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THE INDUSTRIAL EMERGENCY GAME *

prepared by

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Industrial Policy and Perspectives Division

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Foreword

This document was prepared by Jack B. Carmichael, Sectoral Studies Branch, UNIDO as a follow-up to the successful Environmental Decision Game (published in Industry and Environment, Volume 9, No. 2, 1986). The study forms part of the 1986/1987 work programme of Sectoral Studies (programme element 3.14, environmental studies). The Industrial Emergency Game presents the tools by which a team of six can rapidly respond to an industrial emergency. The kinds of emergencies considered in the game are fire, explosion, and/or release of toxic materials. The game is a mechanism that requires the players to come to grips with the tradeoffs associated with a simulated emergency and reach jointly agreed upon conclusions. The game is designed for decision makers from developing or developed countries as players.

Participants: The author believes the game is best suited for participants with diversified backgrounds and middle-level responsibilities as managers and policy makers. Diversity of background would stimulate a greater exchange of experience. I do not believe the game should be restricted to participants with a technical background.

In its present form the document is designed as an instructor's manual for playing the game.

Notes for the instructor:

1. Pass out the game (parts 1 - 9 except for parts 6 and 8) and one sample emergency response card from appendix A a few days before it is to be played.
2. The day before the game is to be played, give a lecture presenting an overview of the game and the details of section 2. - Planning for Industrial Emergencies. Then assign the players for each team, indicating their assignments for Role 1. Pass out the respective briefing pages for Role 1.
3. Pass out part 6, the description of the emergency to be fought and the full appendix A, once the teams are in place and just before the game is to begin.
4. Allow a half day to play the game. A five minute refresher talk just before the game is played should suffice. Stress that each group of six players must decide how to organize discussions, take notes, and prepare the two reports required. Go around to each group as necessary encouraging them to (a) reach to required decisions rapidly, and, (b) to get on with the writing of the reports.
5. Allow about one and a half hours for playing Role 1 and writing the interim report.
6. Once the interim reports have been collected, add to each the following further complication: Conglomerate Chemicals has just reported the rupture of a second chlorine cylinder. Then pass out part 8, the briefing pages for Role 2.

7. After the final report (part 9) has been collected, pass out appendices B and C to each team.
8. Immediate follow-up. While it is hardly possible to produce a report on the ideal way in which the emergency could have been handled, it would be useful to distribute a list of "dos and don'ts" to players after the game, e.g. don't try to rescue the three workers without breathing apparatus; do send security officers to make sure that employees are being evacuated upwind from the leak. Players should be given the chance to discuss what their team did right and what they should have done differently. Pass out the questionnaire (p. 42).
9. At the next session examine the results of the game in comparison with those in section 10 (Note: The complication of the second ruptured chlorine cylinder was not introduced in the team playings reported in part 10). Discuss the recommendations of appendices B and C. Observe how the results of your teams compared. Try to get comment from your students (or employees) as to why the results turned out as they did.

Summary of the game

The emergency begins at a chemical factory manufacturing chemicals, plastics, and explosives.

The chemical factory, Conglomerate Chemicals, is fictional. However, it has a complete plant layout which is reproduced in the document for each team. The illustration includes the location of all firefighting equipment and the alarm system.

This game takes place in the fictional country of Teleroy. A map shows the location of important cities, towns, and industrial facilities. Each team which plays the game has six players. The only limit to the number of teams is that which can be managed by the instructor. In the case of the author's previous work, The Environmental Decision Game, four or five teams seemed practical.

Phase 1. Each team (representing employees from Conglomerate Chemicals) must deploy its resources in the manner it sees fit to stop the emergency with minimum loss of life and personal injury, loss of industrial equipment and infrastructure, and minimum damage to the environment. As soon as a team has finished this assignment (maximum time: 1 1/2 hours), the team will present the report to the instructor.

Phase 2. Each team then takes on the identities of members of the National Emergency Co-ordination team. A one-page written report must follow the preliminary report from phase 1 within 3 hours.

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1. INTRODUCTION

- I. This game tests the players' reactions to an industrial emergency which occurs at the fictitious international corporation called Conglomerate Chemical Company, which is located in the fictitious country of Teleroy. This firm is manufacturing chemicals, plastics, and explosives.
- II. The game has six players on each team. Each player must play two roles. Each of the first roles represents an employee of Conglomerate Chemicals. The second roles are managers representing Conglomerate Chemicals, the neighboring corporation Corporación de Explotación de las Minas, the resident representative from the United Nations Development Programme which is located in Teleroy City, the Minister of Industry in Teleroy, the National Director of Hospitals from the Ministry of Health, and the National Fire Chief from the Ministry of the Interior.
- III. Role 1. The Conglomerate Chemicals Emergency Response. Each team will discuss the industrial emergency and reach decisions on how to deploy resources in order to mitigate the consequences of the accident. As soon as a team has deployed its resources and observed the results, it prepares an interim report. The report must be no more than one page in length. A format for the interim report by each team of players appears on page 25.
- IV. Role 2. The National Emergency Response. Each team will use its resources to fight, and hopefully conquer, the emergency situation at Conglomerate Chemicals and turn its attention outside the factory gates. A second report describing the actions taken, current status and further recommendations, if any are needed, will be prepared (also in one page - format on p. 35) for the President of Teleroy.

2. PLANNING FOR INDUSTRIAL EMERGENCIES

The general purpose of industrial contingency planning is to prepare to meet any foreseeable emergency. Contingency plans for industrial emergencies can be developed 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 parts of contingency plans.

Our game will draw upon both kinds of plans, and each player must assume two roles. One plan (and one set of roles) is prepared for immediate action at the chemical plant itself in case of an emergency. The second plan, a co-ordination plan, goes into operation as soon as the players (from the national government and elsewhere) reach the command post (owned by Conglomerate Chemicals but remote from the plant site where the emergency has occurred).

All good 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.

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. For purposes of the game, contingency plans may be grouped in three categories:

1. Lists of resources and equipment, and telephone rosters
2. Action guides
3. Co-ordination plans.

However, a comprehensive plan can include features of two or even more categories. Some plans to be used in this game have features of two categories.

1. Lists of resources and equipment, and telephone rosters

Lists of possible resources and equipment are prepared for use in an emergency, together with locations and way the resources can be alerted (if people) or obtained (if material). The telephone usually 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. Possible

hazards must have been considered at the time of plan preparation but these may not be mentioned explicitly. The plan does not describe subsequent actions to be taken. It is designed for response personnel such as a fire department or trained industrial personnel who know the action to be taken such as the main gate guard at Conglomerate Chemicals (p. 18).

The resource and equipment lists maintained by the response personnel usually describe the resources available within their own organizations (e.g. fire department or industrial complex). Lists of technical experts and equipment from local companies may be useful. Even when an industry is covered by a national or city contingency plan, it should know the extent of the local capabilities and resources so that the information can be made available to the person or team in charge in cases of emergency.

This kind of plan is most suitable for individual industrial plants. It is simple and little preparatory work required. Skilled personnel who know what to do with the plan are required.

In the game, lists of firefighting equipment and resources are assumed to be at the fingertips of the fire chief at Conglomerate Chemicals. A telephone roster (p. 18) is available to the man in charge of the main exit gate from the factory.

2. Action guides

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. In the game, the action guides consist of 11 Emergency Response Cards explaining briefly how to deal with vapor clouds, spills, fires or explosions involving chemicals found at the plant. Action guides are generally subsidiary to more comprehensive plans. They are designed to ensure that a few basic things always get done, such as 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. In our game the action guides will be supplemented during the co-ordination phase of fighting the emergency. An action guide may be all that plant personnel need for handling a small emergency. However, a co-ordination plan covering that plant will also be necessary to provide follow-up response to a large-scale emergency.

3. Co-ordination plans

A designated response agency, such as a fire department, the civil defence agency, or the control centre of a large industrial plant may have detailed specific field responsibilities defined in the plan. A city or national plan will define the responsibilities and capabilities of various community response agencies and explain how to activate them.

The plan will contain information on whom to notify and how in the case of an accident, and it may indicate in outline form the initial actions to be taken by the response personnel. The co-ordination plan will also describe the response organization and procedure. In the game there is a co-ordination team with roles assigned (Section 8). However, this team must function

without a previously developed co-ordination plan (frequently the case in developing countries). Appendix B describes how this can be remedied so that a co-ordination plan is in place in case of a large emergency.

A hazard analysis section will be generally included in the co-ordination plan: it will also specify the vulnerable areas and include detailed maps of the region. The plan also should indicate the type and timing of exercises and training sessions. The response plan should have been updated recently.

A good co-ordination plan defines 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 level or in very large cities. National disaster plans prepared by civil defence organizations are often primarily co-ordination plans and may include technological disasters as part of a matrix showing who does what during different kinds of disasters.

A co-ordination plan indicates the administrative procedures that should be followed in cases of emergency. It notes the chain of command within each of the agencies or groups involved in the emergency response operations and specifies a chain of command when they work together. Such a plan thereby co-ordinates the actions of those agencies or groups.

B. Hazard analysis

Basic to emergency planning is an understanding of the problems one might anticipate. Hazard analysis should be the first step in planning. It should also be included as a site-specific part of a co-ordination plan.

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 each of these located (or through what route does it pass)?

2. Identification of vulnerable areas

What can the above identified hazards affect, and how?

3. Assessment of risk

What is the likelihood that the hazard will occur and affect the vulnerable areas? The methodologies used in risk assessment may be qualitative or quantitative. In the game, a quantitative methodology for assessing the risk posed by the emergency is used by one of the players during the co-ordination plan (the National Fire Chief of Teleroy).

4. Hazard analysis for national or municipal contingency plans

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

(b) Contact the officials in charge of the industry and interview them in person using a written questionnaire. The questionnaire should aim to establish:

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 areas: people, property and environment. Fire and police departments are good sources of information when planning for large industrial accidents which could spread outside the plant. As examples of vulnerable areas outside the plant one may consider sensitive public health concerns:

Drinking water intakes
Vulnerable population centres
Hospital locations
Schools, playgrounds.

(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).

(e) Consult records (the industry, newspapers, police, and fire department records) for actual industrial or industry-related accidents 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 known or potential accidents, clusters of industrial production, and storage of hazardous materials.

(g) Try to estimate the probability of industrial accidents at the plant: the most difficult part of the whole analysis. The probability of an accident can be estimated in qualitative categories such as low, medium, or high risk.

Examples of high risk factors are:

Past accidents
Major industrial production 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 secondary effects (such as traffic jams).

Time, resources, and priorities dictate the extent to which a hazard analysis is conducted. A thorough industrial survey might develop and analyze a long set of "what if" scenarios to assess the vulnerability of the plant and surroundings.

A good hazard analysis should help decide:

The type(s) of contingency plan(s) required
The degree of detail needed in the plan
The types of response to emphasize in the plan
The location of response and clean-up resources
The type of help needed if resources available do not suffice.
When this help may be contacted and/or located.

5. Hazard analysis for plant contingency plans

No single ideal hazard identification system exists. For example, a firm involved in batch manufacture of a large number of organic chemicals should be much more interested in screening chemicals and reactions than a firm operating an ethylene plant.

The safety audit is a useful tool. It consists in a critical, detailed examination of all facets of a particular industrial activity with the objective of minimizing danger. It is usually carried out by a team of professionals who produce a formal report and action plan, including emergency procedures. In the case of the game, a safety audit at Conglomerate Chemicals was used to prepare the contingency plan, including detailed instructions for the various plant personnel.

Table 1. Hazard analysis checklist (examples are given for illustrative purposes)

- a. Plant site (applicable only if an environmental impact analysis was carried out before the final plant site was selected) (7 items in the checklist)

Example:

Could toxic fumes from fire, explosion, or other accidents at the plant affect the surrounding community?

- b. Plant layout (10 items in the checklist)

Example:

Are administrative buildings and warehouses on the periphery of the plant?
Are storage tanks away from the periphery, not too closely spaced, and diked or buried?

(Note: During the game it will be quickly evident that administrative buildings at Conglomerate Chemicals have been placed too close to chemical storage.)

- c. Structures (10 items in the checklist)

Example:

Do all buildings conform to the national building code for industrial structure? (If none exists, perhaps the country should adopt one.)

- d. Materials (9 items in the checklist)

Example:

Have the quantities of materials 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?

(Note: The answer is yes, and Conglomerate Chemicals has adapted the Action Guides of the European Chemical Federation for 11 hazardous chemicals used in production processes. These have been prepared as Emergency Response Cards. Several sets are hung up at different parts of the plant. But an accident happened all the same. The Emergency Response Cards turn out to be useful in emergency response to that accident).

e. Chemical process evaluation. (13 items in the checklist)

Example:

Have the primary hazards of each process been identified and examined in detail?

f. Unit operations, transport and storage (8 items in the checklist)

Examples:

1. Have the potential hazards of all materials involved been evaluated?
2. Are precautionary measures taken to guard against accidental release of flammable or toxic liquids, gases or combustible dusts?

(Note 1.: How well this has been done will unfold in the course of the game)

(Note 2.: The precautionary measures were not sufficient, as we shall see in the game).

g. Operator practices and training (7 items in the checklist)

Example:

Are operators trained in the utilization of protective equipment?

(Note: Yes, thank goodness they know how to use protective breathing apparatus. This will prove to be very important in the game).

h. Equipment (10 items in the checklist)

Example:

Is the safety equipment adequate for the hazards?

(Note: We shall see as the emergency unfolds during the game).

C. Identification of Resources

After the hazard analysis, the next step is to identify the resources (equipment, people, and agencies) that could be made available to combat possible accidents. The resources should be identified for at least the two simplest contingency plans - resource lists and telephone rosters, and action guides.

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

Industrial contingency plans should always be examined in order to ascertain the appropriate resources required to face industrial emergencies. When planning at the government level for accidents spreading beyond the plant boundary, all organizations capable of providing immediate active and material support in the event of an accident should be identified (table 2).

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

Existing emergency response plans and activities

Defined responsibilities and duties

Existing mutual aid or interagency agreements

Table 2. Industrial contingency response or information sources

<u>National agencies</u>	Ministry of Industry Ministry of Interior Ministry of Transportation Ministry of Labour Ministry of Energy Ministry of Public Works Environmental Protection Agency (if present) Armed Forces Coastguard (if present)
<u>Municipal agencies</u>	Mayor/City Council/City Administrator Civil Defence (if present) Fire Department Public Works Department - Roads - Water Supply - Sanitation
<u>Industry</u>	Chemical Plants and Petroleum Refineries Other large industrial facilities Spill Clean-up Contractors (if present) Trade Associations and Professional Societies
<u>Voluntary organizations</u>	Red Cross or Red Crescent Local Citizens Associations Service Groups
<u>United Nations organizations</u>	UNDP United Nations Disaster Relief Organization United Nations Environment Programme World Health Organization (including the International Programme on Chemical Safety) United Nations Industrial Development Organization

3. SUMMARY OF THE ACTIVITIES AT CONGLOMERATE CHEMICALS

Conglomerate Chemicals is a company with 300 employees manufacturing antiseptics, dyestuffs, disinfectants, chlorinated compounds for sanitation, and explosives. A number of raw materials are used. The eleven which are hazardous have been studied and Emergency Response Cards have been prepared explaining how to respond to accidental releases. These cards are posted at various locations in the plant. The plant layout is shown on page 11 (Figure 1). The emergency equipment is shown in the layout.

In this game, each player must assume two roles. The first role is as a member of the immediate emergency response team from Conglomerate Chemicals. This team fights the emergency alone for the first hour and a half. Then help arrives. A brief report is submitted to the Conglomerate General Manager. The second role is as a member of the national emergency co-ordination team. This team co-ordinates actions against the emergency to its conclusion. Then a one-page report is submitted to the President of the country.

Several sets of emergency breathing apparatus are in the housing of the main gate guard at the plant entrance.

Conglomerate Chemicals is located about five kilometres westward from the processing site and company town of Corporación de Explotación de las Minas. Conglomerate is about fifteen kilometres to the east of the capital, Teleroy City. A good two-lane paved road links Conglomerate with the Corporación and with Teleroy City (Figure 2).

Figure 1. Layout of the Conglomerate Chemicals Plant in Telerecy

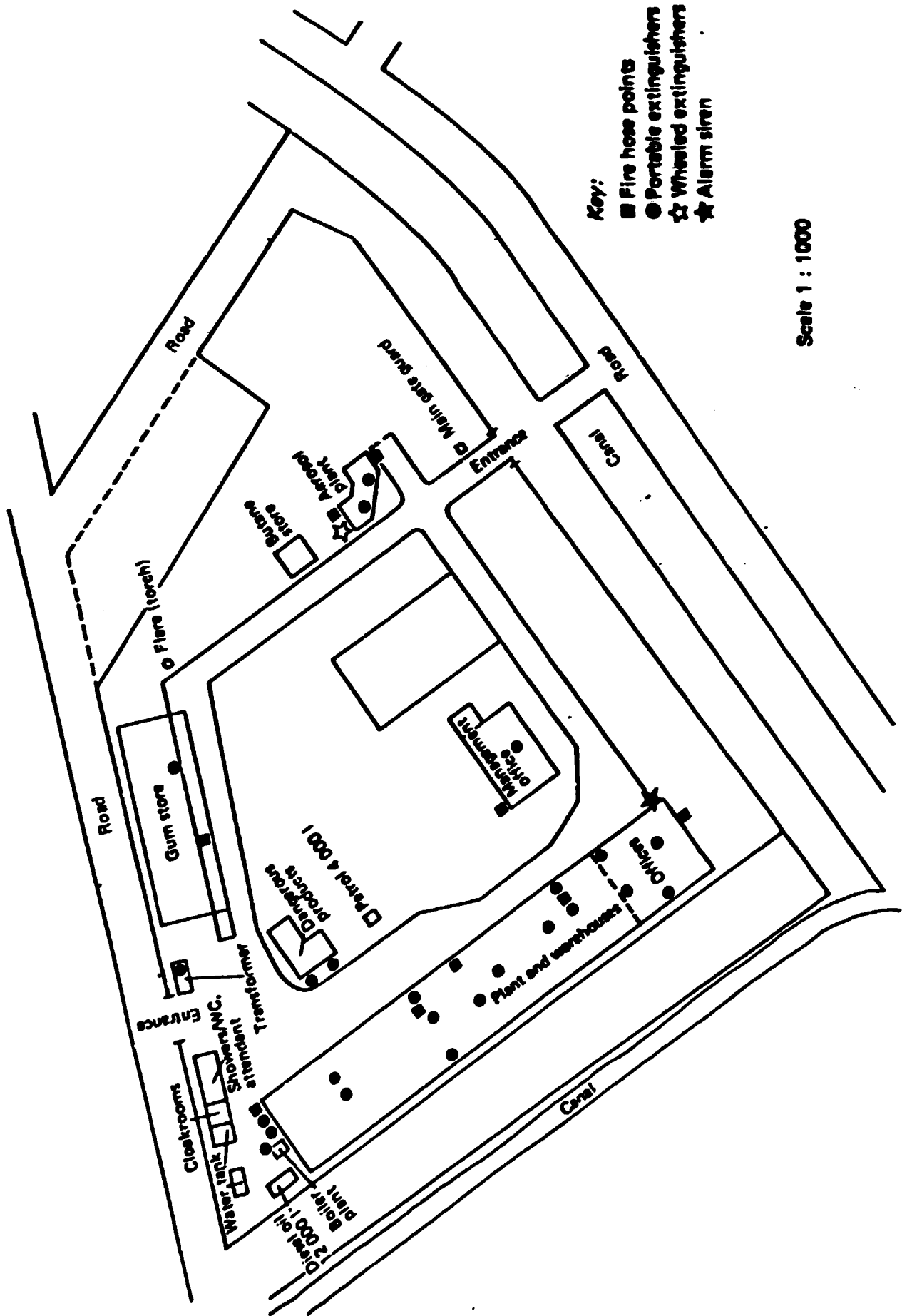
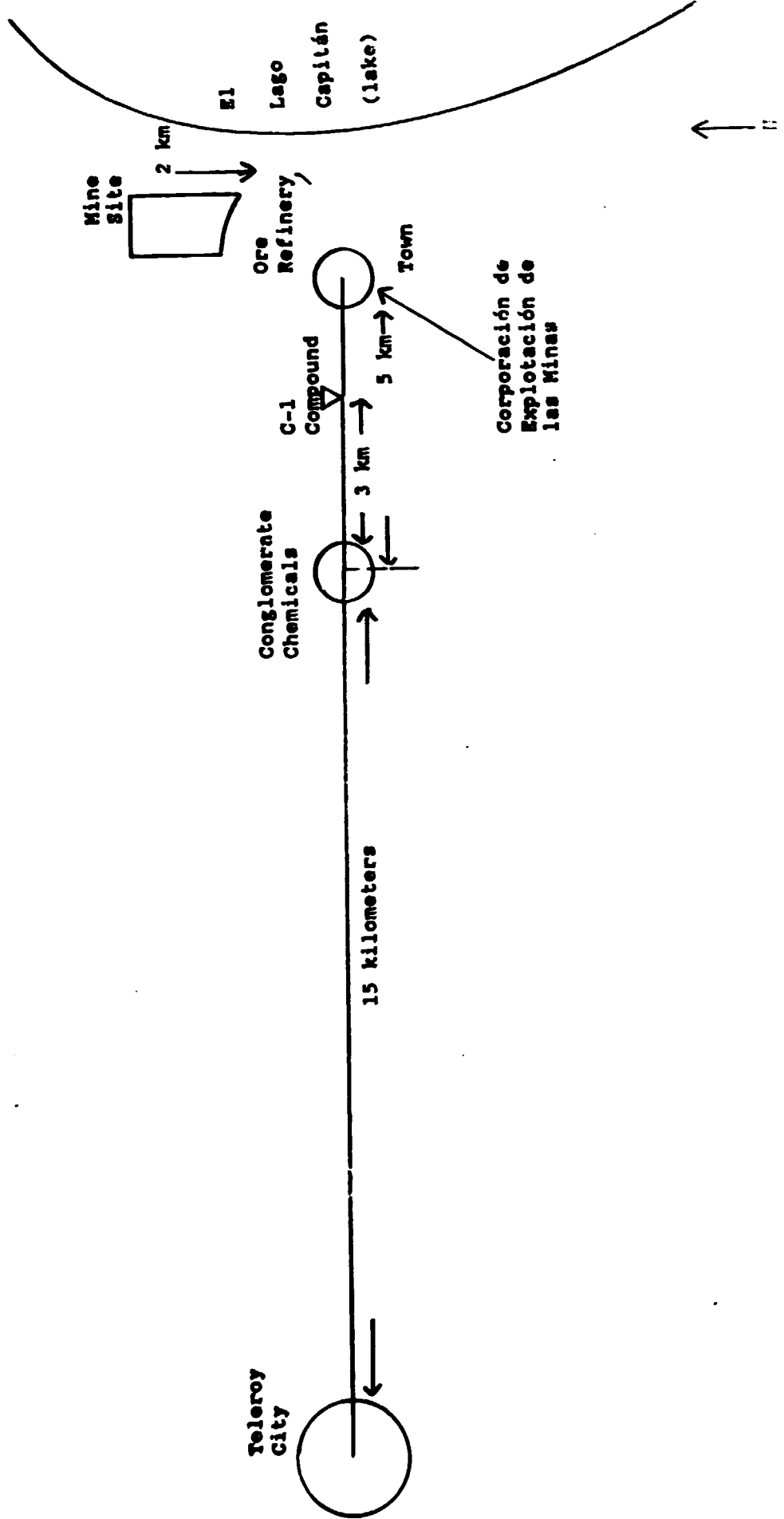


Figure 2. Layout of the area surrounding Conglomerate Chemicals



4. SUMMARY OF THE ACTIVITIES OF CORPORACION DE EXPLOTACION DE LAS MINAS:

A Nickel Ore Mining and Refinery Project in the Country of Teleroy

Project Summary

The State-owned mining corporation of Teleroy, Corporacion de Explotación de las Minas, has a project to mine and refine one million tons per year of ore containing an average of 1.5 per cent nickel. The ore is mined from a mountainside near El Lago Capitán in Teleroy. The mine is about seven kilometers from Conglomerate Chemicals. The mined ore is trucked down the hills to the refinery, about five kilometers from Conglomerate Chemicals.

The refinery is built on the lakeshore adjacent to the mine. The processing of a ton of ore yields about 50 lbs of final product. Another major construction associated with the project is a residential area of 200 homes for plant supervisors. About eight hundred people are housed in the village.

Emergency equipment

Since there are some dangers of fire at different points in the operations, the plant is equipped with a fire truck. In addition to a 2000 liter tank and hoses with connection, the truck can carry fifteen 10 liter fire extinguishers and a six man crew.

A fire station has also been installed to serve the new village. The fire truck is equipped with a 1000 liter tank and hoses, six 10 liter fire extinguishers and a four man crew.

Some of the procedures to mitigate environmental impacts

The following agreements were reached, among others, with the government of Teleroy to mitigate various environmental impacts of the nickel ore mining and refining projects:

1. Two air sampling stations are located at the east and west of the plant to monitor ground levels of SO₂, dust, and other air pollutants.
2. A water sampling station has been placed at the discharge of the cooling and process waters. Analyses include temperature, suspended solids, oils, and metals such as iron, nickel, and zinc.

The Mine Site

The ore contains an average of 1.5 per cent nickel. This ore is surface mined to depths of 10 to 30 meters. About six hundred miners are required, working in shifts of three hundred men each.

Port Operations:

A port has been constructed next to the ore processing plant to receive the raw materials sulfur, sand, and oil. Oil is the only material which poses an environmental hazard. Oil barges unload at the dock into an oil pipeline

through which the oil is pumped to storage tanks at the plant site. This Bunker C type oil is used to fuel the 60 MW power plant which will provide steam and power for the ore processing plant.

Potential environmental problems could be Bunker C oil leakage from a barge, an oil transfer pipeline, or from the onshore fuel storage tank. In the absence of controls, an oil spill would float on the surface and jeopardize fish, waterfowl, recreation, and the aesthetics of the lake.

The fire department from Corporación de Explotación de las Minas has gained experience from fighting one oil spill and two small fires that have broken out when oil has leaked at the dock and caught ablaze.

The ore processing and refining operation:

Water from El Lago Capitán will be brought into the plant for two major purposes: (1) 30,000 gpm for the power plant condenser and auxiliaries cooling, and, (2) 9,000 gpm for process and drinking water.

This water is also pumped directly in the fire trucks of the refinery and the town.

Air Quality Impacts

There is little available data on air quality in Teleroy. Apparently just the two refinery air sampling stations exist. Visual observations and conversations with inhabitants indicates that the present air quality is good. The only notable existing source of air pollution is smoke from the slash and burn practice of agriculture. However the smoke from this operation is reported to frequently hang in the air for a day or more at a time, especially during the summer.

The plant and the village are surrounded by mountains, and inversions are apparently a common occurrence during the summer months. No hazards have existed thus far because of the low level of industrial activities in the region. Potential problems from the ore processing plant and the power plant are thought to be fly ash and sulfur dioxide.

New air pollution control facilities are planned to eliminate fly ash and other particulates from exhaust gases. A series of multicyclone filters and electrostatic precipitators will eliminate particulates from gases in the ore processing and power plant operations.

No plans are incorporated for removal of SO_2 . Twenty two tons of sulfur (as SO_2) per day will be emitted by the power plant, and another eight tons will originate in the converter operation of the processing plant. Two stacks of 400 feet have been constructed in order to disperse the exit gases. Those gases have been calculated to contain about 0.05 per cent SO_2 .

Sulfur dioxide is hazardous to human health when breathed. However the two air pollution monitoring stations at ground level one mile east and west of the processing plant report that ground levels of SO_2 have not exceeded 0.1 ppm for 24 hours or 0.5 ppm for 1/2 hour during the months of heavy atmospheric inversion. These levels are not harmful to human health.

5. OPERATIONAL INDUSTRIAL CONTINGENCY PLAN FOR CONGLOMERATE CHEMICALS IN TELEROY
(Briefing Pages for Role 1 follow)

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. Keep production losses 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 first the security chief, then the operations manager, must make full use of available resources with the four objectives listed above in mind.

The major aim of the procedure given in the plan is to provide the co-ordinator with these resources in such a way that they can be deployed quickly with a minimum amount of direction and maximum effectiveness.

There are three possible situations which require implementation of emergency procedures at the explosives and chemicals plant:

1. Fire which cannot be controlled or isolated to a small area, or which threatens magazines or ammonium nitrate.
2. Major accident. One source could be a plane crash within the plant area. Another source could be a truck which becomes out of control in the plant area. A third source could be a toxic release.
3. Explosion. Although normally a result of either (1) or (2) above, emergency procedures must take into account an unforwarned detonation.

In an emergency situation, people react better when they understand what they are to do and what is expected of each and every one. This booklet is for your SAFETY; you are asked to thoroughly read it and keep it handy at all times.

Definitions

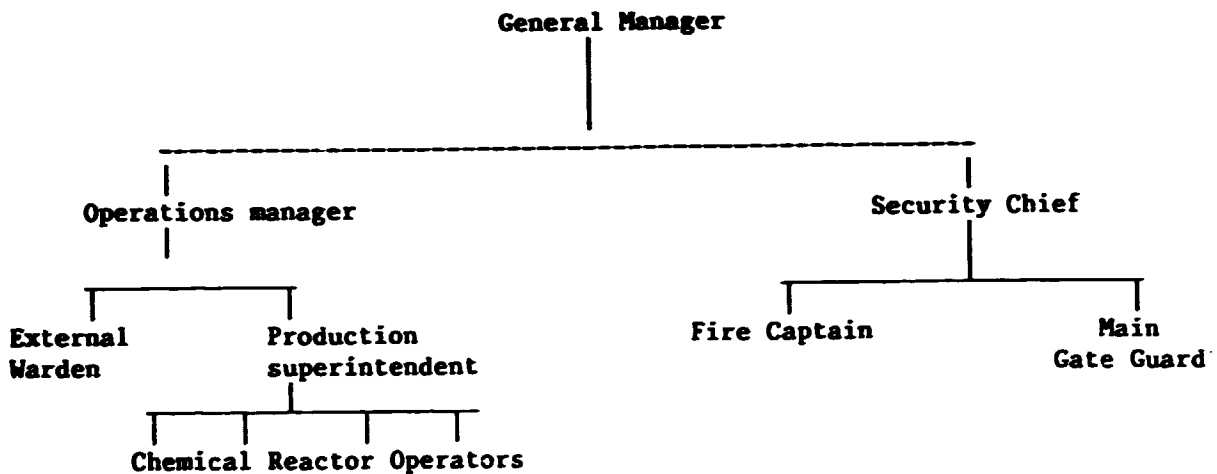
External warden

The senior person at the Farm (C-1 Compound)^{a/} who is available to take charge of co-ordination with outside agencies.

Reporter of an incident

Any person who observes an incident which he thinks should be classified as a fire, explosion or accident.

Organization Chart



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 implement the emergency procedures.

The reporter of an incident, 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 session.

^{a/} A small farm three kilometres east of Conglomerate Chemicals where the external warden is lodged.

CHEMICAL REACTOR OPERATOR (REPORTER OF THE INCIDENT)^{a/}

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
2. Have main gate security guard repeat message	Have main gate security guard repeat message	Have main gate security guard repeat message
3. Note explosives (a) Remove any explosives to a safe place (b) Fight fire	Help any slightly injured persons Report serious injuries to main gate guard	Help any slightly injured persons Report serious injuries to main gate guard
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 for evacuation

a/ In addition to viewing the emergency he sees three workers lying near the entrance to the warehouse.

MAIN GATE GUARD

Fire	Accident	Explosion
<p>1. Repeat message to incident reporter to check accuracy. Write down his name, status, where he is, and time.</p>	<p>Repeat message to incident reporter to check accuracy. Write down his name, status, where he is, and time.</p>	<p>Repeat message to incident reporter to check accuracy. Write down his name, status, where he is, and time.</p>
<p>2. (a) Call security chief (tel. 10) (b) Call fire captain (tel. 11) (c) Call production superintendent (tel. 28 or 23) (d) Call operations manager (tel. 12) Repeat message each time.</p>	<p>(a) Call security chief (tel. 10) (b) Call fire captain (tel. 11) (c) Call production superintendent (tel. 28 or 23) (d) Call operations manager (tel. 12) Repeat message each time.</p>	<p>(a) Call security chief (tel. 10) (b) Call fire captain (tel. 11) (c) Call production superintendent (tel. 28 or 23) (d) Call operations manager (tel. 12) Repeat message each time.</p>
<p>3. Announce "EMERGENCY" 3 times on radio channel 2 to external warden, HOLD ON channel 2.</p>	<p>Announce "EMERGENCY" 3 times on radio channel 2 to external warden, HOLD ON channel 2.</p>	<p>Announce "EMERGENCY" 3 times on radio channel 2 to external warden, HOLD ON channel 2.</p>
<p>4. Sound alarm 1 minute continued blast on the siren.</p>	<p>On instructions from security chief or production superintendent, sound alarm.</p>	<p>On instructions from security chief or production superintendent, sound alarm.</p>
<p>5. Let only plant personnel into plant. Check out visitors.</p>	<p>Let only plant personnel into plant. Check out visitors.</p>	<p>Let only plant personnel into plant. Check out visitors.</p>
<p>6. Follow radio instructions from security chief.</p>	<p>Follow radio instructions from security chief.</p>	<p>Follow radio instructions from security chief.</p>

SECURITY CHIEF

Fire	Accident	Explosion
1. Locate personnel as follows:	Locate personnel as follows:	Locate personnel as follows:
(a) <u>Day shift</u>	(a) <u>Day shift</u>	(a) <u>Day shift</u>
(i) Main gate guard: check out visitors; let in only personnel authorized by security chief.	(i) Main gate guard: check out visitors; let in only personnel authorized by security chief.	(i) Main gate guard: check out visitors; let in only personnel authorized by security chief.
(ii) Security driver: pick up at least 4 more off-duty security guards.	(ii) Security driver: pick up at least 4 more off-duty security guards.	(ii) Security driver: pick up at least 4 more off-duty security guards.
(iii) Lieutenant: assumes duties as assistant fire chief.	(iii) Lieutenant: go carefully to scene with a portable two-way radio; report facts.	(iii) Lieutenant will stand-by near control centre.
(b) <u>Off-shift</u>	(b) <u>Off-shift</u>	(b) <u>Off-shift</u>
(i) Main gate guard: Stand-by at guard-house radio; prohibit entry to all except plant staff.	(i) Main gate guard: Stand-by at guard-house radio; prohibit entry to all except plant staff.	(i) Main gate guard: Stand-by at guard-house radio; prohibit entry to all except plant staff.
(ii) Guards: go quickly to scene of fire with wheeled extinguishers; fight it with all available security guards.	(ii) Guards: go to scene of accident with portable radio; report	(ii) Guards: withdraw to fence gates (3), (4).

SECURITY CHIEF (continued)

Fire	Accident	Explosion
2. 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.
3. Contact production superintendent and operations manager at home.	Check that security contacts production superintendent and operations manager.	Check that security contacts production superintendent and operations manager.
4. Contact maintenance supervisor and superintendent, or the electrician.	Contact maintenance supervisor and superintendent, or the electrician.	Contact maintenance supervisor and superintendent, or the electrician.
5. Contact (a) fire chief, (b) transport and magazine supervisors at home 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.
6. Go to scene of fire with a portable radio tuned to channel 2.	Stand by at control centre.	Stand by at control centre.
7. Send for auxiliary fire crew. Call external warden for additional help if necessary.	Call external warden for drivers and help.	Call external warden for drivers and help.

FIRE CAPTAIN

Fire	Accident	Explosion
1. Assemble fire crew.	Assemble fire crew.	Assemble fire crew.
2. (a) <u>Fire in areas accessible to hoses:</u>	(a) <u>Fire in areas accessible to hoses:</u>	(a) <u>Fire in areas accessible to hoses:</u>
(i) Uncoil hoses from hydrant houses.	(i) Uncoil hoses from hydrant houses.	(i) Uncoil hoses from hydrant houses.
(ii) Start fire pumps.	(ii) Start fire pumps.	(ii) Start fire pumps.
(b) <u>Fire in other areas:</u>	(b) <u>Fire in other areas:</u>	(b) <u>Fire in other areas:</u>
(i) Put all spare extinguishers on a truck.	(i) Put all spare extinguishers on a truck.	(i) Put all spare extinguishers on a truck.
(ii) Send truck front end loader, grader to scene of fire.	(ii) Stand-by for instructions from security chief.	(ii) Stand-by for instructions from security chief.
(iii) Go by car with radio to take charge of fire fighting. Switch radio to channel 2.		

PRODUCTION SUPERVISOR

Fire	Accident	Explosion
1. Remove all HE ^{a/} including TNT ^{b/} to nearest safe magazine or to P1 ^{c/} sample room. Lock up.	Remove all HE including TNT to nearest safe magazine or to P1 sample room. Lock up.	Remove all HE including TNT to nearest safe magazine or to P1 sample room. Lock up.
2. Dump P1 mixer batches, whatever stage, into packer tanks. Leave packaged slurry inside building.	Dump P1 mixer batches, whatever stage, into packer tanks. Leave packaged slurry inside building.	Dump P1 mixer batches, whatever stage, into packer tanks. Leave packaged slurry inside building.
3. Park any slurry or ANFO ^{d/} in transit at nearest safe barricaded magazine or any building on side away from fire and plant.	Park any slurry or ANFO in transit at nearest safe barricaded magazine or any building on side away from fire and plant.	Park any slurry or ANFO in transit at nearest safe barricaded magazine or any building on side away from fire and plant.
4. Send work leaders (a) to control point or (b) to nearest safe exit gate if control point is not accessible. Work leaders will regulate and record exit of personnel from the plant.	Send work leaders (a) to control point or (b) to nearest safe exit gate if control point is not accessible. Work leaders will regulate and record exit of personnel from the plant.	Send work leaders (a) to control point or (b) to nearest safe exit gate if control point is not accessible. Work leaders will regulate and record exit of personnel from the plants.
5. Provide any personnel needed to assist the fire crew.	Provide any personnel needed to assist the fire crew.	Provide any personnel needed to assist the fire crew.
6. Line up orderly departure to control centre or, if the evacuation siren is sounded, to nearest exit gate.	Line up orderly departure to control centre or, if the evacuation siren is sounded, to nearest exit gate.	Line up orderly departure to control centre or, if the evacuation siren is sounded, to nearest exit gate.
7. Off-shift: call in 6 men who are off shift.	Off-shift: call in 6 men who are off shift.	Off-shift: call in 6 men who are off shift.

a/ HE - High explosive

b/ TNT - Trinitrotoluene, a high explosive

c/ P1 - Identification code for one of the operation buildings

d/ ANFO - Trade name for nitrocarbonitrate, a commercial blasting agent

OPERATIONS MANAGER

Fire	Accident	Explosion
1. Take over on arrival at control point.	Take over on arrival at control point.	Take over 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 from channel 2 radio from main gate guard or fire chief.	Obtain feed-back from security man at the scene.	Obtain feed-back from production superintendent.
4. Contact external warden and general manager relating nature of incident and help required.	Contact external warden and general manager relating nature of incident and help required.	Contact external warden and general manager 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 from security to record proceedings.	Arrange for one person from security to record proceedings.	Arrange for one person from security to record proceedings.
7.	Notify hospital as to type of injuries.	
8.	Record names of persons sent to hospital.	

6. PRESENTATION OF THE EMERGENCY

The emergency is a release of chlorine gas which is discovered at 6:00 p.m. The plant works a double shift. There are 100 men on duty. Due to the dense fumes it is not immediately possible to ascertain whether a crack has developed in the storage cylinder or whether the gas is escaping through a faulty valve. A member of the team dons emergency breathing apparatus and ascertains there is a crack in the cylinder. The capacity of the cylinder when full is 2 1/2 tons. The exact amount of chlorine present at the time of the leak is not known, but the production supervisor can remember about when the cylinder was delivered and hence estimates it contained about 2 tons when the leak was discovered.

The cylinder of Cl₂ has been housed in the plant and warehouses building instead of the area for dangerous products because it was serving as a raw material in a production reactor. As a result of the close proximity, the office building is soon also engulfed in the cloud of chlorine gas. The wind speed is low (about 4 km/hour) and the wind direction is approximately west.

The format of the report on the status of the emergency after 1 1/2 hours appears on page 25.

7.

Report 1: Status of the emergency after one and one-half hours

1. **Team members (nationalities only)**

2. **Date of report**

3. **Summary of immediate steps taken to fight the emergency**

4. **Status of the emergency after one hour**

5. **Recommendations for further action**

8. National Emergency Co-ordination Team for the emergency at Conglomerate Chemicals in Teleroy (Briefing pages for Role 2 follow)

Representative from the Ministry of the Interior (the National Fire Chief)

General Manager, Conglomerate Chemicals

General Manager, Corporación de Explotación de las Minas

Resident Representative of UNDP

Representative from the Ministry of Health (the National Director of Hospitais)

The Minister of Industry

Co-ordination planning: identifying comprehensive emergency responsibilities

The first objective of the national emergency co-ordination plan is to establish clearly who is in charge of fighting the emergency. Certain governmental agencies may have legal responsibility, jurisdictional authority, a charter or an interagency agreement which covers an emergency situation.

The various necessary emergency response functions should be assigned to agencies most logically capable of dealing with them. The team may call in other resources as required. 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 more thought 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 3.

Each 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.

Table 3. Agencies which may meet specific 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
- 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/Policy Welfare Official
 - State Welfare Official
- 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
 - Ministry of Health

Representative from the Ministry of the Interior of Teleroy

You are the National Fire Chief of Teleroy, reporting to the Minister of the Interior. You have been chosen because you have the most experience in fighting fires and other emergencies of any man in Teleroy. That is why upon arrival you will take over as accident commander even though you will be technically outranked in the group by the Minister of Industry.

You have been alerted at your office as to the general nature of the emergency; You have had time to study emergency response material on chlorine gas emissions. You know that the recommended action is to use a water spray to knock down the vapor cloud. You know that chlorine is slightly more than 1 per cent soluble in water at 20°C, dissolving to form hydrochloric (HCl) and hypochlorous (HOCl) acids. You know that a continued water spray will dilute these acids to harmless levels of acidity.

From reading quickly the World Health Organization Environmental Health Criteria document on chlorine, you know that the gas causes irritation in humans at a concentration of one part per million. At 2 parts per million it is very annoying. At or above 4 parts per million it is intolerable. The question is: What concentrations are present downwind from the scene of the accident?

What concentrations are present at the scene of the accident? A single exposure of 400 - 3,000 parts per million for 30 to 60 minutes is lethal.

You must also decide on the spot what equipment to send immediately to the accident. In the case of equipment held in reserve, you must know the time required for it to arrive after you have called in the order.

At this time you do not know the severity of the situation. Should you take preliminary steps in case all or part of Teleroy City should need to be evacuated?

General Manager, Conglomerate Chemicals

You are the senior official of Conglomerate Chemicals in Teleroy. You have been summoned from your home by telephone to the farm (C-1 compound), upwind from the accident. You must immediately arrange for all members of the Conglomerate Chemicals staff who are fighting the emergency to co-operate with the national fire fighting forces. The operations manager will serve as the line officer at Conglomerate co-ordinating with the National Fire Chief. The National Fire Chief will serve as accident commander.

Next you must inform the National Fire Chief as to the seriousness of the chlorine leak. You have a report prepared by European consultants on chlorine emissions at the site. They were able to predict the plumes - shapes and sizes - for different amounts of chlorine released over 20 minutes, under varying conditions of wind velocity and vertical stability. Some 15 plume overlays were provided. Unfortunately the report is locked in a filing cabinet in your office which lies 30 meters downwind from the escape of chlorine.

Fortunately you are able to remember that, on the average for a two ton release*, at 4 km downwind the average concentration will be 3 parts per million.

* The amount estimated to be released by the operations manager.

General Manager, Corporación de Explotación de las Minas

You are the senior official of Corporación de Explotación de las Minas. You report to the Minister of Industry.

Conglomerate Chemicals has telephoned the Corporación. An official there called you at home in Teleroy City to come to the farm (C-1 compound) where the emergency action is being co-ordinated. You immediately speak with the National Fire Chief to tell him what fire fighting and other emergency equipment is available at the Corporación. If he requests any or all of this equipment, you immediately get on the phone to give instructions. Don't forget to have someone from Conglomerate take down enough emergency breathing apparatus for the Corporación and village fire fighting teams.

Your next concern is whether to request an emergency evacuation of mine workers and inhabitants of the village. Discuss this with the emergency team, based on data from the National Fire Chief and the General Manager of Conglomerate Chemicals.

Call the monitoring group at the Corporación to get the exact wind direction and wind speed.

Finally, the team has asked you whether the monitoring equipment for SO₂ which you have in place can also analyze for chlorine in the atmosphere, either immediately, or with some modification. Find out from your monitoring group and report to the emergency team.

Resident Representative of UNDP (United Nations Development Programme)

You are the senior United Nations official in Teleroy. The Teleroy Government has asked you to participate as a member of the emergency team at C-1 compound to fight the industrial accident at Conglomerate Chemicals.

You have considerable resources that are far from Teleroy. Examples are the United Nations Disaster Relief Organization (emergency supplies and housing for evacuated persons if the situation is prolonged, assistance to the government in contingency planning in the case of future major accidents), the United Nations Industrial Development Organization (post-accident decontamination, assistance in repair of the faulty equipment) and the World Health Organization (medical assistance to persons hospitalized from over exposure to chlorine).

At this time turn your attention and your good judgement towards helping make the decisions that will minimize the effect of the accident. You recall, for example, that you have one or two technical experts working on UN projects in Teleroy who could help with the emergency.

Representative from the Ministry of Health of Teleroy

You are the National Director of Hospitals in Teleroy. You report to the Minister of Health. Your first responsibility as a member of the emergency team at C-1 compound is to make sure the injured from Conglomerate Chemicals are evacuated to a safe place. Get a medical doctor on the scene as soon as possible. Arrange for a certain number of ambulances. The doctor can treat the injured and evacuate them as necessary to hospitals in the capital. Inform those hospitals in the capital which are to receive injured.

Check with the National Fire Chief as to whether you should detail a safety officer to him to review safety of all activities, crowd control, and to monitor movements of the press.

Carefully review the calculations and data before you offer your medical opinion on the importance of a full scale evacuation of the mine and town at Corporación de Explotación de las Minas or an evacuation of Teleroy City.

The Minister of Industry

You are the senior member of the emergency team. As Minister, you report to the President of the Republic of Teleroy. Line responsibility for fighting the emergency belongs to the National Fire Chief, since he is the experienced man in mobilizing men and materials to fight large fires and other large scale emergencies.

You lead the discussions, recommendations and decision making of the emergency team at C-1 compound. Your main responsibility is to prepare a report on the emergency and its handling for the President. The format of the report is given on page 35.

Report 2: Report of the National emergency Co-ordination Team to the President of Teleroy

1 Team members (nationalities only)

2. Date of report

3. Summary of major actions taken to fight the emergency

4. Status of the emergency at this time

5. Conclusions and further recommendations

Team 1

Report 1: Status of the emergency after one and one-half hours

1. **Team members (nationalities only)**
 - UK
 - UK
 - Hungarian
 - Syrian
 - USA
2. **Date of report**

31/3/1987
3. **Summary of immediate steps taken to fight the emergency**
 - (a) Operator discovers accident, calls main gate guard on radio while walking to three workers. Main gate guard should call people on list (fire chief, medical aid) and send breathing apparatus, goggles and rescue workers. Main gate guard sounds alarm on own volition.
 - (b) Fire captain assembles crew (in breathing apparatus), enters, sees leak, and rescues people in building.
 - (c) Production supervisor and trained personnel available with apparatus; production supervisor sends personnel into warehouse in co-ordination with fire chief's personnel to determine if possible to stop leak. Stop all machines.
 - (d) Security chief. Sends lieutenant to report back. Checks that other chiefs/supervisors are aware of situation. Sends guards with instructions to tell everyone to maintain radio silence.
 - (e) Production personnel check crack in chlorine cylinder and check open valve to reactor. Arrange for reducing agent. Use crane to tip cylinder so that leak is on top.
 - (f) Operations manager arrives 6:30. Checks that duties were carried out and receives report from security chief. Calls police and makes report and says that no additional help is needed. Calls hospital that 10 serious cases chlorine inhalation expected. Instructs security supervisor to record their names. Contacts relevant local authorities and Corporación de Explotación de las Minas.
4. **Status of the emergency after one and one-half hours**

Stopped leak but 500 kg cloud spreads slowly in high concentration.

Team 1

Report 2: Report of the National Emergency Co-ordination Team to the President of Teleroy

1. **Team members (nationality only)**
 - UK
 - UK
 - Hungarian
 - Syrian
 - USA
2. **Date of report**

31/3/1987
3. **Summary of major actions taken to fight the emergency**
 - (a) Operations Manager calls National Fire Chief and General Manager of Conglomerate Chemicals, gives information to Chief on concentration of cloud and gives location. Requests meeting at C-1 compound (General Manager of Corporación de Explotación de las Minas, and National Director of Hospitals already there)
 - (b) General Manager of Conglomerate Chemicals informs National Hospital Director that 81 people need hospital care.
 - (c) Corporación de las Minas sends trained crew and equipment, as mine and town not affected, leaving a residue staff at Corporación de las Minas. Crew is under National Fire Chief.
 - (d) National Fire Chief uses two trucks and sprays cloud, using water from canal. Firemen have and use breathing apparatus.
 - (e) Medical officers on site. Ambulances used to evacuate 81 people to hospitals. Minister of Industry co-ordinates traffic control with police to evacuate victims to hospital.
 - (f) Minister of Industry informs local authorities to alert population of Teleroy City to close doors and windows, avoid going out, particularly aged and children.
 - (g) At wind speed of 4 km/hour, authorities have four hours to deal with cloud before it reaches capital.
 - (h) Situation monitored on site by Corporación de las Minas monitoring stations, which have been ordered near capital by General Manager.
 - (i) Minister of Industry contacts emergency public information, welfare services, water services (to check chlorine levels) and environmental agency.
 - (j) Minister of Industry issues statement to press that emergency has been contained and that further steps are being taken to protect life and property.
 - (k) Hospitals in area, which had been alerted, receive patients, check monitoring stations for chlorine levels and, in co-ordination with Minister of Industry, assess need for evacuation.
 - (l) General Manager of Conglomerate Chemicals contacts trade unions to brief them and explain problems suffered by workers.
4. **Status of emergency at this time**
 - (a) Minister of Industry prepares report on situation and handling, stating that emergency limited to plant and immediate vicinity, not town or mine. Any leakage will be dissipated in the atmosphere and rendered harmless by the time it reaches capital. May be harm to wildlife, however.

- (b) Minister of Industry requests Police Chief and relevant security people to establish cause of accident.

5. Conclusions and further recommendations

While the present emergency was contained, in the event that it was not, more national authorities should be on the alert in case it would be necessary to evacuate large numbers of people, and the population should be alerted. There is a need for an emergency plan at the national level.

Team 2

Report 1: Status of the emergency after one and one-half hours

1. Team members (nationalities only)

USA
USA
Austrian
Polish
German

2. Date of report

31/3/1987

3. Summary of immediate steps taken to fight the emergency

- (a) Sent team to site of accident to identify specific cause and nature of emergency.
- (b) Main gate guard sounded alarm.
- (c) Production stopped; emergency breathing masks distributed.
- (d) Evacuation of workers not needed to fight emergency.
- (e) Initiated waterspray to knock down gas cloud.
- (f) Informed city authorities (police, fire, hospital), ambulance and emergency medical team requested.
- (g) Production supervisor organized three teams specially clothed and masked to empty leaking cylinder.
- (h) Access roads to plant closed off except for those required for emergency.
- (i) Closed off plant water treatment outlet pipes, channeled waste water into water treatment system.
- (j) Informed Corporación de Explotación de las Minas.

4. Status of the emergency after one and one-half hours

- (a) Production stopped.
- (b) 90 per cent of plant workers evacuated - of which 10 per cent given extensive first aid and remainder sent to hospital for examination and treatment if necessary.
- (c) Chlorine gas transferred to emergency cylinder - about 500 kg released.
- (d) Search through plant for injured workers completed. None found.
- (e) Municipal authorities informed of status of emergency.
- (f) Gas is still within factory site, moving slowly west.

5. Recommendations for further action

- (a) Sewage water should be treated.
- (b) Municipal authorities should notify people living in vicinity of plant (west of plant).
- (c) The General Manager should clear public information statements about the accident.

Team 2

Report 2: Report of the National Emergency Co-ordination Team to the President of Teleroy

1. **Team members (nationalities only)**
 - USA
 - USA
 - Austrian
 - Polish
 - German
2. **Date of report**

31/3/1987
3. **Summary of major actions taken to fight the emergency**
 - (a) Report of on-site situation obtained from Conglomerate Chemicals.
 - (b) Contacted meteorological service for short and medium term weather conditions (wind speed and direction). Wind direction west, low speed - no immediate danger to mine - about 6 hours to deal with measures to protect city.
 - (c) Establish analytical check points to measure air and water quality.
 - (d) Fire protection services (including mine fire trucks) sprayed cloud.
 - (e) President was told that army should be informed of possible need for evacuation - begin detailed planning.
 - (f) Hospital personnel were put on notice.
4. **Status of the emergency at this time**
 - (a) No further danger at plant.
 - (b) Closely following movement of chlorine gas towards city, measuring air and water.
 - (c) Public information releases being prepared (as truthful as possible) - no reason for panic.
 - (d) Only five of the 90 people remain in hospital for further treatment - others checked and released.
 - (e) Preparatory arrangements for evacuation have been made but no evacuation has been ordered - indications are that cloud is breaking up.
5. **Conclusions and further recommendations**
 - (a) Set up an independent panel of experts under chairmanship of Minister of Industry with participation of Conglomerate Chemicals to investigate the causes of the accident and recommend measures to avoid repetition.
 - (b) Need to increase supply of protective clothing and breathing equipment and training.
 - (c) Set up arrangements for orderly processing of claims for damages.
 - (d) Spray roads to dilute or wash away remnants of chlorine.
 - (e) Establish plan for re-start of plant operations.

Analysis of the reports of Teams 1 and 2

Given the independence of the two teams, they reached remarkably similar conclusions. The major criticism of Team 1 (Report 1) is that they initially tried a sophisticated means of dealing with the emergency with no indications of success. Furthermore, the procedure ("arrange for reducing agent") was vague (arrange how?) and imprecise (what reducing agent?).

Report 1 of Team 2 presented a better example. Simple but direct actions were taken. Criticism: the evacuation of workers should have begun immediately.

For both Teams 1 and 2, Report 2 was satisfactory.

QUESTIONNAIRE FOR PARTICIPANTS

1. Did you learn (something, nothing, a little, a lot) about dealing with industrial emergencies through the lectures, the background material and playing the game?

2. Did you enjoy playing the game?

3. What suggestions would you care to make to improve the text of the game or its playing.

4. Please list any typographical errors you encountered or editorial comments you would like to make.

Signature _____ (optional)

APPENDIX A

EMERGENCY RESPONSE CARD

Substance AMMONIA (anhydrous)
Liquified 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 sever damage to eyes
Reaction with moist air produces mist which has strongly irritant effect on eyes, skin and air passages

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

EMERGENCY ACTION

- No naked lights. No smoking
- Mark area and warn other plant employees
- Keep public away from danger area
- Keep upwind
- Put on protective equipment before entering danger area

Spillage

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

Fire

- Keep containers cool by spraying with water if exposed to fire

First aid

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

EMERGENCY RESPONSE CARD

Substance

CHLORINE

Greenish-yellow liquefied pressure gas with strong odour

Nature of Hazard

Toxic. Exposure to 1000 ppm for an hour can be fatal.

Severe poisoning perhaps fatal when inhaled

Symptoms may develop after several hours

The liquid causes severe damage to eyes, skin and air passage

The gas causes strong irritation to eyes, skin and air passages

Contact with moist air produces corrosive fumes

Spilled liquid has very low temperature and evaporates quickly

The gas is heavier than air and spreads along ground

Heating will cause pressure rise with risk of bursting

Protective Devices

Suitable respiratory protective device

Goggles giving complete protection to eyes

Apron or other light protective clothing, boots and plastic or rubber gloves

Eyewash bottle with clean water

EMERGENCY ACTION

- Consult an expert immediately
- No naked lights. No smoking
- Mark area and warn other plant employees
- Keep public away from danger area
- Keep upwind
- Put on protective equipment before entering danger areas

Spillage

- Prevent liquid entering sewers, basements and workpits
- Contain leaking liquid with sand or earth
- Warn everybody--toxic and corrosive hazard. Evacuate if necessary
- If vapour cloud drifts towards populated area, warn inhabitants
- Use waterspray to "knock down" vapour
- Do not use water jet on a leak of the tank
- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police or other authorities

Fire

- Keep containers cool by spraying with water if exposed to fire

First aid

- If substance has got into the eyes, immediately wash out with plenty of water for at least 15 minutes
- Remove contaminated clothing immediately and drench affected skin with plenty of water
- In case of contact with liquid, thaw frosted parts with water, then remove clothing carefully
- Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes
- Persons who have inhaled the gas may not show immediate symptoms. They must lie down and keep quite still and should be taken to a doctor with this card. Patient should be kept under medical observation for at least 48 hours
- Keep patient warm
- Apply artificial respiration only if patient is not breathing

EMERGENCY RESPONSE CARD

<u>Substance</u>	SULPHUR DIOXIDE (liquefied pressure gas) Greenish liquefied pressure gas with pungent odour
<u>Nature of Harzard</u>	Toxic Spilled liquid has very low temperature and, unless contained, evaportates quickly Contact with liquid causes skinburns and severe damage to eyes The gas is heavier than air and spreads along ground, is invisible but produces mist on contact with moist air The gas poisons by inhalation Heating will cause pressure rise with risk of bursting
<u>Protective Devices</u>	Suitable respiratory protective device Goggles giving complete protection to eyes Apron or other light protective clothing, boots and plastic or rubber gloves Eyewash bottle with clean water
EMERGENCY ACTION	<ul style="list-style-type: none">- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Keep upwind
<u>Spillage</u>	<ul style="list-style-type: none">- Prevent liquid entering sewers, basements and workpits; vapour may create toxic atmosphere- Warn everybody in sewers, basements and workpits--danger of toxic hazard- Contain leaking liquid with sand or earth--Consult an expert about subsequent action- Use waterspray to "knock down" vapour; advise police of possible contamination to watercourses, sewers, soil or vegetation- Do not use water jet on a leak of the tank- If vapour cloud drifts towards populated area, warn inhabitants- If substance has entered a water course or sewer or contaminated soil or vegetation, advice police or other authorities
<u>Fire</u>	<ul style="list-style-type: none">- Keep containers cool by spraying with water if exposed to fire
<u>First aid</u>	<ul style="list-style-type: none">- If substance has got into the eyes, immediately wash out with plenty of water for at least 15 minutes- In case of contact with liquid, thaw frosted parts with water, then remove clothing carefully- Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes- Apply artifical respiration only if patient is not breathing

EMERGENCY RESPONSE CARD

Substance PHOSPHORUS (molten)
Very hot white or yellow liquid with slight odour (temperature 60-65°C), solidifies at 44°C

Nature of Hazard The substance is liable to spontaneous ignition when dry and causes severe damage to skin
Ignites readily forming fumes (phosphorus pentoxide) which have strongly irritant effect on eyes and air passages
Heating will cause pressure rise with risk of bursting
The substance increases fire risk; contaminated material, e.g. clothing ignites more readily and burns fiercely
May react vigorously with oxidizing agents creating explosion hazard

Protective devices Suitable respiratory protective device
Goggles giving complete protection to eyes
Apron or other light protective clothing, boots and gloves
Eyewash bottle with clean water

EMERGENCY ACTION

- No naked lights. No smoking
- Mark area and warn other plant employees
- Keep public away from danger area

Spillage

- Cover spilled substance with wet sand or wet earth
Spray with water. Consult an expert about subsequent actions
- Keep remaining cargo wet
- Do not repack
- If substance has entered a water course or sewer or been split on soil or vegetation, advise police or other authorities

Fire

- Keep containers cool by spraying with water if exposed to fire
- Extinguish preferably with waterspray or sand
- Do not use water jet

First aid

- If substance has got into the eyes, immediately wash out with plenty of water for at least 15 minutes
- If clothing is burning extinguish with copious amount of water. Remove loose clothing, but do not attempt removal if adhering to skin. Cover affected areas with well wetted cloths. Remove to hospital immediately maintaining cloths wetted at all times. Even if contaminated clothing is not burning drench with water immediately. Remove clothing and drench affected skin with plenty of water till all traces of substance have been removed
- Seek medical treatment when anyone has symptoms apparently due to contact with skin or eyes or inhalation of the fumes produced in a fire

EMERGENCY RESPONSE CARD

<u>Substance</u>	ACETYLENE (dissolved under pressure) Compressed gas with slight odour dissolved in a solvent absorbed in a porous substance
<u>Nature of hazard</u>	Highly inflammable The gas is invisible, slightly lighter than air Can form explosive mixture with air Heating will cause pressure rise, severe risk of bursting and explosion
<u>Protective devices</u>	Leather or thick textile gloves
EMERGENCY ACTION	<ul style="list-style-type: none">- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Use explosionproof electrical equipment- Keep upwind
<u>Spillage</u>	<ul style="list-style-type: none">- Shut off leaks if without risk- Consult an expert about subsequent actions- Warn everybody--explosion hazards. Evacuate if necessary
<u>Fire</u>	<ul style="list-style-type: none">- Keep containers cool by spraying with water if exposed to fire; any warm cylinders must be continuously cooled- Consult an expert- Extinguish preferably with dry chemical or waterspray- If possible fight fire from protected position- In case of fire warn everybody--explosion hazard
<u>First aid</u>	<ul style="list-style-type: none">- In case of burns immediately cool affected skin as long as possible with cold water

EMERGENCY RESPONSE CARD

<u>Substance</u>	PROPANE Colourless, often odourless liquefied pressure gas
<u>Nature of Hazard</u>	Highly inflammable Spilled liquid has very low temperature and evaporates creating serious explosion hazard The gas is heavier than air and spreads along ground, is invisible but produces mist on contact with moist air In high concentrations the gas induces unconsciousness Can form explosive mixture with air particularly in empty uncleaned receptacles Heating will cause pressure rise, severe risk of bursting and explosion Contact with liquid causes skinburns and severe damage to eyes
<u>Protective Devices</u>	Goggles giving complete protection to eyes Leather or thick textile gloves and anti-static boots
EMERGENCY ACTION	<ul style="list-style-type: none">- If possible move vehicle to open ground and stop the engine- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Use explosionproof electrical equipment- Keep upwind
<u>Spillage</u>	<ul style="list-style-type: none">- Shut off leaks if without risk- Prevent liquid entering sewers, basements and workpits. Vapour may create explosive atmosphere- Contain leaking liquid with sand or earth. Remove or make safe all sources of ignition.--Consult an expert about subsequent actions- Warn everybody--explosion hazard. Evacuate if necessary
<u>Fire</u>	<ul style="list-style-type: none">- Keep containers cool by spraying with water if exposed to fire- Do not extinguish a leaking gas flame unless absolutely necessary.--Consult an expert- If absolutely necessary extinguish with dry chemical or foam- Do not use water jet
<u>First aid</u>	<ul style="list-style-type: none">- In case of contact with liquid, thaw frosted parts with water, then remove clothing carefully- Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes

EMERGENCY RESPONSE CARD

<u>Substance</u>	HYDROGEN FLUORIDE (anhydrous) Usually colourless fuming liquid with pungent odour
<u>Nature of Hazard</u>	Highly toxic and corrosive Causes severe damage to eyes, skin and air passage Severe poisoning perhaps fatal when splashed on skin, inhaled or swallowed Symptoms may develop after several hours Highly volatile The vapour is invisible but produces mist on contact with moist air Heating will cause pressure rise with risk of bursting Contact with a relatively small quantity of water creates violent reaction generation much heat and spattering of hot acid and produces toxic fumes
<u>Protective Devices</u>	Suitable respiratory protective device Goggles giving complete protection to eyes Plastic or rubber gauntlet gloves, knee-length boots, suit and hood giving complete protection to head, face and neck Eyewash bottle with clean water First aid equipment and medical advice for special treatment
EMERGENCY ACTION	<ul style="list-style-type: none">- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Keep upwind- Put on protective equipment before entering danger area
<u>Spillage</u>	<ul style="list-style-type: none">- Contain leaking liquid with sand or earth- Do not use water jet on a leak of the tank- Prevent liquid entering sewers, basements and workpits- Warn everybody--toxic and corrosive hazard. Evacuate if necessary- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police or other authorities
<u>Fire</u>	<ul style="list-style-type: none">- Keep containers cool by spraying with water if exposed to fire; beware dangerous reaction with water if containers ruptured
<u>First aid</u>	<ul style="list-style-type: none">- If substance has got into the eyes, immediately wash out with plenty of water for at least 15 minutes- Remove contaminated clothing immediately and drench affected skin with plenty of water- Special treatment by a doctor is required as soon as possible in cases of exposure to the substance or its vapours even if persons may not show immediate symptoms. They must lie down and keep quite still and should be taken to a doctor with this card and the special first aid kit containing medical advice. Patient should be kept under medical observation for at least 48 hours.- Do not induce vomiting- Keep patient warm- Apply artificial respiration only if patient is not breathing

EMERGENCY RESPONSE CARD

Substance **AMMONIUM NITRATE SOLUTION (conc. 80-95%)**
Very hot liquid at a temperature up to 150°

Nature of Hazard **Contact with liquid causes skinburns and severe damage to eyes**
The substance increases fire risk. Contaminated combustible
material, e.g. clothing, ignites more readily after drying
May react with combustible substances creating fire or
explosion hazard and formation of toxic fumes: oxides of
nitrogen
Symptoms may develop after several hours
Decomposes in a fire giving off toxic fumes: oxides of nitrogen
Symptoms may develop after several hours
Heating will cause pressure rise with risk of bursting

Protective Devices **Suitable respiratory protective device**
Goggles giving complete protection to eyes
Apron or other light protective clothing, hood giving complete
protection to head, face and neck, boots and plastic or rubber
gloves
Eyewash bottle with clean water

EMERGENCY ACTION - **No naked lights. No smoking**
 - **Mark area and warn other plant employees**
 - **Keep public away from danger area**
 - **Keep upwind**
 - **Put on protective equipment before entering danger area**

Spillage - **Drench with water**
 - **If this is not practicable contain leaking liquid with sand**
 or earth. Consult an expert
 - **If substance has entered a water course or sewer or**
 been split on soil or vegetation, advise police or other
 authorities

Fire - **Extinguish preferably with water**
 - **Keep containers cool by spraying with water if exposed to**
 fire
 - **In case of a major fire or a decomposition drain the tank.**
 If possible open the covers of the tank

First aid - **If substance has got into the eyes, immediately wash out**
 with plenty of water for several 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
 - **Persons who have inhaled the fumes produced in a fire or in**
 chemical reaction may not show immediate symptoms. They
 must lie down and keep quite still and should be taken to a
 doctor with this card. Patient should be kept under medical
 observation for at least 48 hours
 - **Keep patient warm**
 - **Apply artificial respiration only if patient is not breathing**

EMERGENCY RESPONSE CARD

<u>Substance</u>	o-NITROPHENOL (molten) Yellow to brown hot liquid with light odour which solidifies at 4 °C Soluble in a large quantity of water
<u>Nature of Hazard</u>	Harmful by contact, inhalation and ingestion Consumption of alcohol increases toxic effect Contact with liquid causes severe damage to eyes and skinburns Contact with solid causes irritation to eyes and skin Combustible Combustion causes toxic fumes: nitric oxide Symptoms may develop after several hours
<u>Protective Devices</u>	Suitable respiratory protective device Goggles giving complete protection to eyes Apron or other light protective clothing, boots and plastic or rubber gloves Eyewash bottle with clean water
EMERGENCY ACTION	<ul style="list-style-type: none">- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Keep upwind
<u>Spillage</u>	<ul style="list-style-type: none">- Prevent liquid entering sewers, basements and workpits- Contain leaking liquid with sand or earth. Remove to safe place after it has solidified.-- Consult an expert- Small leaks may be sealed by application of large quantity of water- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police or other authorities
<u>Fire</u>	<ul style="list-style-type: none">- In case of fire warn everybody--toxic hazard- Keep containers cool by spraying with water if exposed to fire- Extinguish preferably with dry chemical, foam, waterspray or halones
<u>First aid</u>	<ul style="list-style-type: none">- If substance has got into the eyes, immediately wash out with plenty of water for several minutes- Remove contaminated clothing immediately and wash affected skin with soap and water- Seek medical treatment when anyone has symptoms apparently due to inhalation, swallowing or contact with skin or eyes- Persons who have inhaled the fumes produced in a fire may not show immediate symptoms. They must lie down and keep quite still and should be taken to a doctor with this card. Patient should be kept under medical observation for at least 48 hours

EMERGENCY RESPONSE CARD

<u>Substance</u>	BENZYL CYANIDE (Phenylacetonitrile) Colourless to yellowish oily liquid with strong odour Immiscible with water Heavier than water
<u>Nature of hazard</u>	Toxic The substance poisons by absorption through skin, inhalation or ingestion Symptoms may develop after several hours The substance has irritant effect on skin and eyes Combustible Decomposes in a fire giving off toxic fumes Symptoms may develop after several hours Danger of explosive vapour-air mixture after heating
<u>Protective Devices</u>	Suitable respiratory protective device Goggles giving complete protection to eyes Apron or other light protective clothing, boots and plastic or rubber gloves Eyewash bottle with clean water
EMERGENCY ACTION	<ul style="list-style-type: none">- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Keep upwind
<u>Spillage</u>	<ul style="list-style-type: none">- Shut off leaks if without risk- Prevent liquid entering sewers, basements and workpits- Absorb leaking liquid with sand or earth--Consult an expert- Warn everybody in sewers, basements and workpits--toxic hazard- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police or other authorities
<u>Fire</u>	<ul style="list-style-type: none">- Keep containers cool by spraying with water if exposed to fire- Extinguish preferably with waterspray, dry chemical or foam- In case of fire warn everybody--toxic hazard
<u>First aid</u>	<ul style="list-style-type: none">- If substance has got into the eyes, immediately wash out with plenty of water for several minutes- Remove contaminated clothing immediately and wash affected skin with soap and water- Seek medical treatment when anyone has symptoms apparently due to inhalation, swallowing or contact with skin or eyes- Persons who have been in contact with the substance or inhaled the fumes or the vapour produced in a fire may not show immediate symptoms. They must lie down and keep quite still and should be taken to a doctor with this card. Patient should be kept under medical observation for at least 48 hours

EMERGENCY RESPONSE CARD

<u>Substance</u>	TITANIUM TRICHLORIDE Dark violet deliquescent crystals under nitrogen with pungent odour
<u>Nature of hazard</u>	The substance is liable to spontaneous ignition on contact with air Reaction with water, alkalis and oxidizing agents produces heat and toxic fumes (hydrochloric acid) Reaction with moist air produces mist which has strongly irritant effect on eyes, skin and air passages Corrosive Contact with solid causes severe damage to eyes and skin Decomposes in a fire giving off toxic fumes
<u>Protective Devices</u>	Suitable respiratory protective device Goggles giving complete protection to eyes Apron or other light protective clothing, boots and rubber gloves Eyewash bottle with clean water
EMERGENCY ACTION	<ul style="list-style-type: none">- No naked lights. No smoking- Mark area and warn other plant employees- Keep public away from danger area- Keep upwind
<u>Spillage</u>	<ul style="list-style-type: none">- Cover spilled substance with dry sand or earth, protect against water.—Consult and expert about subsequent action- Keep remaining cargo dry- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police or other authorities
<u>Fire</u>	<ul style="list-style-type: none">- Keep containers cool by spraying with water if exposed to fire; beware dangerous reaction with water if containers ruptured- Extinguish with dry chemical- Do not use water or foam
<u>First aid</u>	<ul style="list-style-type: none">- If substance has got into the eyes, immediately wash out with plenty of water for at least 15 minutes- Remove contaminated clothing immediately and drench affected skin with plenty of water- Seek medical treatment when anyone has symptoms apparently due to contact with skin or eyes or inhalation of the fume produced in a fire or of the gas produced in chemical reaction

APPENDIX B

Aftermath to the emergency at Conglomerate Chemicals

General remarks:

Conglomerate Chemicals was able to produce a rather elaborate contingency plan - telephone rosters, checklists for each of the players, and action guides for each of the dangerous chemicals in the plant. On the other hand the national Government had no well developed co-ordination plan to handle an industrial emergency. This choice was made deliberately to illustrate concepts of good and bad planning through the game. In actual experience, the author has observed that neither industries nor the government unit that has jurisdiction are generally well equipped to deal with a large scale industrial emergency. Hopefully this game will provide some motivation towards better contingency planning.

Since most of the rules of industrial contingency planning are illustrated through the game, the remainder of this appendix is devoted to how to prepare and implement a national contingency plan.

An experienced fire chief or police chief may consider this section as too theoretical. However, it is meant to present a possible framework and illustrate organizational steps for those officers without practical experience in fighting emergencies. Perhaps in some smaller countries, the national fire chief will simply have to meet with the major industries and certain government departments to build up the national contingency plan.

In actuality, one Mediterranean Government has recently established a formal mechanism for national industrial contingency planning with many of the features in appendix B. An interministerial steering committee on the treatment of hazardous substances, especially during emergency conditions and natural disasters, has been consolidating policies and instructions on: prevention of accidents in potentially dangerous plants; supervision and follow-up over the institution of safety procedures; guidelines for action in emergencies; realms of responsibility, collaboration and co-operation among government ministries, local authorities, industry, the army and the police; operative preparations for dealing with a mass accident; and data collection and provision of scientific services to various bodies.

The following national contingency plan is developed in the assumption that the country is small enough to disregard the need for separate provincial plans.

NATIONAL CONTINGENCY PLANNING FOR INDUSTRIAL EMERGENCIES

Industrial accidents are an unavoidable by-product of industrialization. For certain types of industrial establishments such as refineries, explosives or other chemicals manufacturing companies the possibility exists that an accident will develop into a large-scale disaster. On 24 September 1977, lightning ignited an eight-million-gallon tank of diesel fuel at the Union Oil Company Refinery in Romeoville, Illinois, U.S.A. Subsequently two additional tanks containing a total of seven million gallons of gasoline were ignited. The situation was brought under control after two days of fire fighting and the use of 20,000 gallons of foam concentrate as extinguishing agent. Eighteen fire departments were involved in the operation.

National contingency planning is the only effective way to combat large-scale industrial accidents. National resources are mobilized and a co-ordination effort mounted at a level higher than any private company can manage. The direct intervention of the government authority is required. Therefore national contingency planning is a governmental responsibility. Many public institutions, from ministries to fire departments, may be involved in development, elaboration, and implementation of the plan.

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 national emergency forces and resources in case of industrial disaster
- Co-ordinate the emergency response actions between the plant and the response forces
- Make available to single industries emergency resources that they would not be able to obtain otherwise
- If properly publicized, the plan will instil confidence within the industry and the public
- Delineate the authority of the government in industrial emergency response and industrial safety.

A. Preliminary planning steps

National contingency plans are mainly co-ordination plans. Therefore the focus will be on the distribution of general responsibilities and tasks in case of a major accident. A hazard analysis will be the first step in the planning process, followed by the specification of emergency responsibilities of the different ministries and agencies.

One ministry or agency should be given the initiative to commence the planning process. This might be the national fire fighting force. Then the representatives of the other important ministries or agencies should be brought together in a series of meetings to develop the plan. The first meeting might make clear the need for such a plan and how everybody could be called upon to meet expected needs. Participants would then be requested to indicate in writing where their agencies could best help.

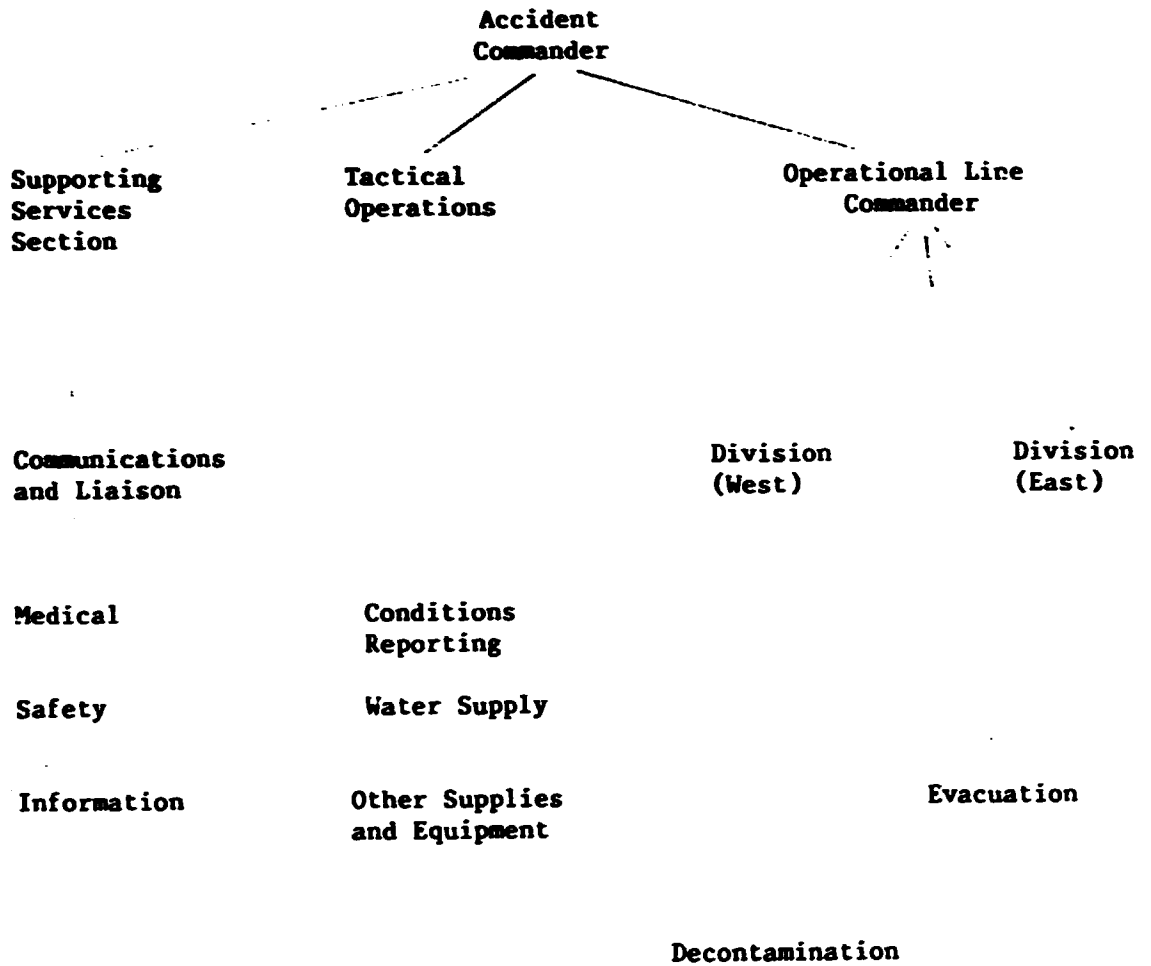
After the written submission had been organized and analyzed, command organization would be discussed at the second meeting. The agencies would also identify all other groups, or organizations that could provide assistance to their command staff assignment. A list should be compiled and edited of the 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 reach a disaster in different districts.

The written preparation of the full contingency plan would be initiated at the next meeting. The national contingency plan should include a section for each agency function, such as evacuation or safety, and outline the specific duties. For example, the police could contain municipal, provincial and national personnel. The role of each would be designated as well as the responsibilities of specific units, such as traffic and communications.

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 agencies 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 for the national contingency plan



1. Accident commander

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

The commander must co-ordinate fire fighting tactics with other actions such as process or pipeline shutdowns, and seek advice from plant or carrier personnel with knowledge or specialized training in dealing with dangerous products involved. He must be prepared to apply tactics 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. Secondly, 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 in the national emergency contingency plan.

If the accident commander leaves 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 as necessary to line and staff members. 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. They are headed by the operational line commander. A divisional officer may be responsible for each front of the emergency.

The staff officers provide technical assistance and support. The tactical operations section develops alternative strategies and tactical approaches for the commander's review. The logistics section co-ordinates and acquires needed supplies, equipment, and personnel. Supporting services provide communications, medical services, and others.

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.

The responsibility of a division command officer should be to supervise the crew and co-ordinate its actions with other crews. 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, explosion, or other hazards. The crew may also have other functions, such as evacuation or decontamination.

4. Supporting services section

The supporting services section may include a communications officer, medical officer, safety officer and information officer. This section directs radio communications (including those to other agencies), treats the injured, maintains overall safety, and handles the media.

Communications and liaison officer. The communications officer must establish communications with all units responding and on the scene, outside agencies and technical information sources. He should record arriving agencies and keep track of their assignments. They should inform him of any resource shortages. He handles all transmissions into the command post and dispatched from it. The accident commander may of course require direct communication with the operation line commander.

The communications and liaison officer should have a detailed list of telephone numbers of local doctors and outside agencies which may have to be called. 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.

The communications and liaison officer also co-ordinates the actions of the outside agencies who can offer assistance to the emergency operations. Some of the agencies with whom the 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.

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 so that one is not overcrowded while another awaits victims.

The medical officer may have to co-ordinate with a coroner on identification procedures, 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 safety of everyone: emergency response personnel at the scene, the public living in the area and spectators, if any. He ascertains 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 co-operates 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 providing accurate information to the news media. He should decide where the press can go. He may hold news conferences if the emergency continues. He may establish telephone lines for the media.

5. Tactical operations

Tactical operations consist of the 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 logistics and operation line sections. The tactical operations section must also consider and present alternatives on how the operation line should be divided into divisions; 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 such as shift of the command post, if necessary.

Conditions officer. The conditions officer keeps a record of what is happening on the scene and prepares progress reports of the situation for the accident commander. The reports should include the area involved, possibility and direction of spread, progress of the operation line forces, and any special factors, such as re-routing of traffic, arrival of special extinguishing agents, or evacuations 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.

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 for improvement. Records will also serve as a justification for 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 determines the location, accessibility, and quantities of water available from all usable sources, evaluates the accident water requirements and initiates operations to overcome water supply deficiencies. He should have maps indicating storage capacities, main sizes, hydrant locations, and flow available in the area. The water supply officer will need to know apparatus capacities, locations and numbers of lines in operation.

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 and apparatus to the line divisions at the scene of the accident on orders to the accident commander. He must then inform the liaison officer of the assignments.

The supply officer must keep an inventory of equipment and make sure that supplies are maintained, including 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, absorbing materials for oil or chemical spills; decontamination or neutralizing materials for corrosives (lime and soda ash, for example); a supply of gasoline, diesel fuel and oil. Even if these are not within the stores maintained by the supply officer, he has an inventory list indicating where the equipment or material is available.

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. Some of the general indications on how to handle a major emergency are given below.

The sequence of events which culminates in the implementation of the national contingency plans is, in an idealized setting, the following:

- a) The first alarm is communicated to police or fire fighters which arrive at the scene of the accident and begin the response operations.
- b) The fire chief decides that resources are not sufficient to bring the accident under control. He asks for reinforcement from other fire departments in the same area.
- c) The joint units still cannot control the accident. The ranking fire chief alerts the authority in charge of activating the national contingency plan.
- d) An emergency is declared and the implementation of the plan begins.

The authority in charge of activating the plan will be, in general, a high ranking government official most likely in the Ministry of Interior. He may be the national fire chief.

2. Establishment of the command post

The command post is the operating centre from which control of the accident is maintained. All incoming information and feedback from the accident will be directed to this post.

In order to co-ordinate the actions of the response teams at the accident location, a field 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 field command post. The reports should include the current accident situation and control possibilities, any rescue or evacuation procedures, safety concerns, the condition of the area affected by the accident, any further resource requirements, and any special hazardous developments. The reports are 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, or withdraw. The response actions may be a combination of these three with co-ordinated activities carried out by the response teams.

Many problems arise in the decision making process during an accident. Most of them are attributable to lack of correct information and communication problems. Examples are unknown products, accident locations that cannot be seen or easily reached, committing response units prematurely, difficulties in co-ordinating response teams from many 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 non-working emergency response personnel and the press from the immediate area of danger.

Evacuation may be necessary downwind from gases and vapours, downgrade from liquids or high vapour density gases, or in a circular area for products that explode. A simple rule of thumb is to initiate evacuation for at least one mile.

Evacuation, especially when dealing with large numbers of people, immediately raises numerous difficulties and problems. Some of these 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 silicon tetrachloride cloud)

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

How will the public be moved, if a vapour cloud is present? The routing recommended 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?

From where will sufficient trained personnel be obtained in a minimum of time to perform an adequate 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 emergency and be able to carry out evacuation only in the immediate proximity.

5. Restoration of services

A number of vital services could be impaired by the accident. Examples are contamination of the ground water table supplying wells or the water source for a community's water filtration plant. Auxiliary water supplies would have to be provided for the population. Another example would be the restoration of electrical power. The fire department may have to supply emergency lights and power for its own operations while awaiting the intervention of the power company.

D. Legislation and standards

The existence and enforcement of a proper legislation on industrial plant safety and accident prevention is a necessary prerequisite to minimize the catastrophes which require activation of the national contingency plan.

Questionnaires and plant inspections by technically trained government representatives could be utilized for this purpose in order to learn:

1. Information relating to the installations

Type of industrial activities

A general description of the technical processes

The geographical location of the installations, predominant meteorological conditions and possible dangers arising from the location of the site

The maximum number of persons working on the site of the establishment; number of those persons exposed to hazards

A description of the establishment which is important from the safety point of view; the sources of hazard and the conditions under which a major accident could occur; a description of the preventive measures planned

The arrangements made to ensure the safe operation of the plant and to deal with any malfunctions that might arise.

2. Information on the substances present at the installations

Data on substance identification (chemical and trade names, empirical formula, composition and degree of purity)

Substances stored or used in connexion with the industrial activities

The stage of the activity in which the substances are involved or may be involved

The approximate quantities

The chemical and/or physical behaviour under normal conditions during the process

The forms in which the substances may occur or into which they may be transformed in the case of abnormal conditions

Final products, by-products and residues

Other dangerous substances at the plant

Detection methods available at the installation

Means available at the installation for rendering the substance harmless

3. Contingency information relating to major accident situations:

Emergency measures prepared by the manufacturer in the event of accidental dispersion of dangerous substances

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

The names of the person and deputies authorized to set the emergency plans in motion and to alert the competent government authorities

The government could also require that serious industrial accidents be promptly reported. Steps could then be taken to alleviate the long-term consequences and prevent the recurrence of each accident. Examples of serious accidents are:

Any accident which causes death or results in disablement resulting in absence for more than a week 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 one day's down time to the plant
Release of toxic substances in the plant which escape into the environment in concentrations which exceed acceptable limits

Information of an accident should be supplied by the plant to the government. The report format might be:

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 by the government

The manufacturers could be required by law to prove to the government 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.

Legislation on transport of hazardous industrial materials deserves special attention. A government may require that dangerous goods arriving at its frontiers be properly packed, labelled and carried according to national regulations. The government may prepare:

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 represent a good example of international legislative agreement on this subject.

E. Municipal contingency planning

A national contingency plan should only be utilized in case of a major disaster. For smaller-scale accidents municipal resources might be enough to bring the accident under control. Contingency plans could also be drawn up at this levels. The procedures for preparing, organizing and implementing the plan are similar to those for a national plan. Therefore this appendix 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.

A hospital contingency plan should include a telephone roster of all the medical personnel listed according to the proximity of their residence to the hospital. The University Hospital in Ghent, Belgium, has a 13-page emergency admittance plan 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:

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

APPENDIX C

Sample Hospital Contingency Plan:

Emergency Admittance Instructions:

I. During normal working hours

1. For the telephone office

- As soon as "900" call centre announce an emergency situation, inform:

Office of the Director	Tel. 110
Person in charge of:	
- Emergency admittance	Tel. 120
- Intensive care	Tel. 130
- Operating theatre	Tel. 140
- Social service	Tel. 150
- Central reception	Tel. 160
- Waiters	Tel. 170
- Patients' transportation	Tel. 180
- Equipment and furnishing	Tel. 190

Doctor on duty and stand-by:

- Administrative doctor responsible for emergency admittance
 - Surgical dpt.
 - Internal dpt.
 - Orthopaedic dpt.
 - Radiological dpt.
 - Clinical biologist on duty
- All further incoming messages should immediately be transferred to the Office of the Director (Tel. 110)
 - Telephone request for information on incoming patients are immediatcly transferred to Tel. 200 or Tel. 201.

2. For the emergency admittance

- Prepare immediately everything necessary to receive victims.
- Make sure that there are enough stretchers available to clear the ambulance as quickly as possible. Note: The Ministry of Health should make sure that stretchers are standardized and interchangeable in different ambulances. After one major fire in Belgium several years ago it was discovered at the admitting hospital that ambulance crews were wating around for their particular stretchers to be cleared and returned because others wouldn't fit. Since then there has been standardization.

3. For the Nursing Department

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

- 6 sheets
- 3 big pillows
- 3 impermeable blankets
- 3 underlying blankets

Nurses Services:	1st floor	Tel. 210
Nurses Services:	2nd floor	Tel. 220
Nurses Services:	3rd floor	Tel. 230
Nurses Services:	4th floor	Tel. 240

4. For the social service and reception service

After having been informed by the telephone centre:

- One or more social nurses should join the personnel in the hospital reception (main building); they are responsible for the first contact with the family or interested persons.

- One or more social nurses should join the emergency admittance in order to assist, together with the responsible personnel at the spot, with the inventory of incoming patients. Try to collect as much information as possible on the patients physical state. The nurses are also responsible for the safe deposit of valuables. All information is regularly transmitted to the central reception. (The regular supervisor or the person in charge).

- One or more social nurses are going to the regular supervisor or her replacement in the central reception. This team collects all incoming information. This is kept on hand at Tel. 250 or 260 This information is also transmitted to the records service - Tel. 270.

- The telephone centre transfers all requests from the outside for information on patients immediately to the above team on Tel. 265.

- The supervisor or her replacement supervises the transfer of patients to the different floors.

5. For the person responsible for furnishings

- He calls:
- manual workers
 - painters
 - carpenters
 - electricians
 - metal workers

With this personnel, spare beds and equipment are moved from the basement and installed on:

- 1st floor
Day room in front of central elevator: 6 beds
 - 2nd floor
Day room in front of central elevator: 6 beds
 - 3rd floor
Day room at the end of the building: 6 beds
Space in front of reception: 6 beds
 - 4th floor
Day room at the end of the building: 6 beds
Space in front of reception: 6 beds
- Total number of beds to be placed: 36 beds

Hospital Emergency Admittance

Instructions:

II. During nights, weekends and holidays

1. For the telephone office:

- As soon as the "900" call comes in, inform
 - * person responsible for
 - emergency admittance
 - intensive care
 - operating theatre
 - assistant head nurse on duty
 - * the doctors on duty and stand-by:
 - Anaesthetical dpt.
 - Surgical dpt.
 - Internal dpt.
 - Ophthalmological dpt.
 - Orthopaedic dpt.
 - Radiological dpt.
 - Clinical biological dpt.
 - The administrative doctor responsible for emergency admittance
 - * Operator of central heating and electrician on duty
 - * The head medical officer
The head nurse
The head secretary
The head of the 3rd class of nursing students

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

2. For the emergency admittance

- Prepare immediately admittance
- Make sure that there are enough stretchers available to clear the ambulances as quickly as possible.

3. For the assistant head nurse on duty

- Go immediately to the large reception
- Call one nurse from the following services to come to the emergency admittance with a stretcher equipped with:
 - 6 sheets
 - 3 big pillows
 - 3 impermeable blankets
 - 3 underlying blankets

Nurses Services: 1st floor Tel. 210
Nurses Services: 2nd floor Tel. 220
Nurses Services: 3rd floor Tel. 230
Nurses Services: 4th floor Tel. 240

- Send one student nurse to each floor of which one nurse has been called to the emergency admittance. The student nurses are sent by the school to the reception where they must present themselves to the assistant head nurse on duty.
- Order the central heating operator and electrician on duty to take beds and mattresses out of the reserve stock (Red-white door in basement K.2 in front of the stairs of emergency admittance. The key is to be collected in the telephone centre).
- Take care that all administrative information concerning patients is registered.
- Remove and register clothes and valuables separately for each patient.

Note: If the head nurse thinks it is necessary, she may call for help from nurses in the reception from the social service. Tel. 250 or Tel. 260.

4. For the central heating operator and electrician on duty

Both in co-operation, help in collecting and placing of reserve beds and equipment.

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

- 2nd floor
Day room in front of central elevator: 6 beds

- 3rd floor
Day room at the end of the building: 6 beds
Space in front of reception: 6 beds

- 4th floor
Day room at the end of the building: 6 beds
Space in front of reception: 6 beds

Total number of beds to be placed: 36 beds

5. For the nursing school

- 10 student nurses from the third year are sent to the reception where they have to present themselves to the assistant head nurse on duty.
- The assistant head nurse shall send the students to all floors where a nurse had been called away to the emergency admittance.
- Moreover, a certain number of students (to be established by the person responsible for the emergency admittance) have to be sent to the emergency admittance to give assistance in preparing beds, removing clothes and washing of patients, and other duties.