


Figure XXI. Accident intervention



VI. SUMMING UP: RECOMMENDED STRUCTURES FOR INDUSTRIAL EMERGENCY CONTINGENCY PLANS

Once the appropriate type of plan has been chosen, the background material collected (such as hazardous material information, manufacturing process descriptions, resources available) and the preliminary work completed (such as hazard analysis), one can outline the kind of information the contingency plan should contain, and then proceed to write it down. In this chapter, a list of the major sections usually found in contingency plans is given, together with a brief description of the contents of those sections. Table 6 outlines the sections usually present in a typical contingency plan and indicates the types of plans to which each section is applicable. (A description of the different types of plans was given in chapter II.) It is not mandatory that all plans contain the sections indicated. The list has been developed to provide planners with a set of guidelines mapping out what can be included in different types of plans [6]. With reference to table 6, the detailed plan sections are now examined and described.

Table 6. Contents of different contingency plans

Sections	RL + TR	AG	RP	CP
Emergency response notification	1	1	1	1
Record of changes or amendments	1	1	1	1
Letter of promulgation	NA	NA	2	2
Glossary and abbreviations	1	NA	1	1
Table of contents	NA	NA	1	1
Introduction	NA	NA	1	1
Emergency response operations	NA	1	1	2
Emergency assistance telephone roster	1	NA	1	2
Legal authority and responsibility	NA	NA	2	1
Disaster assistance and co-ordination	NA	NA	1	1
Procedures for changing or updating plan	2	2	1	1
Plan distribution	2	2	1	1
Emergency handling techniques	NA	NA	1	2
Resources available	1	NA	1	2
Laboratory and consultant resources	1	NA	1	2
Technical library or bibliography	NA	NA	1	1
Hazards analysis	2	2	1	1
Documentation of industrial accidents	NA	NA	1	1
Hazardous materials information	NA	NA	1	2
Training exercises	NA	NA	1	1

Explanation of symbols:

RL + TR - Resources and equipment list and telephone roster
AG - Action guide, checklist
RP - Response plan
CP - Co ordination plan

1 Recommended
2 Optional
NA Not applicable

A. Emergency response notification (front page notification)

This section is designed to provide the plan user with a quick method to communicate the industrial emergency situation, its seriousness and other relevant information to the "action-response people" or others to be alerted in case of an emergency. The quickest method for notifying an emergency is the telephone, if available. In this case, the relevant phone numbers to be called should appear in this section. Alternatively, any other method of making the emergency known could be used and the relative instructions described in this section. In many industrial plants, an alarm is commonly used in case of an emergency. If this system is used, the way the alarm could be raised and the location of the alarm stations should be given in this section. The emergency response notification section should be:

(a) Brief (never more than one page in length);

(b) Easily accessible (located on the cover or first page of the plan. It should also be repeated at least once inside the plan, in case the cover is torn off);

(c) Simple (reporting information, emergency telepone numbers or other operating instructions should be kept to a minimum).

The following is an example of the type of information included in the emergency response notification section:

(a) 24-hour emergency response telephone number and/or method to raise the alarm;

(b) Emergency reporting information:

(i) Caller's name, telephone number, identification;

(ii) Location and source of accident;

(iii) Material involved and amount thereof;

(iv) Time of accident;

(v) Area and/or waterbody endangered;

(vi) Personnel at scene;

(vii) Actions initiated;

(viii) Shipper, manufacturer identification (applicable to transport accidents);

(ix) Container type (applicable to transport accidents);

(x) Railcar/truck identification numbers (applicable to transport accidents);

(xi) Placard/label information (applicable to transport accidents);

(c) Other agencies to notify immediately.

The contents of the initial accident report are critical. Incomplete or inaccurate information transmitted or communicated at the beginning of an

emergency can lead to improper response and delay which may produce additional hazards.

B. Records of amendments and changes

Maintaining an up-to-date version of a plan is of prime importance. When corrections, additions or changes are made, they should be recorded in simple bookkeeping style so that all plan users will be aware that they are using a current plan. The signature of the person making the change, the changes made, and the date should all be noted.

C. Letter of promulgation

This letter is a statement by the legal authority responsible for putting the plan into action. The letter is usually signed by the chief executive for the area the plan covers.

D. Glossary and abbreviations

The glossary section defines terms and abbreviations used in the plan.

E. Table of contents

Page references should be used to make sure key sections can be found quickly during emergencies. Critical tables and figures should also be listed.

F. Introduction

This section explains the purpose of the plan, its scope and the major assumptions made during the plan preparation.

G. Emergency response operations

Ten response actions can be categorized:

(a) Notification of emergency;

(b) Initiation of actions;

(c) Co-ordination of decision-making;

(d) Containment and countermeasures;

(e) Clean-up and disposal;

(f) Restoration;

(g) Recovery of damages;

(h) Follow-up;

(i) Special response operations;

(j) Agent-specific considerations.

Certain response actions may occur simultaneously. For example, during containment and countermeasures, one may be using clean-up and disposal techniques.

1. Notification of emergency

An industrial accident, inside or outside an industrial facility, may be discovered by a variety of persons such as carriers, plant workers, Government workers, or bystanders. It is necessary that these people have at their disposal a way of communicating the emergency to key plant personnel for accidents occurring in an industrial facility, or to the proper governmental agency for accidents occurring outside the plant or spreading beyond its boundaries. The methods of communicating the emergency should have already been described in the emergency response notification section. Therefore, this sub-section of the plan should:

(a) Repeat and reinforce any item listed in the response notification section;

(b) Offer any explanation, discussion or special comments on those items;

(c) Add any item that has not been included in the response notification sections such as:

(i) Type of aid required;

(ii) Person to contact on the scene;

(iii) Observed behaviour of fire and/or material involved in the accident;

(iv) Weather and local terrain conditions;

(v) Population of area;

(vi) Anticipated movement of spilled material or fire.

In some countries, it may be mandatory to report any spill of oil or designated hazardous material, or other types of severe industrial accident. In this case, the governmental agency to be contacted, its address and telephone number should appear in this sub-section of the plan.

2. Initiation of action

Before actually responding to an industrial accident, there are certain actions that must be taken to establish a firm base of operations. In this section, the following actions should be covered:

(a) Establish on-scene authority, i.e. who is in charge;

(b) Establish command post and communications network;

(c) Identify material (from labels, shipping papers, placarding etc.);

(d) Determine hazard threat (workers and public safety, environmental, property etc.);

(e) Warn plant workers and employees and/or public;

(f) Activate emergency response teams;

(g) Initiate evacuation procedure if necessary and feasible.

3. Co-ordination of decision-making

In any industrial emergency contained within the plant the internal structure of command will have to be decided in advance (see previous chapters) and described in this sub-section. In any other case (i.e. for a larger accident requiring external help), at least two or more agencies are likely to be involved (local police and fire departments). In even larger accidents, the number of agencies involved can grow to many more as municipal provincial or national resources are mobilized. In addition, materials, manpower and technical assistance may be requested from other industries. Consequently, one should work out in advance, and describe in this sub-section to the greatest extent possible, the following:

(a) First and foremost, who will be in charge;

(b) What will be the chain of command;

(c) Who will maintain the command post;

(d) When will the on-scene authority pass to another level and who will be the new official responsible;

(e) Who will have advisory roles;

(f) Who will have the technical say-so on response actions;

(g) How do the officials in charge of different tasks keep each other informed.

4. Containment and countermeasures

Actions taken during this phase are directed towards limiting the damage caused to life, environment and property by the industrial accident. Depending on the type of accident and its consequent hazards, several procedures may be employed. The following is a list of the most common actions to be taken in case of an emergency. This list is obviously not exhaustive and should be completed with whatever actions the planner estimates to be most appropriate:

(a) Evacuate workers and public from danger of explosion, poisoning or direct fire exposure;

(b) Fight fire (if any). Avoid hazard to firefighters. Let fire burn out, if prudent;

(c) Shut off or isolate sources of hazardous or flammable materials, whenever feasible;

(d) Try to predict spilled or escaped material movement (such as a toxic gas cloud subject to wind action), if applicable;

(e) Contain spilled materials;

(f) Contact manufacturer of hazardous material in case of transport accidents;

(g) Perform surveillance activities.

5. Clean-up and disposal

After the acute phase of the emergency is over, the clean-up and disposal of any hazardous materials that were released during the accident should follow. This phase is particularly relevant in transport accidents in which some of the technical aspects of the problem are interwoven with legal responsibilities. The actions to be considered in this sub-section include:

(a) Determine clean-up responsibility;

(b) Determine availability of approved disposal sites;

(c) List temporary storage sites.

6. Restoration

The purpose of this response phase is to restore the environment, to the extent practical, to natural conditions. The extent of damages should be assessed and guidelines established for replanting and restocking of species, as necessary.

7. Recovery of damages

This sub-section of the plan deals with the recovery of the losses due to the accident and costs of emergency actions. Hence, it should cover some or all of the following:

(a) Determination of liability (witness statements and photographs may be required);

(b) Extent of damages (short- and long-term monitoring may be required);

(c) Recommended reimbursement procedures;

(d) Legal means for resolving disputes.

8. Follow-up

This sub-section explains the use of post-accident monitoring data and other scientific reports for updating accident response procedures.

9. Special response operations

Safety of response personnel, wildlife clean-up and protection techniques, and special region-specific problems are documented in this section. The response personnel safety section should include a discussion of recommended safety equipment and personal hygiene activities.

10. Hazard-specific considerations

Guidelines for response to particular hazards, such as fire, oil and petroleum-related substances or hazardous chemicals, may be required. Fire department personnel are usually trained and equipped to fight conventional fires. In some industrial plants, the presence of chemicals may require that possible fires be fought with special techniques, which should be outlined in this sub-section. An example is provided by uncontained liquid fires being fed by a liquid not held in an open or closed vessel, such as a storage tank, bund

or deep depression. When the liquid fire is uncontained, it may spread very rapidly if the spilled liquid fuelling the fire continues to flow. In such a case, the first step is usually not to extinguish the fire, but to cut off the flow of liquid from the spilling tank. If such a fire is merely extinguished, without cutting off the flow of fuel, there is a serious risk that it will re ignite and cause a much larger fire or possibly an explosion. As Rinsinger wrote: "It is more important to know when not to put a fire out than to know the details of actual extinguishment" [52].

Oil and related petroleum products may have caught fire or simply spilled. Fire departments are generally prepared to cope with such fires. However, they may not be prepared to contain a spill properly. When hazardous chemicals are handled, guidelines are required to deal with spills and hazards (such as fire and toxic release of gases) [53].

H. Emergency assistance telephone roster

An accurate and up-to-date emergency telephone roster is an essential item of any response-type contingency plan. A comprehensive telephone roster should contain the numbers of all those individuals, personnel, agencies, industries and organizations to be contacted when an emergency occurs. All phone numbers should be verified by periodic calls to see that the numbers and the personnel are still current.

I. Legal authority and responsibility

In many cases, planned responses to certain emergencies may have been established as a result of laws, statutes, ordinances etc. These laws provide the legal background to do some or all of the following:

(a) Authorize preparation of a plan;

(b) Require accident notification;

(c) Determine liabilities;

(d) Impose penalties;

(e) Require clean-up;

(f) Define governmental responsibilities;

(g) Appropriate funds for clean-up.

This section gives the opportunity to explain what laws are in effect, who has the authority to enforce them, and what are the mandated responsibilities of Government.

J. Disaster assistance and co-ordination

This section should indicate where assistance can be obtained when the operating emergency response system becomes overburdened during an emergency. Pre-arrangements for assistance may be made with governmental agencies, bordering political provinces and large industrial firms. Provisions for interfacing with other contingency plans (e.g. natural disaster) may be made.

It is important to be familiar with the civil defense disaster plan, if any, covering the area in question. When industrial accidents or hazardous

material emergencies reach disaster magnitudes, or when a natural disaster threatens to complicate an already existing industrial emergency, industry officials or governmental authorities must know whom to contact to receive disaster assistance from the civil defense sector.

Any outside co-ordination should be formalized through mutual aid agreements or memoranda of understanding specifying delegation of authority, responsibility and duties. These agreements can be included in the plan if desired.

K. Procedures for changing or updating the plan

This section provides the mechanism for ensuring that plan contents are kept correct and up-to-date. Accurate plan information is necessary for swift and efficient emergency response actions. Responsibility should be delegated to someone to make sure that the plan is updated frequently and that all plan holders are informed of any changes made. Someone should periodically (at least every six months) check to see if stockpiled resources are available, as indicated in the plan. Notification of changes should be via some type of written memorandum or letter, and the changes should be recorded on the record of amendments section.

L. Plan distribution

The plan distribution list should cover all individuals, agencies, industries and organizations receiving copies of the plan. This information is essential when determining to whom revisions and updates of the plan should be sent. Also, it is important for each individual or group on the list to be aware of who has access and reference to the plan. This awareness will promote co-ordinated emergency readiness and response among the various organizations. When planning at plant level, it is advisable that a copy of the plan be distributed to the outside response groups (such as police or fire fighters) most likely to intervene in case of major emergencies.

M. Emergency handling techniques

This section should serve as a complement to some parts of section G concerning action to be taken during industrial emergency situations. It should contain some basic reference techniques for coping with the accidents most likely to occur in a particular industry or area. References [54, 55, 56, 57] could be used as sources of information concerning hazardous material spills, surface transportation accidents, fire protection and hazardous material, or spill clean-up technqiues.

N Resources available

This section should contain three important pieces of information:

(a) What types of resources are available in case of emergency;

(b) How much material and equipment is stockpiled;

(c) Where it is located (including the way it can be obtained if necessary, as well as relevant addresses and telephone numbers).

A comprehensive list of resource items would cover:

(a) Fire fighting equipment (both fixed and mobile);

(b) Hazardous material spill clean-up equipment;

(c) Communication equipment;

(d) Emergency transportation (land vehicles, boats, aircraft etc.);

(e) Response personnel;

(f) Personal protective equipment;

(g) Approved disposal sites for hazardous materials.

When preparing a plan at the plant level, it is advisable to list not only the resources available within the plant, but also those of the community (city or province, depending on the plant size) that could be made available in case of a major accident. Conversely, when planning at the municipal, provincial or national level, private resources should be included besides those of public agencies such as fire department, police, and civil defence. As resource availability will change with time, this section of the plan should be kept up-to-date.

O. Laboratory and consultant resources

The scientific community may be a valuable source of technical information during hazardous material spill emergencies. Technical experts can provide such services as advising on chemical toxicity, reactivity and environmental damage. Public and private laboratories may be equipped to perform chemical analyses for monitoring purposes or for identifying unknown spilled substances. This section should identify the various scientific facilities capable of providing technical support; the persons at these facilities to contact in an emergency; and the services available. Places to contact include colleges and universities, as well as both public and private industrial laboratories.

P. Technical library

Much information has been published on industrial emergencies, hazardous materials, hazardous material spills, and contingency planning. For an emergency response or planning organization, a technical library at a convenient location could serve as a reference source and an instructional tool. This section should simply list the technical references kept on hand. The references may be annotated to supply additional information about reference contents. The following are some of the types of material to be included:

(a) General references, such as pertinent laws, legislation, regulations and contingency plans operating in the area;

(b) Specific technical references;

(c) Maps, covering land use, topography, streams and drainage basins.

Q. Hazard analysis

This analysis consists of determining where hazards are likely to exist, what places would most likely be adversely affected, and what is the probability that an industrial accident could occur at a given location. (A method for conducting a hazards analysis was given in chapter II.) The

results of the analysis should be outlined in this section. When a numerical calculation of the risk has been carried out, the method adopted should also be described here.

R. Documentation of industrial accidents

Written reports are necessary to evaluate successfully an industrial accident as well as to lend support to possible cost reimbursement and legal action. A standard format should be established. The following is a list of the various types of reports that have been used to document industrial accidents:

(a) Initial accident report. This reports the initial specifics of an accident, such as type, time, location, materials involved, source of accident, health hazards, response teams involved, agencies contacted, and comments;

(b) Chronological log. This maintains a minute-by-minute account of accident-response activities, such as emergency response team activation and calls for help outside the plant;

(c) Final accident report. This summarizes the total event, including cause of accident, accident critique, damage assessment, expenditures, and liability conclusions.

(d) Investigative report. This is the foundation for civil action against the individuals or companies responsible for the accident. The report also includes who and what was involved in the accident; where, when, how and why the accident occurred; witness statements; photographs; and other relevant material.

S. Hazardous material information

This section should provide technical support information on the hazardous materials involved in the manufacturing process (for a plant contingency plan) or on the most common hazardous materials (for municipal, provincial or national plans). Information to be developed in this section includes the following [32, 42, 55]:

(a) Listing of hazardous materials;

(b) Technical information:

(i) Chemical properties;

(ii) Physical properties;

(iii) Measurement techniques;

(iv) Toxicological data;

(v) Response personnel safety data;

(vi) Recommended fire fighting techniques (if not already mentioned in previous sections);

(c) Shipping regulations (packaging, labelling, and placarding).

T. Training exercises

Training exercises are the most important tool in keeping a plan functionally up-to-date. These are simulated fire or hazardous material spill exercises where the emergency response personnel act out their duties and co-ordination interfaces are checked for proper match-up. The exercises may be realistic enough so that equipment is deployed, communication gear is tested, and "victims" are sent to hospitals with, for example, simulated toxic exposures. The purpose of such exercises may be threefold.

(a) To test the adequacy of the plan;

(b) To train personnel;

(c) To introduce new procedures, concepts, or equipment.

The contingency plan should delegate the authority for establishing training exercises, their frequency, and means of evaluating their effectiveness.

VII. CASE STUDIES: COUNTRY A*

A. Introduction

A field mission to Country A was carried out by UNIDO in the autumn of 1983. The purpose of the mission was to document the situation in the country concerning preparedness and capability of intervention at national, provincial, municipal and plant level in case of major industrial accidents. An assessment of the hazards present in some of the major industrial establishments in the country was carried out. Whenever possible, local responsible officials were advised on measures to take in order to prevent, control and fight industrial accidents, with particular reference to the preparation of contingency plans.

An officer attached to the United Nations Development Programme office in the capital established the initial contact between the UNIDO consultant and the local Government officials. The Government counterparts were officials of the Ministry of Planning and Economic Affairs. They proved to be of valuable help in contacting representatives of Government and industries.

The UNIDO consultant and a Government counterpart visited a number of ministries and industrial establishments in order to collect relevant data and information. An earlier UNIDO study, "Survey of marine pollutants from industrial sources in the West and Central African region" and the associated country survey of Country A were used as a general source of background information.

B. General information on Country A

1. Population and employment

The population was estimated to be 1.9 million in 1981, with a density of some 43.6 inhabitants per square mile. The projected population for 1985 is about 2.2 million. The employment structure is presented in table 7. The figures for 1985 were obtained by using an annual growth rate of 3.1 per cent.

2. Administrative organization

The country is divided into nine counties and six territories, each administered by a superintendent under the direction of the Ministry of Internal Affairs.

3. The industrial sector

The economy is still predominantly agrarian (see table 7). Monetary agriculture, which includes the agricultural concessions and plantations as well as forestry, accounts for some 9 per cent of total employment. The industrial sector, including both mining and manufacturing activities, employs only 4.2 per cent of the working force, but accounts for some 40 per cent of the gross domestic product (mining, 30 per cent; manufacturing, 10 per cent).

---

*These case studies (chapters VII and VIII) have been prepared from actual field studies carried out by UNIDO in developing countries. The names of the countries have been omitted in order to respect the confidentiality of certain economic planning information and investment data.

Table 7. Estimated employment structure distributed by major industry divisions as at 31 December 1980

Major industry division	Number employed	Distribution (per cent)
Agriculture and related activities a/	538 000	79.6
Mining and quarrying	17 500	2.6
Manufacturing	11 000	1.6
Electricity, gas and water	1 450	0.2
Construction	8 000	1.2
Wholesale/retail trade, restaurants and hotels	32 000	4.7
Transport, storage and communications	15 600	2.3
Finance, insurance and business services	1 650	0.2
Government services	32 000	4.7
Other services	18 800	2.8
All industries	676 000	100.0

a/ Including monetary agriculture.

About 95 per cent of the annual production value from mining activities comes from iron-ore production. The remaining 5 per cent is divided among gold, diamonds, barite and uranium mine exploitation. Current iron-ore production is of the order of 17 million tonnes/year.

The manufacturing sector includes some 850 registered manufacturing establishments, mainly concentrated in the area of the capital. They are all private, except for 24 joint ventures and 4 public. They are, in general, small-scale enterprises producing goods such as wearing apparel or furniture. Only about 60 enterprises are medium- or large scale, employing 20 to 400 people. Some 25 industries in this group manufacture chemical, plastic, petroleum and other non-metallic mineral products. They employ some 20 per cent of the labour force of the medium- and large-scale industry group. With few exceptions, only semi-processing or assembly plants exist in the country.

The total installed capacity for electric power generation is estimated at 355 MW, of which 68 are hydro-electric and the remaining thermo-electric. Some 45 per cent of the total capacity comes from power plants owned by the three major iron-ore companies. About one half of the total installed capacity is concentrated in the capital area and produced by a Government-owned enterprise. Due to age and attendant defects, the available capacity in the capital area is probably much less.

4. Development plans

Two four-year development plans have been elaborated by the Government. The first covers the period 1976-1980. The second covers the period 1981-1985. In spite of the world-wide recession in the steel industry, the three major mining companies plan to invest some $630 million in the expansion of rail and port capacities. More investments will be necessary if new deposits of iron ore in outlying regions (estimated reserves 530 million tonnes) are exploited. The

capital expenditure for new facilities and equipment is expected to be $296.4 million during the years 1983-1985. Additional funds are going to be infused in the rehabilitation of the national iron ore company which at present is not financially viable. A consortium of banks granted a $64.1 million loan in 1982.

Three programmes in the second plan are aimed at promoting and supporting industrial development, both in the public and private sectors. Their headings are: Industrial Park; Country A Industrial Free Zone; and the Small- and Medium-Scale Enterprises Department. The Industrial Park and the Free Zone are areas devoted to industrial development and are operated under the management of special institutions created by the Government. These areas should be provided with utilities and infrastructure facilities to accommodate industrial establishments. The Industrial Park has nine manufacturers. It is proposed to spend a further $3.1 million to improve and expand its infrastructure. An additional $3.8 million has been made available to improve and enlarge the Free Zone.

The Small- and Medium-Scale Enterprise Department assists the country's businessmen to establish and manage small- and medium-scale industries. Assistance is given in a package that includes financial, technical and managerial assistance. The three loan schemes which have already been arranged will provide a total of $6.6 million for this on-going project.

The projects proposed in the second plan to improve and expand the existing power-generating facilities will cost about $38 million, of which $27 million for on-going projects and $11 million for projects to be implemented during the period 1982-1985.

C. Contingency planning in Country A at the national, provincial and municipal levels

Interviews were conducted with officials of the following ministries and agencies.

(a) Ministry of Commerce, Industry and Transportation;

(b) Ministry of Finance;

(c) Ministry of Internal Affairs;

(d) Ministry of Justice;

(e) Ministry of Labour;

(f) Ministry of Land, Mines and Energy;

(g) Ministry of Planning and Economic Affairs;

(h) National Fire Service Bureau;

(i) National Investment Commission;

(j) National Port Authority;

(k) Country A Industrial Free Zone Authority.

At present, the capacity of the country to respond to a major industrial accident appers to be rather limited, in terms of resources and equipment, and response structure and organization. The country does not have a code of laws dealing specifically with the prevention and combatting of industrial accidents. A civil defence organization does not exist.

A National Disaster Relief Commission was created in 1976 to co-ordinate the actions of different ministries in case of national disaster. The Commission was never operational, however. A proposal for its re-establishment should be under preparation, but it is difficult to anticipate if and when it will be finally approved. Its implementation would also be an additional problem because of the lack of funds and resources to be used or mobilized during an emergency. In case of national disaster, the Head of State has the power to mobilize all the resources that he may deem necessary, including the army.

Country A does not have a uniform code of laws dealing with classification of industries according to risk to the population, which specifies criteria for plant safety and plant siting. The existing laws are only geared towards the prevention of accidents at the individual worker level (e.g. prescription of mechanical guards on moving or rotating machinery, or availability of first-aid kits). As for large industries, such as the mining companies, the Government has dealt so far on a one to-one basis, by approving concession acts which also contain plant safety and accident prevention measures based on international standards and subject to international arbitration in case of conflict.

An internal safety committee exists in each mining company. Its tasks consist of investigating injuries and accidents, examining plant and worker safety measures, and inspecting the plant. Even though no generalized laws on industrial plant siting and land use exist at present in Country A, some industrial parks have been created in the neighbourhood of the capital, such as those described in Section B. Most of the manufacturing industries of the country are located in these parks. The authorities in charge of the activities in two of these parks have set up a code of rules and regulations dealing with industrial safety. As an example, the National Port Authority has a general set of guidelines for dealing with dangerous goods such as calcium carbide or tetraethyl lead. As for the transport and handling of other dangerous goods, the Authority refers to United States maritime law. The industries operating within the industrial parks are not required to elaborate or keep any kind of contingency plans. As a safety precaution, both the Industrial Park and the Free Zone have at their disposal teams of internal fire fighters which can intervene in case of industrial accidents.

A national investment commission, created in 1979 with the broad mandate of co-ordinating investment policies in the country and promoting its development, is in charge of reviewing applications for any new, large investment in the industrial sector. New projects are examined mainly from an economic standpoint, but a technical committee within the commission also exists. The committee, which is formed by representatives of the commission and different interested ministries, can in principle give recommendations on safety aspects, even though only a very limited number of technical experts are members of the committee.

At present, no legislation exists in Country A concerning the establishment or implementation of national contingency plans for natural disasters or industrial accidents. The legislation on prevention of industrial accidents is also very limited. The Division of Standards of the Ministry of Commerce, Industry and Transportation has elaborated some standard codes for the storage

and transport of flammable goods such as gasoline. Other dangerous goods, such as toxic, corrosive or poisonous chemicals, are not mentioned. The implementation phase is assigned to the Fire Service Bureau and its inspectors.

Industries are not required to notify ministries or agencies of any accidents. Nevertheless, the Ministry of Labour publishes yearly statistics of industrial accidents, on the basis of the requests filed for workman compensations. Country A lacks contingency plans also at the provincial level. The county or territory superintendents, who depend on the Ministry of Internal Affairs, are not even required to prepare any intervention plan for natural disasters. The possible intervention groups in case of accidents would be the fire fighters (who are under the jurisdiction of the Ministry of Justice), the police, local units of the army and other relief organizations (such as the Red Cross).

The statutory duties of the fire fighters are fire prevention, fire fighting and rescue. The first task is accomplished by periodical inspections (usually once a year) of building and industrial facilities to check the availability of fire-fighting equipment, as established in the country's fire code. A fire certificate should be issued by the fire department before the start of operations at any new industrial establishment. In practice, enforcement of the fire code is rather difficult, because of the lack of resources, in terms of both personnel and equipment.

This problem also seriously affects fire-fighting and intervention capability in case of accidents. Four counties out of nine have virtually no fire protection. Only two fire stations, with a total of 75 men, exist in the capital (where the large majority of manufacturing industries are located). They are equipped with just one fire engine, which is frequently out of action because of lack of spare parts. Most of the hydrants in the capital area are not operational. In most circumstances, only the limited amount of water carried by the fire engine could be used to put out a fire. Communication problems are also extremely serious, thus rendering difficult the quick raising of the alarm. Some areas in the neighbourhood of the capital could not be quickly reached because of bad road conditions. The capacity for intervention in accidents other than fire (e.g. toxic release or spills) is non-existent.

This negative situation could be partially rectified if new equipment and material were available. Negotiations are already under way to purchase some $1.5 million worth of new fire fighting equipment. Given the situation, some of the major industries in the capital area have organized their own fire-fighting teams and intervention schemes. In general, the co-ordination between these and the municipal fire fighting team is rather limited. In some instances, however, industry fire-fighting teams have co-operated with the municipal team in putting out fires.

No list of industries is kept, and no preplanning for major accidents at local industrial facilities is carried out by the municipal fire fighters. They are not aware of the industry intervention plans, when these exist. However, a record of all fires and interventions is kept by the municipal fire department.

D. Contingency planning in Country A: the plant level

Many local industries were visited and the officials in charge were interviewed. The interviews were conducted using the questionnaire prepared and shown in table 8. The most relevant information obtained is reported in table 9. Comparatively speaking, the larger facilities visited tended to be

better equipped and organized than the smaller ones. This improved capability is due to:

(a) Use of international safety standards derived from past experiences in industrialized countries;

(b) Larger negative impact on people, property and environment in case of accident;

(c) Better design of plant layout;

(d) Plant location in industrial parks or away from populated areas;

(e) Use of more qualified manpower and management;

(f) Better worker training;

(g) Higher public "visibility".

Table 8. Questionnaire used during visits to industrial facilities

1.	Date of establishment, number of employees and shifts.
2.	Raw materials, final and intermediate products (including plant capacity).
3.	Manufacturing process, machinery and process units.
4.	Amount of raw materials and final products usually in storage. Type of storage.
5.	Safety devices on storage and process units (e.g. safety valves, bunds, flame arresters).
6.	Basic layout of plant (is storage separated from process?).
7.	Fire proofing.
8.	Alarm and fire detection systems.
9.	Fixed and mobile fire-fighting equipment.
10.	Contingency plans and safety audits.
11.	Command and responsibilities in case of accident.
12.	Internal fire fighter department and/or emergency squad.
13.	Arrangements and connections with external fire department.
14.	Training and evacuation exercises.
15.	Access to the facilities from the outside.
16.	Transportation of raw materials and finished pr to and from the plant.
17.	Labelling and placarding of dangerous goods.
18.	Past accidents and consequences.
19.	Major accidents that could occur.

Table 9. Overview of major industries in Country A and their emergency preparedness

Company	Products and annual production	Raw materials	Amounts of raw materials and products in storage	Number of employees	Intervention squad	Training exercises	Fire-fighting equipment: Water hoses	Fire-fighting equipment: Foam monitor	Fire-fighting equipment: Dry powder extinguishers	Fire-fighting equipment: CO_2 or other type	Contingency plan
Produce marketing company	Coffee (10,000 t), Cocoa (5,200 t) Palm kernel oil (1764 t)	Same	Seasonal	1 100	No*	No*	No*	No*	Yes	Yes	No
Industrial Park	-	-	-	N.A.	Yes 2 fire engines	Yes	Yes 167 000 gallons reservoir	Yes	Yes	Yes	Yes (not written)
Industrial free zone	-	-	-	-	Yes 1 fire engine 6 men	Yes	Yes	Yes	Yes	Yes	No
Oxygen corporation	Oxygen	Air	1 month stock	22	Yes workers	No	Yes	No	Yes	Yes	Yes (not written)
Soap corporation	Soap (900 t)	NaOH Fatty acids	3 month stock	101	No	No	Yes	No	Yes	Yes	No

continued

Table 9 (continued)

Company	Products and annual production	Raw materials	Amounts of raw materials and products in storage	Number of employees	Intervention squad	Training exercises	Fire-fighting equipment: Water hoses	Fire-fighting equipment: Foam monitor	Fire-fighting equipment: Dry powder extinguishers	Fire-fighting equipment: CO_2 or other type	Contingency plan
Acetylene corporation	Acetylene	Calcium carbide	3 month stock	N.A.	No	No	Yes	No	Yes	Yes	Yes (not written)
Mattress corporation	Mattresses (11,000)	TDI, Freon Polyols	1 month stock 500 mattr.	32	No	No	Yes	No	No	Yes	No
Battery manufacturing company	Batteries (21,000)	Sulphuric acid, lead oxide, lead	30 t 28 t 10 t	26	No	No	No	No	No	Yes	No
Petroleum refining company	Distillation products (4.5 mill bbl)	Crude oil	600,000 bbl Gasoline: 65,000 bbl Kerosene: 43,000 bbl Fuel oil: 200,000 bbl Gas oil: 131,000 bbl LPG: 1,000 bbl	480	Yes 1 fire engine 10 men	Yes (weekly)	Yes	Yes	Yes	Yes	Yes (written)

continued

Table 9 (continued)

Company	Products and annual production	Raw materials	Amounts of raw materials and products in storage	Number of employees	Intervention squad	Training exercises	Fire-fighting equipment: Water hoses	Fire-fighting equipment: Foam monitor	Fire-fighting equipment: Dry powder extinguishers	Fire-fighting equipment: CO_2 or other type	Contingency plan
Plastics company	Plastic items (300 tons)	Polyethylene, polypropylene, PVC	10 tons total	30	No	No	Yes	No	No	No	Yes
Matches company	Matches 100,000 boxes/day (50 m/box)	Potassium clorate, antimony sulphide, red phosphorus, sand, glue, water	3 month stock; 2 million boxes	53	Yes 6 men	Yes (monthly)	Yes	No	Yes	Yes	No
Footwear industry	Rubber shoes, sport shoes 7,000 pairs/day	Shoe uppers, soles, glue	N.A.	50	No	No	No	No	No	Yes	No
Tobacco company	Cigarettes 60,000/day	Tobacco Paper Glue	3 month stock	39	No	No	No	No	Yes	Yes	No
Breweries	Beer (180,000 hl) Soft drinks (700,000 hl)	Hop Malt Barley Yeast	3 month stock	300	No	No	Yes 100,000 gal. reservoir	Yes	Yes	Yes	No

continued

Table 9 (continued)

Company	Products and annual production	Raw materials	Amounts of raw materials and products in storage	Number of employees	Intervention squad	Training exercises	Fire-fighting equipment: Water hoses	Fire-fighting equipment: Foam monitor	Fire-fighting equipment: Dry powder extinguishers	Fire-fighting equipment: CO_2 or other type	Contingency plan
Petrochemical industries	Storage of lubricants, oil, gasoline, propane	-	2,000 drums	45	No*	No*	No*	No*	Yes*	No*	No*
Paint industries	Paint and lacquers (280,000 gal)	Pigments Solvents	3 month stock	112	No	No	Yes	No	Yes	Yes	No
Explosives and chemicals company	TNT, shotgun shells 3,600 t explosives	TNT Smokeless and black powder Ammonium nitrate	150,000 t total	113	Yes	Yes (monthly)	Yes	Yes	Yes	Yes	Yes (written)
Plantation company	Rubber (140,000 t)	Rubber Ammonia	N.A.	10,000	Yes 5 fire engines 40 men	Yes	Yes	Yes	Yes	Yes	Yes
Cement company	Cement (72,000 t)	Clinkers, Gypsum	26,000 t total	125	No	No	Yes	No	Yes	Yes	No
Oil company	Gasoline Diesel oil Kerosene storage	Same	210,000 bbl	25	Yes	No	Yes	No	Yes	Yes	Yes

*Plants are located in a zone which possesses its own fire department.

N.A. = Not available.

Of the three major industrial hazards, i.e. fire, explosion, and toxic release, the first one appears to be, by far, the most serious. All the industries visited had some kind of fire-fighting equipment, even though only a few had some kind of intervention scheme and even fewer had it in a written form. However, one good contingency plan was obtained from a local industry. This is discussed in Section E, below, and reproduced in full in the appendix to this chapter (appendix VII.A). Larger industries were the only ones to have an intervention squad or even an internal full-time fire-fighting team. When existing, these teams were relatively well equipped and trained. Three industries had very well equipped teams prepared to combat accidents. Intervention squads, where they existed, generally held training exercises regularly.

Because of the lack of governmental standards on safety, most larger industries used their own standards, including those concerning fire fighting. Smaller industries relied on guidelines and inspections of local fire fighters and insurance companies. Because of the higher risk generally involved, insurance companies charged premiums 50 to 100 per cent higher than those they would charge an equivalent company in an industrialized country. In some instances, obsolete industrial equipment was being used which did not contain the built-in safety devices that would be considered standard on modern equipment.

So far, Country A has been spared large industrial disasters, with the exception of one industry-related accident - a landslide of iron-ore waste onto a village, which caused many casualties. The most common industrial accidents are due to machine or vehicle operation. Because of the small size of the industries and their siting, it seems rather unlikely that an accident of large proportion would affect the population. The only exceptions could be transport accidents in an urban area and accidents in small industries located in built-up areas.

E. Example of a contingency plan in Country A

A good example of an industrial contingency plan was obtained from an explosives and chemicals plant, a subsidiary of an international explosives manufacturing company. The plan, reproduced in appendix VII.A, is concise and simple enough to be adapted to the different circumstances in which an accident may occur. It contains all the main elements of a contingency plan as described in chapter VI.

The plan is organized in sections. Section 1 contains the introduction, the purpose of the plan and the results of the hazard analysis, indicating what type of accidents can be expected. Section 2 contains a glossary of terms and the command structure in case of accident. This structure is the same as during normal operation so as to avoid confusion during an emergency.

Section 3 indicates the actions to be taken in case an accident occurs. Several possibilities are considered as a result of the hazard analysis. The emergency actions and responsibilities assigned to every employee of the plant are specified.

Section 4 contains a telephone roster and the radio channels to be used to contact external response teams. This list also includes emergency phone numbers to obtain resources from another nearby company; the phone number of a legal office for consultation on legal aspects of an accident; and the number of a public relations firm.

Section 5 deals with training exercises and with procedures to review and update the manual. During the interview with the consultant, the general manager of the plant confirmed that these exercises were held according to the schedule fixed in the contingency plan.

The layout of the plant is shown schematically in the appendix, following the text of the contingency plan. The layout shows the location of the fire fighting equipment, the assembly area, the control centre in case of accident, the emergency communication equipment and the accesses to the plant, usually guarded by security guards. During the visit to the plant, security measures were in effect at all times and only clearly identified and authorized personnel had access to the plant.

F. Planning for transport accidents in Country A

There is no special legislation on the subject, except for the transport of petroleum products. The requirements for the use of a gasoline tank truck are specified. The international systems which are used to label hazardous materials are only occasionally known (through properly labelled packages imported from more industrialized countries) and very seldom used. A notable exception is the local explosives factory. Explosives are usually roved at night, by ship or by trucks, using routes through non-populated areas. Most dangerous goods can circulate freely, unlabelled, through densely populated areas. In some instances, the location of the industry and the availability of just one route do not leave any other alternative.

G. Conclusions and recommendations

Country A does not possess effective structures, organization or resources to fight major industrial accidents. Exceptions exist in the case of certain industrial plants, but the resources available would probably not be sufficient to cope with an industrial disaster spreading outside the plant boundaries.

An informal co-ordination plan exists among most of the local industries. In case of a major accident in one plant, the emergency teams of the neighbouring facilities would most likely intervene, as they have already done in the past, during fires in the capital area.

The larger industries in the country appear to be, in general, relatively well equipped and organized to combat industrial accidents. The threat such accidents pose to the population is small because of the small number of large firms. Furthermore, the firms are located in sparsely populated areas or industrial parks, and the probability that a major accident will spread beyond a plant boundary is minor.

The medium- and small-scale industries are more numerous and, generally speaking, much less prepared to cope with industrial accidents. In addition, some of these industries are located in relatively highly populated areas. Therefore, the vulnerability of the population to accidents occurring in these industries is much larger than from larger industries. Overall, the level of industrialization of the country is very modest. The risk of exposure of the population to industrial accidents is, in absolute terms, still very small.

Because of the ongoing process of urbanization in the capital area, the population is most likely to increase. This is true also of areas near industrial plants. This, when combined with the expansion of the local industry, could create new hazards and increase the vulnerability of the population to industrial accidents.

It is recommended that the Government take measures to limit this occurrence by preparing zoning regulations specifying the areas to be assigned to industrial and human settlements.

Fire appears to be the most common industrial hazard, particularly in small industries with limited intervention capability and organization. Therefore, it is especially vital that the local fire departments be brought to an acceptable level of intervention capability by providing them with the necessary equipment, manpower and training. The plan for buying new fire-fighting equipment should be implemented in stages, starting immediately.

In order to document more thoroughly the existing situation, the Government should make a census of existing industries and classify them according to the risk they represent for the population. Then, the local response teams could start to develop intervention plans together with the local industries.

At present, transport accidents involving dangerous materials represent a major industry-related hazard to the population. The risk associated with the transport of hazardous materials in urban areas is likely to become even greater as a result of the higher population and traffic congestion in certain urban areas, and the increasing number and volume of hazardous materials transported. Therefore, transport regulations need to be adopted and enforced. A well equipped and trained fire department is again the most important response team.

It is recommended that the Government include the institution of a national contingency plan as a part of the next four-year plan (beginning in 1986). The guidelines discussed in the present study could be used for this purpose. The development of the national contingency plan should also be based on the conclusions and recommendations of this study. A good plan, combined with an expanded intervention capability of the fire fighters, should reduce the number and consequences of major industrial accidents and minimize damage from those which occur, thereby protecting the population.

Appendix VII. A

OPERATIONAL INDUSTRIAL CONTINGENCY PLAN FOR AN EXPLOSIVES AND CHEMICALS PLANT IN COUNTRY A

Section 1

Introduction

The objective of the emergency plan is to set up a sequence of actions designed to have the following effect:

1. Reduce or eliminate injury and loss of life.

2. Reduce or eliminate material damage.

3. Reduce lost production to a minimum.

4. Reduce external effects to a minimum.

An emergency is something which cannot be clearly predicted as to time, scope or location. To deal with an emergency, direction by a knowledgeable, responsible person is required. This person, described in this plan as the warden, must make full use of available resources with the four objectives listed above in mind.

The major aim of the procedures given in the plan is to provide the co-ordinator with these resources in such a way that they can be deployed quickly with a minimum amount of direction and maximum effectiveness.

There are three possible situations which require implementation of emergency procedures at the explosives and chemicals plant:

1. Fire which cannot be controlled or isolated to a small area, or which threatens magazines or ammonium nitrate.

2. Major accident. In the case of the particular plant, the most likely source will be a plane crash within the lease area.

3. Explosion. Although normally a result of either (1) or (2) above, emergency procedures must take into account an unforwarned detonation.

In an emergency situation, people react better when they understand what they are to do and what is expected of each and every one. This booklet is for your SAFETY; you are asked to thoroughly read it and keep it nandy at all times.

Section 2

Definitions

On-site-warden

The senior person at the plant, among the ones listed under Organization, to take charge of the Emergency Procedures.

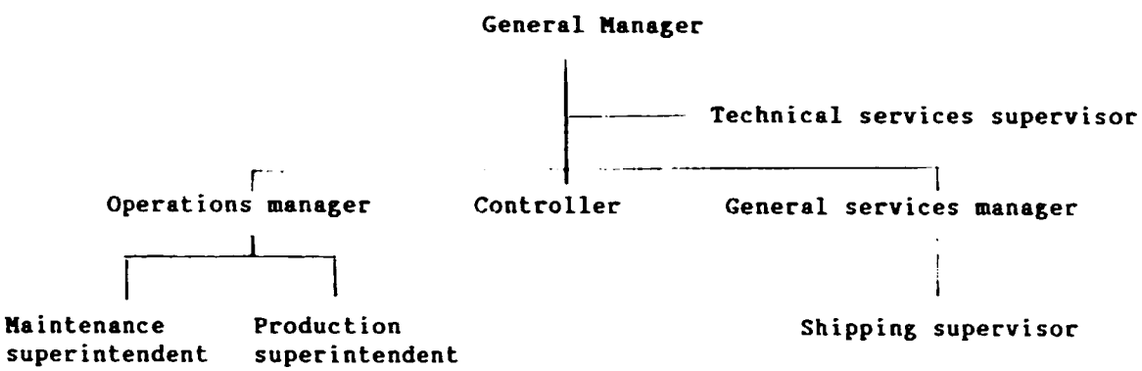
External warden

The senior person at the Farm (C-1 Compound) a/ who is available to take charge of co-ordination with outside agencies.

Observer

Any person who observes an incident which he thinks should be classified as a fire, explosion or accident.

Organization



Section 3

This section of the plan has been tabulated in such a way that individual members of the supervisory staff will refer to only one sheet in order to perform the actions necessary to get the emergency procedures rolling.

The observer, who may be any employee and may not be literate, has only simple actions to make; these can be explained to all employees in group sessions.

The wardens will require a complete knowledge of the plan in order to make full use of the facilities at their disposal.

---

a/ A nearby small farm where the external warden is lodged.

PAGE 1. OBSERVER

Fire	Accident	Explosion
1. Call guard house (tel. 24) or use VHF radio Have main gate security guard repeat message	Call guard house (tel. 24) or use VHF radio Have main gate security guard repeat message	Call guard house (tel. 24) or use VHF radio Have main gate security guard repeat message
2. Not explosives (a) Remove any explosives to a safe place (b) Fight fire	Help any injured person	Help any injured person
3. If there are burning explosives go quickly to guard house or nearest gate	Stand by to help supervision	Go to guard house or to nearest gate

PAGE 2. MAIN GATE GUARD AND SECURITY SERGEANT

Fire	Accident	Explosion
1. Repeat message to observer to check accuracy. Write down his name, where he is, and time.	Repeat message to observer to check accuracy. Write down his name, where he is, and time.	Repeat message to observer to check accuracy. Write down his name, where he is, and time.
2. (a) Call duty supervisor (see board) (b) Call production superintendent (tel. 28 or 23) (c) Call operation manager (tel. 12) Repeat message each time.	(a) Call duty supervisor (see board) (b) Call production superintendent (tel. 28 or 23) (c) Call operation manager (tel. 12) Repeat message each time.	(a) Call duty supervisor (see board) (b) Call production superintendent (tel. 28 or 23) (c) Call operation manager (tel. 12) Repeat message each time.
3. Announce "EMERGENCY" 3 times on radio CH 2 HOLD ON CH 2.	Announce "EMERGENCY" 3 times on radio CH 2 HOLD ON CH 2.	Announce "EMERGENCY" 3 times on radio CH 2 HOLD ON CH 2.
4. Sound stand-by alarm 1 minute continued blast on the siren.	On instructions from duty supervisor or warden, sound stand-by alarm.	On instructions from supervisor or warden, sound stand-by alarm.
5. Let only plant personnel into plant. Check out visitors.	Let only plant personnel into plant. Check out visitors.	Let only plant personnel into plant. Check out visitors.
6. Follow radio instructions from warden.	Follow radio instructions from warden.	Follow radio instructions from warden.

PAGE 3. SECURITY CHIEF

Fire	Accident	Explosion
1. Locate personnel as follows:	Locate personnel as follows:	Locate personnel as follows:
(a) Day shift	(a) Day shift	(a) Day shift
(i) Sergeant at control centre.	(i) Sergeant at control centre.	(i) Sergeant at control centre.
(ii) Gatemen: check out visitors; let in only personnel authorized by warden.	(ii) Gatemen: check out visitors; let in only personnel authorized by warden.	(ii) Gatemen: check out visitors; let in only personnel authorized by warden.
(iii) Security driver: pick at least 4 more off-duty security guards.	(iii) Security driver: pick at least 10 more off-duty security guards.	(iii) Security driver: pick at least 10 more off-duty security guards.
(iv) Lieutenant: assist fire chief.	(iv) Lieutenant: go carefully to scene with a portable radio; report facts.	(iv) Lieutenant will stand-by near control centre.
(b) Off-shift	(b) Off-shift	(b) Off-shift
(i) Sergeant: open outer gate (2); close inner gate (1). Stand-by at guard-house radio; pro-hibit entro to all except plant staff.	(i) Sergeant: open outer gate (2); close inner gate (1). Stand-by at guard-house radio; pro-hibit entry to all except plant staff.	(i) Sergeant: open outer gate (2); close inner gate (1). Stand-by at guard house radio; pro-hibit entry to all except plant staff.
(ii) Gateman: go quickly to scene of fire; fight it will all available security guards.	(ii) Gateman: go to scene of accident with portable radio, report facts.	(ii) Guards: withdraw to fence gates (3), (4).
When additional help arrives, go with 2 men to pole gate at end of plant access road and regulate access of traffic to plant area.	When additional help arrives, go with 2 men to pole gate at end of plant access road and regulate access of traffic to plant area.	When additional help arrives, go with 2 men to pole gate at end of plant access road and regulate access of traffic to plant area.

PAGE 4. FIRE CAPTAIN

Fire	Accident	Explosion
1. Assemble fire crew.	Assemble fire crew.	Assemble fire crew.
2. (a) Fire in areas accessible to hoses:	(a) Fire in areas accessible to hoses:	(a) Fire in areas accessible to hoses:
(i) Uncoil hoses from hydrant houses.	(i) Uncoil hoses from hydrant houses.	(i) Uncoil hoses from hydrant houses.
(ii) Start fire pumps.	(ii) Start fire pumps.	(ii) Start fire pumps.
(b) Fire in other areas:	(b) Fire in other areas:	(b) Fire in other areas:
(i) Put all spare extinguishers on a truck.	(i) Put all spare extinguishers on a truck.	(i) Put all spare extinguishers on a truck.
(ii) Take truck, front end loader, grader to scene of fire.	(ii) Stand-by for instructions from warden.	(ii) Stand-by for instructions from warden.
(iii) Go by car with radio to take charge of fire fighting. Switch radio to CH 2.		

PAGE 5. DUTY SUPERVISOR

Fire	Accident	Explosion
1. Call for radio silence on both channels by all except supervision.	Call for radio silence on both channels by all except supervision.	Call for radio silence on both channels by all except supervision.
2. Check that security contacts production superintendent and operations manager.	Check that security contacts production superintendent and operations manager.	Check that security contacts production superintendent and operations manager.
3. Contact maintenance supervisor and superintendent, or the electrician.	Contact maintenance supervisor and superintendent, or the electrician.	Contact maintenance supervisor and superintendent, or the electrician.
4. Contact (a) fire chief, (b) production, transport, security and magazine supervisors to have them initiate emergency procedures.	Contact (a) fire chief, (b) production, transport, security and magazine supervisors to have them initiate emergency procedures.	Contact (a) fire chief, (b) production. transport, security and magazine supervisors to have them initiate emergency procedures.
5. Go to scene of fire with a portable radio tuned to CH 2.	Stand by at control centre.	Stand by at control centre.
6. Off-shift send for auxiliary fire crew.	Send to plant road junction for drivers and help.	Send to plant road junction for drivers and help.

PAGE 6. PRODUCTION SUPERINTENDENT

Fire	Accident	Explosion
1. Take over as on-site warden until the arrival of operations manager.	Take over as on-site warden until the arrival of operations manager.	Take over as on-site warden until the arrival of operations manager.
2. Check that requirements listed in all sections are being carried out. Nominate deputies as required.	Check that requirements listed in all sections are being carried out. Nominate deputies as required.	Check that requirements listed in all sections are being carried out. Nominate deputies as required.
3. Assist warden and oversee recruitment and allocation of personnel.	Assist warden and oversee recruitment and allocation of personnel.	Proceed to safe viewpoint with car or with portable radio and report on nature and size of explosion.
4. Evacuation: Co-ordinate check out of personnel and their removal to a safe location.	Evacuation: Co-ordinate check out of personnel and their removal to a safe location.	Evacuation: Co-ordinate check out of personnel and their removal to a safe location.

PAGE 7. PRODUCTION SUPERVISOR AND MAGAZINE SUPERVISOR

Fire	Accident	Explosion
1. Remove all HE a/ including TNT b/ to nearest safe magazine or to P1 c/ sample room. Lock up.	Remove all HE including TNT to nearest safe magazine or to P1 sample room. Lock up.	Remove all HE including TNT to nearest safe magazine or to P1 sample room. Lock up.
2. Dump P1 mixer batches, whatever stage, into packer tanks. Leave packaged slurry inside building.	Dump P1 mixer batches, whatever stage, into packer tanks. Leave packaged slurry inside building.	Dump P1 mixer batches, whatever stage, into packer tanks. Leave packaged slurry inside building.
3. Park any slurry or ANFO d/ in transit at nearest safe barricaded magazine or any building on side away from fire and plant.	Park any slurry or ANFO in transit at nearest safe barricaded magazine or any building on side away from fire and plant.	Park any slurry or ANFO in transit at nearest safe barricaded magazine or any building on side away from fire and plant.
4. Send work leaders (a) to control point or (b) to nearest safe exit gate if control point is not accessible. Work leaders will regulate and record exit of personnel from the plant.	Send work leaders (a) to control point or (b) to nearest safe exit gate if control point is not accessible. Work leaders will regulate and record exit of personnel from the plant.	Send work leaders (a) to control point or (b) to nearest safe exit gate if control point is not accessible. Work leaders will regulate and record exit of personnel from the plant.
5. Provide any personnel needed to assist the fire crew.	Provide any personnel needed to assist the fire crew.	Provide any personnel needed to assist the fire crew.
6. Line up orderly departure to control centre or, if the evacuation siren is sounded, to nearest exit gate.	Line up orderly departure to control centre or, if the evacuation siren is sounded, to nearest exit gate.	Line up orderly departure to control centre or, if the evacuation siren is sounded, to nearest exit gate.
7. Off-shift: call in work leaders, 6 men from Charlesville and road junction.	Off-shift: call in work leaders, 6 men from Charlesville and road junction.	Off-shift: call in work leaders, 6 men from Charlesville and road junction.

a/ HE - High explosive
b/ TNT - Trinitrotoluene, a high explosive
c/ P1 - Identification code for one of the operation buildings
d/ ANFO - Trade name for nitrocarbonitrate, a commercial blasting agent

PAGE 8. MAINTENANCE SUPERINTENDENT/SUPERVISORS/ELECTRICIAN

Fire	Accident	Explosion
1. Check that power to fire pump is on. Get plumber on stand-by.	Have electrician stand-by to isolate areas specified by fire chief or warden.	Check that power to fire pump is on. Get plumber on stand-by.
2. Have electrician stand-by to isolate areas specified by fire chief or warden.	Start engines on grader, front end loader, buses, two trucks and pickup. Provide drivers for graders and pickup.	Have electrician stand-by to isolate areas specified by fire chief or warden.
3. Start engines on grader, front end loader, buses, two trucks and pickup. Provide drivers for graders and pickup.	Start stand-by generator. Have men ready to connect it to main transmitter.	Start engines on grader, front end loader, buses, two trucks and pickup. Provide drivers for graders and pickup.
4. Start stand-by generator. Have men ready to connect it to main transmitter.	Load oxyacetylene equipment on pickup.	Start stand-by generator. Have men ready to connect it to main transmitter.
5. Have mechanic with tools on stand-by near control point.	Have mechanic with tools on stand-by near control point.	Have mechanic with tools on stand-by near control point.
6. Off-shift: bring electrician, mechanic, drivers, plumber, grader operator.	Off-shift: bring electrician, mechanic, drivers, plumber, grader operator.	Off-shift: bring electrician, mechanic, drivers, plumber, grader operator.

PAGE 9. TRANSPORTATION SUPERVISOR

Fire	Accident	Explosion
1. Have drivers take buses, two trucks and pickup to be parked in orderly fashion outside gate No. 1.	Have drivers take buses, two trucks and pickup to be parked in orderly fashion outside gate No. 1.	Have drivers take buses, two trucks and pickup to be parked in orderly fashion outside gate No. 1.
2. Have two more drivers stand-by near control site.	Have two more drivers stand-by near control site.	Have two more drivers stand-by near control site.

PAGE 10. OPERATIONS MANAGER/ON-SITE WARDEN

Fire	Accident	Explosion
1. Take over as warden on arrival at control point.	Take over as warden on arrival at control point.	Take over as warden on arrival at control point.
2. Check that requirements listed in all sections are being carried out.	Check that requirements listed in all sections are being carried out.	Check that requirements listed in all sections are being carried out and determine whether it is safe to approach the scene of explosion.
3. Obtain feed-back on CH 2 radio from duty supervisor or fire chief.	Obtain feed-back from security man at the scene.	Obtain feed-back from production superintendent.
4. Contact external warden relating nature of incident and help required.	Contact external warden relating nature of incident and help required.	Contact external warden relating nature of incident and help required.
5. Arrange for additional help as required.	Arrange for additional help as required.	Arrange for additional help as required.
6. Arrange for one person to record proceedings.	Arrange for one person to record proceedings.	Arrange for one person to record proceedings.
7.	Notify hospital as to type of injuries.	
8.	Record names of persons sent to hospital.	

PAGE 11. EXTERNAL WARDEN

All emergencies

Set up control point at house of General Manager. Have one portable radio and the car with four-channel radio available.

Call personnel on the outside contact list requesting EMERGENCY stand-by.

On request from the on-site warden, give specific requirements and timing to the outside contacts.

Arrange to record a sequence of events, action taken and timing.

Provide feedback on the progress of help to the on-site warden.

Prepare statements and data for press and Government agencies. The General Manager or his assistant is the only one authorized to deal with the press and public agencies.

Section 4

Outside contact list

A. International Airport

1. Communications equipment
2. Airport approach hazard notification
3. Ambulance, first aid
4. Fire equipment
5. Security assistance
6. Generator, portable lighting
7. Personnel transportation

For all items contact:	Phone Office	Home
General manager	200	112
Aircraft handling services manager	293	5-2603
Fire/rescue	209	
Police	199	
Base safety manager	262	

B. Plantations Company

1. Ambulance/first aid
2. Hospital services
3. Front-end loader, bulldozer

For items 1 and 2, contact:		
Medical director - hospital	5-2939/ 5-2336	5-2424 (night) 5-2494
Ambulance service and Police	5-2876	5-2222 (night)
For item 3, contact:		
Engineering manager	5-2011	5-2341
Radio Corp.	5-2131	5-2567 (night)

Alternatively, use channel 3 on the 4-channel car radio for any Gabbit contact.

	Phone
C. National police force	199

1. Traffic control
2. Bystander control

D. National security agency

contact - Director

E. Legal advice

	Phone
contact	21457

F. Public relations enterprises

	Phone
contact	22833 (res.) 26229 (home)

Section 5

Routine upgrading

Practice and drills

Fire drills will be held monthly, simulating different hazards.

Full emergency drill, including evacuation and setup of control centres, to be held twice yearly.

Review of procedures and manuals

Manual to be reviewed before and after the bi-yearly practice. Procedures and write-up to be updated accordingly.

Figure VII.A.1. Layout of plant

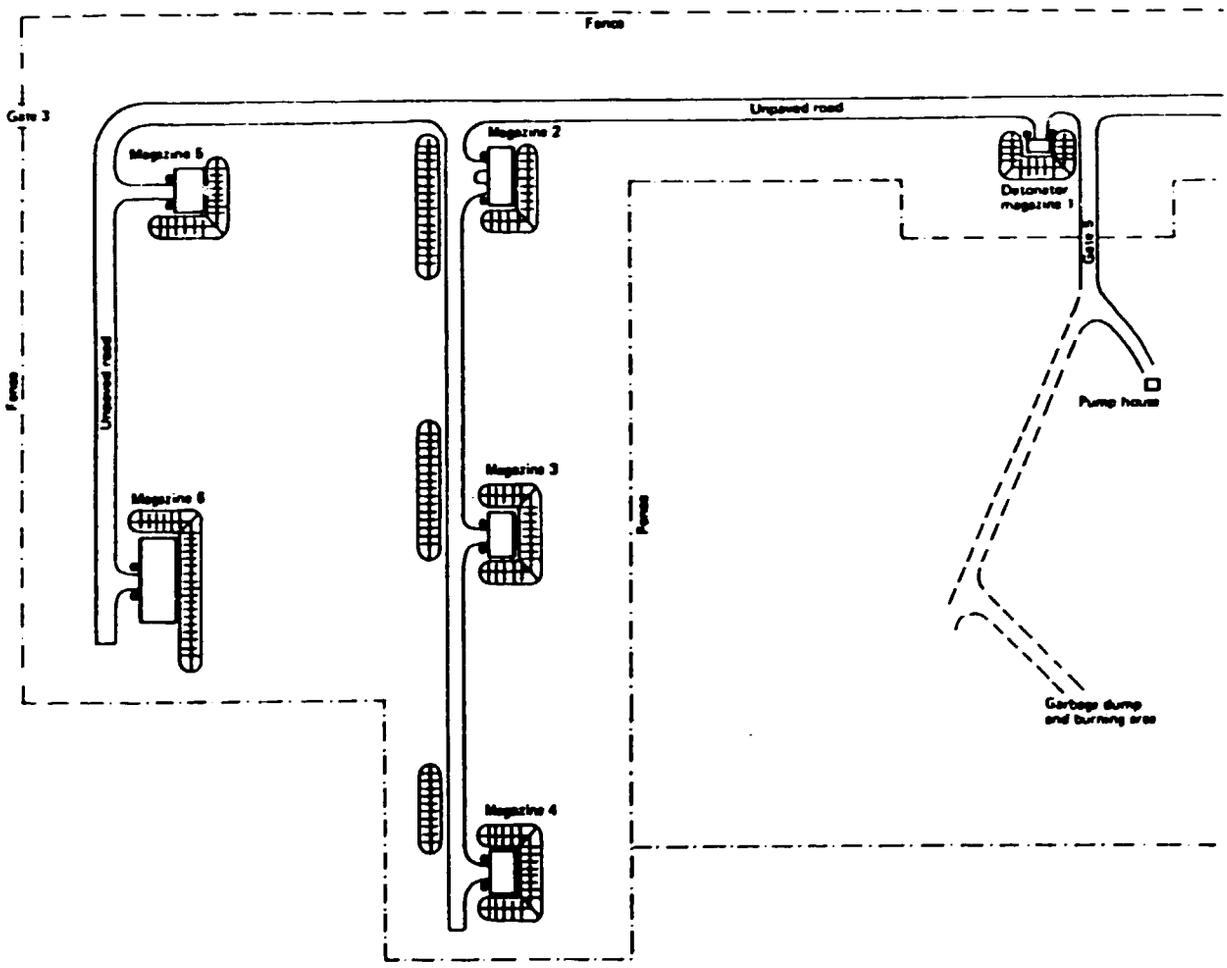
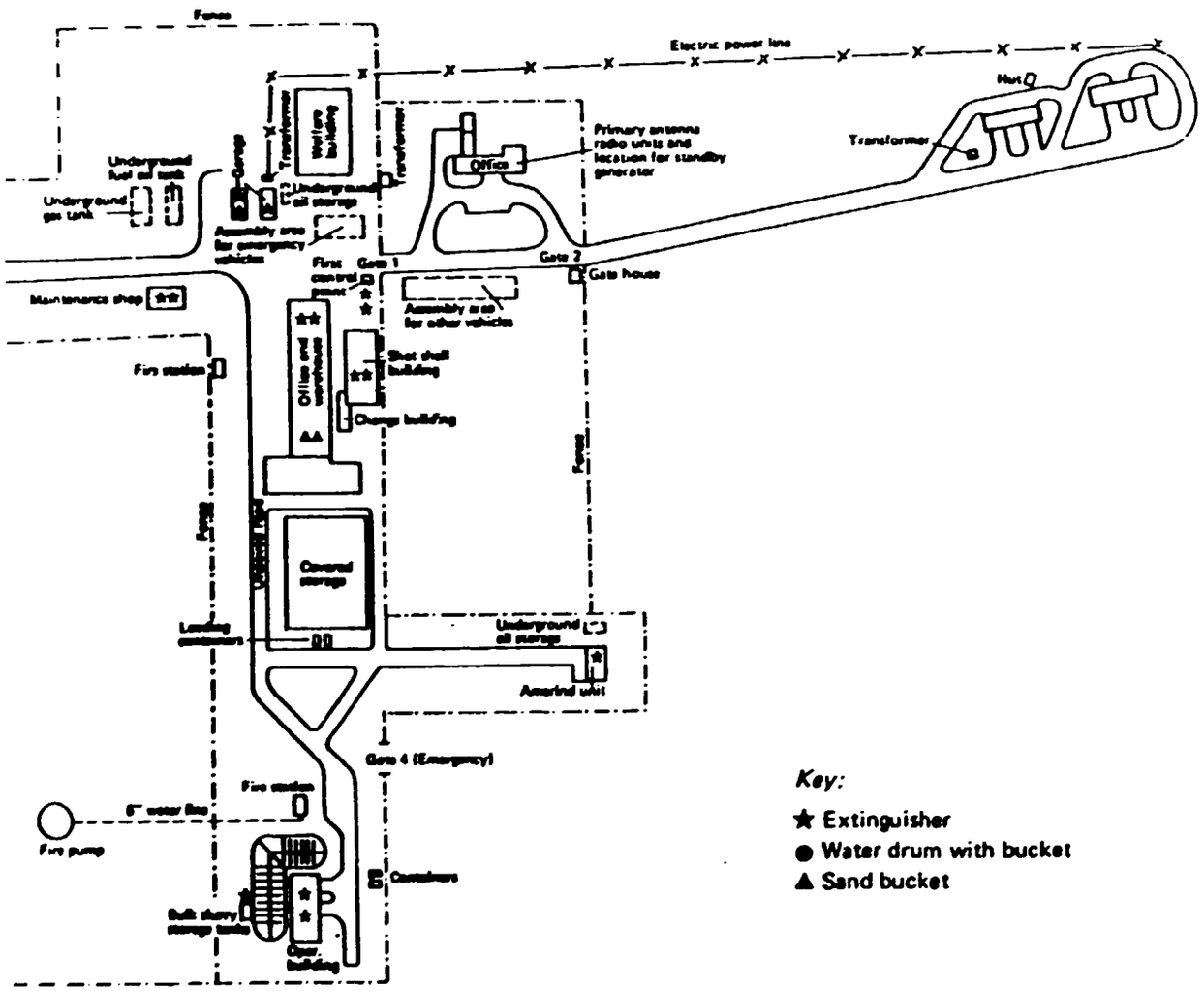


Figure VII.A.2. Layout of plant



Scale 1 inch = 200 feet

VIII. CASE STUDIES: COUNTRY B

A. Introduction

A field mission by UNIDO was carried out in the autumn of 1984. The purpose of the mission was to establish: (a) whether there were any national or local plans for action in the event of a disaster; (b) whether there were any such plans in industry; and (c) what provisions were made for collaboration and co-ordination.

On the basis of a UNIDO study, "Etude des polluants marins d'origine industrielle" (UNIDO/IS.170 of 30 July 1980), and in conjunction with Country B authorities, a number of plants were identified which might present some danger by reason of their products or their situation. Later, after a visit to the industrial zone near the capital, a final list of plants to be visited was drawn up. A summary of the findings of these visits is given in table 10. This is followed by a discussion of the most complete and practical contingency plan found in Country B.

On the basis of discussions with the competent authorities, it is possible, in section C, to give a review of the general means available for dealing with disasters. To complete the picture, information has been added, in the same section, on marine pollution. The expert was greatly assisted by the great commitment shown by counterpart officials representing the Government of Country B, especially those in the Department of the Environment.

B. General information on Country B

Area and population (1981)

Table 11 shows the distribution of population in the different regions into which the country is divided. It will be noted that there is a heavy concentration of population in Region b and that industry is also concentrated in that region.

Administrative organization

There are eight regions, 30 departments and 90 districts in Country B.

Resources

The principal resources are: phosphates, limestone, ilmenite, zircon and marine salt. There are known deposits of iron, manganese, aluminium, graphite. tin lead, gold, molybdenum, lithium, barium, tungsten, uranium and petroleum.

Employment: private and semi-private

Table 12 shows the employment situation in Country B, by sector.

Economic development

The Fifth Plan (1977-1981) resulted in 4,708 new jobs and the following achievements:

(a) Setting up of a marine project with a floating dock for vessels of up to 60,000 tonnes;

(b) Construction of a new 200,000-tonne oil works to replace the old installations;

(c) Fish-meal project in Region c;

(d) Expansion of textile dyeing and printing facilities;

(e) Start of exploitation of natural gas.

The Sixth Plan (1981-1985) provides for the creation of 6,270 jobs and new chemical factories, the extension of bricks and cement plants, crude oil refining, and textile manufacturing. Table 13 shows the proposed investment by sector. On 19 May 1983, a revision of the Plan was introduced. By 30 June 1983, some 37 per cent of the total value of the planned projects had been implemented. With 41 of the approved projects, Region b has more than half of the total investment. Region d has 15 projects. The further away one goes from the capital city, the smaller the number of projects. The main risks of industrial accidents are thus around this industrial development zone. Heavy industry (e.g. chemicals, petrochemicals, iron and steel) is not much developed at present, but with a new project, Country B will enter this field. Certain new dangers will then arise with the transport of dangerous goods by road and sea. The industrial indicators for the country are given in table 14. Some of the country's major projects are listed below.

Chemicals project. The purpose of this project is to exploit tertiary calcium phosphate, with a view to the production, mainly for export, of liquid phosphoric acid and derivatives such as monoammonium phosphate (MAP) and diammonium phosphate (DAP), as well as simple and triple superphosphates. All are used in the manufacture of fertilizers. The new plant will have an output of 600 tonnes a day of phosphoric acid, necessitating an annual input of 600,000 tonnes of crude phosphate.

Production of nitrogenous fertilizers. The production of nitrogenous fertilizers involves an extension of existing production facilities. The manufacture of solid primary fertilizers (MAP, DAP), which will be produced and exported, and that of complex fertilizers primarily intended for the domestic market, is best combined in a single unit.

Extension of the refinery. The extension project for the refinery will increase its annual refining capacity from 900,000 to 1,200,000 tonnes. The existing plant will also be modified and adapted for the treatment of heavier crudes. Lastly, the tanker-unloading facilities will be modelled and enlarged to take ships with a higher unit tonnage. The chemicals and refinery projects represent 98 per cent of investment planned in the chemicals sector.

Mechanical and electrical engineering industries. The establishment of a steel plant with an electric furnace and a rolling mill producing long iron and steel products - concrete reinforcing rods, light and medium sections and wire rods (to supply the capital city drawing mill) - should make it possible to achieve the objective of setting up a steel industry. The planned switch to industrial-scale operations by the existing foundry should take place during the Sixth Plan. A project for the manufacture of electric cables has been under consideration since the Fifth Plan. A start could be made during the Sixth Plan.

Mining and construction materials industry. Major features are:

(a) Exploitation of the iron-ore deposit;

(b) On the basis of a licence granted by the Government, preparations will continue for working a gold deposit (production in 1988);

(c) Only one brick-making plant is at present operating in Region c. This plant produces approximately 12,000 tonnes of brick products a year. An extension project should be carried out during the Sixth Plan. Two projects for new brick-making plants are under study, one in Region c (12,000-14,000 tonnes/year) and the other in Region d. Since 1982 a plant has been producing 14,000 tonnes a year of unslaked lime or 20,000 tonnes a year of slaked lime;

(d) Plaster production is 2,000 tonnes a year. However, the industrial capacity is 20,000-25,000 tonnes a year;

(e) Planned extension and renovation of the cement plant should lead to annual output of upwards of 820,000 tonnes;

(f) Clays are being exploited for industrial purposes in Region a. The producers applied for a licence for the production of 50,000 tonnes of attapulgite in 1983 and 60,000 tonnes in 1985.

C. Action in the event of a disaster or major accident

Civil defence

Country B has had a civil defence system since 1964 (Decree No. 64-564 of 30 July 1964). The relevant decree makes the Minister of the Interior responsible for drawing up organizational reports; he is to be assisted by the Department for Civil Defence. Civil defence measures of prevention, protection and assistance are to be undertaken to deal with fire and other disasters or catastrophies which threaten public security.

Organization

Measures to combat fire and to provide assistance are to be undertaken by units of the National Fire Service. The most senior officer of the National Fire Service serving in a region is responsible, under the authority of the Governor, for matters concerning the organization of assistance. As part of the general arrangements for assistance in the event of a major accident or serious incident, the Minister of the Interior, with the assistance of the ministers concerned, organizes and co-ordinates intervention by the machinery of the public services and private agencies capable of rendering assistance. The organization of civil defence includes measures of assistance such as fire fighting, removal of rubble, rescue operations, health protection, decontamination and the provision of food for affected populations. Orders specify the particular provisions applicable to the areas and large population centres covered by special measures.

Department for Civil Defence

The functions of this Department are:

(a) To study appropriate methods to protect the population against the risks of peacetime accidents and the dangers of wartime;

(b) To prepare the necessary legal instruments;

(c) To organize and direct the various civil defence services at all levels and, in particular, the National Fire Service;

(d) To undertake the recruitment and supervise the training of civil defence personnel.

The department consists of an administrative office (personnel and equipment), a research office and a secretariat. The research office is responsible for:

(a) Drawing up legal instruments relating to matters of prevention;

(b) Examining files relating to the construction or alteration of establishments open to the public, with a view to ensuring conformity with the laws and regulations in force. Such examination will enable the Director to give his opinion on the advisability of authorizing construction or alteration;

(c) Monitoring the application of the rules and regulations relating to establishments open to the public;

(d) Analysing incident reports prepared by the National Fire Service;

(e) Applying permits issued by the Minister for Industrial Development for the opening and operation of dangerous, unhealthy or noxious industrial establishments;

(f) Determining the general principles governing reports for the organization of assistance;

(g) Maintaining a national index of classified establishments.

Higher Commission

Decree No. 81-1105 of 18 November 1981 establishes the membership of the Commission, which is a consultative body to be convened by the Minister of the Interior whenever he deems it necessary, but not less than twice a year. The Commission gives its opinion on all matters relating to the protection of persons and property in establishments open to the public and on many other questions which may be referred to it by the Minister.

Regions

The eight regions have co-ordination commisssions in which all parties concerned, including industry, are represented. In an emergency, the civil defence system may, if necessary, seek help from any quarter, e.g. the police or the public. The civil defence system is based on community response capabilities. The headquarters of the Higher Commission is in the capital. Each regional capital has a similar entre (making eight in all). In addition, there are 30 emergency action centres in the districts and departments. Each emergency action centre has a transport unit, a fire unit and a rescue unit.

Search and rescue service: aviation

A search and rescue service has responsibility for the organization, management and supervision of search and rescue operations. It is under the dual authority of the Minister of Transport and the Minister for the Armed Forces.

Action in the event of marine pollution

Facilities are available. A developed country sent Country B a surveillance

aircraft in June 1983. A regional protocol relating to co-operation to combat pollution in critical situations provides for the establishment of an emergency plan of action to deal with such situations, to be established at national, bilateral and international levels of co-operation. In July 1981, the Minister for Housing and the Environment submitted a proposal for a Country B contingency plan to the National Council for Town Planning and the Environment.

Outline of proposed contingency plan

(a) Spillage alert and evaluation report;

(b) Assessment of situation and mobilization of action teams;

(c) Action on land and sea;

(d) Administrative and legal procedures. The project for the establishment of an emergency plan of action is scheduled for inclusion in the Sixth Plan.

Alert. This initial phase is the joint responsibility of national agencies, i.e. Air Force, Navy and Engineer Corps. The Commander of the Navy is responsible for ordering the alert in the same circumstances as those applying to coastal water monitoring operations, for transmitting the message, and for making an evaluation report (within the hour).

Assessment. The report of the naval commander should contain an assessment of the incident (nature, extent, location, flag under which ship is sailing etc.). The mobilization of the action team is the responsibility of the naval commander, the commander of the Military Engineer Corps and the Ministry of the Interior. These action teams, which should be set up in each coastal region, would be composed of:

(a) (For action at sea.) Specially trained staff from the National Guard of the Fire Service, placed under the authority of the naval commander and the commander of the Military Engineer Corps. The naval commander has overall charge of the operation;

(b) (For action on land.) Specially trained staff from the mobile operational group; volunteer services; and, as required, prisoners convicted under the ordinary law.

These teams shall be under the authority of the Minister of the Interior.

Action. The success of this crucial phase depends on the availability of the following:

(a) (For action at sea.) Permanent and adequate stocks of anti-oil-slick products, stored in ports, floating dams, powder cannons with air compressors, tugs, fire boats, vortex pumps and separating tanks, if the operation concerns the recovery of crude petroleum etc. Some of these supplies are already available in ports;

(b) (For land operations.) Equipment, and cleaning and coastal restoration materials.

Procedures. This phase, which begins as soon as the alert is announced, comprises the following:

(a) Co-ordination of the administrative and legal procedures;

(b) The administrative procedures and legal follow-up;

(c) Diplomatic action.

Fire Service

Measures to combat fires and provide assistance shall, in normal circumstances, be undertaken by units of the National Fire Service. Each town has fire brigades. The one in the capital is well organized and has all the usual facilities for dealing with fires. Every industrial plant is obliged to contact the Fire Service before starting operations. The Service makes suggestions as to the fire-fighting devices to be installed. Communications, particularly by telephone, are the greatest problem. The network is often out of order.

Industry

Contingency planning

The plants visited have the usual facilities for dealing with fires: powder extinguishers, hoses, powder wagons. Table 10 shows the findings of the visits. Few of the plants have a proper plan of action for dealing with a major accident. Two did produce such a plan, however. One of them is summarized here in appendix VIII. A. It is therefore recommended that plants which present some danger should draw up emergency plans.

Classified establishments

When a classified establishment is opened, special fire prevention measures are laid down. There are three categories of such establishment, depending on the degree of danger, and based on European legislation. Act No. 83-05 of 28 January 1983 (Official Journal of 23 April 1983) reorganized the system of dangerous establishments, superseding the existing Act, which was based on a European one of 1919. There are now two categories. Texts regulating the new system of applying for authorization are in the course of preparation. So far 2,881 applications for permission to open a classified establishment have been made in Country B. Most of them are related to hydrocarbon depots and petrol stations. There are still 1,718 in operation. The opinion of the Department for Civil Defence is requested each time. As regards the use of dangerous substances, few people know the meaning of the danger labels - such as the United Nations or EEC labels - on barrels.

Transport

There is no special legislation on the transport of dangerous goods. The ADR system for providing information on such goods and marking them is unknown. Consignments of goods other than hydrocarbons are practically always accompanied by the police or by a special escort car from the factory. However, one might ask whether that will always be possible in the future. Various dangerous goods are transported in drums, in containers or by lorry from the port to the factories. These goods include solvents, sulphur, caustic soda, ethylene glycol, TDI and pesticides. Some system, therefore, needs to be established for identifying this type of transport operation.

D. Organization of environmental protection

Act of 1983

The Official Journal of Country B in 1983 published Act No. 83-05 of 28 January 1983 promulgating the Environmental Code. The Code is concerned with reform of the system of classification of dangerous establishments and the introduction of arrangements for preventing water, air and noise pollution.

Classified establishments

The new Act replaces the existing legislation based on the European Act of 1919. It reduces the three categories to two and broadens the meaning of the term "dangerous establishment". It simplifies the administrative system. It allows a dangerous establishment to be temporarily closed if it is physically impossible to comply with the existing regulations.

Financial support

Various innovations are to be noted:

(a) Introduction of a single fee, charged when the permit is issued;

(b) An annual charge levied (by category) on the basis of the area occupied and the actual control costs;

(c) Exemption of enterprises which have been approved (under the Investment Code = exemption from taxes in certain industrial zones) from taxes on purchases of equipment for the control of pollution and other harmful phenomena;

(d) Non-approved enterprises are entitled to faster depreciation of the anti-pollution equipment;

(e) Persons operating pollutant installations who have not taken the necessary measures by 23 April 1984 (exemption from taxes and royalties and accelerated depreciation are incentives for the installation of equipment) will be liable to a pollution tax, depending on the nature, quantity and toxicity of the waste produced by their plants.

Water pollution

The procedure for authorizing certain kinds of waste disposal, and laying down the conditions under which other kinds may be forbidden, will be regulated by a decree.

Air pollution

Enforcement decrees will specify the cases and conditions in which the emission of smoke; soot; dust; or toxic, corrosive, odorous or radio-active gas into the atmosphere will be forbidden or regulated.

Sound pollution

Measures will be taken to regulate a whole range of activities. International standards will be applied.

Ministry of Nature and Natural Resources

The Department of the Environment is organized as follows:

Director
Deputy
2 Secretaries

Division of Dangerous Establishments:	Chief 1 professional
Division of Pollution Control:	Chief 2 professionals
Division of Co-ordination:	Chief 2 professionals
Administrative Office:	2 professionals

E. Conclusions, Country B

The industrial plants visited have, for the most part, the usual facilities for dealing with fires. They also maintain good contact with the Fire Service. As regards contingency plans issued in written form or under study for fires, explosions or accidental releases of large quantities of pollutants into the air or water, there is very little of a specific nature. Plants ought to draw up practical contingency plans, on the basis of a general plan. This need not necessarily require the introduction of sophisticated equipment or complicated arrangements; the plant plans should be simple, practical and effective. In collaboration with the fire service, practice drills can then be organized. At the international level, danger labels and a system for providing information on the dangers have been developed for the transport of dangerous goods. Drivers and other persons handling such goods should be familiar with the meaning of the labels and other safety aspects.

Table 10. Overview of major industries in Country B and their emergency equipment

Plant	Production	Raw materials	Work-force	Plan	Facilities			
					Personnel	Powder extinguishers	Water hoses	Powder wagon
1	Polyurethane foam (35 t per month); Industrial soap; 80% NaOH (29,000 to 30,000 t per year)	Polyol, TDI, freon, palm oil, HCl		No	12 staff	Yes	Yes	Yes
2	Polyurethane foam (40 to 60 t per month); Furniture	Polyol, TDI, freon		Yes		Yes	Yes	Yes
3	Water-based vinyl paints; car paint; epoxy paint for industrial use; polyurethane (2,200 t per year)	Toluene, naphtha, pigments		No		Yes	Yes	Yes
4	Phosphoric acid (60 t per year); Sulphuric acid; Superphosphate fertilizers (300 to 400 t per year); Plaster (5 t per hour)	Ammonia, phosphate, sulphur	340 to 350	No	Own security and medical services	Yes	Yes 300 m^3 tank	Yes

continued

Table 10 (continued)

Plant	Production	Raw materials	Work-force	Facilities				
				Plan	Personnel	Powder extinguishers	Water hoses	Powder wagen
5	Plastics processing (350 to 400 t per year)	Plastic pellets	250	No	No	Yes	Yes	Yes
6	Toilet paper; tissues; writing paper; cardboard etc.	Paper rolls, cardboard	225	No	No	Yes	Yes sprinkler under study	Yes
7	Regeneration of mineral oils (1,600 t per year)	Used engine and industrial oil	16	No	7 persons	Yes	Yes motor pump	Yes
8	Crude oil refining (1,200,000 t per year)	Crude oil	270	Yes in written form	2 firemen per post 1 security auxiliary own fire-fighting school	Yes Foam system	Yes 4 motor pumps 1,800 m^3 per hour 1,600 m^3 reserve tank	Yes 1 fire engine 2 ambulances
9	Pesticides (packaging and filling); Valva pastilles			Yes in written form	Yes	Yes	Yes 75 m^3 reserve	Yes
10	Groundnut oil; cake	Groundnuts, cottonseed, hexane	600 to 1,000	No	Yes 19-man security unit. 2 fire-fighting teams	Yes	Yes Water tower 260 m^3 well 100 m^3 per hour	Yes 1 ambulance

Table 11. Population distribution in Country B

Region	Population			Area	
	Number	Percentage	Number/km^2	km^2	Percentage
Region a	1 167 000	20	49	23 945	12.2
Region b	1 271 000	21	2 310	550	0.3
Region c	815 000	14	29	28 350	14.4
Region d	786 000	13	119	6 601	3.4
Region e	464 000	8	106	4 359	2.2
Region f	566 000	10	12	44 [illegible]	22.4
Region g	466 000	8	16	29 188	14.8
Region h	333 000	6	6	59 602	30.3

Table 12. Employment by sector, Country B

	1976	1985 a/
Agriculture, hunting, fishing	2 584	.. b/
Extractive industries	2 319	.. b/
Manufacturing industries	25 402	37 120
Electricity, water and gas	4 520	5 131
Building and public works	4 339	5 181
Commerce, hotels, restaurants	17 447	19 790
Transport, storage, communications	15 097	33 210
Banking, insurance, real estate	3 345	7 023
Other activities	6 780	28 638
Total	81 833	136 093

a/ Extrapolated from mean annual growth for the period 1971-1978.

b/ These two activities are included in the figure of 28,638 for "other activities".

Table 13. Proposed investment by sector, Country B

Region	Proposed investment in millions of Country B Kronen					
	Agro	Chemicals	Engineering	Mining and construction	Textiles and others	Percentage
Region a	614				9 597	8.3
Region b	4 950	26 513	1 311	14 600	5 465	42.8
Region c	799			3 921	568	3.7
Region d	624	36 657	1 467	6 115	770	36.9
Region e	116	83		360	96	0.5
Region f	3 260			200	319	3.6
Region g	459			2 895	184	0.5
Region h	459			2 895	80	2.8
Country	11 942	63 253	2 788	28 510	17 079	123 562
Percentage	9.66	51.19	2.22	23.07	13.82	100

Table 14. Industrial indicators, Country B

Industrial indicator	1980	1985
Fishing	344 000 t	510 000 t
Petroleum refining (1983)	900 000 t	1 200 000 t
Phosphates of lime	1 300 000 t	1 900 000 t
Phosphates	140 000 t	90 000 t
Phosphates of crude alumina	80 000 t	150 000 t
Phosphates of calcined alumina	105 000 t	170 000 t
Installed power capacity	184 MW	
Number of ships recorded at the capital	7 536	11 200
Volume of water produced (1979)	58 025 (1,000 m^3)	83 950
Number of hospitals	12	15
Number of health centres	36	66

Appendix VIII.A

OPERATIONAL INDUSTRIAL CONTINGENCY PLAN IN COUNTRY B

General information

Fire Service: emergency tel. No.: 18
Station Emergency Centre: tel. 212629
Works alarm: siren
alarm button

The plant stipulates that:

(a) Smoking is totally forbidden in the workshop;

(b) Access to all workshops must be kept free at all times (cardboard boxes, cases, shovels, must not be in the way);

(c) Workshops must be tidied and swept at the end of the day (stools under tables to permit free passage);

(d) The low-voltage substation must be turned off before workshops are closed at the end of the day;

(e) Finished or semi-finished products must be returned to their respective store rooms;

(f) Fire extinguishers must be accessible at all times;

(g) Premises must be kept closed;

(h) Before departure, the foreman must activate the workshop disconnecting switches in the low-voltage unit;

(i) Only the pilot light must remain on.

The names of the staff responsible are also given and their duties are laid down in official memoranda. The staff responsible for the fire prevention service carry out regular checks and organize practice drills. There is a contract for assistance with the fire protection department in the capital. The layout of the plant is shown in figure VIII.A.1.

Special checks are carried out in the case of (a) the high- and low-voltage station, and (b) gas equipment.

(a) High- and low-voltage station. These checks are carried out by the responsible staff of the station, i.e. the mechanical engineer and the assistant works manager. Checks are carried out:

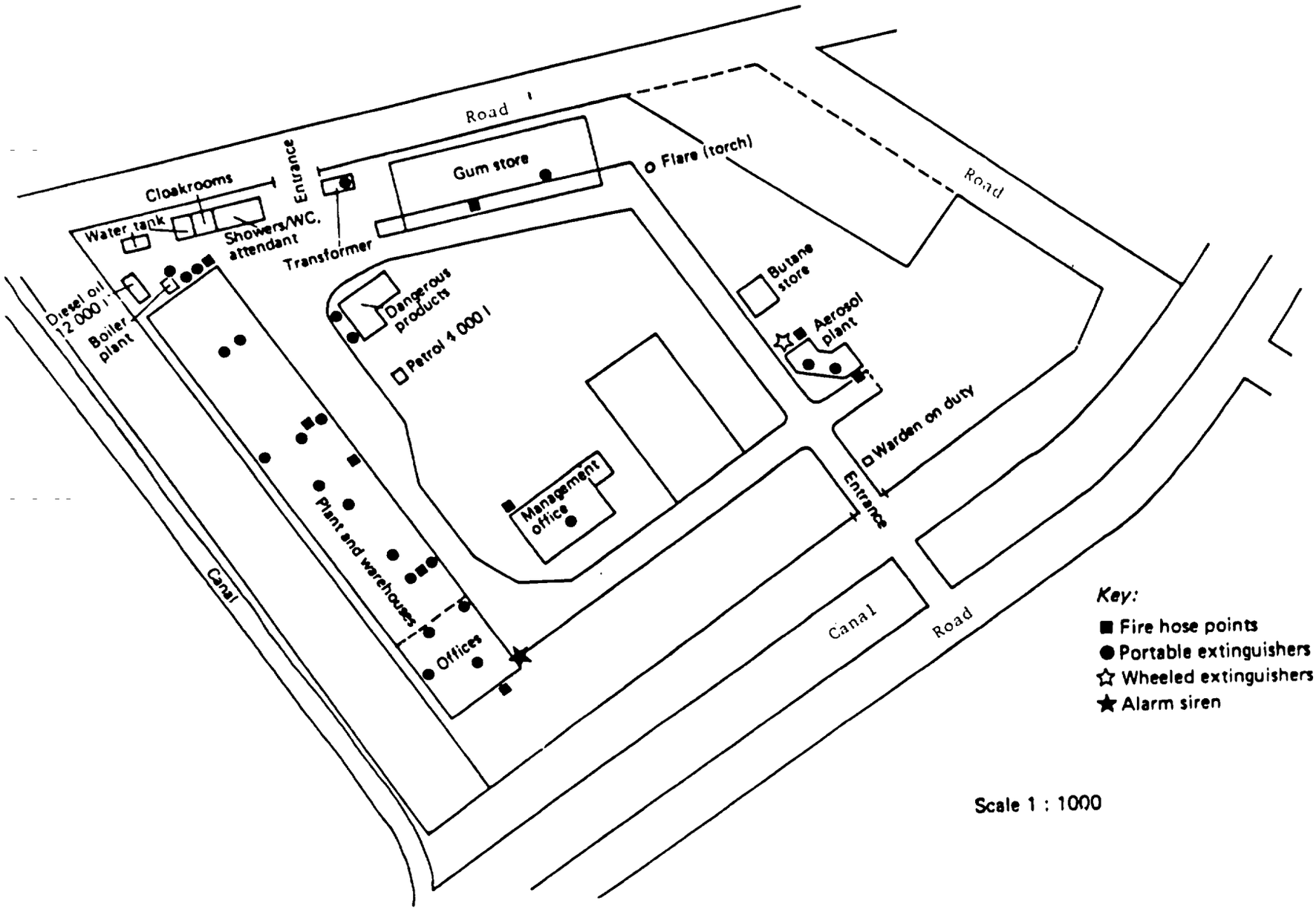
(i) During scheduled interruptions in the high-voltage supply, e.g. for cleaning, dusting, lubrication or painting;

(ii) Every weekend on low-voltage circuits and during periods of preventive maintenance (July-August);

(b) Gas equipment. Checks here involve permanent monitoring during use of deodorizing apparatus, and weekly checking of flange joints with soap foam. At the end of each working day, the circuit valves must be turned off and checked.

The emergency equipment consists of a 75 m^3 reserve water supply (25 m^3 underground tank and 50 m^3 water tower) and fire hose points and extinguishers. This equipment is checked every quarter and the checks are entered in a register. In addition, personnel from the plant also check the equipment periodically.

Figure VIII.A.1. Layout of plant in country B



References

1. United Nations Environment Programme (UNEP), Conference of Plenipotentiaries on Co-operation in the Protection and Development of the Marine and Coastal Environment of the West African Region, Final Act, Abidjan, 16-23 March 1981 (UNEP/IG 22/7).

2. United Nations Environment Programme (UNEP), report of the Meeting of the Steering Committee for the Marine Environment of West and Central Africa, Abidjan, 20-22 July 1981 (UNEP/WG.61/5).

3. United Nations Environment Programme (UNEP), Report of the Meeting of the National Authorities for the Action Plan for the West and Central African Region, Geneva, 19-21 April 1982 (UNEP/WG.71/4).

4. United Nations Environment Programme (UNEP), Report of the Meeting of the Steering Committee for the Marine Environment of West and Central Africa, Geneva, 22-23 April 1982 (UNEP/WG.72/3).

5. United Nations Industrial Development Organization (UNIDO)/United Nations Environment Programme (UNEP), Survey of Marine Pollutants from Industrial Sources in the West and Central African Region, 1982 (UNEP Regional Seas Reports and Studies No. 2).

6. Federal Emergency Management Agency, Planning Guide and Checklist for Hazardous Materials Contingency Plans (Washington, D.C., 1981).

7. University Hospital of Ghent, Admission to the Hospital in Case of Emergency: Instructions (Ghent, Belgium). In Flemish.

8. Amtliche Nachrichten der Niederösterreichischen Landesregierung (Official Bulletin of the Province of Lower Austria), vol. 23, 15 December 1973, p. 1. In German.

9. Prefecture de Police, Plan O.R.S.E.C. de la Ville de Paris et des Départment des Itants-de-Seine, de la Seine-Saint-Denis et du Val-de-Marne (Paris).

10. Dow Chemical Company, Fire and Explosion Index: Hazard Classification Guide, 5th ed. (New York, 1981).

11. D. J. Lewis, Loss Prevention, vol. 13, 1980, p. 20.

12. H. G. Lawley, "Operability studies and hazard analysis", Chemical Engineering Progress, vol. 10, No. 4 (1974), p. 45.

13. L. P. Jennergren and R. L. Keeney, "Risk assessment", Handbook of Applied Systems Analysis (Laxenburg, Austria, International Institute for Applied Systems Analysis, 1979).

14. F. P. Lees, Loss Prevention in the Process Industries (London, Butterworths, 1980). 2 volumes.

15. The Oil Companies' International Study Group for Conservation of Clean Air and Water - Europe, Methodologies for Hazard Analysis and Risk Assessment in the Petroleum Refining and Storage Industry (Den Haag, The Netherlands, 1982).

16. D. E. Embrey, Transactions of the Institution of Chemical Engineers, symposium series, vol. 66, 1981, p. 124.

17. G. W. Westbrook, Loss Prevention and Safety Promotion, vol. 1, 1974, p. 197.

18. R. E. Colburn, Fire Protection and Suppression (New York, McGraw Hill, 1975).

19. A. Spiegelman, Loss Prevention, vol. 3, 1969, p. 1.

20. A. W. M. Balemans, Loss Prevention and Safety Promotion, vol. 1, 1974, p. 7.

21. H. E. Webb, Jr., "Be hard-headed about safety gear", Chemical Engineering, vol. 69, 23 July 1962, p. 136.

22. Chemical Industry Safety and Health Council, Recommended Procedures for Handling Major Emergencies, 2nd ed. (London, 1976), item 5.

23. American Petroleum Institute, Manual on Disposal of Refinery Wastes (New York, 1969).

24. American Petroleum Institute, Guide for Inspection of Refinery Equipment (New York, 1976).

25. American Petroleum Institute, Recommended Practices (New York).

26. American Petroleum Institute, Standards (New York).

27. British Standard Yearbooks (London).

28. American National Standards Institute, Catalogue (New York).

29. American Society of Testing and Materials, Annual Book of ASTM Standards (Philadelphia, 1978).

30. American Society of Mechanical Engineers, ASME Codes and Standards.

31. National Fire Protection Association, Selected National Fire Codes (Boston, Massachussetts, 1976).

32. W. E. Isman and G. P. Carlson, Hazardous Materials (Encino, California, Glencoe Publishing, 1980).

33. European Economic Community (EEC) ve of 24 June on the major-accident hazard of certain ies, Official Journal of the EEC, vol. 25, 5 August 198 EC).

34. Department of Transportation, Eur Concerning the International Carriage of Dangerous Road (London, HM Stationery Office, 1978).

35. D. J. Bruce and W. M. Duggle, Loss Prevention and Safety P tion, vol. 1, 1974, p. 3.

36. L. E. Carlson, J. F. Erdmann and G. J. Hanks, Jr., Control of Hazardous Materials Spills: Proceedings (New York, American Institute of Chemical Engineers, 1974).

37. C. L. Gilmore, "Trouble-shooting heat-exchanger design", Chemical Engineering, vol. 74, No. 13 (19 June 1967), p. 221.

38. H. C. Underwood, Jr., R. E. Sourwine and C. D. Johnson, "Organize for plant emergencies", Chemical Engineering, Deskbook Issue, vol. 83, 11 October 1976, p. 118.

39. United States Department of Labour, Emergency Response for Hazardous Materials (Washington, D.C., 1982).

40. J. L. Risinger, Fire Protection Manual for Hydrocarbon Processing Plants, C. H. Vercalin, ed. (Houston, Texas, Gulf Publishing, 1964), p. 320.

41. Amy E. Dean, ed., Handling Hazardous Material: Transportation Emergencies (Boston, Massachussetts, National Fire Prctection Association and US Department of Transportation, 1978).

42. United Nations Economic and Social Council, Transport of Dangerous Goods: Recommendations prepared by the UN Committee of Experts on the Transport of Dangerous Goods, 2nd ed. (ST/SG/AC.10/1 Rev.2).

43. R. F. Cumberland, Hazardous Materials, vol. 6, 1982, p. 227.

44. National Fire Protection Association, NFPA Handbook No. 704M (Boston, Massachussetts).

45. R. F. Cumberland, the Harwell Chemical Emergency Centre, Mass Emergencies vol. 1, 1975, pp. 63-72.

46. R. L. Rawls, "Chemical transport - coping with disaster", Chemical and Engineering News, vol. 58, No. 47 (24 November 1980), p. 20.

47. D. L. Dowell, Loss Prevention, vol. 5, 1971, p. 29.

48. R. D. Kogler, Loss Prevention, vol. 5, 1971, p. 26.

49. United States Department of Transportation, Emergency Action Guide for Selected Hazardous Materials (Washington, D.C., 1978).

50. National Fire Protection Association, unpublished documentation.

51. United States Department of Labour, Mine Safety and Health Administration, National Mine Health and Safety Academy, "First Aid", Safety Manual, No. 3, 1984.

52. J. L. Risinger, Fire Protection Manual for Hydrocarbon Processing Plants, C. H. Vervalin, ed. (Houston, Texas, Gulf Publishing, 1964), p. 300.

53. C. C. Hale, Ammonia Plant Safety, vol. 16, 1974, p. 23.

54. Association of American Railroads, Bureau of Explosives, Emergency Handling of Hazardous Materials in Surface Transportation, pamphlets 1-4 (Washington, D.C.).

55. Amy E. Dean and Keith Tourer, Fire Protection Guide on Hazardous Materials, 7th ed. (Boston, Massachussetts, National Fire Protection Association, 1978).

56. A. J. Smith, Managing Hazardous Substance Accidents (New York, McGraw-Hill, 1981).

57. Federal Emergency Management Agency, Disaster Operation: A Handbook for Local Governments, CPG 1-6 (Washington, D.C., 1972).