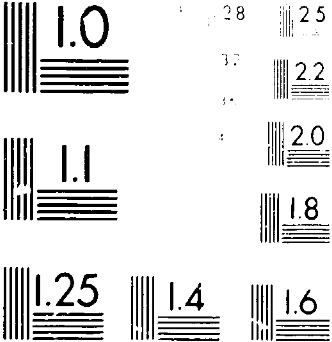

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CONTINGENCY PLANNING FOR INDUSTRIAL EMERGENCIES FOR THE WEST AND CENTRAL AFRICAN REGION

Prepared by the

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NOTE

This document has been prepared jointly by the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) under project FP/0503-82-11 as a contribution to the development of the Action Plan for the protection and development of the marine environment and coastal areas of the West and Central African Region.

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PREFACE

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans.

The Regional Seas Programme at present includes ten regions and has over 120 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities.

By Decision 88(V.)C of 25 May 1977, the Governing Council of UNEP requested the Executive Director to initiate the development of an action plan for the West and Central African Region.

After a preparatory process, which included a number of expert meetings, fact finding missions and in-depth studies on resources and environmental problems of the region, the Conference of Plenipotentiaries on Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan, 16-23 March 1981) adopted:

- the Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the West and Central African Region;

- the Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region; and

- the Protocol Concerning Co-operation in Combating Pollution in Cases of Emergency.

The Governments of the region also established a trust fund to support the activities called for in the Action Plan. UNEP was designated as the secretariat of the Action Plan and the Convention.

This document was prepared as a contribution to the development of the Action Plan for the West and Central African Region. Its main objective is to provide the Governments of the Region with appropriate guidelines for the preparation of national and plant contingency plans for industrial accidents.

Two UNIDO consultants carried out field missions to Liberia and Senegal in order to collect relevant information on the current state of preparedness and intervention capability in case of major industrial accidents in these two countries.

A regional industrial risk assessment for the WACAF region was also carried out in order to determine the zones in the region most exposed to the risk of industrial accidents.

CONSULTANTS

Piero M. Armenante, Chemical Engineer, was the principal consultant for this project. He also prepared the case study for Liberia. Jos Bormans, Chemical Engineer, prepared the case study for Senegal. Mr. Kenneth Strzepek, Civil Engineer, assisted by Mr. S.C. Onyeji, Economist, prepared the WACAF regional risk assessment.

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SUMMARY

Guidelines for the preparation of national and plant level contingency plans for industrial accidents in the WACAF region have been prepared. A generalized procedure for conducting an industrial hazard analysis is presented.

Information on the current state of preparedness and intervention capability in case of major industrial accidents was collected during field missions to Liberia and Senegal.

A regional industrial risk assessment for the WACAF region has been carried out based on calculation of relative a) fire and explosion risk and b) environmental risk, for the major industrial sectors and the five geographical zones which make up the region.

CONCLUSIONS

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.

2. A hazard analysis is the first step in the planning process. It consists of identifying potential hazards, vulnerable points and risks associated with those hazards. Checklists and safety audits are the most important methods for hazard identification in industrial plants.

3. The identification of resources (such as equipment, people and agencies) is the second step in the planning process. Functions and responsibilities of different persons or groups should also be identified.

4. The definition of the authorities in charge of an emergency, the chain of command, and the procedure defining the shift of 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 nation to industrial emergencies. Municipal, provincial or national contingency plans are needed to integrate plant contingency plans in case of major emergencies.

6. Appropriate general legisation 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 national fire fighters is the essential backbone of any national, provincial or municipal response capability.

On the basis of the country missions it appears that:

8. The larger industries are, in general, relatively well equipped and better prepared than the 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 hazardous material transport regulations exist. 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 given the limited level of industrialization of most countries in the region.

11. The vulnerability of the population could increase 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 the existing industrial establishments in order to collect all the available information by means of which possible accidents could be identified, including flammable and other hazardous materials present at these installations.

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

3. Set up regulations governing proper design, operation and maintenance for particular classes of hazardous industries.

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

5. Establish procedures for licensing and inspecting industrial installations and designate a governmental agency for enforcement.

6. Require manufacturers to show that they have identified the major hazards existing at their plants and adopted appropriate safety measures, including the preparation 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 governmental contingency plans develop their own plans, so as not to rely solely on public resources in case of an emergency.

9. Require the manufacturers to notify 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.

Chapter I. INTRODUCTION

The West and Central African Region has been recognized by the Governing Council of UNEP (Decision 88.C(V) of 25 May 1977) as a "concentration area" in which UNEP, in close collaboration with the relevant components of the United Nations system was mandated to carry out a catalytic role in assisting the developing states of the West and Central African region to formulate and implement, in a consistent manner, a commonly agreed upon Action Plan.

Recognizing the complexity of the problem and being aware of ongoing activities, UNEP has undertaken numerous activities to provide a sound basis for the development and implementation of the Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the West and Central African Region adopted by the Conference of Plenipotentiaries in Abidjan, March 1981.[1/]

The main purpose of the present study is to support the implementation of the Action Plan, taking into account the guidance provided by the subsequent intergovernmental meetings and in particular:

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

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

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

The First Meeting of the Steering Committee (Abidjan, July 1981) defined the institution and co-ordination of national contingency plans as one of the priority projects to be developed in the framework of the WACAF Action Plan (paragraph 14 of ref. 2). The outline of the project has been reviewed and revised by the Meeting of National Authorities (Geneva, April 1982) and approved by the Second Meeting of the Steering Committee (Geneva, April 1982) (paragraph 10 of ref. 4). The approved outline of the project served as the basis for the design of the present study.

The objective of this project is to provide the West and Central African region with guidelines for the preparation of contingency plans to deal with emergencies arising from catastrophic failures of industrial plants or breakdown of industrial waste disposal systems. Plans for responding to spillages of toxic substances occurring during handling or transportation are also developed. Means for incorporating the methodology to cope with these emergencies into National Contingency Plans are presented.

The hazards considered in this study are fire, explosion, and toxic release of hazardous materials in the environment.

A hazardous material is defined as any substance which is explosive, inflammable, 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 current study are the results from the UNIDO/UNEP survey of industrial pollution of the marine environment from land-based sources (project FP/0503-79-18) which resulted in the publication UNIDO/UNEP: Survey of Marine Pollutants from Industrial Sources in the West and Central African Region[5/]. The information contained in this survey helped identify the industrial establishments in the WACAF region which are associated with the highest risk of industrial accidents.

The results of this work should assist the governments of the WACAF cor to:

- Identify the zones and industrial sectors exposed to the greatest risk of industrial catastrophies
- Focus the attention of the responsible local officials on the problems of industrial accident prevention and contingency planning
- Develop national contingency plans for industrial emergencies
- Co-ordinate national contingency plans in cases of main regional emergencies.

Chapter 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:

Analysis of the hazards

Identification of resources

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 the preparation of the plan. Section A of this chapter will list and describe the most common types of contingency plans, indicating which type of plan is most appropriate to a given planning purpose. Hazard analysis and resource identification will be dealt with in sections B and C. Actions and duties will be 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/]:

Lists of resources and equipment, and telephone rosters

Action guides and checklists

Response plans

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

The simplest of all plans, they comprise lists of possible resources and equipment for use in an emergency, together with their locations and/or 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 methods, 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, the plan 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 departments or public works departments). Lists of technical experts from local companies and universities may be useful. A list may be prepared of volunteer organizations who could provide hard work, such as preparing and laying sand bags. These may be assembled by co-ordinating response personnel into city or other province lists . The industrial community can provide a wide range of equipment sometimes on a volunteer, 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 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 little preparatory work; however, it presupposes 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 industrial plant.

Action guides and checklists are generally subsidiary to more comprehensive plans. They are designed to ensure that a few basic things always get done, such as shutting down machines or industrial pieces of equipment, extinguishing small fires at the very onset, 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 method for 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 that plant will be necessary to provide following response to a large-scale emergency.

Response plans

A response plan provides instructions on handling one or more emergency situations. Its emphasis derives from the persons who prepare and use it. A designated response agency, such as a fire department, the civil defence agency, or the control centre of a large industrial plant may include detailed specific field techniques in the plan. A city or province plan will define the responsibilities and capabilities of various community response agencies and show how to activate them.

A response plan will contain information on whom and how to notify in the case of an accident, and it may indicate the initial actions to be taken. These will be 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 response organization and procedure. The most vital element in the plan is 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 takes on the new responsibility. A hazard analysis section will be generally included in the plan: it will also specify the vulnerable areas and include detailed maps of the region . If the response plan is to be effective, it must contain provisions for updating and upgrading (e.g. by audit). The plan also should indicate the type and timing of exercises and training sessions. In summary, the response plan is similar to a hospital procedure book. It specifies realities and stipulates what people are to do in an emergency. Section E of Chapter III contains a brief description of hospital contingency planning. Reference 7 contains a more detailed set of emergency procedures governing admissions to hospital.

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[8/] or in very large cities[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. These plans co-ordinate the actions of those agencies or groups as well as define their responsibilities from a legal standpoint.

B. Hazard analysis

Basic to emergency planning, no matter how simple, is an understanding of the problems one might anticipate. 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, and documented in the accompanying letter when the plans are distributed.

In general terms, a hazard analysis may be broken up as follows[6/]:

1. 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 type of hazardous materials and/or industrial processes exist? Where is it (or where does it pass through)?

2. 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 above identified hazards affect, and how?

3. 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 group 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 group comprises methods such as Fault Tree Analysis[13,14], Event Analysis[14,15], Human Error Prediction Studies[16], Epidemiological Approach Study[15,17]. Quantitative evaluation of risk may be very complex. The corresponding methodologies should only be used when a very comprehensive hazard analysis is required.

Hazard analysis for national, provincial or municipal contingency plans

In this case, 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 these industries (or departments within an industry) and interview them, in person or through a written questionnaire, about their activities. The questionnaire should be aimed at establishing the following facts:

Hazardous materials and trade names
Hazardous properties
Product safety information and emergency guidelines
Types of storage/shipping containers
Transportation routes/frequency
Persons to contact for technical assistance
Company accident plans, and possibility of interfacing with community plans.

(c) Identify particularly vulnerable or sensitive areas, in terms of people, property and environment. Fire and police departments are good sources of information when planning at the provincial or municipal level or for large industrial accidents which could spread outside the plant or facility. As an example of vulnerable areas outside the plant one may consider:

<u>Sensitive public health concerns</u>

Drinking water intakes
Vulnerable population centres

Table 1. Sources of hazardous materials

Farm and related industry

- Crop dusting
- Fertilizers
- Pesticides

Petroleum industry

- Bulk consumers
- Producers
- Oil fields
- Refineries
- Storage facilities
- Waste disposers
- Refueling facilities
- Bulk terminals

Transporters

- Airway
- Highway
- Waterway
- Pipeline
- Railway

Chemical industry

- Manufacturers
- Processors
- Distributors
- Recycling plants

Manufacturers (chemical users)

- Rubber
- Paint
- Plastics
- Textiles
- Soap/Detergents
- Any others

Waste disposal

- Sanitary wastes
- Hazardous wastes

Hospital locations

Schools, playgrounds

Sensitive environmental areas

Coastal areas

Wildlife habitats

Parks and recreational areas

Wild and scenic rivers

Historical sites

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). Pre-fire planning, as done by some fire departments[18/], may have led to maps of this type already having been prepared.

(e) Consult records (newspapers, police/fire, civil defence records) for actual industrial or industry-related accidents (no matter how small) and mark them 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: the most difficult part of the whole analysis. One should notice that even very sophisticated techniques based on approaches such as "fault-trees" and "event-trees"[14/] can lead to controversial results. Therefore, when numerical approaches are too complicated or time consuming to be applied, the probability of an accident could also be estimated in terms of qualitative categories such as low, medium, or high risk or even "likely-unlikely".

Examples of high risk factors are:

Past accidents
Major transportation routes
Major industrial concentrations
Transportation routes in urban areas
Drinking water intakes close to major transportation routes or hazardous material facilities
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: all the complications of a really large accident, and the effects of a natural disaster (fire, flood, earthquake) on the ability to cope with the accompanying accident. Secondary effects (such as traffic jams, business closure, reduced availability of manpower for emergency squads) should also be considered as well as the direct problem of accident handling and control.

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 transportation patterns with shippers, and go through a long set of "what if" scenarios to assess plant vulnerability.

Once completed, the hazard analysis should help decide the following things:

The type of contingency plan required
The degree of detail needed
The types of response to emphasize
The location of response and clean-up resources
The type of help needed if resources available do not suffice

Hazard analysis for plant contingency plans

No single ideal hazard identification system exists as systems vary with the type of industry and process. Thus, for example, a firm involved in a batch manufacture of a large number of organic chemicals is likely to be much more interested in techniques of screening and testing chemicals and reactions than one operating ethylene plants.

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 Table 2[19/], but one should be aware that many examples of checklists are available in the technical literature[14, 20, 21/] and 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 method outlined in this reference 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/]. It consists in 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. The examining team often uses checklists during the audit.

Table 2. Hazard analysis checklist

Plant site

(a) Is plant well situated with regard to topography and adequate drainage?
(b) Will the climate or natural disasters materially affect plant operations? (Earthquake, floods, fog, hurricane, lightning, smog, snow ,tornados and very low temperature)
(c) Will toxic fumes from fire, explosion, or other accidents at the plant affect the surrounding community?
(d) Are 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 adequate? (Water, gas, electricity, etc.)
(f) Does the community provide adequate fire fighting personnel and equipment?
(g) Does the community provide adequate ambulance, hospital and police protection?

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, office and laboratory areas, and down wind from ignition sources?
(d) Are hazardous units separated from all critical areas such as control rooms or process computer installations?
(e) Does spacing of equipment consider the nature of the material, the quantity, the operating conditions, equipment sensitivity, the need to combat fires, and the concentration of valuables?
(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 down wind from personnel concentration?
(j) Are there adequate roadways for vehicles for entrance 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 structural steel members and supports insulated so as to be fire resistive?
(d) Have fire spread factors such as openings in floors, walls, elevator shafts, air conditioning and ventilation ducts been minimized?
(e) Are hazardous process areas separated by fire walls?
(f) Are buildings exposed to explosion hazards ventilated according to standards?
(g) Are all buildings properly ventilated to limit toxic and flammable substances?
(h) Are there sufficient and clearly marked exits in all buildings?
(i) Do electrical installations conform to the national electrical code?
(j) Are drainage facilities in buildings adequate?

Materials

(a) Have the quantities of material in all stages of production handling and storage and all physical states been considered in relation to the hazards of fire, explosion, toxicity and corrosion?
(b) Have the pertinent physical properties of each material been determined: melting point, boiling point, vapour pressure, particle size, etc.?
(c) Have the chemical properties of each material been classified?
(d) Have the hazards of the material been classified? Have highly hazardous materials been identified and their location in the plant determined?
(e) Is the material toxic?
(f) Have the stability hazards of the material been determined? (Reactivity, spontaneous combustion, self-polymerization)
(g) Is the material corrosive?
(h) Have the effects of impurities been taken into account as related to fire and explosion, toxicity, corrosivity and stability of the material?
(i) Is the material 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:

a. abnormal temperatures

b. abnormal pressures

c. abnormal rate of reaction

d. improper addition of reactants

e. material flow stoppage

f. equipment leaks or spills

(f) Are emergency measures prepared in the event that the items 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 combustile dusts?

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

(d) Are the unit operation facilities (distillation columns, adsorbers, strippers, etc.) 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 for operator safety?

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

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

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) Are adequate employee training programmes 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 well-operated permit system for 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 encouraged?

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

Equipment

(a) Does each piece of equipment have its own detailed check list?

(b) Are recognized standards used in the design of equipment?

(c) Is equipment designed with adequate safety control? Overpressure? Overtemperature?

(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?

C. Identification of Resources

After the hazard analysis, the next step is to identify the resources, in terms of equipment, people, and agencies, that should be made available to combat possible accidents. The functions and responsibilities of the different response group should be defined. The resources to be identified for the two simplest - resource lists and telephone rosters, and action guides and checklists - are similar to those for response plans, and 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 industries. Standards and regulations already exist for many types of industries, such as refineries[23, 24, 25, 26/]. They may be used in all the stages of plant life, 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 safety, for people, property and 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 then 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 level and the next highest level listed in Table 3. These groups can either provide direct information or references to other sources of information. The accident response capabilities of the various agencies or groups can be determined by asking questions about the following topics:

The person in charge
Personnel assigned: training and skills
Equipment available

Table 3. Contingency planning information sources

Source	Examples
National agencies	Ministry of Industry Ministry of Interior Ministry of Transportation Ministry of Labour Ministry of Energy Ministry of Public Works Environmental Protection Agency Armed Forces Coastguard
Provincial agencies	Provincial Environmental Protection Agency Provincial Police Provincial Fire Marshal Provincial Department of Transportation Civil Defence
Municipal agencies	Mayor/City Council/City Administrator Civil Defence Fire Department Public Works Department - Roads - Water Supply - Sanitation - Flood Control
Industry	Chemical Plants and Petroleum Refineries, as well as Users, Transporters, Storage Facilities Spill Clean-up Contractors Trade Associations Professional/Technical Societies
Voluntary organizations	Red Crescent Red Cross Local Citizens Associations Service Groups
United Nations organizations	UNDP United Nations Disaster Relief Organization United Nations Environment Programme World Health Organization (especially the International Programme on Chemical Safety) United Nations Industrial Development Organization

Existing environmental emergency response plans and activities

Defined responsibilities and duties

Existing mutual aid or interagency agreements

Internal chain of command.

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 accident response capabilities for the area. Once an area's available capabilities are known, assignment of planning 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 furthermore, how that responsibility shifts, and to whom, as more and more resources come into play. If there is a network of contingency plans at different levels and planning is being undertaken at the municipal level, one should determine how the municipal plan will fit into the network and what its limitations are. Hence one should know exactly how far the available resources can go alone, and when and for what reason additional support is 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 assigned, care must be taken to ensure that the assignments are in accord with legally mandated responsibilities and that no contradictions or unnecessary overlapping of duties occur.

The various necessary emergency response functions should be assigned to agencies most logically capable of dealing with them. Some assignments will be obvious, such as law enforcement and fire protection. However, some duties such as transportation or emergency public information services may require some deeper searching in order to determine which agency or agencies is best equipped to handle the situation. A suggested list of emergency responsibilities is given in Table 4.

Table 4. Emergency responsibilities

o Law enforcement services

- City Chief of Police
- Provincial Police Representative
- Army Representative

o Fire protection services

- City Fire Chief
- Volunteer Fire Chief
- Province Fire Marshal

o Communications and warning

- Provincial Civil Defence
- National Army
- Parks Department
- Fish and Game
- Local and Province Police
- Weather Bureau

o Public works engineering services

- City/Province Engineer
- Public Works Director

o Utilities

- Public Utilities Representative
- Private Utilities Representative

o Health and medical services

- City/Province Health Officer
- State Health Official
- Nursing Administrator
- Hospital Administrator

o Welfare Services

- City/Province Welfare Official
- State Welfare Official

o Personnel and financial services

- Personnel Director
- Finance Director

o Damage assessment

- Tax Assessor
- Records Department
- Ministry of Public Works

o Transportation services

- Ministry of Transportation
- Fleet Supervisors
- Parks Department
- Fish and Game

o Emergency public information

- Chief Executive
- Mayor/City Manager
- Province Executive
- Public Relations Officer

o Legal services

- Province/City Attorney
- Attorney General

o Rescue services

- Fire Department
- Police Department
- National Army

o Hazardous Materials

- Civil Defence
- Fire Department
- Environmental Protection Office
- Ministry of Public Works
- Ministry of Transportation

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 that task. Listing the agencies first and then assigning the most appropriate tasks may result in some task being left unattended.

Each task should be attached 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 they 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 that describes detailed procedures governing that agency's response to emergencies.

Chapter 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 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, on 24 September 1977, lightning ignited an eight-million-gallon tank of diesel fuel at the Union Oil Company refinery in Romeoville, Illinois. Subsequently two additional tanks containing two million and five million gallons of gasoline were ignited. The situation was brought under control after two days of fire fighting and delivery of 20,000 gallons of foam concentrate as extinguishing agent. Eighteen fire departments were involved in the operations[32/].

In this and in many other cases the population may be unaffected by the disaster, but the size of the 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 companies 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 members of 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:

- Limit the consequences of an industrial accident in terms of human lives and economic losses

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

Co-ordinate the emergency response actions between the plant and the local response teams

Make available to single industries emergency resources that they would not be able to obtain otherwise

Promote co-ordination activities between local intervention teams

Instil confidence within the industry and the public

Delineate 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 will be on the distribution of responsibilities and tasks among the parties involved more than on the description of specific actions to be taken in case of a major accident. A hazard analysis will be the first step in the planning process, followed by the 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 to commence the planning process. Then the representatives of the other interested ministries or agencies should be brought together in a series of meetings to develop the plan. A suggested workplan is the following: the first meeting would make clear the need for such a plan and how everybody would be called upon to meet expected needs. The participants should be asked how they could assist during an emergency. Some of those present will have capabilities not previously known. They would then be requested to indicate in writing where they can best help. After the meeting, those in attendance would be divided into working committees based on the information they provided.

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

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

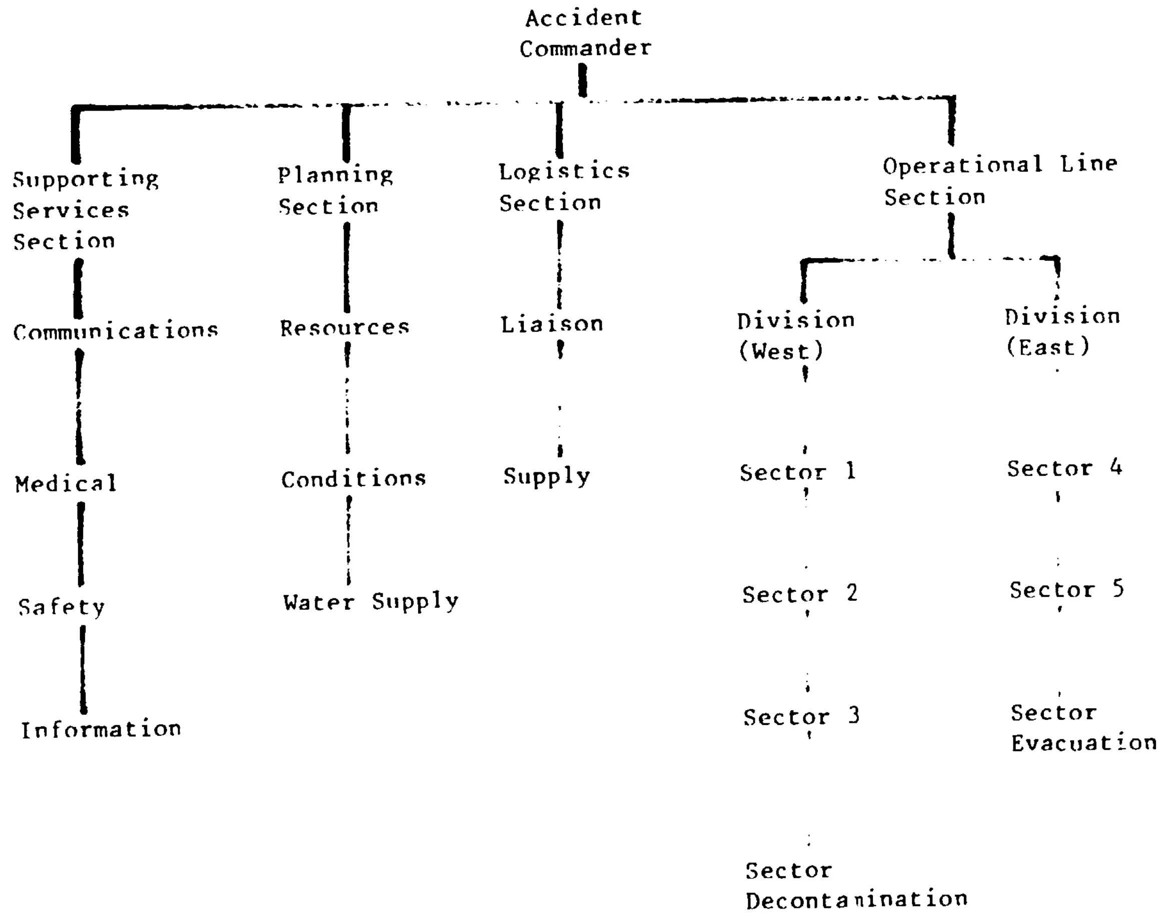
The national contingency plan should include a section for each committee function, such as evacuation or safety, and outline the specific duties of each participant group and of the various divisions and units within that group. For example, the Police Group could contain municipal, provincial, national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

Once each functional group has developed a section of the plan detailing responsibilities and duties, the sections must be 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 would 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 could be carried out during large scale accidents. A suggested organization chart of the command structure is shown in Figure 1.

Figure 1. Organization chart of the command structure



1. Accident commander

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

The commander must co-ordinate fire fighting tactics with other actions such as process or pipeline shutdown, and seek advice from plant or carrier personnel with knowledge or specialized training in handling the products involved. The accident commander must oversee planning for personnel, equipment, and other outside assistance or support. 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 in use of preplanning 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 and the commander should remain in constant radio contact with him.

2. Overall command structure

The accident commander should delegate authority and responsibility at any complex, large accident to line and staff officers. The commander is then free to develop the overall strategy and make the 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 detail 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.

3. 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 about:

The type of operation: control, attack, or withdraw
Resources needed by each group to carry out these operations
Escape routes to safe areas and appropriate retreat signals
Handling unexpected hazardous situations
How long personnel are to stay in action before rotation or being relieved

The operations at large accidents can be divided into geographical areas of appropriate size with division commanders. Sector commanders (Fig. 1) 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 other companies so they do not work against each other. The crew must function as a team; the officer should be concerned at all times with the safety and protection of the crew from exposure to toxic fume inhalation, poison ingestion or absorption, pressure vessel rupture, corrosive action, or explosion.

4. Supporting services section

The supporting services section includes a communications officer, medical officer, safety officer and information officer. They assist the incident 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 handles 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 into the command post and dispatched from it. The operation line commander must provide constant, specific and timely feedback to him.

The communications officer should obtain a detailed list of telephone numbers of local people (such as MD's) 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 an entire 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 victims.

The medical officer must also co-ordinate with a coroner on identification procedues, removing bodies, and establishing a temporary morgue. In situations of lesser magnitude the duties of the safety officer and the medical officer may be combined.

Safety officer. The safety officer is responsible for the life safety of everyone: emergency response personnel at the scene, the public in the area and spectators. He 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 to identify danger. The safety officer must have the authority to stop unsafe operations immediately if deemed 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 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 proper and 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.

5. Planning section

The planning staff consists of the resources officer, conditions officer, and water supply officer. They 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 and keeping track of their assignments, and supplying the accident commander with current resources, including what companies are actually available for assignment. He also maintains the chart of the command post staff assignments.

Conditions officer. The conditions officer keeps record of what is happening on the scene and prepares progress reports of the situation for the accident commander. The reports should include the area involved, 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, which would detail 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 preestablished. Records of all decisions should be clear, establishing who made it, and why. Records will assist in planning for the next accident and point out areas in need for improvement. They will also serve as a justification for any monies 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, main sizes, hydrant locations, and flows available in various areas. The water supply officer will need to know apparatus capacities, locations, number of lines in operation, pressure drops, residual pressures, available hose, and discharge ports. His duties overlap the duties of line operations.

6. Logistics section

The logistics section consists of the liaison officer and supply officer. This section is responsible for providing personnel and material for the duration to control the hazardous material emergency.

Liaison officer. The liaison officer co-ordinates the actions of the outside agencies who can offer assistance to the emergency response team. The officer should know who represents the various agencies and where and/or how to contact them.

Some of the agencies with whom liaison will be maintained include law enforcement; rescue or emergency medical services; local government officials; utility company personnel, especially water, sewer, telephone, and electrical; health officials, hospitals, and ambulance services; the city lawyer for legal advice, if necessary; local, environmental agencies; local contractors for heavy equipment; service groups for facilities if evacuation of large numbers is necessary; manufacturers' representatives or trade association officials who respond to 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 will acquire, store, and record 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 must then inform 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 would be: breathing apparatus; generators and lights for nighttime 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 could include lime, soda ash, and chlorine bleach to name only a few); normal supply of gasoline, diesel fuel and oil.

C. Actions under the National Contingency Plan

National contingency plans are comprehensive plans geared towards the organization of the emergency resources rather than the 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 indications are given below.

1. 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 arrive at the scene of the accident and begin 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 the 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 authority in charge of activating the plan will be, in general, a high ranking officer of the administration, most likely in the Ministry of Interior, or any equivalent authority. Alternatively, this authority can be delegated to the representatives of this ministry at the provincial level, in order to accelerate the whole procedure.

The authority who activates the plan is also the person in charge of the operations. This command responsibility may be delegated to another officer especially designated for this job.

2. 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 advanced command post could 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 advanced command post. The reports should include the current accident situation and control probability, any 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.

3. 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. Therefore a detailed account is 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 possible unknown products, places that cannot be seen or easily reached (a train may be a mile or longer in length), allowing responding units to become committed before being given a definite assignment, difficulties in co-ordinating multiple companies, multi-department or multi-agencies operations, and hesitation in decision making.

4. Evacuation

Evacuation is considered to be the removal of all private citizens, including public officials, press, nonessential employees or officials, and all non-working emergency response personnel from the immediate area of danger.

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 one mile. In larger metropolitan areas evacuation in all directions for one mile would be a major untertaking 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:

How to alert the people effectively?
How to handle persons who will not want to move unless they can see the imminent danger?
How will large groups be moved? (for example, Chicago once had to evacuate 16,000 persons from a silicone tetrachloride cloud[32/])
How will persons in the area be moved if they cannot drive because of visibility?
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.

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

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

How will they be trained for search and evacuation?

The personnel to do evacuation work may be a critical factor. In many situations the fire service will be concentrating on the control of the situation and will only be able to complete evacuation in the immediate proximity of the emergency. Police lines should be set up at the designated perimeter and no one allowed into the area. Police should also take care of the evacuation procedure.

5. 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, thus 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 lights or power for vital operations while awaiting the intervention of the power company people. Numerous other services requiring the assistance of the fire department and co-ordination of the accident commander might be necessary to bring the accident 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 of the country, the government could make a census of the local industries[33/].
Questionnaires and plant inspections by technical government representatives could be utilized for this purpose in order to learn:

1. Information relating to the installations, such as:

Type of industrial activities
The geographical location of the installations and predominant meteorological conditions and sources of danger arising from the location of the site
The maximum number of persons working on the site of the establishment and particularly of those persons exposed to the hazard
A general description of the technological processes
A description of the 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
The arrangements made to ensure that the technical means necessary for the safe operation of plant and to deal with any malfunctions that arise are available at all times

2. Information on the substances present at the installations, such as:

Substances stored or used in connexion with the industrial activities
Final products, by-products and residues
Data on substance identification (i.e. chemical and trade names, empirical formula, composition and degree of purity)
The stage of the activity in which the substances are involved or may be involved
The quantity (order of magnitude)
The chemical and/or physical behaviour under normal conditions of use during the process
The forms in which the substances may occur or into which they may be transformed in the case of abnormal conditions which can be foreseen
If necessary, other dangerous substances whose presence could have an effect on the potential hazard presented by the relevant industrial activity
Detection methods available at the installation
Methods available at the installation for rendering the substance harmless
Indication on hazards to man and environment

3. Information relating to possible major accident situations, that is to say:

Emergency measures laid down by the manufacturer in the event of accident dispersion of dangerous substances mentioned in item 2

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

Any information necessary to the competent authorities to enable them to prepare emergency plans for use outside the establishment

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 authorties

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 the recurrence of such accident. Examples of serious accidents are:

Any accident which causes death or results in disablement for more than a given time (e.g. 3 days) from a person's regular job

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)

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 oppositely delegated agency and be concerned with:

Type of accident (explosion, fire, toxic release)

Description of the circumstances of the accidents

Dangerous substances involved

Nature and extent of damage to persons' properties and environment, both within and outside the plant

Causes of the accident

Data available for assessing the effects on man environment

There are certain industrial activities which are more liable than others to cause major accidents. The government could recognize this by means of a legislative act which classifies industries according to the threat they pose to man and environment. This classification could divide industrial activities in broad groups (e.g. chemical industries) or narrower groups (e.g. explosive manufacturing industries). Then, regulations could be set on 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 drawn for specific processes such as sulphuric acid or caustic soda manufacturing.

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. Periodical 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 as part of these protective measures and be required ,at least, to 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.

If existing, the Ministry of Civil Defence (or any equivalent governmental agency) will most likely be put in charge of establishing contingency plans for major industrial accidents, as a part of a general scheme concerning the assistance to the populations affected by natural or man-made disasters.

Legislation on transport of hazardous material deserves special attention because of the most likely international implication. If not previously agreed upon, each country may require that dangerous good arriving at its frontiers be properly packed, labelled and carried according to its own peculiar national regulations. Therefore international agreement should be established concerning:

The list of substances prohibited for transport by road or by any other means

Special measures to be adopted when transporting certain classes of material

Special requirements for the construction of the carrier vehicles, train cars, or barges

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 only be utilized 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. Therefore this chapter can also be utilized for this purpose.

F. Hospital contingency planning

The number of casualties caused by a major emergency could be so elevated in some cases, that the local hospitals may be overburdened. Therefore, each hospital management should also develop a contingency plan so that all the available resources may be mobilized and properly used in such events.

Although a detailed presentation is beyond the scope of this document, a hospital contingency plan should include a telephone roster of all the medical personnel listed according the 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/]. The plan is updated annually. In recent years the plan has been activated five times due to emergency admittance of fifteen or more persons following an accident. One accident involved 17 injured persons resulting from the transport accident of a truck carrying inflammable industrial gas. In another accident 33 persons were admitted after inhaling chlorine gas released in an accident at an industrial plant.

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

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

- Co-ordinate and unify the actions of different governmental ministries and agencies in case of a major industrial accident
- Establish the authority(ies) responsible to declare a major emergency
- Identify the responsibilities of the different ministry or agencies involved
- Identify the resources that could be mobilized if necessary
- Establish how responsibilities shift as more resources intervene to combat the accident
- Establish how provincial, municipal and plant contingency plans are going to fit into the national plan
- Identify and organize the different services or sections in charge of implementing the plan (e.g. the supporting services, logistic, planning sections)
- Define the procedure to be followed to update the plan and carry out training exercises
- Identify the funds available to cover the expenses incurred as a result of the emergency operations

Chapter 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 nation to industrial emergency situations.

In many countries companies are under no legal requirements 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 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:

- Familiarize personnel with the plant, layout, fire fighting equipment, and special tasks to be performed during an emergency
- Instil confidence and reduce panic when an emergency occurs
- Reduce casualties among plant workers and/or members of the public
- Reduce liability compensation due to casualties and/or outside damages
- Limit damage to the plant
- Help identify existing hazardous processes, materials or procedures
- Suggest new methods of reducing hazards (e.g. introducing new safety devices, working devices or procedures)
- 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/]:

- Rescue and treat casualties
- Safeguard other people
- Minimize damage to property and environment
- Contain and control the incident
- Identify any dead
- Provide for the needs of relatives
- Provide authoritative information to the news media
- Rehabilitate affected areas
- 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 those 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 Table 2). However, even the most appropriate and accurate checklist will not be effective in identifying hazards in the plant unless: (i) it is used (and not left on a shelf), and (ii) used properly so as to ensure nothing has been neglected and 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 or procedures are systematically more hazardous than others. Examples are[36/]:

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

Sources of process upsets, and process start-up, shutdown and clean-up procedures

Equipment and storage tank diking, surface drainage routing, and sewer system layout

Past history of individual departments with spillages

Proper personnel training and orientation may also reduce accidents. A study on the subject[36/] 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:

Population densities in the areas likely to be affected
Location of the incident in relation to built-up areas and
other sources of hazard, such as neighbouring plants or tank farms
Prevailing winds
Possible contamination of drains, crops and water supplies
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:

Where, whithin 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?

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

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

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 reason 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 the shift managers may be are 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 ambulance 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 firefighting 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:

Providing extra first-aid services to deal with casualties
Performing emergency engineering work, such as the provision of extra or replacement lighting, isolating equipment, and providing temporary by-pass lines
Transporting equipment to the accident from other parts of the works
Moving tankers or other vehicles from areas of risk
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, in so far 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. An emergency control 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 the centre to plan accordingly.

An emergency control center should therefore contain:

An adequate number of telephones
An adequate number of internal plant telephones
Radio equipment
A layout of the plant showing:

- Areas where there are large inventories of hazardous materials, such as tanks, reactors, or drums, as well as the location of compressed gas cylinders
- Sources of safety equipment
- Fire-water system and alternative sources of water
- Stocks of other fire-extinguishing media
- Works entrances and road system, updated at the time of the emergency to indicate any road which is impassable
- Assembly points and casualty treatment centres
- Location of the plant in relation to surrounding community

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

- Areas affected or endangered
- Deployment of emergency vehicles and personnel
- Problem areas such as factured pipe-lines
- Areas evacuated
- Other relevant information

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

Nominal roll of employees

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:

- Size and complexity of the plant
- Number of employees
- Materials handled

Nature of the process

Location of the plant

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 possible 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 the 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:

1. 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 are given further instructions. If the alarm and its message are kept simple, people will tend to react calmly rather than panic[37/].

2. 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 the 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.

After evaluating the situation, the squads may choose to do one of two things: attack the fire until it is brought under control or ask for help through the emergency control centre, and begin rescuing the injured if any.

3. 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 recognise a major emergency or its potential.

4. Making the emergency known

a. Inside the plant

It is important for everyone to know that 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 re-sounding the alarm over an extended period. Alternatively, it may be considered that a separate major emergency alarm, having a signal readily distinguished 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 considered, 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 make known by other methods, and many plants adopt this approach. In such cases, a site-wide alarm activitates the emergency procedures whereby:

All members of the work return to their normal place of work, provided it is safe for them to do so

Those in charge of plants and departments and who are not nominated as key personnel go to their normal offices to await instructions from the plant emergency control centre

Senior managers nominated as key personnel report to the plant emergency control center 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.

b. 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 high risk plant and 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. Local discussion with the outside services will help decide, 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.

c. 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 address and 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 their traffic control arrangements.

d. 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 a 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 extra supplies 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.

5. Taking action at the plant in case of a major emergency

a. 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 in Section 2 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.

b. 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. On small plants, or at plants where a 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 has been effected.

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:

To ensure that employees do not have to pass through the dange-zone to reach the assembly point

In case any assembly point lies in the path of wind-blown harmful materials, e.g. toxic gas or burning brands.

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

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

6. Taking actions 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 buring 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 by 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 to estimate as far as practicable which downwind areas are at risk. It may be necessary to prepare in advance simple charts or tables relating the likely spread of the vapour cloud taking into account its expected buoyancy, the 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 has to be halted or diverted. The responsibility for controlling road traffic flow rests with the police, taking account of 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.

7. 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, flame-cutting equipment until it has been established that no flammable materials remain where they could be ignited.

E. Example of a response action: handling a storage tank fire[32,39/]

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 one product is stored in the tank. (Is it compartmented?).

Step 3. Refer to the various reference sources to determine the hazards, physical properties, and extinguishing methods and agents for the identified product:

Effect on humans (special protective equipment needed? evacuation?)
Effect on the environment (streams, ground water, air)
Specific gravity
Water solubility
Water reactivity
Flash point
Reactivity problems
Explosive limits
Polymerization
Extinguishing agents or effective cover which will reduce hazardous vapors

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

Step 5. Determine the types of storage tanks, their safety features, shutoff valves and dike drain valves.

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

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

Phase II. Decision-making and emergency procedures

There are three actions that could be taken:

Alternative 1. - Attack the fire

Alternative 2. - Contain the fire and let it burn up the fuel

Alternative 3. - Withdraw emergency response personnel.

Alternative 1: Attack the fire.

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

Step 1. Evacuate the downwind area 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 including spectators at least one mile away.

Step 4. If there is a gas leak without a fire, use hose streams to disperse the vapor. 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, then 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, civilians, 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. Incident 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. Based upon the type of construction of the tanks, the attack will vary. 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 vapuor pressure products, such as carried in spheriods cannot be extinguised by any fire fighting agent or device now known. Furthermore, if such a fire could be extinguished to do so in most cases would create greater hazards than the existing fire itself, since the unburned vapour might accumulate at other locations. Therefore, the most effective means of controling fires in these products is to use plenty of water to keep exposed property cool and shut off 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 vent or broken line is playing blow torch flame on steel above liquid level, direct streams of water on this spot. If this cannot be done quickly, stay clear of rupture of the container which is almost sure to occure from heat weakening of the steel. Water is very effective in cooling steel in such cases.

Step 4. By all means 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 sizes can be extinguished by use of dry chemical extinguishers. On large fires of this kind, water fog of spray should be used to protect the approach and cool steel or extinguish wood and rubbish fires against reignition of the gas before source of flare or gas can be cut off. If flow is not cut off, vapors 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 the possibility of intervening with Alternatives 1 or 2.

Chapter 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 plan 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:

- Raising the alarm
- Identification of the hazardous materials involved in the accident
- Immediate actions to be taken at the scene of the accident
- Accident information and control network
- Direction of emergency operations
- 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 that. 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 that they can contact other emergency response team 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 harzardous material accident one of the first things to be determined is the material involved. 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:

To provide an immediate warning of potential danger
To inform the emergency response personnel of the nature of the hazard
To indicate any required protective action
To minimize possible injurious effects if exposure to the product does occur

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

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

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

Several placarding and labelling systems already exist in many nations, and continuous efforts are made to standardize some of them at 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[40/]. Some of these systems will be described in the remaining of this section.

1. United Nations Classification System

The United Nations Organization (UN) has established a standardized class number system for hazardous materials[40/]. Some countries have adopted the system and require that all imported goods be properly labeled. 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 liquified, dissolved under pressure or deeply refrigerated

Class 3. Inflammable liquids

Class 4. Inflammable solids; substances liable to spontaneous combustions; 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 2 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 Figure 2. The labels are divided into halves. The upper half of the label is reserved for the pictorial symbol and the lower half for the class number.

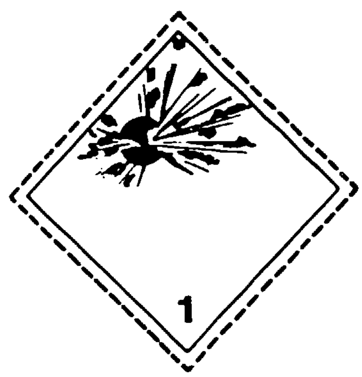
The UN placarding system is very similar to the labeling system. The major differences consist in the minimum size of the placard (250 mm by 250 mm) and the display of the UN identification number (except for goods of Class 1). For more details, see reference 40. The UN identification numbers for an 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 (U.S.A.)

This placarding and labeling system[32/] closely resembles the UN system. 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 UN system, the only difference being an inscription in English (such as "Corrosive", "Flammable" or "Explosive") appearing within the placard. No UN identification number or equivalent material identification number is.

Figure 2 Specimen labels (UN system)

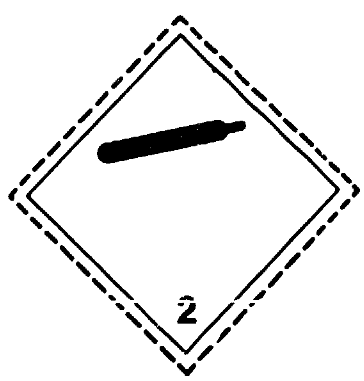
Class 1



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

Figure 2 (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

Figure 2 (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

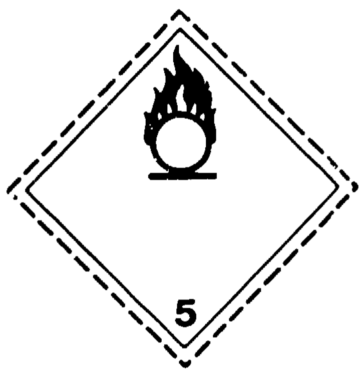
Division 4.3

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

Figure 2 (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

Figure 2 (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

3. HAZCHEM Scheme (U.K.)

This is a rather comprehensive system currently used in the United Kingdom[14,41]. An example of a placard is given in Figure 3. With reference to this figure, each placard is divided into four main sections containing the HAZCHEM action code (2YE), the UN 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 UN 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 (e.g. 2YE) 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 4 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 UN system. Two placards are used instead of one. The first placard consists of one of the diamond-shaped UN hazard symbols. The second placard is orange and contains two numbers one above the other. The bottom one is the UN material identification number. The top number is made up of two digits, the first representing the UN class and the second an additional hazard index if the material presents more than one hazard[34].

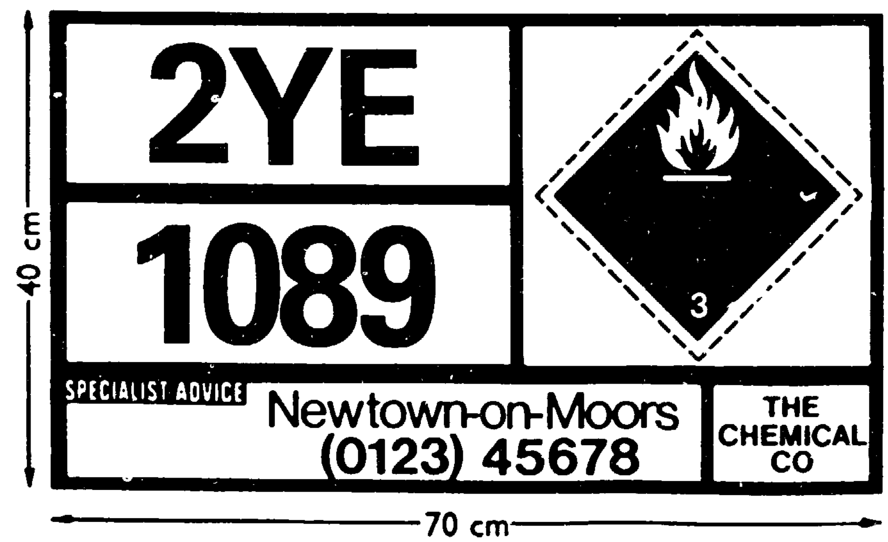
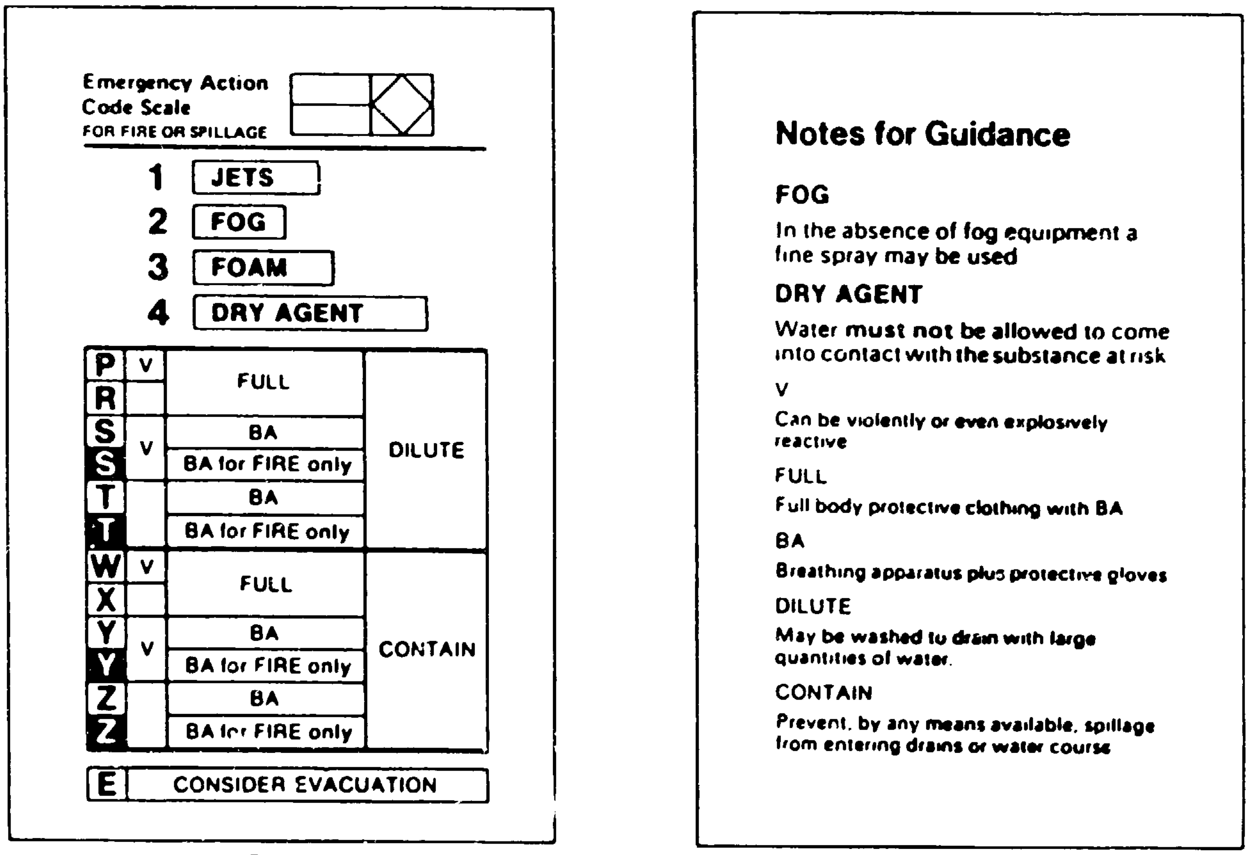


Figure 3 HAZCHEM placarding system (UK)

The panel illustrated is for acetaldehyde



Front Back

Figure 4 HAZCHEM card (UK)

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 insure maximum immediate response effectiveness:

Drivers and engineers should be adequately protected
Appropriate emergency equipment should be carried on board
Simple and adequate emergency instructions should be carried on board and be easily accessed.

Certain requirements for construction of vehicles or train cars will help assure driver safety. As an example, there should be a fireproof screen between the tank of a tank truck 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 a double-pole switch close to it[14/].

The vehicle or train should carry a tool kit, emergency lighting and first aid equipment. Protective clothing and breathing equipment may also be carried. The fire estinguisher 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 along 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[14,41/]. 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 necessay 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 5.

CEFIC TEC (R)-1
April 1979, Rev 1

TRANSPORT EMERGENCY CARD (Road)

Class 2 ADR
item 3at
UN No. 1005

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

—Notify 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

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 o sewer or been spilt on soil or vegetation advise police

Keep containers cool by spraying with water if exposed to fire

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 m st lie down and keep quite still
Keep patient warm
Apply artificial respiration only if patie nt 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

Applies only during road transport

E h

Figure 5 TREMCARD system

If the immediate actions taken by the truck driver or train engineers are not sufficient to keep the accident under control then external response teams must intervene. The placard or label system may greatly help these teams 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:

Shipper's name and address
Consignee's name and address
Proper shipping name
Proper classification of the shipment
Total quantity by weight or volume
A certification by the shipper that the shipment has been properly prepared.

The United Nations have also developed their system for documenting the shipment of dangerous goods[40/]. Accordingly, the basic items of information considered necessary for the identification of a dangerous substance transported by any mode are:

The proper shipping name.
The class or, when assigned, the division of the goods (see also reference 40). 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.
The United Nations serial number assigned to the substance or article.
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 UN dangerous goods declaration form is given in Figure 6.

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 should 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 these 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 centers 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[42,43/].

These centers 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 center should be able to tap many other sources to obtain information.

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 6 UN dangerous goods declaration

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:

Name of caller
Means of maintaining the contact
Place and time of accident
Shipper
Manufacturer
Container type
Rail car or truck number
Materials involved
Type of problem
Injuries or deaths
Surrounding area (open country, town)
Weather conditions
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 centers 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.

E. 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 tranport accidents falls in 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 it is 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[44,45]. In this accident a train consisting of 157 cars including 8 containing vinyl chloride monomer (VCM) derailed near the town of Glendora, Mississipi, (U.S.A.). 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 populaton 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 posteriori judgement of the accident revealed that the phosgene poisoning risk actually run by the population was marginal.

F. Emergency teams and procedures

Unless properly informed on the nature of the hazard and equipped to fight it the role of police and city fire fighters should be limited to evacuation of the population (if necessary) and containment of spills and/or fires. A more specialized emergency team should intervene in any other case. The 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 have expertise 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[44/]. 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:

Chemical data
Protective clothing
Breathing apparatus

Safety harness and line

General tools and flashlights

Leak plugging equipment (e.g. wood plugs)

Analytical equipment

Floodlights with generators

First aid kit.

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 reported in the following[32/].

1. Guidelines for handling oxidizer accidents

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

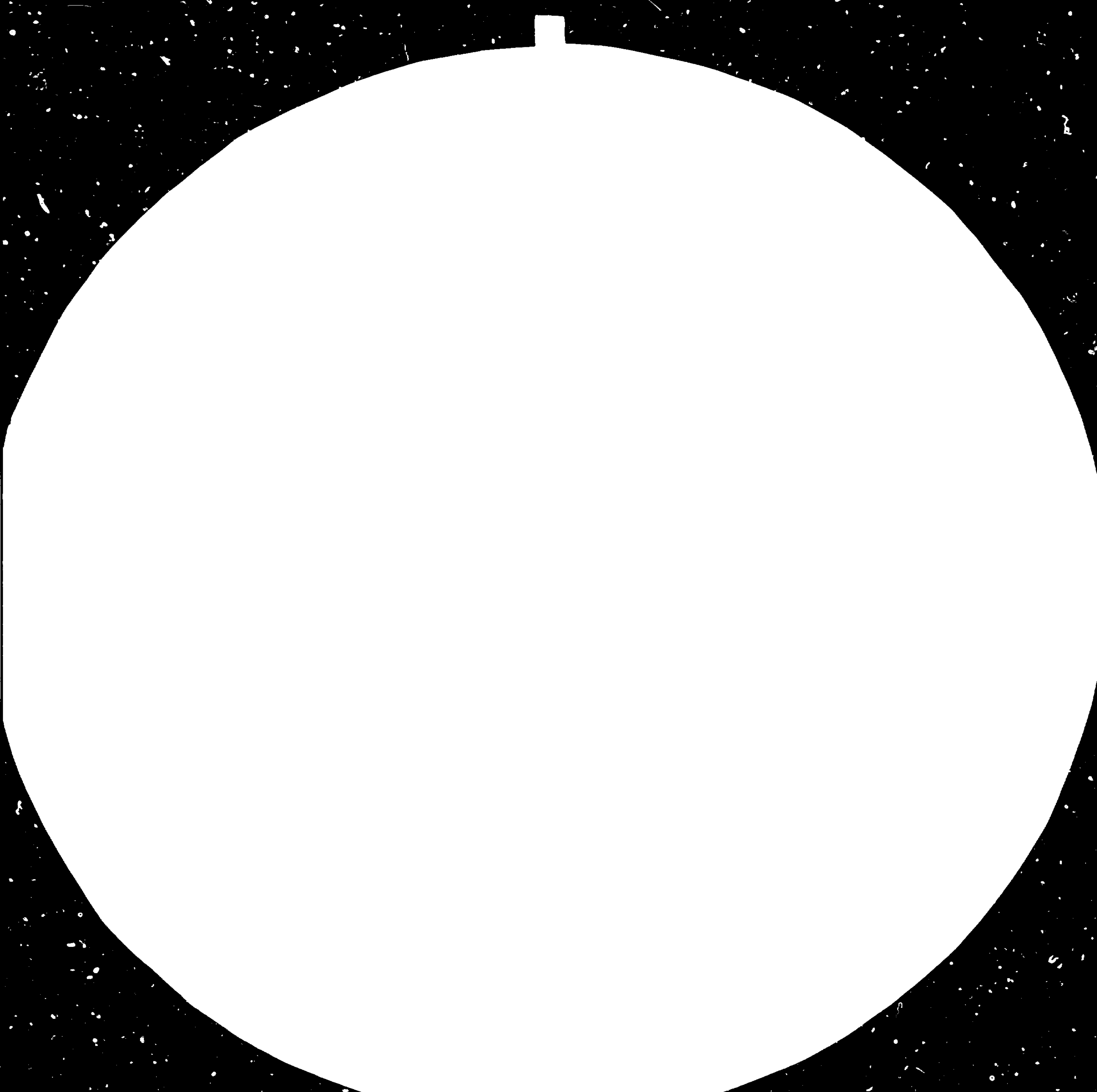
a. Evacuate personnel from surrounding areas.

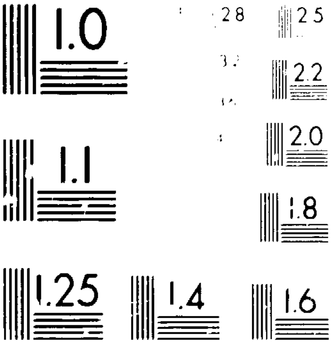
b. Try to identify the product involved. Use reference sources to determine hazard.

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





MICROCOPY RESOLUTION TEST CHART

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

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. Then, as the material dries out, it could possibly 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. The generalized procedures for handling the accident are detailed 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, unnecessary emergency response personnel, and sightseers 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 immediately stopped. This must be carefully followed because the vapors 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 Vapor 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, then 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 generalized procedures are given for handling the incident:

Unignited Leak

a. Evacuate personnel downwind and downhill from the leak. Use caution in locating and 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 vapors. If possible, the spill should be covered with a foam to reduce vapor 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. Coordinate 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.

Chapter VI. A 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 these sections. Table 5 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 to planners a set of guidelines mapping out what can be included in different types of plans[6/]. With reference to Table 5, the detailed plan sections are now examined and described.

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:

Brief (never more than one page in length)
Easily accessible (Locate 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)

Table 5. Contents of different contingency plans

Sections	R.L. + T.R.	A.G	R.P	C.P
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:

R.L. + T.R. - Resources and Equipment List and Telephone Roster
A.G. - Action Guide,Checklist
R.P. - Response Plan
C.P. - Co-ordination Plan

1 - Recommended
2 - Optional
NA - Not Applicable

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

The following is a sample of the type of information included in the emergency response notification section:

24-hour emergency response telephone number and/or method to raise the alarm.

Emergency reporting information

Caller's name, telephone number, identification
Location and source of accident
Material involved and amount thereof
Time of accident
Area and/or waterbody endangered
Personnel at scene
Actions initiated
Shipper, manufacturer identification*
Container type*
Railcar/truck identification numbers*
Placard/label information*
*Applicable to transport accidents

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. <u>Records of amendments or changes</u>

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 a 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:

1. Notification of emergency
2. Initiation of actions
3. Co-ordination of decision-making
4. Containment and countermeasures
5. Clean-up and disposal
6. Restoration
7. Recovery of damages
8. Follow-up
9. Special response operations
10. Agent-specific considerations

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

i. Notification of emergency

An industrial accident, within 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 a plant key personnel, for accidents occurring in an industrial facility, or to the proper governmental agency, for accidents occurring outside the plant or spreading out of 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:

Repeat and reinforce any item listed in the response notification section
Offer any explanation, discussion or special comments on those items
Add any item that has not been included in the response notification sections such as:

type of aid required
person to contact on scene
observed behaviour of fire and/or material involved in the accident
weather and local terrain conditions
population of area
anticipated movement of spilled material or fire.

In some country 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:

Establish on-scene authority, i.e. who is in charge
Establish command post and communications network
Identify material (from labels, shipping papers, placarding, etc.)
Determine hazard threat (workers and public safety, environmental, property, etc.)
Warn plant workers and employees and/or public
Activate emergency response teams
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 subsection. In any other case (i.e. for larger accident requiring external help) at least two or more agencies are likely to be involved (local police and fire personnel). 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:

First and foremost, who will be in charge
What will be the chain of command
Who will maintain the command post
When will the on-scene authority pass to another level and who will be the new official responsible
Who will have advisory roles
Who will have the technical say-so on response actions
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 competed with whatever actions the planner estimate to be most appropriate:

Evacuate workers and public from danger of explosion, poisoning or direct fire exposure

Fight fire (if any); avoid hazard to firefighters, and let it burn out if prudent

Shut off or isolate sources of hazardous or flammable materials, whenever feasible

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

Contain spilled materials

Contact manufacturer of hazardous material in case of transport accidents

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:

Determine clean-up responsibility

Determine availability of approved disposal sites

List temporary storage sites

6. Restoration

The purpose of this response phase is to restore the environment, to such an extent as 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 items:

Determination of liability (witness statements and photographs may be required)
Extent of damages (short and long term monitoring may be required)
Recommended remibursement procedures
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.

(a) 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[46/]: "It is more important to know when not to put a fire out than to know the details of actual extinguishment".

(b) 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.

(c) When hazardous chemicals are handled, guidelines are required to deal with spills and hazards (such as fire and toxic release of gases)[47/].

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 telephone numbers and 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:

- Authorize preparation of a plan
- Require accident notification
- Determine liabilities
- Impose penalties
- Require clean-up
- Define governmental responsibilities
- 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 in a correct and up-to-date manner. 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 the changes. 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 account for 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. This section should contain some basic reference techniques for fighting the most

likely accidents expected in a particular industry or area.
References[48, 49, 50, 51] could be used as sources of information concerning hazardous material spills, surface transportation accidents, fire protection and hazardous material, or spill clean-up techniques.

N. Resources available

This section should contain three important pieces of information:

What types of resources are available in case of emergency
How much material and equipment is stockpiled
Where it is located (including the way it can be obtained if necessary, address and telephone numbers)

A comprehensive list of resource items could include:

Fire fighting equipment (both fixed and mobile)
Hazardous material spill clean-up equipment
Communication equipment
Emergency transportation (land vehicles, boats, aircraft etc.)
Response personnel
Personal protective equipment
Approved disposal sites for hazardous materials.

When preparing a plan at the plant level it is advisable to include 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. Vice versa, when planning at the municipal, provincial or national level, private resources should also be included besides those of public agencies such as fire department, police, and civil defence.

Resource availability will change with time so 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 advice on chemical toxicity, reactivity, and environmental damage, and public and private laboratories may be equipped to perform chemical analyses for monitoring purposes or for determination of unknown spilled substances.

This section should identify the various scientific groups 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, Government 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 reference may be annotated to supply additional information about reference contents.

The following are some of the types of publications to be included:

General references, such as pertinent laws, legislation, regulations and contingency plans operating in the area
Specific technical references
Maps, including land use, topographic and streams, 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 a 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 lending 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:

Initial accident report: it reports the initial specifics of an accident, such as type, time, location, materials involved, source of accident, health hazards response teams intervened, agencies contacted and comments.

Chronological log: it maintains a minute-by-minute account of the accident response activities such as emergency response team activiation, calls for help outside the plant.

Final accident report: it summarizes the total event including cause of accident, accident critique, damage assessment, expenditures, and liability conclusions.

Investigative report: it is the foundation for civil action against the accident responsible individuals or companies. 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, 40, 49, 52]:

- Listing of hazardous materials
- Technical information
  - Chemical properties
  - Physical properties
  - Measurment techniques
  - Toxicological data
  - Response personnel safety data
  - Recommended fire-fighting techniques (if not already mentioned in previous sections)
- 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 exercises may be threefold:

- To test the adequacy of the plan
- To train personnel
- 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.

Chapter VII. CASE STUDIES: LIBERIA AND SENEGAL

LIBERIA

A. Introduction

A field mission to Liberia was carried out by a UNIDO consultant during the period 2-23 September 1983. The purpose of the mission was to document the existing situation in Liberia concerning the preparedness and capability of intervention at national, provincial municipal and plant level in case of major industrial accidents. The consultant carried out an assessment of the hazards present in some of the major industrial establishments in the country and, when possible, advised the local responsible officials 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 UNDP office in Monrovia established the initial contact between the consultant and the local government officials. The Liberian government counterparts were officials of the Ministry of Planning and Economic Affairs, Mrs. Estelle Liberty, Director of Economic Planning and Ms. Louiza Reeves, Research Officer. They proved to be of valuable help in contacting the representatives of the local government and industries.

The consultant and a counterpart visited a number of ministries and industrial establishments in order to collect relevant data and information.

The previous UNIDO study "Survey of marine pollutants from industrial sources in the West and Central African region"[5/] and the associated country survey of Liberia[53/] were used as a general source of background information.

B. General information on Liberia

1. Population and employment

The population of Liberia was estimated to be 1.9 million people in 1981 with a density of some 43.6 inhabitants per square mile. In 1985 the projected population will be about 2.2 millions[54/].

The employment structure is presented in Table 6. 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 Liberian economy is still predominantly agrarian (see Table 6). Monetary agriculture, which includes the agricultural concessions and plantations, and forestry accounts for some nine 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)[54/].

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 tons/year[54/].

The manufacturing sector includes some 850 registered manufacturing establishments, mainly concentrated in the Monrovia area[54/]. They are all private except for 24 joint ventures and four 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

Table 6. Estimated employment structure distributed by major industry divisions as at 31 December 1980[54]

Major Industry Division	Number Employed	Distribution by Per Cent
1. Agriculture and Related Activities*	538,000	79.6
2. Mining and Quarrying	17,500	2.6
3. Manufacturing	11,000	1.6
4. Electricity, Gas and Water	1,450	0.2
5. Construction	8,000	1.2
6. Wholesale/Retail Trade, Restaurants and Hotels	32,000	4.7
7. Transport, Storage and Communications	15,600	2.3
8. Finance, Insurance and Business Services	1,650	0.2
9. Government Services	32,000	4.7
10. Other Services	18,800	2.8
11. All Industries	676,000	100.0

*including monetary agriculture

400 people. Some 25 industries of this group manufacture chemical, plastic, petroleum and other non-metallic mineral products employing some 20 per cent of the labour force of the medium and large industry group. With a few exceptions, only semi-processing or assemblying plants exist in Liberia.

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 Monrovia area and produced by a government-owned enterprise. Due to age and attendant defects, the available capacity in the Monrovia area is probably much less[54/].

4. Development plans

Two four-year development plans have been elaborated by the Liberian government. The first covers the period 1976-80. The second covers the period 1981-1985[54/].

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 are located in the Tokadeh, Grangra and Ymelliton regions (estimated reserves 530 million tons) are exploited. The capital expenditure for new facilities and equipment is expected to be $296.4 million during the years 1983-85. Additional funds are going to be infused in the rehabilitation of the National Iron Ore Company (NIOC) which, at present, is not financially viable. A consortium of banks has already granted a $64.1 million loan in 1982.

There are three programmes in the Second Plan aimed at promoting and supporting industrial development both in the public and private sectors: Monrovia Industrial Park, Liberian Industrial Free Zone, and Small and Medium Scale Enterprise Department. The Monrovia Industrial Park and the Free Zone are areas devolved to industrial development and operated under the management of special institutions created by the Liberian government. The areas should be provided with utilities and infrastructure facilities to accommodate industrial establishments. The Monrovia Industrial Park has nine manufacturers . It is proposed to spend further $3.1 million to improve and expand its infrastructure. Additional $3.8 million have been made available to improve and enlarge the Industrial Free Zone facility.

The Small and Medium Scale Enterprise Department assists Liberians in establishing and managing small and medium scale industries throughout the country Assistance to the enterprises is given in a package including 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 1982-85.

C. Contingency planning in Liberia: the national, provincial and municipal levels

The consultant obtained information on this subject through interviews with officials of the following ministries and agencies:

- Ministry of Commerce, Industry and Transportation
- Ministry of Finance
- Ministry of Internal Affairs
- Ministry of Justice
- Ministry of Labour
- Ministry of Land, Mines and Energy
- Ministry of Planning and Economic Affairs
- National Fire Service Bureau
- National Investment Commission
- National Port Authority
- Liberian Industrial Free Zone Authority

At present the capacity of the country to respond to a major industrial accident appears to be rather limited in terms of resources and equipment, and response structure and organization.

Liberia does not have a code of laws dealing specifically with the prevention and combatting of industrial accidents. A Civil Defence Division or Bureau does not exist.

A National Disaster Relief Commission was created in 1976 in order to co-ordinate the actions of different ministries in case of national disaster. The commission was never operational. 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 National Army.

Liberia 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 is present 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 Liberia, some industrial parks have been created in the neighbourhood of Monrovia such as these 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 (Monrovia Freeport and Industrial Free Zone) have set up a code of rules and regulations dealing with industrial safety[55,56]. As an example, the National Port Authority (NPA) in charge of the Freeport area has a general set of guidelines to deal with dangerous goods such as calcium carbide or tetraethyl lead. As for the transport and handling of other dangerous goods within the Freeport area, NPA refers to the US Maritime law which is explicitly declared to be the maritime law adopted by the government of Liberia.

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 Monrovia Freeport and the Industrial Free Zone have at their disposal a team of internal fire fighters who can intervene in case of industrial accidents.

The National Investment Commission (NIC) was created in 1979 with the broad mandate of co-ordinating the investment policies in Liberia and promoting its development. NIC is in charge of reviewing the applications for any new large investment in the industrial sector. New projects are examined by NIC mainly from an economic standpoint, but a technical committee within NIC also exists. The committee, which is formed by representatives of NIC 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 Liberia 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 inflammable goods such as gasoline[57]. Other dangerous goods, such as toxic, corrosive or poisonous chemicals, are not mentioned. The implementaton 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 yearly publishes statistics on industrial accidents, on the basis of the requests filed for workman compensations[58/].

Liberia 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 elaborate 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, the local units of the army, and other relief organizations (such as the Red Cross).

The statutory duties of the fire fighters are fire prevention, and fire fighting and rescue[59/]. 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 Liberia Fire Code. A fire certificate should be released by the fire department before starting the operation at any new industrial establishment. In practice, the enforcement of the fire code is rather difficult because of the lack of resources in terms of both men and equipment.

This problem also seriously affects the fire fighting and intervention capability in case of accidents. Four counties out of nine have virtually no fire proteccion. Only two fire stations with a total of 75 men existy in Monrovia (where the large majority of manufacturing industries exist). They are equipped with just one fire engine which is frequently out of work because of lack of spare parts. Most of the hydrants existing in the Monrovia 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 Monrovia could not be quickly reached because of bad road conditions. The capacity for interventions in accidents other than fire (e.g. toxic release or spills) is non-existing.

The 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 Monrovia 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 building fires in downtown Monrovia.

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 existing. A record of all fires and interventions is kept by the municipal fire department.

D. Contingency planning in Liberia: the plant level

The consultant visited many local industries and interviewed the officials in charge. The interviews were conducted using the questionnaire prepared by the consultant and shown in Table 7 as a model. The most relevant information obtained is reported in Table 8.

Comparatively speaking, the larger facilities visited tended to be better equipped and organized than the smaller ones. In the judgement of the author, this improved capability is due to:

- Use of international safety standards derived from past experiences in industrialized countries
- Larger negative impact on people, property and environment in case of accident
- Better design of plant layout
- Plant location in industrial parks or away from populated areas
- Use of more qualified manpower and management
- Better worker training
- Higher public "visibility"

Table 7. Questionnaire used during the visits to industrial facilities

1. Data 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 products to and from the plant
17. Labelling and placarding of dangerous goods
18. Past accidents and consequences
19. Major accidents that could occur

Table 8. An overview of major industries in Liberia 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	Foam monitor	Dry powder extinguishers	CO_2 or other type	Contingency Plan
Liberia Produce Marketing Corp. (LPMC)	Coffee (10,000 t) Cocoa (5,200 t) Palm kernel oil (1764 t)	same	seasonal	1100	no*	no*	no*	no*	yes	yes	no
Freeport of Monrovia (NPA)	-	-	-	N.A.	yes 2 fire engines	yes	yes 167,000 gallons reservoir	yes	yes	yes	yes (not written)
Liberia Industrial Free Zone (LIFZA)	-	-	-	-	yes 1 fire engine 6 men	yes	yes	yes	yes	yes	no
Mesurado	Oxygen	air	1 month stock	22	yes workers	no	yes	no	yes	yes	yes (not written)
Mesurado	Soap (900 t)	NaOH Fatty acids	3 month stock	101	no	no	yes	no	yes	yes	no
Mesurado	Acetylene	Calcium carbide	3 month stock	N.A.	no	no	yes	no	yes	yes	yes (not written)
LIPFOCO	Mattresses (11,000)	TDI, Freon Polyols	1 month stock 500 mattr.	32	no	no	yes	no	no	yes	no

Company	Products and annual production	Raw materials	Amounts of raw materials and products in storage	Number of employees	Inter-vention squad	Training exercises	Fire fighting equipment				Contingency Plan
							Water hoses	Foam monitor	Dry powder exting-uishers	CO_2 or other type	
Liberia Battery Manufactur-ing Co.	Batteries (21,000)	Sulphuric acid Lead oxide Lead	30 t 28 t 10 t	26	no	no	no	no	no	yes	no
Liberia Petroleum Refining Company	Distilla-tion 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: 131,00 bbl LPG: 1000 bbl	480	yes 1 fire engine 10 men	yes (weekly)	yes	yes	yes	yes	yes (written)
Metallo-plastica	Plastic items (300 tons)	Poly-ethylene Poly-propylene PVC	10 tons total	30	no	no	yes	no	no	yes	no
Liberia Matches Co. (LIMACO)	Matches 100,000 boxes/day (50 m/box)	Potassium clorate Antimony sulphide Red phos-phorus Sand, Glue Water	3 month stock; 2 million boxes	53	yes 6 men	yes (monthly)	yes	no	yes	yes	no
Modern Liberia Footwear Industry Co. (MOLIFCO)	Rubber shoes, sport shoes 7000 pairs/day	Shoe uppers Soles Glue	N.A.	50	no	no	no	no	no	yes	no

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				Contingency Plan
							Water hoses	Foam monitor	Dry powder extinguishers	CO_2 or other type	
Monrovia Tobacco Company	Cigarettes 60,000/day	Tobacco Paper Glue	3 month stock	39	no	no	no	no	yes	yes	no
Monrovia Breweries Inc.	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
Petro-chemical Industries	Storage of lubricants, oil, gasoline, propane	-	2000 drums	45	no*	no*	no*	no*	yes*	no*	no*
Parker Industries	Paint and lacquers (280,000 gal)	Pigments Solvents	3 month stock	112	no	no	yes	no	yes	yes	no
West African Explosives and Chemicals	TNT, shot-gun shells 3600 t explosives	TNT Smokeless and black powder Ammonium nitrate	150,000 t total	113	yes	yes (monthly)	yes	yes	yes	yes	yes (written)
Firestone Plantation Company	Rubber (140,000 t)	Rubber Ammonia	N.A.	10,000	yes 5 fire engines 40 men	yes	yes	yes	yes	yes	yes

Company	Products and annual production	Raw materials	Amounts of raw materials and products in storage	Number of employees	Inter-vention squad	Training exercises	Fire fighting equipment				Contingency Plan
							Water hoses	Foam monitor	Dry powder exting-uishers	CO_2 or other type	
CEMENCO	Cement (72,000 t)	Clinkers Gypsum	26,000 t total	125	no	no	yes	no	yes	yes	no
TEXACO	Gasoline Diesel oil Kerosene storage	same	210,000 bbl	25	yes	no	yes	no	yes	yes	yes

* The plants are located in the Monrovia Freeport zone which possesses a fire department available for intervention in the zone.

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. An example of a good contingency plan obtained from a local industry is given in Section E. 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 which 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 instead 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 to an equivalent company in an industrialized country.

In some instances the consultant observed the use of some obsolete industrial equipment which did not contain the built-in safety devices that would be considered standard on modern equipment.

So far Liberia has been spared large industrial disasters with the exception of one industry-related accident: the land slide of iron ore waste on a village, which caused tens of casualties. The most common industrial accidents are due to machine or vehicle operation. Because of the small size and the site of the industries 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 Liberia

A very good example of an industrial contingency plan was obtained from West African Explosives and Chemicals, Ltd. (EXCHEM), which has a plant (Caulfield Plant) at Harbel, Monserrado County. This company is a subsidiary of a Canadian explosives manufacturing company.

The plan 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 as to avoid confusion during an emergency.

Section 3 contains 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 available in another nearby company (the Firestone plantation, which is a few miles away from the plant), the phone number of a legal office for consultation on the legal aspect related to an accident, and that of a public relations firm.

Section 5 deals with training exercises and with the procedures to review and update the manual. During the interview with the consultant, the general service 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 following the text of the contingency plan (see Figure 7). 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.

The consultant noticed during the visit to the plant that security measures were in effect at all times and that only clearly identified and authorized personnel had access to the plant.

The plan is presented in Section H.

F. Planning for transport accidents in Liberia

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 moved at night by ship or by trucks using routes through non-populated areas.

Most dangerous goods can freely circulate, unlabelled, through densely populated areas. In some instances the location of the industry and availability of just one route do not leave any other alternative.

G. Conclusions and recommendations

1. The country does not possess effective structures, organization and resources to fight major industrial accidents. Exceptions exist for certain industrial plants, but their resources would probably not be sufficient to cope with an industrial disaster spreading outside the plant boundaries.

2. 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 Monrovia area.

3. The larger industries in the country appear to be, in general, relatively well equipped and organized to combat industrial accidents. The threat they

posed to the population is small because of the small number of large firms. Furthermore, they are located in sparsely populated areas or industrial parks, and the probability that a major accident will spread beyond a plant boundary is minor.

4. The medium and small 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 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.

5. Because of the ongoing process of urbanization in the Monrovia area the population is most likely increase, also in areas nearby local industries. This, when combined with the expansion of the local industry, could create new hazards and increase the vulnerability of the population to industrial accidents.

6. It is recommended that the local government take measures to limit this occurrance by preparing zoning regulations specifying the areas to be assigned to industrial and human settlements.

7. 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 in 1984.

8. In order to document more thoroughly the existing situation, the government should make a census of the 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.

9. At present, transport accidents involving dangerous materials represent a major industry-related hazard faced by 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 the Monrovia area, 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.

10. 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 this document could be used for this purpose. The development of the national contingency plan should be bas[illegible] the conclusions and recommendations of this study. A good plan, combined w[illegible] 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.

H. Sample operational industrial contingency plan from the WACAF region:

WEST AFRICAN EXPLOSIVES AND CHEMICALS LIMITED

CAULFIELD PLANT

EMERGENCY PLAN

1. Introduction
2. Definitions
3. Individual Action Sheets
4. Outside Contact List
5. Routine Upgrading

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 Caulfield 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 Caulfield 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 everyone. This booklet is for your SAFETY; you are asked to thoroughly read it and keep if handy 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.

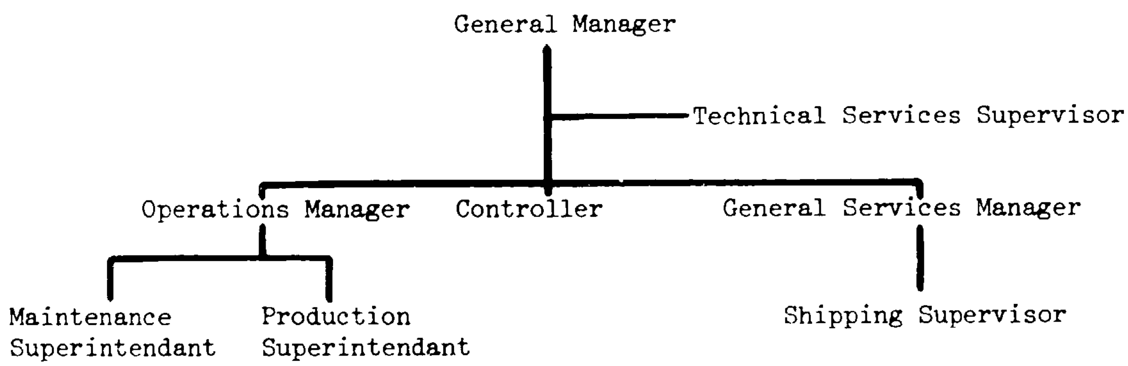
External Warden

The senior person at Peabody Farm (C-1 Compound)* 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



* A nearby small farm where the external warden is lodged (UNIDO explanatory note)

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.

PAGE 1

OBSERVER

FIRE	ACCIDENT	EXPLOSION
1 -Call Guard House (tel. 24)or use VHF radio	-Call Guard House (tel. 24) or use VHF radio	-Call Guard House (tel. 24) or use VHF radio
-Have Main Gate Security guard repeat message	-Have Main Gate Security guard repeat message	-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 oberver to check accuracy. Write down his name, where he is and time.
2-a) Call duty Supervisor (see board) b) Call Production Superintendant (tel.28 or 23) c) Call Operation Manager (tel. 12) Repeat message each time.	-a) Call duty Supervisor (see board) b) Call Production Superintendant (tel.28 or 23) c) Call Operations Manager (tel. 12) Repeat message each time.	-a) Call duty Supervisor (see board) b) Call Production Superintendant (tel.28 or 23) c) Call Operations Manager (tel. 12) Repeat message each time.
3-Announce "EMERGENCY" 3 times on radio CH2 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 instruction from duty Supervisor or warden sound stand-by alarm.	-On instructions from duty Supervisor or warden sound stand-by alarm.
5-Let only EXCHEM personnel into plant. Check out visitors.	-Let only EXCHEM personnel into plant. Check out visitors.	-Let only EXCHEM 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: a)Day Shift i Sergeant at control centre. ii Gateman-check out visitors, let in only personnel authorized by warden. iii Security driver-pick at least 4 more off-duty security personnel. iv Lieutenant-assist fire chief.	-Locate personnel as follows: a)Day Shift i Sergeant at control centre. ii Gatemen-check out visitors, let in only personnel authorized by warden. iii Security driver-pick at least 10 more off-duty security guards. iv Lieutenant-go carefully to scene with a portable radio report facts.	-Locate personnel as follows: a)Day Shift i Sergeant at control centre. ii Gatemen-check out visitors, let in only personnel authorized by warden. iii Security driver-pick at least 10 more off-duty security guards. iv Lieutenant will stand by near control centre.
b)Off-Shift i Sergeant open outer gate (2), close inner gate (1). Stand-by at guard house radio, prohibit entry to all except EXCHEM staff. ii Gateman-go quickly to scene of fire, fight it with all available security guards.	b)Off-Shift i Sergeant open outer gate (2), close inner gate (1). Stand-by at guard house radio, prohibit entry to all except EXCHEM staff. ii Gateman-go to scene of accident with portable radio, report facts.	b)Off-Shift i Sergeant open outer gate (2), close inner gate (1). Stand-by at guard house radio, prohibit entry to all except EXCHEM staff. ii Guards-withdraw to fence gates (3), (4).
- When additonal 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 traffice to plant area.

PAGE L

FIRE CAPTAIN

FIRE	ACCIDENT	EXPLOSION
1-Assemble fire crew.	-Assemble fire crew.	-Assemble fire crew.
2-(a)Fire in areas accessible to hoses: i Uncoil hoses from hydrant houses. ii Start fire pumps.	-(a)Fire in areas accessible to hoses: i Uncoil hoses from hydrant houses. ii Start fire pumps.	-(a)Fire in areas accessible to hoses: i Uncoil hoses from hydrant houses. ii Start fire pumps.
(b)Fire in other areas: i Put all spare extinguishers on a truck. ii Take truck, front end loader, grader to scene of fire. iii Go by car with radio to take charge of fire fighting. Switch radio to CH 2.	(b)Fire in other areas: i Put all spare extinguishers on a truck. ii Stand-by for instructions from warden.	(b)Fire in other areas: i Put all spare extinguishers on a truck. ii Stand-by for instructions from warden.

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 view point 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 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.	-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 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 assit 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.

UNIDO explanatory notes:

- HE - high explosive
- TNT - trinitrotoluene, a high explosive
- P-1 - identification code for one of the operation buildings
- ANFO - trade name for nitrocarbonitrate, a commercial blasting agent

PAGE 8

MAINTENANCE SUPERINTENDENT/SUPERVISORS/ELECTRICIAN

FIRE	ACCIDENT	EXPLOSION
1-Check that the 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 the 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 man ready to connect it to main transmitter.	-Load oxyacetylene equipment on pickup.	-Start stand-by generator. Have man 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 Firestone 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 Peabody Farm house of the 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. Roberts 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. Firestone 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
U.S. Liberia Radio Corp.	5-2131	5-2567 (night)

Alternatively, use channel 3 on the 4 channel car radio for any Firestone contact.

Section 4

Outside Contact List - cont'd

		PHONE
C. National Police Force, Robertsfield		199
	1. Traffic control	
	2. Bystander control	
D. National Security Agency		
	contact - Director	
E. Simpson, Bright and Cooper		
	Legal advice	
	contact - H.R. Cooper	21457
F. A and A Enterprises		
	Public Relations	
	contact - J. Adighibe	22833 (res.) 26229 (home)

SECTION 5

Routine Upgrading

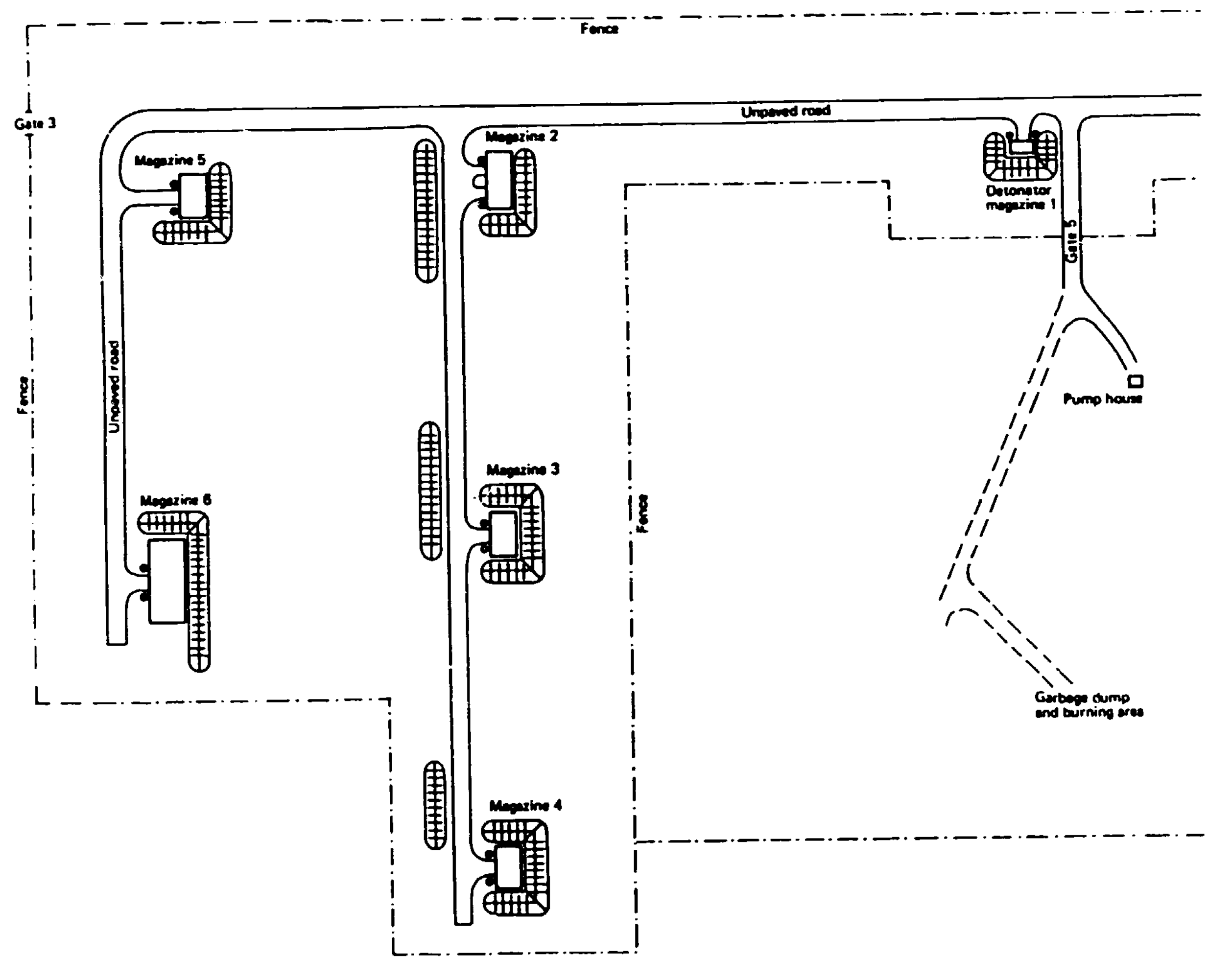
Practice and Drills

Fire drills will be held monthly simulating different hazards.

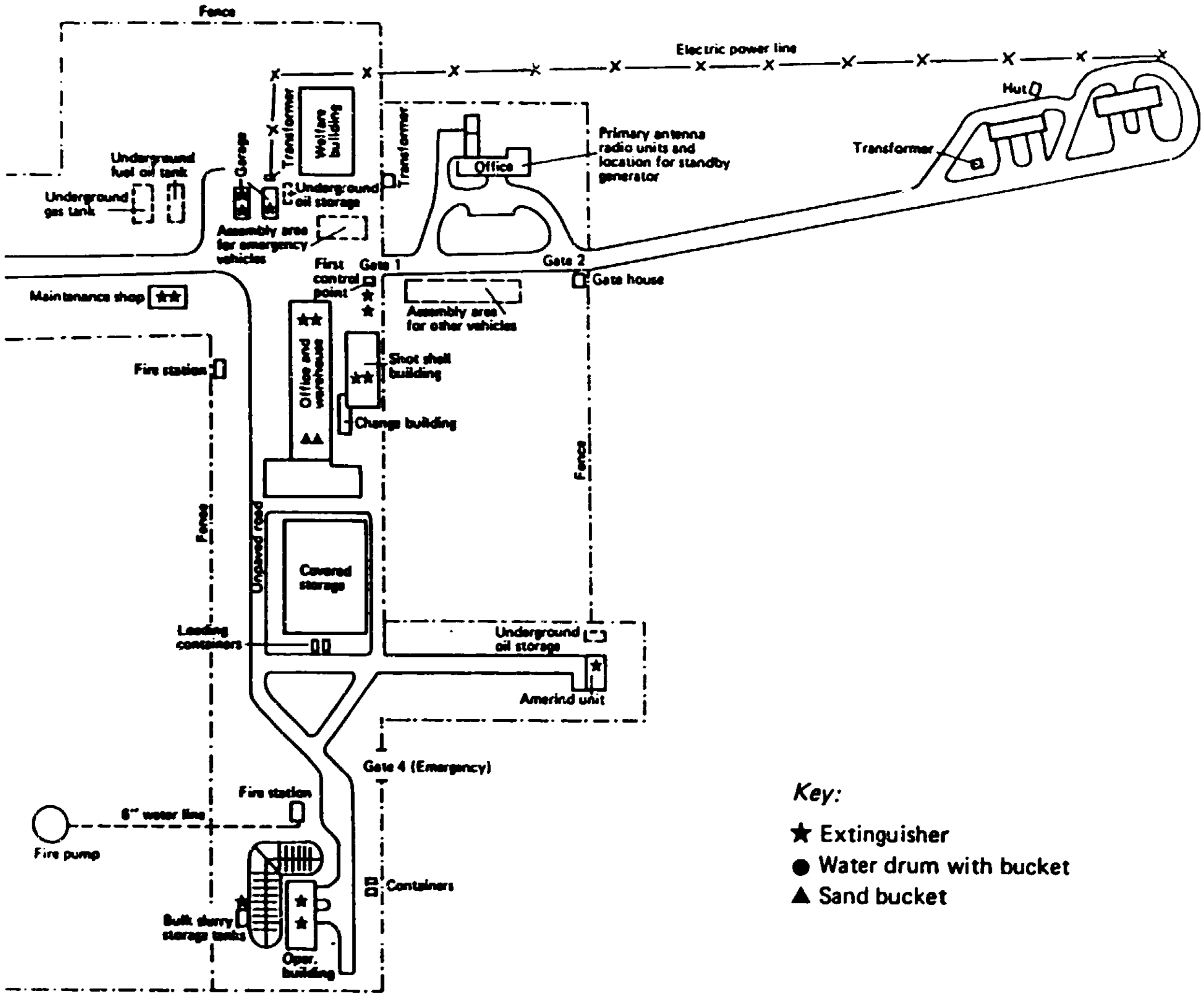
Full emergency drill including evacuation and setup of control centres to be held twice yearly.

Review of Procedures and Manuals

Manual to be reviewed before and after the bi-yearly practice. Procedures and write-up to be updated accordingly.



Fence
Gate 3
Unpaved road
Magazine 5
Magazine 2
Detonator magazine 1
Gate 5
Unpaved road
Fence
Pump house
Magazine 3
Magazine 6
Fence
Garbage dump and burning area
Magazine 4



Key:

★ Extinguisher
● Water drum with bucket
▲ Sand bucket

Scale 1 inch = 200 feet

Figure 7
Layout of EXCHEM plant

SENEGAL

A. Introduction

The purpose of the study was to establish:

- Whether there were any national or local reports for action in the event of a disaster;
- Whether there were any such reports in industry;
- What provision was made in whatever reports there were for collaboration and co-ordination.

In addition, if there was no general plan, the aim was to draw up a draft general scheme for the implementation of contingency reports in a disaster.

On the basis of UNIDO/ICIS study No. 170 of 30 July 1980, "Etude des polluants marins d'origine industrielle"[60/], and in conjunction with the Senegalese authorities concerned, a number of plants were chosen which might present some danger by reason of their products or their situation. Later, after a visit to the industrial zone (Dakar-Thiès), a final list of plants to be visited was drawn up. A summary of the findings resulting from these visits is given in Table 13.

A more detailed description has been prepared separately for a more specific study to assess the risks that exist.

On the basis of discussions with the competent authorities, it has been 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, although that subject does not lie within the scope of the study.

Throughout his mission the expert greatly appreciated the fact that he was able to call on the collaboration of the services of the UNIDO SIDFA, Mr. Luong, and the UNDP Resident Representative, Mr. Borna.

The expert was also greatly assisted by the great commitment shown by Mr. B. Kanté, representing the Senegalese Government, and the help given by Mr. Diop and his colleagues in the Department of the Environment. Without their support, the mission could not have been brought to a successful conclusion.

B. General information on Senegal

1. Area and population (1981)

Table 9 shows the distribution of population in the different regions in which the country is devided. It is to be noted that there is a heavy concentration of the population in Cap-Vert and that industry is also concentrated in that region.

2. Administrative organization

Eight regions, 30 departments and 90 districts.

3. Resources

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.

4. Employment: private and semi-private

Table 10 shows the employment situation in Senegal by section.

Table 9. Population distribution.

Region	Population No.	Population %	Population No./km²	Area km²	Area %
Sine-Saloum (Kaolack)	1 167 000	20	49	23 945	12.2
Cap-Vert (Dakar)	1 271 000	21	2 310	550	0.3
Casamance (Ziguinchor)	815 000	14	29	28 350	14.4
Thiès (Thiès)	786 000	13	119	6 601	3.4
Diourbel (Diourbel)	464 000	8	106	4 359	2.2
Fleuve (Saint-Louis)	566 000	10	12	44 127	22.4
Louga (Louga)	466 000	8	16	29 188	14.8
Sénégal-Oriental (Tambacounda)	333 000	6	6	59 602	30.3
	5 868 000	100	29.8	196 722	100

Table 10. Employment by sector.

	1976	1985 (1)
Agriculture, hunting, fishing	2 584	.. (2)
Extractive industries	2 319	.. (2)
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

(1) Extrapolated from mean annual growth for the period 1971-1978.

(2) These two activities are included in the figure of 28,638 for "other activities".

5. Economic development

Fifth Plan (1977-1981)

The Fifth Plan resulted in the following achievements:

Setting up of Dakar-Marine project with a floating dock for vessels of up to 60,000 tonnes;

Construction of a new 200,000-tonne oil works at Diourbel to replace the old SEIB and Petersen installations;

Fish meal project at Dijffer;

Expansion of textile dyeing (ICOTAF) and printing (SOTIBA-SIMPAFRIC) facilities;

Start of exploitation of DIAM-MIADIG gas.

This resulted in 4,708 new jobs.

Sixth Plan (1981-1985)

The Sixth Plan provides for the creation of 6,270 jobs and new ICS factories at Taiba and Mbao, the extension of Socomin (bricks and cement), SAR (crude oil refining), STS and the Sotexka project (textiles). Table 11 shows the proposed investment by sector.

On 19 May 1983, a revision of the plan was introduced. By 30 June 1983, 37 per cent of the total value of the planned projects had been implemented. With 41 of the approved projects Cap Vert has more than half of the total investment, while the Thiès region has 15; the further away one goes from the Dakar-Thiès zone 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 the ICS project Senegal will enter this field. Certain new dangers will then arise with the transport of dangerous goods by rail and sea.

Some industrial indicators for Senegal are given in Table 12.

Table 11. Proposed investment by sector

Region	Proposed investment in millions of CFA francs					
	Agro	Chemicals	Engineer-ing	Mining and construction	Textiles and others	%
Sine-Saloum	614				9 597	8.3
Cap-Vert	4 950	26 513	1 311	14 600	5 465	42.8
Casamance	799			3 921	568	3.7
Thiès	624	36 657	1 467	6 115	770	36.9
Diourbel	116	83		360	96	0.5
Fleuve	3 260			200	319	3.6
Louga	459			2 895	184	0.5
Sénégal-Oriental	459			2 895	80	2.8
Whole country	11 942	63 253	2 788	28 510	17 079	123 562
%	9.66	51.19	2.22	23.07	13.82	100

Table 12. Industrial indicators

	1980	1985
Fishing		344 000 t
510 000 t		
Petroleum refining (1983)	900 000 t	1 200 000 t
Phosphates of lime, Thaiba	1 300 000 t	1 900 000 t
Phosphates, Thiès	140 000 t	90 000 t
Phosphates of crude alumina, Thiès	80 000 t	150 000 t
Phosphates of calcined alumina, Thiès	105 000 t	170 000 t
Installed power capacity	184 MW	
Number of ships recorded at Dakar	7 536	11 200
Volume of water producer in 1 000 m^3	58 025 (1979)	83 950
Number of hospitals	12	15
Number of health centres	36	66

The ICS and SAR projects represent 98 per cent of investment planned in the chemicals industry.

(a) ICS project: The purpose of the 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 products 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.

(b) Production of nitrogenous fertilizers: The production of nitrogenous fertilizers involves an extension of SIES, which will be carried out as part of the ICS project. It is in fact desirable that the manufacture of solid primary fertilizers (MAP, DAP), which will be produced and exported by ICS, and that of complex fertilizers primarily intended for the domestic market should be combined in a single unit.

(c) Extension of Société Africaine de Raffinage (SAR): The extension project for SAR 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 remodelled and enlarged to take ships with a higher unit tonnage.

Mechanical and electrical engineering industries

The establishment of a steel plant with an electric furnace and of a rolling mill producing long iron and steel products: concrete reinforcing rods, light and medium sections and wire rods (to supply the Dakar 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 Thiès foundry should take place during the Sixth Plan.

Mehra group: This is a project for the manufacture of electric cables which has been under consideration since the Fifth Plan and on which a start could be made during the Sixth Plan.

Mining and construction materials industry

Exploitation of the La Falémé iron ore deposit;
On the basis of the licence granted by Sénégal-Oriental, BRGM will continue its operations, i.e. preparations for working the Sabodale gold deposit (production in 1988);
Only one brick-making plant is at present operating in the Thiès region. This unit of SOCOCIM-Industrie 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 at Saint-Louis (12,000-14,000 tonnes a year) and the other at Ziguinchor ;
Lime: since 1982 a plant has been producing 14,000 tonnes a year of unslaked lime or 20,000 tonnes a year of slaked lime;
Plaster (SIES): production - 2,000 tonnes a year; capacity 20,000 to 25,000 tonnes a year;
Cement: extension and renovation of the SOCOCIM plant, increasing its present annual output of 370,000 tonnes to 820,000 tonnes in 1983;
Attapulgite: these clays are being exploited for industrial purposes by Prochimat. SSPT has 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

1. Civil defence

Senegal has had an adequate civil defence system since 1964 (Decree No. 64-564 of 30 July 1964).

The decree makes the Minister of the Interior responsible for drawing up organizational reports; he is to be assisted by the Department for Civil Defence and the Higher Commission.

Civil defence measures of prevention, protection and assistance are to be undertaken to deal with fire and other disasters, catastrophies or cataclysms which threaten public security.

Organization

Measures to combat fires 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 among other things 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

Its functions are:

To study appropriate methods of protection of populations against the risks of peacetime and the dangers of wartime;

To prepare the necessary legal instruments;

To organize and direct the various civil defence services at all levels and, in particular, the National Fire Service;

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.

Order No. 012341 of 4 November 1975 makes the research division responsible for:

- Drawing up legal instruments relating to matters of prevention;
- 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;
- Monitoring the application of the rules and regulations relating to establishments open to the public;
- Analysing incident reports prepared by the National Fire Service;
- Applying permits issued by the Minister for Industrial Development for the opening and operation of dangerous, unhealthy or noxious industrial establishments;
- Determining the general principles governing reports for the organization of assistance (ORSEC);
- 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 the consultative body and is convened by the Minister of the Interior whenever he deems it necessary and not less than twice a year.

The Higher Commission gives its opinion on all matters relating to the protection of persons and property in establishments open to the public and on any other questions which may be referred to it by the Minister of the Interior.

Regions

The eight regions have co-ordination commissions, 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, the public, etc.

The civil defence system is based on communal autonomy and responsibility.

The headquarters is in Dakar. and each regional capital has a higher centre (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.

2. Research and rescue service: aviation

Decree No. 68-1274 of 11 December 1968 established a search and rescue service (to be known by the international title of Search and Rescue (SAR)) with responsibility for the organization, management and supervision of search and rescue operations. It is placed under the dual authority of the Minister of Transport and the Minister for the Armed Forces (Defence).

SAR operations are carried out by a rescue co-ordination centre known as CCS.

3. Action in the event of marine pollution

Facilities are available. Canada sent Senegal a surveillance aircraft on 10 June 1983.

The protocol relating to co-operation to combat pollution in critical situations adopted at the Abidjan conference provides for the establishment of an emergency plan of action to deal with such situations, to be established at the national, bilateral and multilateral levels.

On 2 July 1981, the Minister for Housing and the Environment submitted the following proposal for the Senegalese plan to the National Council for Town Planning and the Environment:

- Spillage alert and evaluation report;
- Assessment of the situation and mobilization of action teams;
- Action on land and sea;
- Administrative and legal procedures. The project for the establishment of an emergency plan of action, which is estimated to cost 200 million CFA francs, is scheduled for inclusion in the Sixth Economic and Social Development Plan.

The alert

This initial phase is the responsibility of national agencies, i.e. joint action of the Air Force, the Navy and the 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 shall contain an assessment of the incident (nature, extent, location, flag under which the ship is sailing, etc.).

The mobilization of the action teams is the responsibility of the naval commander, the commander of the Military Engineer Corps and the Ministry of the Interior.

These action teams, which shall be set up in each Atlantic coastal region, shall be composed of:

- 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 shall be in overall charge of the operation.
- For action on land: the teams shall be composed of specially trained staff from the mobile operational group and, as required, prisoners convicted under the ordinary law and volunteer services.
- 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 equipment and other aids. It requires:

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.

For land operations, the action teams should have equipment, and cleaning and coastal restoration products.

Procedures

This phase, which begins as soon as the alert is announced, comprises the following:

Co-ordination of the administrative and legal procedures;
The administrative procedures and legal follow-up;
Diplomatic action.

4. 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 Dakar 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 devices to be installed.

Communications, particularly by telephone, are the greatest problem. The network is often out of order.

5. Industry

Contingency planning

The plants visited have the usual facilities for dealing with fires: powder extinguishers, hoses, powder wagons. Few of them have a proper plan of action for dealing with a major accident. Two of them did produce such a plan. Table 13 shows the findings of these visits.

It is therefore recommended that plants which present some danger should draw up emergency reports. A system which could serve as a guide in drawing up a plan is annexed.

Classified establishments

When a classified establishment is opened (there are three categories, depending on the degree of danger, which are based on French legislation), special fire prevention measures are laid down.

Act No. 83-05 of 28 January 1983 (Official Journal of 23 April 1983) reorganized the system of classified establishments, superseding the existing Act, which was based on the French Act 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 Senegal, most of which 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 on barrels, such as the IMDG, ADR and EEC labels.

Table 13. An overview of major industries in Senegal 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 manufacture	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

(Continued)

Plant	Production	Raw materials	Work-force	Plan	Facilities: Personnel	Facilities: Powder extinguishers	Facilities: Water hoses	Facilities: Powder wagon
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
5	Plastics processing 350 to 400 t per year	Plastic pellets	250	No	No	Yes	Yes	Yes
6	Toilet paper, Kleenex, 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

(Continued)

Plant	Production	Raw materials	Work-force	Plan	Facilities			
					Personnel	Powder extinguishers	Water hoses	Powder wagon
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

6 Example of an existing plan

General information

Fire Service: emergency No.: tel. 18

Thiaroye Station: emergency centre: tel. 212629

Works alarm: siren
alarm button

The plan contains the following specific instructions:

Smoking is totally forbidden in the workshops.

Access to all workshops must be kept free at all times (cardboard boxes, cases, shovels, etc.).

Workshops must be tidied and swept at the end of the day (stools under tables to permit free passage).

The low-voltage substation must be turned off before workshops are closed at the end of the day.

Finished or semi-finished products must be returned to their respective store rooms.

Fire extinguishers must be accessible at all times.

Premises must be kept closed.

Before departure, the foreman must activate the workshop disconnecting switches in the low-voltage unit.

Only the pilot light must remain on.

The names of the staff responsible are also given and their duties are laid down in official memorandums.

The staff responsible for the fire prevention service carry out regular checks and organize practice drills. There is a contract with SICLI (the fire protection department of Etablissements Peyrissac at Dakar). The layout of the plant is shown in Figure 8.

Special checks are laid down for:

High- and low-voltage station

By the responsible staff, plant No. 1:

Mechanical engineer and assistant works manager

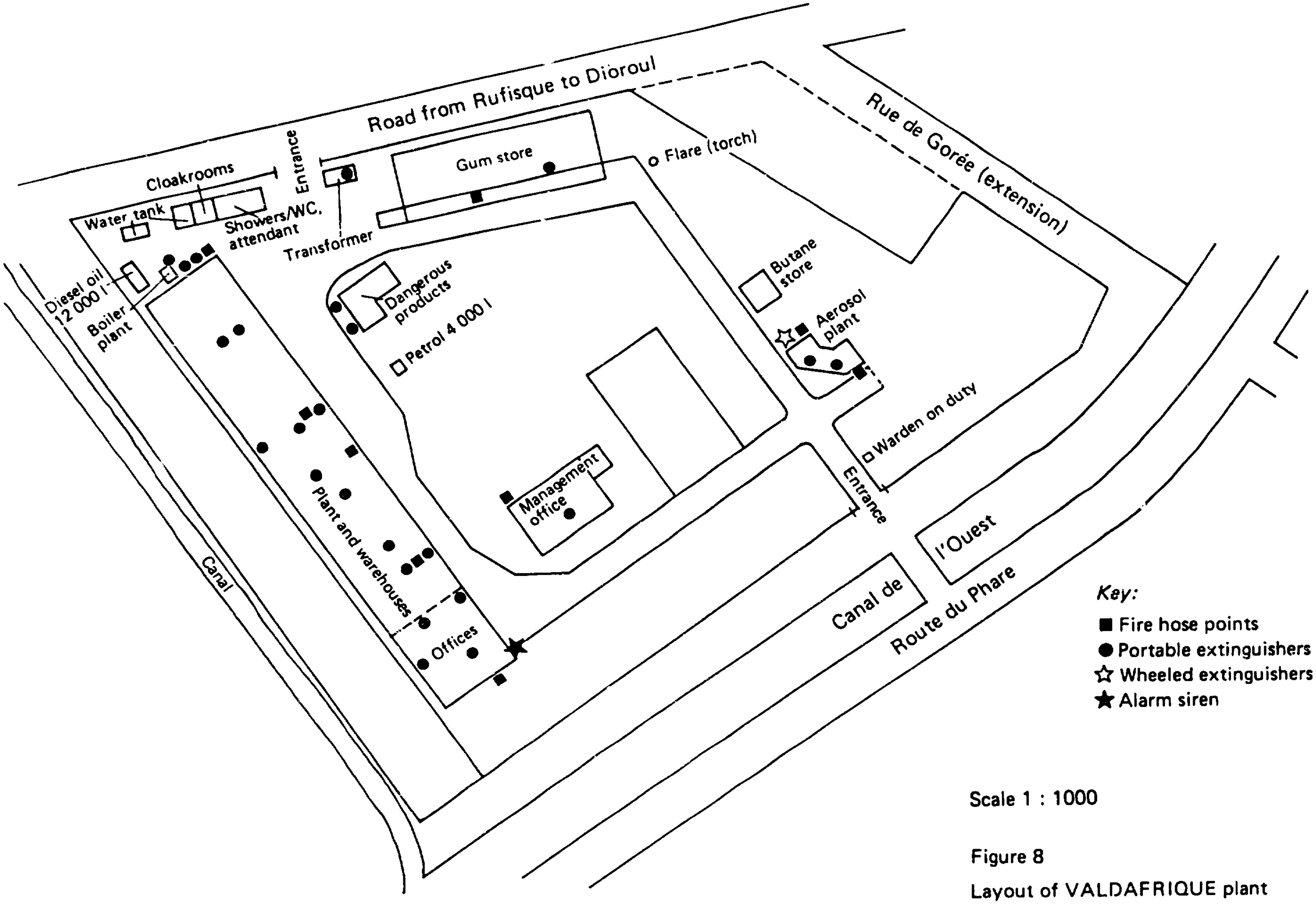


Figure 8
Layout of VALDAFRIQUE plant

(a) During scheduled interruptions in the SENELEC high-voltage supply: Cleaning, dusting, lubrication, painting, etc.;

(b) Every weekend on low-voltage circuits and during periods of preventive maintenance (July-August).

Gas equipment

Permanent monitoring during use of deodorizing apparatus;

Weekly checking of flange joints with soap foam;

At the end of each working day, the circuit valves must be turned off and checked.

As shown above, the emergency equipment consists of a 75 m^3 reserve water supply (25 m^3 underground tank and 50 m^3 water tower), fire hose points and extinguishers. This equipment is checked every quarter and the checks are entered in a register. In addition, SICLI also checks the equipment periodically.

7. 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.

But one may ask whether that will always be possible in the future. Various dangerous goods, moreover, are transported in drums in containers or by lorry from the port of Dakar to the factories, e.g. solvents, sulphur, caustic soda, polyol, TDI, pesticides. Some system therefore needs to be established for identifying this type of transport operation.

D. Organization of environmental protection

1. Senegal: Act of 28 January 1983 promulgating the Environmental Code

The Official Journal of the Republic of Senegal of 23 April 1983 published (pp.324-332) Act No. 83-05 of 28 January 1983 promulgating the Environmental Code. The code is concerned with reform of the system of classified 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 French Act of 1917. It reduces the three categories to two and broadens the meaning of the term "classified establishment". It simplifies the administrative system. It allows a classified establishment to be temporarily closed if it is physically impossible to comply with the existing regulations.

Financial support

There are various innovations to be noted:

Introduction of a single fee, charged when the permit is issued;
An annual charge levied (by category) on the basis of the area occupied and the actual control costs;
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. Non-approved enterprises are entitled to faster depreciation of the anti-pollution equipment;
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 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. The AFNOR standards will be applied.

2. Ministry of Nature and Natural Resources: Department of the Environment

Director: Amadou Demba DIOP

Secretaries: M. Ndiaye
N. Seck

Deputy: M. Ka

Division of
Co-ordination
Chief: B. Kante
A. Konte
Y. Cisse

Division of
Classified Establishments
Chief: M. Ka
I. Sow

Division of
Pollution Control
Chief: B. Bal
A. Ndiaxye
N. Sylla

Administrative
Office:
O. Diaw
A. Mane

E. Conclusions

The plants visited for the most part have the usual facilities for dealing with fires. They also maintain good contact with the Fire Service.

As regards contingengy 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 should certainly not entail 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 persons handling dangerous goods should be familiar with the meaning of the labels and other safety aspects.

Chapter VIII
The WACAF Regional Risk Assessment

A. Introduction

The purpose of this chapter is to provide an analysis of the major industrial sources of risk in the West and Central African Region. This research is an essential first step in identifying high risk zones and sectors of industry, in establishing a baseline to which future risk levels can be compared, and in providing motivation and guidance for the improved management and control of both industrial operations and remedial response preparedness.

The basic data on industries located in the WACAF region is taken from the earlier UNIDO/UNEP "Survey of Marine Pollutants from Industrial Sources in the West and Central African Region" 5/. That study was the first survey of coastal sources of industrial pollution for the entire region, and contains detailed data on industrial products and production. Whereas the focus of that study was on average wastewater discharges to the marine environment the risk assessment focuses on fire,explosion and/or the sudden, accidental releases of air and water pollution into the total environment.

This study consists of several phases, as follows: First is the development of a sound and tractable methodology for a Regional Environmental Risk Assessment (RERA). This includes a review of alternative methods for qualitative and quantitative risk analysis and on assessment of the suitability of each approach for application to the WACAF region. Second is the application of this methodology to the region using the data from the UNIDO/UNEP survey 5/ to perform a preliminary RERA.

The objective is to provide national decision-makers, environmental and resource planners, and public safety managers with information about the relative risk due to existing industrial activity. This information is intended to be of a screening nature. The zones or industrial sectors that have been indicated as relatively high risk then need to undergo more detailed study.

This chapter is composed of 6 sections. Section B describes risk assessment, the basic goals for the analysis, and the assumptions in conducting this research. Section C reviews both qualitative and quantitative methods for conducting a risk assessment. Section D presents the proposed models for estimating (1) Fire & explosion risk and (2) Environmental Risk and a description of required input data Section E is the Regional Environmental Risk Assessment. Section F presents a summary of findings, and recommendations for additional research and action. Section G presents the details of the methodology chosen for the RERA.

B. Risk Assessment

Industrial risk is the probability that an undesirable event will occur (in the operation of an industrial plant or in the product storage or distribution system) and induce undesirable consequences of some magnitude. The goals of risk assessment are to: 1. Define the objectives of concern (e.g. public health, economic, other environmental); 2. Establish measures for the objectives; 3. Define and determine the nature of the industrial accidents which can affect the environment; 4. Establish the relationships between the accidental events and the objectives of concern; 5. Estimate the probabilities of occurrence of the events of concern; 6. Analyze the distribution of impacts on the objectives of concern. The steps may seem straightforward. But actually applying them is a difficult problem. For example, determining consequences of accidents on the environment may depend on the pollutants involved, timing and magnitude of release. Even if the pollutant discharged and the magnitude of discharge were known, expert opinion on the extent of impacts would differ. Carefully studied oil spills have shown that predictions of impacts have often been inaccurate.

The risk assessment is calculated for the WACAF Region at the time at which the data base was gathered. Thus the output is a description of the relative present risk and not an analysis of the increase or decrease of risk which could occur as a result of policy or management actions.

There are several categories of industrial accidents which can lead to environmental impact. These include plant spills, accidental releases, product contamination, fire and explosion, and transportation accidents through abnormal discharge of air, liquid or solid waste. All of these are of potential interest in the current study.

Those affected by industrial accidents include all who come in contact with or are dependent upon the environment. This includes individuals, industries, and governments. Impacts may include public health effects,economic losses and environmental damage.

Basically, the sorts of events, impacted groups, and natures of impacts from industrial accidents are extremely diverse. A simplified model is necessary in order to develop a practical and operational method for calculation of industrial risk for the WACAF Region.

C. Alternatives for Risk Assessment

This section reviews several approaches to risk assessment that may be applicable to the current case and recommends a most appropriate method. There are a number of text and case books which deal with the problem. An OECD study of environmental damage costs, which presented largely the theoretical economic foundation for estimating damage cost function lent some insight into the nature of the underlying problem of environmental risk assessment 65/. Although there is a reasonably large amount of information on environmental impact and many descriptions of environmental disasters, a relatively small body of literature deals specifically with assessment of the risks imposed on the environment by industrial activity. Works by Fisher 63/, Lagadec 64/, Wilson and Crouch 68/, Environmental Resources Limited 62/, and A M Best Company 61/ provided meaningful and/or workable alternatives.

Even if the impacts were well understood, there may not be sufficient data to quantitatively estimate the risk. For example, although the toxicity of a certain pollutant on a particular species of fish might be known, the available current data to estimate transport of the toxin to the site of interest, and the population of the species at the site might be unknown.

Methods of Risk Estimation

This section reviews the several alternative methods for estimation of risk. Lagadec 64/ makes an interesting distinction which is between hazard analysis and risk assessment -- defining hazard analysis as a component of risk assessment. He suggests that an important first step in risk assessment is identification of "what constitutes a menace?" Hazards are defined simply as "the physical possibility of the occurrence of an event". In contrast, risks are distinguished as "the effective realization of this possibility, this realization being approached as a probability". One way of reinterpreting this observation is to view hazard analyses as a more "qualitative" assessment of possibilities, and risk assessment as the "quantitative" assessment of probabilities and consequences.

Qualitative methods in risk assessment are similar to those which have been used in environmental impact assessment; the methods are typically graphical. They display areas of critical resources (e.g. drinking water intakes, cooling water intakes, fishing sites, shellfish sites, critical habitats, recreation areas) and indicate those with the potential for initiating an accident sequence (e.g. industrial plants by types, shipping routes, transportation routes, and storage facilities). These reasonably simple graphical displays will indicate possible hazards but give little idea of the magnitude of impacts. Also, they offer only minimal indication of the frequency of the impacts.

The second major class of risk assessment methods are quantitative methods. These involve postulation of a model (causal or correlative) to explain the manner in which risk may be incurred, and inference to determine the parameters of the model. One of the basic distinctions made for these methods is between hiscorical and "new" risk estimation problems.

Historical risk is defined as events which have occurred frequently enough to have allowed sufficient data collection for estimation of frequencies and impacts of events. As Wilson and Crouch 68/ point out, often theories and even models of impacts and risk will exist for such circumstances. For the case of environmental impact due to industrial accidents in the WACAF Region there has not been sufficient frequency of events of this sort in the area to provide the basis for site specific risk assessments. This is due to the relative rarity of severe events, the changing industrial climate in the area, and the general lack of reconnaissance-level data collection on pollution incidents.

The alternative is to treat the problem as one of a new risk situation. Here there is no history of experience with this process, and therefore simulation methods must be used to predict the likely risks by a step by step analysis of the modes of failure. A common example is the risk due to development of a new drug where there may not be similar chemicals on the market, and inference will probably depend on findings from biological testing.

As in the current case, the "new" risk situation may simply be that of a phenomenon which has occurred elsewhere, but for which there simply does not exist sufficient information for the particular site and situation being analyzed. As Wilson and Crouch 68/ state:

> The basic idea is to break down any new risk into a sequence of events, each of which may be analyzed separately by theory, by analogy with historical risks or from actual occurrence, and then to reconstruct the whole from these parts. (p. 52)

For example, a model could be postulated relating the magnitude and frequency of spill events to loss of aquatic resources. Then this model would be calibrated using data from historical events -- with the model "explaining" all differences between the sites. An analysis of this sort for every industry and pollutant type, for every class of receiving water environment, is well beyond the scope of the current study. Furthermore, it is doubtful that there exists the theoretical understanding to conduct such a study, and the site specific data base certainly does not exist.

The alternative is to estimate "new" risk through empirical data which are available. An important variation of this approach would be the use of experts judgement in the determination of the risks under study. In effect, these inputs are using some sort of a mental model to process data from analogous situations, and a theory relating these data to an estimated risk. This approach is especially attractive in screening or initial reconnaissance studies, for which neither the historic data base nor significant resources exist to conduct a more formal analysis.

Carrying this to an extreme, the entire causal structure, known as an event tree, leading up to a possible accident, can be postulated. Then with probabilities assigned to each event in the tree, the analyst can evaluate the probabilities of each of a number of outcomes, and thereby calculate an estimated risk. This approach requires a complete specification of possible events leading up to an accident, and independence of factors leading to various outcomes. The most notable study of this sort was the Rasmussen study 67/. The Rasmussen Study was an assessment of accident risk in U.S. commercial nuclear power plants. The key difficulties of this approach are the extreme number of factors that must be considered, assignment of probabilities of failure for each of these components, and the inability to verify the risk estimates postulated.

The choice of strategy for the current study

A graphical approach could show potential sources of industrial accidents utilizing the industry descriptions in the UNIDO/UNEP report 3/. In order to complete this method, the potential resources impacted would have to be identified, and a model developed for forecasting the zones of likely impacts around the industrial areas. Although in concept this approach is easy, in practice there are a number of limitations which make this impractical for the current study.

First the graphical approach does not identify the magnitude of potential impacts except in the most rudimentary sense. Miles of shoreline, population, or acres of impacted shellfish beds might be estimated . However the magnitude and frequency of these impacts, are not defined by this approach. The method may identify all areas which might be affected. However, in terms of providing guidance for determining the areas which most urgently require contingency planning, the method is not very useful. Secondly there is no existing model on which to pattern the current study. No studies were found which address the impacts of industrial accidents covering the range of possible pollutants on the continental scale of interest in the current study. Therefore, this qualitative graphical approach was not chosen.

Most of the available quantitative methods are not suitable for the current study. The problem does not easily fall into the area of estimation of a historical risk. There simply have not been enough historical events and there are inadequate data on events which have occurred.

This means that the current problem is best addressed as a problem of estimation of a new risk. The most well developed approach to this sort of problem, namely the estimation of risk on the basis of event trees, and failure rates of components, is far too detailed and information intensive. An analysis of this sort for a single industry type, in a fairly well defined ecosystem, would be a major undertaking, and far beyond the resources available for the current study. Therefore, the approach used was to estimate the risk from relevant empirical data which are available.

Three types of empirical data have been used: First, the reasonably large data base on industrial accidents, including events of the type that lead to adverse environmental impacts. Secondly the UNIDO/UNEP study 5/ provides industrial statistics that can be related to the frequency of accident events. Thirdly , data are available which give the history of major events which have had adverse impacts on the environment -- although not necessarily in the WACAF region. Expert judgment is used to link these three types of data. This is the most expedient approach for screening industrial risk in the region, and consistent with the resources available for the study. Fortunately, two information sources are available which permit an approach of this type. One, developed by A.W. Best 61/ in the USA, provides focuses only on the hazards while the second, developed by Environmental Resources, Ltd. 62/, U.K., is based on environmental risk including hazards and impacts. The details of their strategy, and implementation for the current study, are presented in the next section.

D. Outline of the Chosen Risk Assessment Methodology

The two main elements of risk assessment are the determination of the likelihood of an accident and the subsequent impact from that accident. It is possible for an industry to have a high hazard, but if the vulnerability is low the environmental impact and thus the environmental risk may be small.

Therefore two indexes are calculated in the WACAF industrial risk assessment. The first is the relative index of fire and explosion risk and the second is a relative environmental risk index. There are two basic components of the either index. These are the industry specific factors (Fire and Explosion and Environmental) and the site or plant specific "scaling factor."

The first step in establishing a risk factor is to categorize industrial activity into distinct groups by products or industrial processes that possess similar hazard and impact potentials. Once this is done a risk factor can be determined for each category of industry based upon historical, statistical, or theoretical data.

The risk factor will then be a single number for the "standard or average plant" in each category. That is, the risk factor will assume standard processes and standard safety precautions.

In the absence of data from Africa for establishing a risk factor, data from industrialized regions in the world are used. The causes of fire and explosion of environmental risk from industry in other parts of the world are assumed the same as in Africa. The goal of the study is not an absolute ranking of industries but a relative screening. In view of the screening nature of the study it is assumed tha industries on the average would retain similar relative levels of risk in Africa as elsewhere.

Scaling Factor

Ideally, one would like to distinguish plants using a number of factors to provide for a more realistic assessment, such as location, receiving environment, process type, age of the plant, and safety record. However, this type of data is beyond the scope of this report. Although theoretically it is only an extension of the present methodology. The data for this regional study comes from the UNIDO/UNEP "Survey of Marine Pollutants from Industrial Sources in the West and Central African Region" 5/. The study provides data on industrial production by product for industries in the region. So a scaling factor was determined that is based on level of production.

The UN standard industrial categorization (ISIC) was used in conjunction with a categorization that has been developed by Environmental Resources Ltd.(ERL). (See Table 14). The procedure to develop a scaling factor for each industry in the region is as follows.

Each industry is assigned to an industrial category. Next, the average annual production of industries in each category is calculated. With this average value, which is assumed to represent the standard plant, the industries in each category are normalized with respect to average production. This normalized value of production for each industry is designated the parameter "size" and is the "scaling factor".

When no production datum is reported for an industry, the average production figure of the entire category under which this industry falls, is assumed to represent the industry's production. This means that when this assumed production figure is normalized, the industry's size becomes 1. The error due to this is expected to average be small since actual industrial sizes will be randomly greater or smaller than the average size.

Fire and Explosion Risk Assessment

A "Fire and Explosion Hazard Factor" has been developed based upon data from the "Best Loss Control Engineering Manual", 61/ prepared by A. M. Best Company, New Jersey, USA. This comprehensive Manual is used as the standard reference for insurance companies underwriting loss exposures.

The hazard factor is derived from the Best Exposure Index (BEI). The BEI is calculated for a large number of industries by the systematic application of statistics from different sources. Detailed information on the methodology of calculation is not available. But the applicability and characteristics of the index are summarized in the Manual. Data from individual insurance companies based on their loss experiences and statistics from the U.S. Department of Labour, Insurance Services Office, and National Council on Compensation Insurance were utilized to obtain the Best Index Values. Therefore the values represent an authoritative composite estimate.

There are two volumes of the manual, the Blue and the White.

The white volume classifies loss exposure into four categories:-

Workmen's compensation
Fire
Public Liability
Products Liability

Each of the four categories or coverages is a potential source of economic loss and is graded from 0 - 10 to represent increasing likelihood of the occurrence of such a loss.

The Blue volume classifies loss exposure into an additional four categories, each of which are numerically graded on a scale of 0 - 10. The loss categories are:-

Automobile Liability
General Liability,
Product Liability,
Crime,
Workers Compensation,
Inland Marine,
Business Interruption, and
Fire.

The data for most industial categories WACAF region came primarily from the blue volume. The data for the remaining industrial categories were obtained from the the White volume.

Both volumes of the Best manual judge the Fire and Explosion risk in the light of the following:

Construction
Occupancy

Protection

Exposure

In some cases where a number of Best industrial grouping were contained in a single ISIC or ERL industrial category an average of the Fire and Explosion exposure index was used. The Best Fire Exposure Index does not take into account the consequences of an event. See Table 15 for a list of the Fire and Explosion Risk Factors by industry.

Environmental Risk Factor

An "Environmental Risk Factor" has been derived based upon the Environmental Impairment Liability (EIL) scheme developed by Environmental Resources, Ltd to provide a basis for insurance premiums as a result of environmental impacts 62/. The risk factor we use comes directly from the present state of the EIL as presented by Fisher 63/. The details of the EIL are presented in Section G. The approach is briefly summarized as follows.

The environmental risk factor developed by ERL has three basic parts:

1. The subjective estimation of possible emissions of a set of pollutants to the air and water environment and the severity of those emissions for a sudden or accidental release.

2. The estimation of of vulnerability; that is, the impact of each pollutant on various resources of the environment.

3. The summation of the likelihood of pollutant emission and the impact of these emissions on the environment over all pollutants and all resources of the environment.

The pollutants that are considered are for (Definitions appear in Section G.)
Water:

Physico-chemical
Organic Toxics
Inorganic Toxics

Air:

Particulates
Gases
Nuisance Factors.

The environment has been divided into five vulnerable areas:

- People
- Property
- Ecosystems
- Agriculture
- Sewage Treatment.

The emission severity and impact to the environment are given numerical values that have been refined through iteration of expert judgment. This provides a numerical index of sudden or accidental risk which varies from 50 to 600. See Table 15 for a listing of the Risk Factor by industrial category.

RERA Indexes

With the establishment of the two risk factors and scaling factor it is possible to calculate fire and explosion and environmental risk for each industry in the region. This is done by multiplying the scaling factor for each industry by the risk factor.

$$FEI(i,j) = FE(j) \times SF(i,j)$$

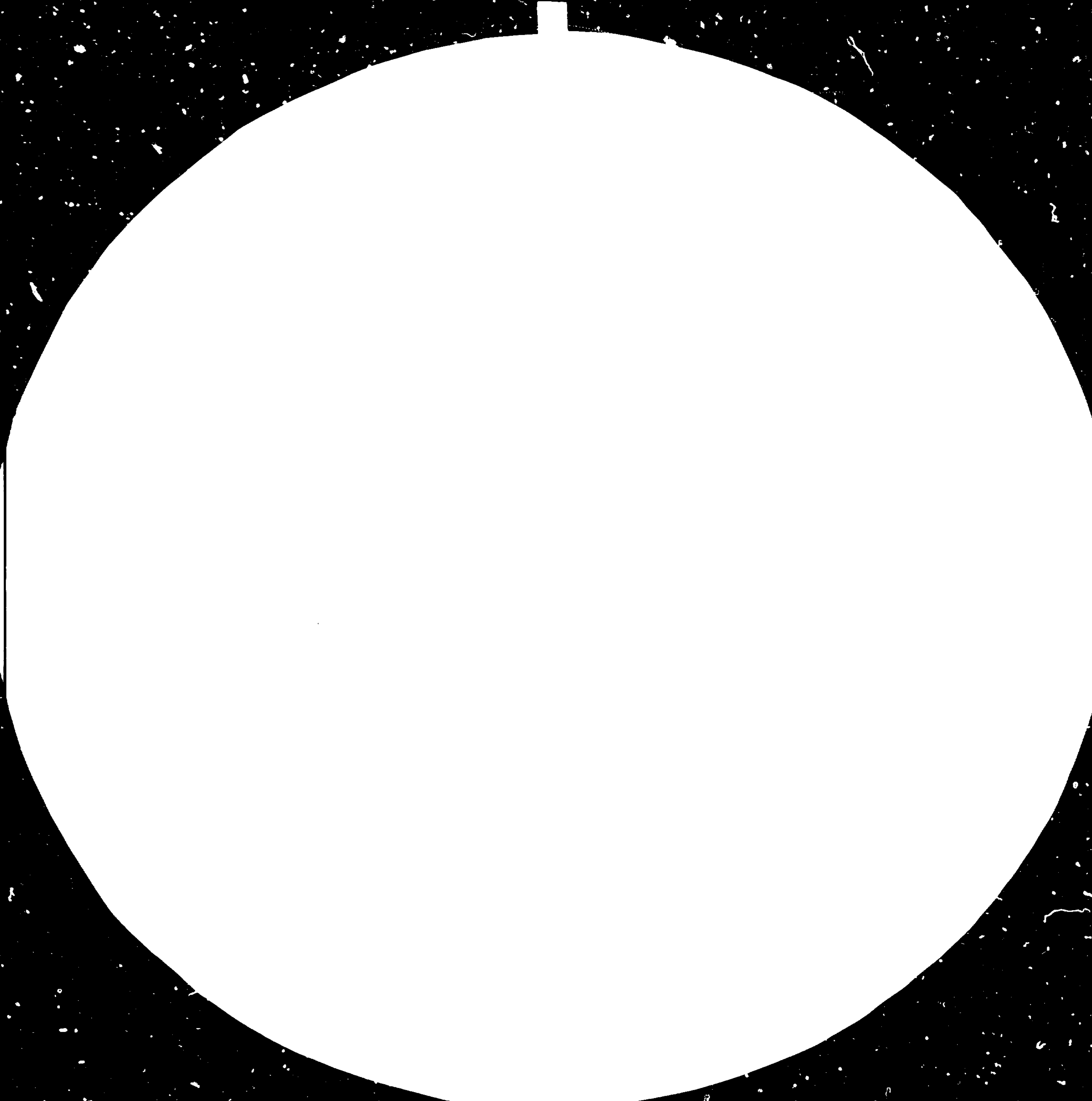
$$ERI(i,j) = ER(j) \times SF(i,j)$$

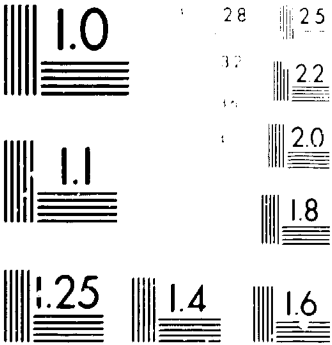
FEI(i,j)= Fire and Explosion index for plant (i) & ind(j)
ERI(i,j)= Environmental Risk index for plant (i) & ind(j)
SF(i,j)= Scale Factor for plant (i)
FE(j)= Fire and Explosion risk factor for industry (j)
ER(j)= Enviromental Risk factor for industry (j)

Each plant is classified to an industry (j) and has a unique number i. This result is the basis for the various output forms to be provided in Section E.

E. The Regional Environmental Risk Assessment

The calculations were performed on an absolute basis, but for a more understandable presentation the results are presented in relative terms. This was done for each industrial sector by determining separately for Fire and Explosion and Environmental Risk the industrial classification with the largest index value. All industrial index values were divided by the largest index





MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

STANDARD REFERENCE MATERIAL 1010a

(ANSI and ISO TEST CHART No. 2)

and then multiplied by 100 to produce a percent value. Thus each results is a percentage of the maximum value of Fire and Explosion or Environmental Risk for highest risk zone in the region or the highest risk industrial sector.

The first results presented in Table 16a show the relative Fire and Explosion Risk by industry classified into the ISIC sectors for the entire Region. It shows the food industry as having the highest total Fire and Explosion Risk in the region with Breweries second. This reflects the high number of agro-industries in the region. Textile plants, chemical plants and oil refineries, although few in number, have a relative high fire and explosion risk due to the high fire and explosion potential at each plant.

The table also shows a very rapid decline in the relative Fire and Explosion index after the first five or six sectors.

The Environmental Risk classified by the ISIC sectors for the region is presented in Table 16b. It shows a much more even distribution of risk among the top half of the sector. Oil refineries with only 17 plants in the region shares first place with food manufacturing with 86 plants. This is due to the high environmental damage potential of the oil refineries. The food industry remains at the top due to the large number of low-medium risk plants in the region.

The results also show that a number of sectors with low plant numbers but high potential environmental damage are found near the top of the list, for example, paints, plastics, storage(primarily oil) and textiles.

The UNIDO/UNEP "Survey of Marine Pollutants from Industrial Sources in the West and Central African Region" 5/ divided the WACAF region into five zones by countries as follows:

Zone I Senegal, Gambia, Guinea-Bissau

Zone II Guinea, Sierra Leone, Liberia

Zone III Ivory Coast, Ghana, Togo, Benin

Zone IV Nigeria, Cameroon, Equitorial-Guinea, Sao Tome & Principe, Gabon

Zone V Congo, Zaire, Angola

Table 17a and 17b provide a geographical distribution of the fire and explosion and Environmental risk, respectively, among the zones of the region. This shows that fire and explosion risk of the food industry is concentrated in zone IV, while the oil refineries risk is distributed a little more evenly amoung the zone, but still is concentrated in zone IV.

The same is true for both industries for Environmental Risk. However, for chemical extraction of oil and fats also all of the environmental risk is found in zone I.

When risk is aggregated over industries to provide total for each zone the result are presented in Table 18 for Fire and Explosion Risk and Table 19 for Environmental Risk. In both cases zone IV contains the highest risk. Zone I contains approximately two-thirds of the zone IV risk. In both cas s zone II has the smallest risk.

F. Summary and Recommendations

The results show that the greatest risks, whether calculated from fire and explosion or environmental damage, are found in zones IV and I and the least in Zone II. This would imply that more detailed study of risk should take place in Zone IV and I on a country by country basis to better understand the risk that appears to be present.

The result by industrial sector reveal that the large number of relatively low risk food industries amount to a high risk from both the fire and explosion and environmental perspective and the assumed low risk of food plants should be investigated. From a fire fighting perspective the high fire and explosion risk of breweries, textiles,chemicals and oil refineries should be noted and be more extensively studied.

The environmental risk analysis shows that a number of high risk sectors with few plants exist. These sectors oil refineries, plastics, textiles, and oil storage should be thoroughly investigated. Due to the small number of plants reduction of risk at these plants could greatly reduce the total environmental risk to the region.

G. Summary of Proposed Environmental Risk Assessment Approach

The approach recommended is a quantitative approach with subjective inputs, based on the Environmental Resources, Ltd. "Environmental Impairment Liability" scheme 62/. This strategy is also summarized in a separate document by Fisher 63/. The method is adapted for application to environmental risk assessment in the WACAF Region.

The Environmental Impairment Liability (EIL) scheme was developed to provide the basis for insurance premiums as a result of environmental hazards, and has evolved since its initial conception in 1973. The method consists of four basic steps:

1. Preparation of an industrial classification;

2. Identification of a set of pollutants of interest;

3. Subjective estimation of the possible emissions in each pollutant category for each industry, in terms of severity of impairment that is likely;

4. Identification of resources with which the pollutants could interact;

5. Estimation for each pollutant category and each resource of the degree of toxic, persistent, and nuisance impact;

6. Integration to determine the likelihood that a particular industry emitting a particular pollutant damages a particular resource;

7. Aggregation to determine the impact by industry over the entire set of pollutants;

8. Weighting by resource and aggregation to determine the impact by industry over all resources.

This approach is very basically a linear scoring function used to construct the risk by industry, based on expert estimation of several factors. It is none the less a reasonably easy to use technique, for which somewhat refined assessments exist based on years of experience.

Table 20 shows a listing of industry by major classes, including agriculture, energy, mining, manufacturing of mineral products, manufacturing of chemicals, other manufacturing, construction, distribution and transportation, and other services. This listing is at an appropriate level of detail for the available data on West and Central African industry.

The EIL ratings developed by Environmental Resources Ltd for generic application are based on the two broad categories of pollutants, namely water or air borne and recalculated to include only discharge to water. The two classes of pollutant are further detailed so that separate subcategories are maintained as follows. For water the categories include "physico-chemical" constituents (e.g. oxygen demand, suspended solids, thermal discharge, nutrients, and oil and grease -- lumped as an aggregate impact), organic toxics, and inorganic toxics. For air, the subcategories included particulates, gases, and nuisance factors (noise, odor, etc.).

0 negligible possible emissions;

1 possibility of moderate impairment;

2 possibility of serious impairment;

3 possibility of very serious impairment;

4 possibility of incident involving catastrophic damage

These ratings were performed by experts, and refined in several iterations, until there was agreement on the probable degree of impairment. The scoring for the various industry groups is shown as Table 21.

The Environmental Resources rating scheme focused on adverse impacts in five categories as follows:

1 people

2 property

3 ecosystems

4 agriculture

5 sewage treatment

Note that these are all primary impacts, and not necessarily reduced to economic measures. For each possible category of resourc , the possible effect in for every pollutant under consideration in terms of three distinct types of impact was rated. The three concerns were toxic, persistent, and nuisance impacts. Toxic impacts were rated on a 0 to 10 scale; persistant impacts on a 0 to 6 scale; and nuisance impacts on a 0 to 3 scale. The range of these scales implies a value judgement on the relative severity of the impacts. The ratings in the three areas, for all category of resource, and for each of the pollutant constituents, is shown as Table 22. Again this is based on an expert assessment.

If weights are assigned to the importance of each category of resource, then the results of the impact scoring can be aggregated to provide a "commensurate" measure of the overall importance of each pollutant constituent with respect to each resource category. The weights used by Environmental Resources for intercomparison of resource categories were as follows: people, 5; property, 2; ecosystems, 2; sewage, 1; agriculture,2. Based on this weighting, the derived importance of each pollution constituent on each resource category is shown as Table 23.

At this point, using the industrial pollutant ratings shown on Table 21, and the weighting of Table 23, Environmental Resources Ltd aggregated to provide an overall EIL hazard rating. Environmental Resources recognized the need to address the problem of sudden or unusual occurrences in their report. Examples they give include the rupture of a storage tank, or other extreme release in a short time frame, and with significant quantity of discharge. They propose that the sudden release events would have a differential impact on each of the several categories of pollutant, and develop a set of multipliers to reflect this increase. The multipliers they propose are as follows. For water: physico-chemical, 1.5; organic toxics, 1.7; inorganic toxics, 1.7. For air: particulates, 1.5; gases, 1.6; nuisance, 1.0. Using these multipliers to adjust the impacts and reaggregating, a revised EIL showing sudden and accidental release can be calculated. These are also shown on Table 15.

The modified ratings represent a fairly simplistic adaptation of the scheme, but one which is fairly consistent and workable. These will be used to form the basis for the assessment for Western and Central Africa. A first step, of course, will be to adjust the ratings to eliminate the air borne constituents.

The output at this point from the ERL scheme is a set of ratings which provide a measure of the "environmental impairment liability" risk for single industrial plants by industry type. The problem at this point is to provide a scheme for aggregation of the risk to establish relative industrial risk for zones and industrial sectors within the WACAF region. Assuming independence of events at industrial plants within the region, it should be possible to aggregate the total risk of any zone by adding the risks of plants within the zone. This works because in fact the EIL rating is a measure of "expected loss" to the various resource categories -- and these losses should be additive for independent occurrences. The major adjustment which should be made is to scale the expected losses in some way to account for differences in plant size within the region. The proposed way of doing this is as follows. Based on an inventory of plants of a specific industrial type, establish an average plant size -- with the average being based either on employment or preferably volume of product. Assume that the average sized plant has the "average" or standard EIL rating. For smaller or larger plants, the EIL can be scaled up or down by relative plant size in order to capture variations in industrial size. Although it is clearly questionable whether or not a plant of one-half the size imposes one-half of the liability, since the primary interest is aggregate risk, the aggregation procedure should not introduce much error.

Table 14. International Standard Industrial Classification (ISIC)

ISIC code	Industrial Sector Name
1110	Agric. & Livestock prod.
1120	Agric. Service
1220	Logging
2200	Crude Petrol. & Nat. Gas Prod.
2301-2302	Ore Mining (Only Preparation)
311-312	Food Manufacturing
3133	Malt liquors and malt (Beer & Wine)
3134	Soft Drinks & Carbon. Water ind.
3211	Spinning, weaving, & finishing Textiles
3240	Man. of footwear, etc rubber or plas.
3311	Sawmill,planing, & other wood mills
3319-3320	Wood Products
3411	Man. of Pulp, paper, & paperboard
3420	Printing, publish. & allied inds.
3511	Man. of basic ind. chemical, etc fert.
3512	Man. of fertilizers & pesticides
3513	Man. of syn.resins, plas. fibers etc glass
3521	Man. paints, varnishes & lacquers
3522	Man. drugs & medicines
3523	Man. soaps,perfumes,cosmetic, toilet preps.
3529	Man. chem. prod not elsewhere classified
3530	Petroleum refineries
3540	Man. of misc. prod. of petrol. and coal
3559	Man. of rubber prod. not elsewhere clas.
3560	Man. of plastic prod. not elsewhere clas.
3710	Iron & Steel basic industries
3720	Non-ferrous basic industries
3819	Man. of fab. metal prod. not mach. or equip.
3829	Machinery & Equip. other, etc electrical
5000	Construction
6100-6200	Wholesale & Retail trade
7111	Land Transport
7115	Pipeline Transport
7192	Storage & Warehousing
9200	Sanitary & Similar Services
9520	Laundries & serv.; clean. and dyeing plants
9592	Photo. studios & comm. photography

Table 15. Fire & Explosion and Environmental Risk Factors by Sector

ISIC Sector Name	ERL Code	ERI	F&E
Agric. & Livestock prod.	3	50	4
Agric. & Livestock prod.	1	100	4
Agric. Service	2	450	4
Logging	60	50	3
Crude Petrol. & Nat. Gas Prod.	502	100	9
Crude Petrol. & Nat. Gas Prod.	501	300	10
Ore Mining (Only Preparation)	15	100	4
Ore Mining (Only Preparation)	17	450	4
Ore Mining (Only Preparation)	16	350	4
Food Manufacturing	54	50	6
Food Manufacturing	53	50	6
Food Manufacturing	52	100	8
Malt liquors and malt (Beer & Wine)	521	100	8
Soft Drinks & Carbon. Water ind.	531	50	6
Spinning, weaving, & finishing Textiles	56	50	8
Spinning, weaving, & finishing Textiles	57	150	8
Spinning, weaving, & finishing Textiles	55	200	4
Spinning, weaving, & finishing Textiles	58	500	6
Man. of footwear, etc rubber or plas.	59	200	5
Sawmill,planing, & other wood mills	61	100	5
Sawmill,planing, & other wood mills	633	300	9
Wood Products	62	200	9
Man. of Pulp, paper, & paperboard	631	350	3.5
Printing, publish. & allied inds.	64	50	6
Man. of basic ind. chemical, etc fert.	48	400	10
Man. of basic ind. chemical, etc fert.	51	500	10
Man. of basic ind. chemical, etc fert.	46	350	7
Man. of basic ind. chemical, etc fert.	47	350	3
Man. of fertilizers & pesticides	30	200	8
Man. of fertilizers & pesticides	41	300	3
Man. of fertilizers & pesticides	29	300	8
Man. of fertilizers & pesticides	40	300	3
Man. of syn.resins, plas. fibers etc glass	32	300	3
Man. of syn.resins, plas. fibers etc glass	45	300	8
Man. of syn.resins, plas. fibers etc glass	31	450	8
Man. paints, varnishes & lacquers	34	300	7
Man. paints, varnishes & lacquers	35	350	10
Man. drugs & medicines	42	400	6
Man. soaps,perfumes,cosmetic, toilet preps.	43	150	6
Man. chem. prod not elsewhere classified	38	100	10
Man. chem. prod not elsewhere classified	37	100	9
Man. chem. prod not elsewhere classified	39	350	10
Man. chem. prod not elsewhere classified	36	300	10
Man. chem. prod not elsewhere classified	33	450	8
Petroleum refineries	50	400	10
Petroleum refineries	49	350	10
Petroleum refineries	601	450	10
Petroleum refineries	602	300	10
Man. of misc. prod. of petrol. and coal	4	550	6.5
Man. of rubber prod. not elsewhere clas.	65	250	3
Man. of plastic prod. not elsewhere clas.	66	200	8
Iron & Steel basic industries	21	150	2
Iron & Steel basic industries	19	250	7

Iron & Steel basic industries	18	400	1
Non-ferrous basic industries	20	400	3
Man. of fab. metal prod. not mach. or equip.	23	300	7
Man. of fab. metal prod. not mach. or equip.	22	150	3

icname	Code	ERI	HI
Machinery & Equip. other, etc electrical	25	100	3
Construction	68	200	7
Wholesale & Retail trade	69	100	5
Land Transport	74	0	6
Pipeline Transport	75	600	8
Storage & Warehousing	70	300	5
Storage & Warehousing	73	500	7
Storage & Warehousing	71	500	7
Storage & Warehousing	72	500	7
Sanitary & Similar Services	77	250	5
Sanitary & Similar Services	76	350	4
Sanitary & Similar Services	28	350	7
Sanitary & Similar Services	78	500	5
Laundries & serv.; clean. and dyeing plants	79	100	7
Laundries & serv.; clean. and dyeing plants	80	200	7
Photo. studios & comm. photography	67	250	7

F&E = Fire & Explosion Factor

ERI = Environmental Risk Factor

Table 16a. Relative Fire and Explosion Risk by Industry for Region

ISIC Sector Name	FE	No. of Plants
Food Manufacturing	100	86
Malt liquors and malt (Beer & Wine)	45	36
Spinning, weaving, & finishing Textiles	43	36
Man. chem. prod not elsewhere classified	40	28
Petroleum refineries	27	17
Soft Drinks & Carbon. Water ind.	25	27
Man. paints, varnishes & lacquers	22	14
Man. soaps,perfumes,cosmetic, toilet preps.	21	22
Sawmill,planing, & other wood mills	17	13
Iron & Steel basic industries	11	14
Man. of syn.resins, plas. fibers etc glass	11	9
Man. of fab. metal prod. not mach. or equip.	10	16
Man. of fertilizers & pesticides	10	11
Storage & Warehousing	9	9
Man. of plastic prod. not elsewhere clas.	8	7
Man. of basic ind. chemical, etc fert.	8	7
Wood Products	7	5
Man. drugs & medicines	5	6
Man. of footwear, etc rubber or plas.	5	7
Construction	4	4
Crude Petrol. & Nat. Gas Prod.	4	3
Man. of rubber prod. not elsewhere clas.	3	8
Non-ferrous basic industries	2	7
Machinery & Equip. other, etc electrical	2	6
Man. of Pulp, paper, & paperboard	2	5
Wholesale & Retail trade	0	1
Agric. & Livestock prod.	0	1

FE- Relative Fire and Explosion Index

Table 16b. Relative Environmental Risk by Industry for Region

ISIC Sector Name	ERI	No. of Plants
Petroleum refineries	100	17
Food Manufacturing	99	86
Spinning, weaving, & finishing Textiles	78	36
Man. paints, varnishes & lacquers	69	14
Storage & Warehousing	60	9
Man. of syn.resins, plas. fibers etc glass	54	9
Iron & Steel basic industries	52	14
Malt liguors and malt (Beer & Wine)	50	36
Sawmill,planing, & other wood mills	49	13
Man. chem. prod not elsewhere classified	49	28
Man. soaps,perfumes,cosmetic, toilet preps.	46	22
Man. of fab. metal prod. not mach. or equip.	44	16
Non-ferrous basic industries	39	7
Man. of fertilizers & pesticides	39	11
Man. of basic ind. chemical. etc fert.	38	7
Man. drugs & medicines	33	4
Man. of rubber prod. not elsewhere clas.	28	8
Man. of Pulp, paper, & paperboard	24	5
Man. of plastic prod. not elsewhere clas.	19	7
Soft Drinks & Carbon. Water ind.	19	27
Man. of footwear, etc rubber or plas.	19	7
Wood Products	14	5
Construction	11	4
Crude Petrol. & Nat. Gas Prod.	9	3
Machinery & Equip. other, etc electrical	8	6
Wholesale & Retail trade	1	1
Agric. & Livestock prod.	0	1

ERI- Relative Environmental Risk Index

Table 17a Relative Fire & Explosion Risk by Industry
Distributed by Zones

ISIC Sector Name	Zone I	II	III	IV	V	Region
Food Manufacturing	16	6	26	41	11	100
Malt liquors and malt (Beer & Wine)	2	5	12	22	6	45
Spinning, weaving, & finishing Textiles	7	1	5	25	4	43
Man. chem. prod not elsewhere classified	27	3	6	3	2	40
Petroleum refineries	2	3	9	8	5	27
Soft Drinks & Carbon. Water ind.	4	3	5	14	1	25
Man. paints, varnishes & lacquers	2	1	2	17	0	22
Man. soaps,perfumes,cosmetic, toilet preps.	13	1	2	4	0	21
Sawmill,planing, & other wood mills	0	0	0	13	4	17
Iron & Steel basic industries	7	0	2	2	0	11
Man. of syn.resins, plas. fibers etc glass	10	0	0	1	0	11
Man. of fab. metal prod. not mach. or equip.	4	1	4	1	0	10
Man. of fertilizers & pesticides	6	0	3	1	0	10
Storage & Warehousing	0	0	1	4	5	9
Man. of plastic prod. not elsewhere clas.	3	1	0	3	3	8
Man. of basic ind. chemical, etc fert.	0	1	4	3	0	8
Wood Products	0	3	3	1	0	7
Man. drugs & medicines	4	1	1	0	0	5
Man. of footwear, etc rubber or plas.	2	0	2	1	1	5
Construction	1	0	1	1	1	4
Crude Petrol. & Nat. Gas Prod.	0	0	0	1	3	4
Man. of rubber prod. not elsewhere clas.	0	0	0	2	1	3
Non-ferrous basic industries	0	0	1	1	0	2
Machinery & Equip. other, etc electrical	0	0	1	0	1	2
Man. of Pulp, paper, & paperboard	0	0	0	2	1	2
Wholesale & Retail trade	1	0	0	0	0	0
Agric. & Livestock prod.	1	0	0	0	0	0

(Note: sum of zone may not equal region due to roundoff of output.)

Table 17b Relative Environmental Risk by Industry
Distriubuted by Zones

ISIC Sector Name	I	II	Zone III	IV	V	Region
Petroleum refineries	8	13	29	33	17	100
Food Manufacturing	14	6	23	45	12	99
Spinning, weaving, & finishing Textiles	19	1	5	46	7	78
Man. paints, varnishes & lacquers	6	2	7	54	0	69
Storage & Warehousing	0	0	4	26	30	60
Man. of syn.resins, plas. fibers etc glass	49	2	0	4	0	54
Iron & Steel basic industries	24	0	19	7	3	52
Malt liquors and malt (Beer & Wine)	2	5	13	24	6	50
Sawmill,,planing, & other wood mills	0	0	1	37	12	49
Man. chem. prod not elsewhere classified	25	6	6	3	5	49
Man. soaps,perfumes,cosmetic, toilet preps.	30	2	5	10	[illegible]	46
Man. of fab. metal prod. not mach. or equip.	18	7	15	5	0	44
Non-ferrous basic industries	6	1	21	11	0	39
Man. of fertilizers & pesticides	22	4	9	4	0	39
Man. of basic ind. chemical, etc fert.	0	5	19	15	0	38
Man. drugs & medicines	23	6	6	0	0	33
Man. of rubber prod. not elsewhere clas.	0	4	4	14	7	28
Man. of Pulp, paper, & paperboard	0	0	0	15	10	24
Man. of plastic prod. not elsewhere clas.	6	3	0	6	6	19
Soft Drinks & Carbon. Water ind.	3	2	4	10	1	19
Man. of footwear, etc rubber or plas.	6	0	8	3	3	19
Wood Products	0	5	6	3	0	14
Construction	3	0	3	3	3	11
Crude Petrol. & Nat. Gas Prod.	0	0	0	1	8	9
Machinery & Equip. other, etc electrical	0	1	3	0	4	8
Wholesale & Retail trade	1	0	0	0	0	1
Agric. & Livestock prod.	1	0	0	0	0	0

(Note: sum of zone may not equal region due to round off of output.)

Table 18. Relative Fire & Explosion Risk by zones

zone	FE	No. of Plants
I	59	118
II	17	46
III	50	103
IV	100	90
V	26	62

FE- Relative Fire and Explosion Index

Table 19. Relative Environmental Risk by Zones

zone	RERI	No. of Plants
I	66	118
II	19	46
III	55	103
IV	100	90
V	35	62

RERI- Relative Environmental Risk Index

Table 20 Industrial Categorization by ERL

ERL Code	Industrial Sector Name
1	arable farming including pesticides,herbicides
2	agriculture,horticulture and silviculture services
3	intensive livestock production, intensive feed lots
4	manufacture of solid fuels, coke
5	mining of mineral oils natural gas:
6	mineral oil processing:
7	natural gas processing in gradual location
8	electricity production thermal plant: coal & oil burning
9	synthetic gas production not syncrude or syngas
10	deep mining metalliferous ores/coal
11	opencast mining metalliferous ores/coal
12	mining/preparation uranium ores
13	deep mining non metalliferous ores, not treatment
14	opencast mining non_metalliferous ores
15	preparation of ores_ dry treatment
16	preparation of ores_ wet treatment plus heat
17	preparation of ores_ chemical treatment
18	manufacture of iron and steel: integrated steel plant
19	drawing cold rolling etc. of steel: foundries
20	non_ferrous metals: aluminium, other
21	forging, pressing, stamping etc.
22	finished metal goods
23	metal plating
24	no entry
25	light machinery manufacture
26	non_metallic mineral products
27	asbestors and its products, asbestos and derivatives
28	dealing in scrap and waste materials
29	organic fertilisers
30	inorganic fertilisers
31	synthetic resins and plastic materials
32	synthetic rubber
33	dyestuffs
34	pigments
35	paints,varnishes
36	adhesives and sealants
37	chemical treatment of oils /fats
38	essential oils and flavouring
39	explosives
40	organic pesticides and herbicides
41	inorganic pesticides
42	pharmaceutical products
43	soap and toilet preparations
44	no entry
45	artificial fibres
46	mineral acids
47	chlorine caustic
48	inorganic fine chemicals
49	bulk olefines primary petrochemical manufacturing
50	aromatics
51	organic intermediate chemicals
52	food_ high organic load effluent
53	food_ medium organic load effluent

54	food_ low organic load effluent
55	woollen and worsted natural fibre preparation
56	cotton and silk natural fibre & general weaving
57	textiles finishing & dyeing
58	tanning and fellmongery
59	footwear and clothing
60	timber logging
61	timber sawmilling/planning
62	wooden products
63	pulp paper and board:
64	printing and publishing
65	rubber products
66	plastics processing
67	photographic/film manufacturing,processing
68	general construction and demolition
69	wholesale and retail distribution
70	storage of solids, bulk storage and handling of solids
71	storage of inorganic liquids/gases and handling
72	storage of organic liquids/gases and handling
73	storage of oil/oil products and handling
74	rail transportation; road haulage
75	pipelines (non_water)
76	municipal waste disposal (discount for secure sites)
77	sewage disposal
78	hazardous waste disposal
79	laundries
80	dry cleaning and allied services

Table 21. ERL Environmental Impact Weighing by Industry for each Pollutant

Industrial Sector Name	Water Pollutants PE	OT	IT	Air Pollutants PT	GS	NS
Arable farming	2	1	0	0	0	1
Agricultural and horticultural services	3	3	1	2	3	1
Intensive livestock production	3	1	0	0	0	3
Manufacture of solid fuels (coke ovens etc.)	3	3	2	2	3	2
Extraction of mineral oils and natural gas	3	0	0	0	1	1
Mineral oil processing	3	3	2	0	2	2
Natural gas processing	2	1	1	0	2	2
Electricity production (thermal power plant)	3	1	1	2	2	1
Prep ores-dry	1	0	0	3	0	3
Prep ores-wet	3	1	3	3	0	3
Prep ores-chem	3	2	3	3	1	3
iron and steel industry (including coke ovens)	3	2	2	2	2	3
drawing,cold rolling,etc. of steel	2	1	2	0	1	2
non-ferrous metals	3	0	4	3	2	1
forging,pressing,stamping etc.	2	0	1	1	1	2
finished metal goods	1	1	1	1	0	1
metal plating	3	2	3	0	0	1
heavy machinery manufacture	2	1	1	1	0	1
light machinery manufacture	1	0	1	0	0	1
Non-metallic mineral products manufacture	3	0	1	3	1	3
Asbestos and its products	3	0	1	4	0	1
Dealing in scrap and waste materials	2	1	2	1	2	2
fertilizers organic	3	1	1	2	2	1
fertilizers inorganic	3	0	1	2	1	1
synthetic resins and plastic materials	3	3	1	2	2	2
synthetic rubber	3	2	1	1	1	1
dyestuffs	3	3	2	1	2	1
pigments	3	0	3	2	0	1
paints,varnishes,etc.	3	2	1	1	2	1
adhesives and sealants	3	2	1	1	1	1
chemical treatment of oils and fats	3	0	0	0	1	1
essential oils and flavouring materials	3	0	0	0	1	1
explosives	3	1	2	1	2	1
pesticides organic	2	4	1	3	2	1
pesticides inorganic	2	0	3	1	1	0
pharmaceutical products	3	3	2	1	1	1
soap and toilet preparations	3	1	1	0	0	1
photographic materials	2	1	3	0	0	0
artificial fibres	3	2	1	1	2	1
mineral acids	2	0	2	1	3	1
chlorine	2	0	2	1	4	2
inorganic fine chemicals	3	1	3	1	2	1
bulk olefines	3	2	1	1	3	2
aromatics	3	3	1	1	3	2
organic intermediates	3	3	2	1	3	2
high organic load effluent	3	0	0	1	0	2
medium organic load effluent	2	0	0	1	0	2
low organic load effluent	1	0	0	0	0	1
woollen and worsted	3	0	1	0	1	2
cotton and silk	2	0	0	1	0	1
textile finishing	2	1	1	0	0	1
tanning and fellmongery	3	3	3	1	1	3
Footwear and clothing	1	1	0	0	0	0

logging	1	0	0	0	0	2
sawmilling,planing,etc.	2	0	0	1	0	3
wood proocts	2	1	0	1	1	2
pulp,paper and boaro	3	1	2	1	2	2
printing and publishing	1	1	0	0	0	1
rubber products	2	1	1	1	2	1
plastics processing	2	2	1	0	0	1
Photographic and film processing	1	1	3	0	0	0
General construction and demolition	1	0	0	2	0	3
Wholesale and retail distribution	1	1	0	1	0	1
Storage of solids	1	0	2	3	0	2
Storage of inorganic liquids and gases	3	0	3	0	3	2
Storage of organic liquids and gases	3	3	0	0	3	2
Storage of oil and oil products	4	2	1	0	2	2
Railways	1	1	1	0	1	2
Pipelines	3	2	0	0	1	1
waste disposal,municipal	3	2	2	1	1	2
sewage disposal	3	1	1	0	1	2
waste disposal,hazardous	4	4	4	1	2	3
laundries	2	1	0	0	0	1
dry cleaning and allied services	2	2	0	0	1	1

PC=Physico-Chemcial
OT=Organic Toxics
IT=Inorganic Toxics

PT=Particulates
GS=Gases
NE=Noises,Odours, etc.

Table 22. ERL Weightings of Pollutant Impacts on Environmental Resources

Pollutants	Damage to People	Property	Ecosystem	Sewage	Agriculture
	Persistence				
Water- Physico-chemical	1	2	4	1	1
Water- Organic toxics	3	0	6	6	6
Water- Inorganic toxics	6	0	3	6	4
Air- particulates	3	2	1	0	2
Air- gases	6	5	0	0	5
Air- noise,etc.	2	1	0	0	2
	Toxicity				
Water- Physico chemical	2	0	7	4	4
Water- Organic toxics	9	0	10	10	8
Water- Inorganic toxics	9	0	10	10	8
Air- particulates	6	4	0	0	4
Air- gases	10	8	3	0	7
Air- noise,etc.	0	0	0	0	0
	Nuisance				
Water- Physico chemical	1	0	2	1	1
Water- Organic toxics	2	0	3	3	2
Water- Inorganic toxics	2	0	2	3	2
Air- particulates	2	0	0	0	1
Air- gases	2	3	0	0	2
Air- noise,etc.	3	0	1	0	0

Table 23. ERL Aggregated Weighting of Pollutant Impacts Upon Enviromental Resources

Pollutant	Damage to People	Property	Ecosystem	Sewage	Agriculture
Water- Physico-chemical	20	4	26	6	12
Water- Organic toxics	60	0	36	18	30
Water- Inorganic toxics	80	0	28	18	26
Air- particulates	55	12	2	0	14
Air- gases	85	30	6	0	28
Air- noise,etc.	35	2	2	0	4

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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 in 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 inflammable 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 inflammable 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 an 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 loading.

WACAF region: The West and Central African region. In this work, the 20 countries of the region were divided into the following five 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