TRAINING, INSTRUCTION, AND RESEARCH ON CHEMICAL ACCIDENTS

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INTRODUCTION

Background

The National Disaster Prevention Center (CENAPRED) has its foundations in the work of the National Civil Protection System (SINAPROC). It should be mentioned, however, that following the earthquake in Mexico City in 1985, Mexico and Japan formalized a technical and scientific cooperation agreement the next year to strengthen friendship and collaboration, which allowed Mexico to take advantage of Japan's technological advances in seismology, complement its own progress, and acquire innovations that benefit the country directly.

Within this framework of collaboration and reciprocity, the Government of Japan donated US$9.5 million to finance the cost of construction and specialized equipment for CENAPRED, through the Nonreimbursable Financial Cooperation System, which provides economic support to the developing countries. The project was formalized in August 1988 as the most important event at the commemoration of the second centennial of friendship, collaboration, and interchange between Mexico and Japan.

A 5-year technical cooperation agreement, beginning in 1990, was subsequently concluded and later extended for two years. This agreement ensures Japanese participation in seismic research.

The Mexican government also allocates considerable resources to consolidate and operate the Center. Thus, the Government has not only met its cooperation commitment with Japan but has also demonstrated the political will to create the conditions for an orderly and timely response to any disaster through SINAPROC. CENAPRED has thus become a technical instrument that facilitates expanded knowledge on regulatory as well as disruptive agents, in addition to promoting optimal prevention measures and responses to disasters based on solid scientific practice.

The decree creating CENAPRED, which was originally targeted to seismic disaster prevention, was expanded to other types of destructive phenomena that could affect the country, including technological events of a chemical nature. It was also determined that the benefits of the center's knowledge and experience should be extended to Central America and the Caribbean.

Infrastructure

Construction of the building that houses CENAPRED began in February 1989 and was completed in late April 1990. Located on a 15,303 m^2 lot granted in commodatum by the Autonomous National University of Mexico (UNAM), some 50% of its facilities are allocated to research; here, experts carry out their activities in an appropriate environment. There is a data processing room whose principal functions are to receive and interpret the information sent by the seismic observation networks and to analyze and monitor the data generated by CENAPRED itself. There is also a structural testing laboratory, where the seismic responses of structures are studied, as well as the resistance of different building materials (steel, concrete, masonry, etc.). This laboratory has a reaction wall that permits testing on full-scale models (specimens). There is a soil dynamics laboratory to study the characteristics of different types of terrain, and a seismic instruments maintenance laboratory to repair, calibrate, and service the equipment of the observation networks.

Some 25% of the constructed area is allocated to training. There are three seminar rooms with a 30-person capacity, a room for the training of instructors, and a library. The rest of the facility, or 75%, is allocated to information dissemination, interinstitutional liaison, programs and standards, and internal administration. There is an auditorium with a 204-person capacity, an area for exhibiting instructional materials, and sufficient infrastructure for printing, binding, and storage activities. There is also a cafeteria.

Organization

The organizational structure of CENAPRED consists of a Governing Board, the Office of the Director, and four coordination offices: Research; Seismic Instruments and Volcanology; Information Dissemination; and Training. There are also three secretariats: Interinstitutional Affairs, Technical Services, and Administrative Services.

The Governing Board is presided over by the Secretary of the Interior, and is comprised of representatives of the sections and agencies that are most involved in disaster prevention and community response in disaster situations: the Secretariat of National Defense (SEDENA); the Secretariat of the Navy (SEDEMAR); the Secretariat of the Treasury and Public Credit (SHCP); the Secretariat of Energy (SE); the Secretariat of Commerce and Industrial Development (SECOFI); the Secretariat of Agriculture, Livestock, and Rural Development (SAGAR); the Secretariat of Communications and Transportation (SCT); the Secretariat of the Environment, Natural Resources, and Fisheries (SEMARNAP); the Secretariat of Public Education (SEP); the Secretariat of Health (SSa); the Secretariat of Labor and Social Welfare (STPS); and the National Community Subsistence Company (CONASUPO).

The following entities also participate on the Governing Board: the Civil Protection Administration of the Department of the Federal District; the UNAM; the National Council on Science and Technology (CONACYT); and the Civil Protection Administration of the Secretariat of Internal Affairs.

The principal functions of the Board are to set the general policies of CENAPRED and to define the work priorities for its substantive areas. It also approves the institution's programs and relevant agreements, as well as its internal regulations.

Center Coordination

a) Research

Specific research activities are conducted on the characteristics and consequences of natural phenomena and human activities that are the potential sources of disasters. Research is also performed on techniques and measures that lead to risk reduction.

The research centers on seismic phenomena but also focuses on problems related to the risk of volcanic eruptions, hurricanes, precipitation, and industrial activities.

The Center conducts research in the following areas:

- Geological Risks
- Structural and Geotechnical Engineering
- Hydrometeorological Risks
- Chemical Risks

b) Seismic and Volcanological Instruments

Networks of instruments have been installed to record ground movement during earthquakes. The Acapulco-Mexico network consists of stations that are linked telemetrically with the central CENAPRED station, where the signals are received directly. The Valle de México network consists of 10 stations with 30 instruments that measure surface movement, subsoil movement, and the movement of certain buildings. There is a third network that monitors the seismic activity of the Popocatepetl Volcano.

c) Training

Training is one of SINAPROC's main activities. CENAPRED therefore gives priority to planning, coordinating, and conducting training courses and programs for officials and others involved in civil protection.

The purpose of the training is to make a diagnostic study of the knowledge of the Mexican population, generate an inventory of the education and training resources available in the country, and finally, to design a training system for national disaster prevention.

In order to achieve this objective, courses are offered that include prevention, assistance, and support activities to train specialized human resources, as well as activities to assist civil protection officials in meeting their responsibilities throughout the country and provide general information on disaster prevention to the population.

d) Dissemination

The primary objective of CENAPRED's information dissemination activities is to promote and consolidate a culture of civil protection in Mexican society that will ensure the coordinated, systematic, and shared participation of society and government. For this purpose CENAPRED prepares and disseminates information on SINAPROC's organizational, implementation, and cooperation activities, through the available communications media, providing information on how the population can protect itself before, during, and after a disaster and granting priority status to prevention activities.

In a similar fashion, the information and techniques generated by the research conducted at the Center are disseminated along with others consistent with the objectives of the System that are developed by other national or foreign institutions.

TRAINING IN CHEMICAL ACCIDENTS

A disaster is defined as an event concentrated in time and space, in which society or a part of society is seriously harmed and incurs losses to its members, such that the social structure and essential activities are jeopardized, thereby affecting the society's vital operations[1].

1. Bases para el establecimiento del Sistema Nacional de Protección Civil. Mexico, Diario Oficial de la Federación. 6 May 1986, p. 19.

Mexico has developed SINAPROC, a series of activities by various ministries in disaster prevention and mitigation.

Through SINAPROC the government seeks to strengthen basic concepts with regard to disasters, assorted chemical agents, systems that may be affected, and mechanisms for disaster prevention and mitigation.

Training in chemical accidents is one of the activities developed to support the population in disaster situations. It includes two strategies:

1. The prevention of chemical accidents.

2. Training for emergencies and their consequences.

Thus, training is conducted to respond to three periods in a disaster: before, during, and after.

In order to achieve an effective response during these three periods, the training is designed to cover aspects of planning, organization, and functional specialization, in accordance with a pre-established emergency plan for each type of phenomenon, accident, or chemical disaster that may occur in industrial plants or during the transportation or storage of hazardous chemical substances.

The training is geared to the state or municipal civil protection agencies and promotes social, public, and private sector participation in achieving the objectives of the SINAPROC, which are to protect the population, private property, and the environment (Figure 1).

The preparation, development, and, above all, execution of these emergency plans depend on the task analyses to be submitted by each and every participant of the emergency assistance team.

The operational definition specifies the steps to follow, the precautions to take, the time required to execute each step (exposure limits), the proper use of the equipment needed to deal with each particular chemical accident, and the potential for a chain reaction leading to other possible accidents, such as scenarios involving variables unrelated to the accident but whose simultaneous occurrence complicates the delivery of the response or else impedes the timely performance of emergency assistance activities.

In order to ensure effective implementation of an emergency plan to deal with a potential emergency situation, the necessary steps should be taken for the basic instruction and periodic training of response personnel. Even if most personnel have the basic knowledge needed to perform their specialized functions in emergency situations, they may not be familiar with the various conditions that may be created by the peculiar nature of an accident, during which they must perform the required tasks. Thus, the basic instruction should present material on these different conditions and also include appropriate information on the organization, plan, procedures, and standards for any given emergency. The necessary structures should also be in place to ensure that the regular training includes the basic information required, as well as any changes in the emergency plan, including both exercises and training.

Drills and exercises should be conducted that realistically simulate the anticipated emergency conditions. Although these practice sessions can be utilized as training to maintain the level of competence of the response groups, they can also be useful in verifying the suitability of the plan, procedures, equipment utilized, communications, etc. Thus, the various task groups should be trained specifically to deal with emergency situations in accordance with their individual functions, and they should also be trained in the management of the team and its coordinated operation.

In light of this, training programs for response personnel should be consistent with organizational needs and with the plan itself and should be designed to ensure the permanent response capability of each participating institution. Thus, the priority activities for the training programs should include the following basic points:

a) Assessment and analysis of the training needs of the emergency response groups

b) Internal training programs for the participating sections in order to train the emergency response personnel. This training is a primary responsibility of the participating institutions, which should plan and structure their programs in accordance with the needs of their own organizations.

c) Training programs geared to response personnel who have recently been incorporated into the organizational structure of the emergency plan.

d) Instruction and continuing education for instructors in order to multiply training within the agencies comprising a local civil protection committee or unit.

The following activities should be included in planning for chemical accident training:

1. Developing the annual program of training activities.

2. Analyzing the training needs of the agencies that make up the civil protection committee or unit.

3. Ensuring that the techniques and methods taught during the training programs are consistent with the procedures established for each specific task.

4. Training and updating the coordinators of the response groups so that they can take appropriate action during emergencies.

5. Developing indicators of response group capabilities through periodic reports on the training of response personnel.

6. Maintaining an up-to-date record of the response personnel trained by the agencies, by each particular task.

7. Ensuring the modification of training programs or the design of programs to retrain personnel to correct errors that may be detected through the evaluations of practice drills and exercises.

In order to develop an efficient training and education program for the various levels participating in a chemical accident emergency plan, SINAPROC provides for the involvement of several ministries whose participation would be based on the risk they face from a particular chemical agent. The objective here is to optimize the participation of properly trained human resources within an emergency response organization.

The following is an example of a scenario utilized in the city of Querétaro, Qro. during a training session on decision-making for the individuals responsible for running the State Civil Protection Program. The group consisted of senior administrative officials.

Participants

- State Director for Civil Protection.
- Director of Public Works.
- Official in charge of the military branch of the Secretariat of National Defense.
- Representative from the State Secretariat of Health.
- Fire Chief of the City of Querétaro.
- Regional Commander of the Federal Highway Police.

Messages from Command

No.	Time	
1.		State Police investigation of the accident at the railroad station on 9 June indicates that deliberate damage to the tracks was the cause of the train derailment.
2.	11:34	The communications office of the railroad station in Querétaro reports the derailment of a train containing ethylene oxide in 25 tank cars. Fourteen cars overturned and their contents have begun to escape.
3.	11:40	The communications office at the railroad station reports that ethylene oxide is escaping and confirms that four cars are the source of the leak. The valves of each car were sheared off when the car overturned.
4.		Patrol No. 0214 reports the overturning of a tractor-trailer carrying steel rods at the intersection of University Ave. and Cuauhtémoc. The tractor-trailer is completely blocking the roadway.

5.	11:42	The communications office of the railroad station reports that it has evacuated its installations. It reports that the chemical cloud is traveling in the direction of University Ave.
6.	11:53	Red Cross ambulance 010 reports panic: people are fleeing the area around the railway station; residents report that many people cannot evacuate.

Training Technique Utilized

- Simulation or role playing, with guided interventions used to describe the simulated response to the emergency, taking into account the human, equipment, and financial resources needed to deal with the accident described in the scenario.

The above example assumes that the participants in the simulated exercise[2] are familiar with the structure of the State Civil Protection Unit and the emergency response plans for chemical accidents that have been formulated for that particular city and have a basic knowledge of the Guide to First Responses to Emergency Situations.

In addition, the types of training and protection activities are closely linked to the organizational levels of the participants in the emergency response plans for chemical accidents postulated during the simulation exercises (Figure 2).

The training activities are geared to the specific tasks that each individual participant in the emergency preparedness plan must carry out.

The foregoing implies detailed task analysis for each level, position, or function for each person in the plan, in accordance with his/her level of intervention. Thus, the review of plan elements in terms of functions and tasks takes place in the design and implementation of the training programs, thereby ensuring a timely and effective response to a particular chemical accident.

In order to develop an efficient training and education program for the various levels participating in a Emergency Plan for Chemical Accidents, the National Civil Protection System provides for the involvement of several national secretariats based on the risk to be faced and the particular chemical agent involved. The objective is to optimize the participation of properly trained human resources within an emergency response organization.

RESEARCH ON CHEMICAL ACCIDENTS

The Research Coordination Office's Chemical Risk Area focuses on industrial risk--not only internal problems related to personnel and plant facilities but others that may arise in the zone around such plants from the accidental release of gases and toxic liquids, fire, and explosions. This area also deals

2. Tabletop exercise (ACTUAL RESOURCES ARE NOT USED, NOR ARE RESPONSE GROUPS MOBILIZED).

with the risks associated with the transport of hazardous substances and the safe disposal of toxic waste and considers their impact on health and the environment.

It performs diagnostic studies, and particularly important cases are analyzed in order to generate data that will provide technical support for the development of standards.

Environmental pollution is evident in damaged areas, and its impact on the ecosystem can range from slight to irreversible. Considering the various physical and biological routes that hazardous substances can travel, as seen in Figure 3, the adverse effects to which the population may be exposed range from mild poisoning to death.

The research of the Chemical Risk Area focuses on the mitigation of accidents caused by chemical substances and the minimization of their impact on the environment and health.

The Chemical Risk Area supports SINAPROC and other agencies in their particular research needs with respect to the prevention of accidents caused by events involving chemical substances that directly affect the civilian population.

Since an accident can have three stages--that is, **before, during, and after**--projects basically address the first stage.

The first step is to perform a **risk evaluation** by identifying risks, defining the vulnerable areas, and analyzing them.

The next stage is **accident prevention,** which attempts to eliminate the risk. Alternatives are then selected to manage the risks, and ultimately, to control them.

Finally, **an impact mitigation plan** is developed through contingency planning, specific knowledge of rehabilitation methods, and the establishment of organizational frameworks for the work.

During and after an event, the Chemical Risk Area participates in the collection of data that may prove useful. The Area gathers and studies information with a view to preventing similar accidents in the future. The Area also determines whether or not the response was adequate and evaluates the timeliness of the response. Follow-up of the accident is performed by investigating the effects of the chemical agents involved and isolating the affected area.

The technologies used to rehabilitate contaminated areas after an accident or the improper disposal of hazardous substances have been of special interest to the working group. This is because human settlements are often built on or near abandoned sites containing potentially hazardous substances.

Research on chemical accident prevention is also conducted through data collection that makes it possible to learn how to treat waste products, control their storage, or better yet, recycle and reuse them, a strategy employed in industrial waste reduction programs in the more advanced countries (Figure 4). Some of these waste management strategies are already being studied in the laboratory, through agreements with other government agencies and educational institutions.

The risk management process in its various stages involves participants from different levels. Here, scientific studies are important. For this reason the research groups exercise a great deal of responsibility at the various stages by contributing to decision-making on the use, control, and substitution of potentially hazardous substances and helping to lay the foundations for regulatory activity (Figure 5).

The main objective of the technical support for the development of norms is to mitigate risk. This is because, given the myriad activities carried out on a daily basis, the source of the hazardous substances cannot always be identified. The countryside, industry, and the home itself generate potentially hazardous substances as a result of current lifestyles. These substances are transported in various ways--by land, sea, and air--often clandestinely.

Accidents occur in different ways, and no two are exactly alike. Many chemical substances that are currently produced may interact with the environment through a leak or a spill, causing fires or explosions. Such materials in combination have an increased impact on the ecosystem and on the health of populations, both human and animal.

Providing technical assistance to committees formed by government agencies involved in programs to prevent major industrial accidents is one of the most important activities of the investigators, since the information is collected and processed in databases that encompass the most significant parameters. One example is the ACQUIM database, which is found in the Chemical Risk Area of CENAPRED. This database contains systematized information on events caused by hazardous substances in Mexico from June 1990 to December 1995.

Finally, but no less important, close communication with the international agencies has facilitated a continuous flow of information that is utilized in research projects. Moreover, collaboration with these agencies in events in which the findings are presented generates useful feedback for the working group. The relationship with international centers interested in implementing methodologies to meet the population's needs in the areas of information and preparedness to mitigate the effects of accidents in high-risk localities has been a very positive experience. It has moved the Center to continue studies designed to promote the well-being of communities and the protection of an environment that will be passed on to future generations.

Figure 1. Basis for the establishment of the National Civil Protection System

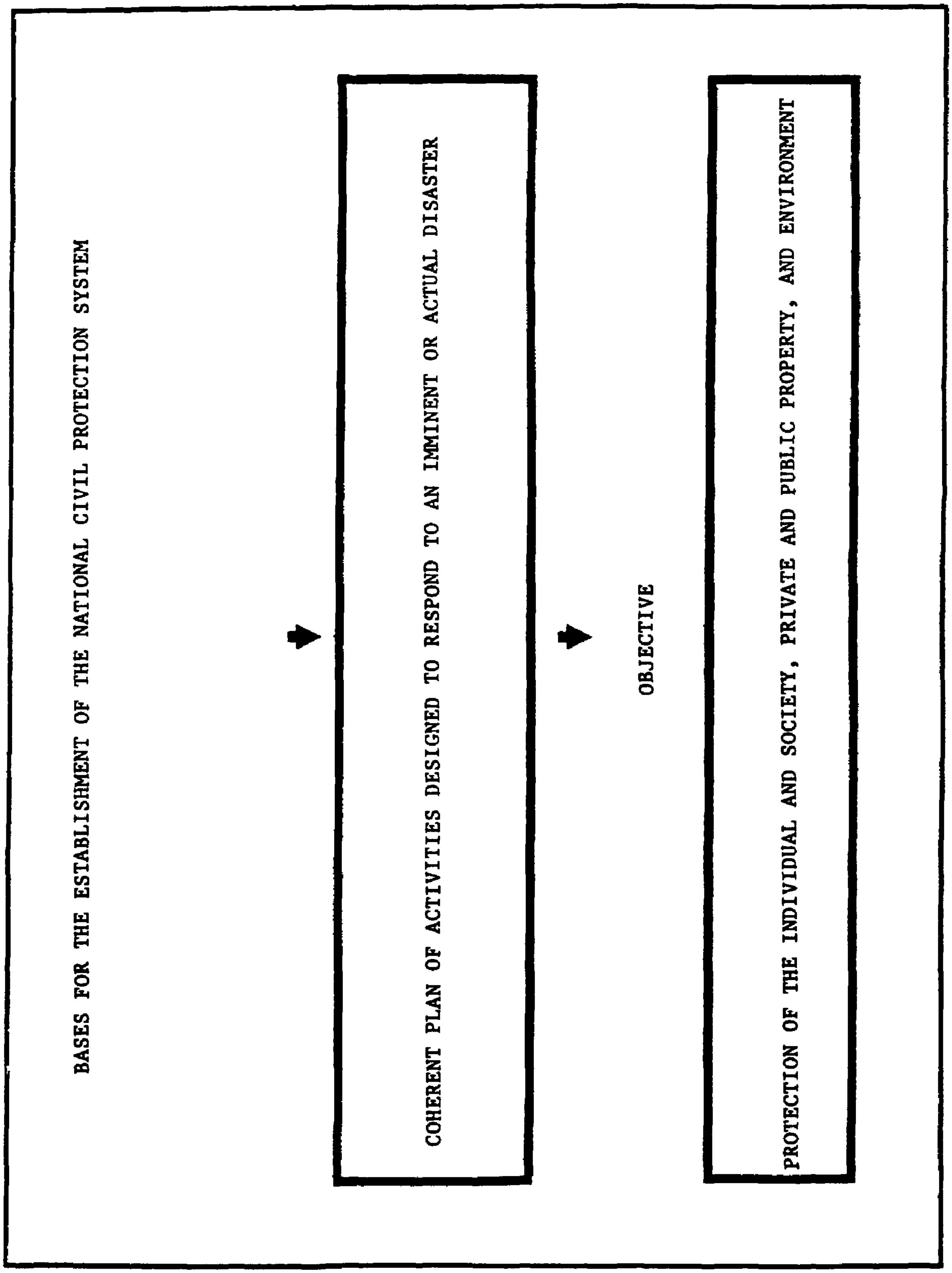


Figure 2. Links between levels of training and type of training required to deal with a chemical accident

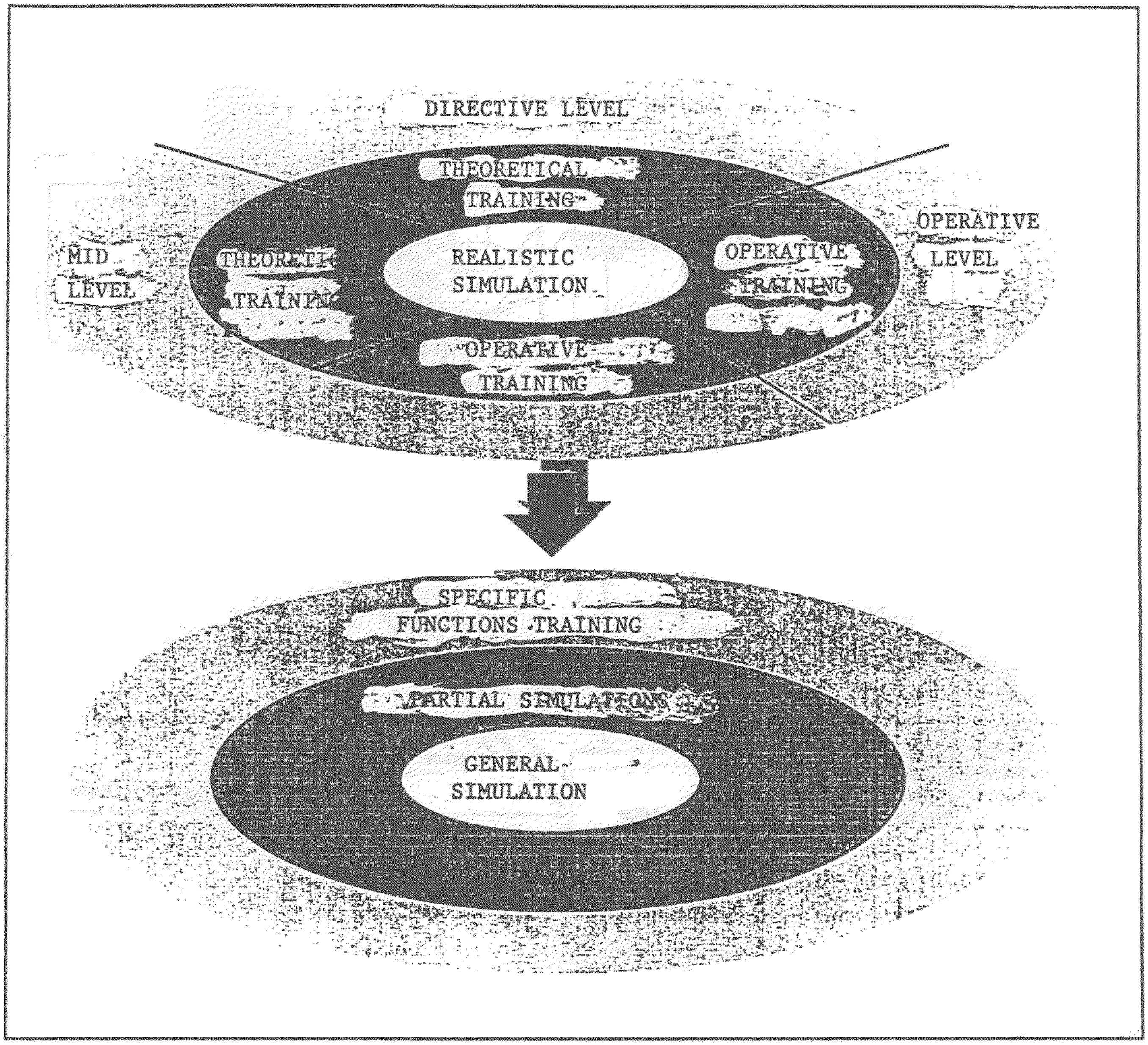
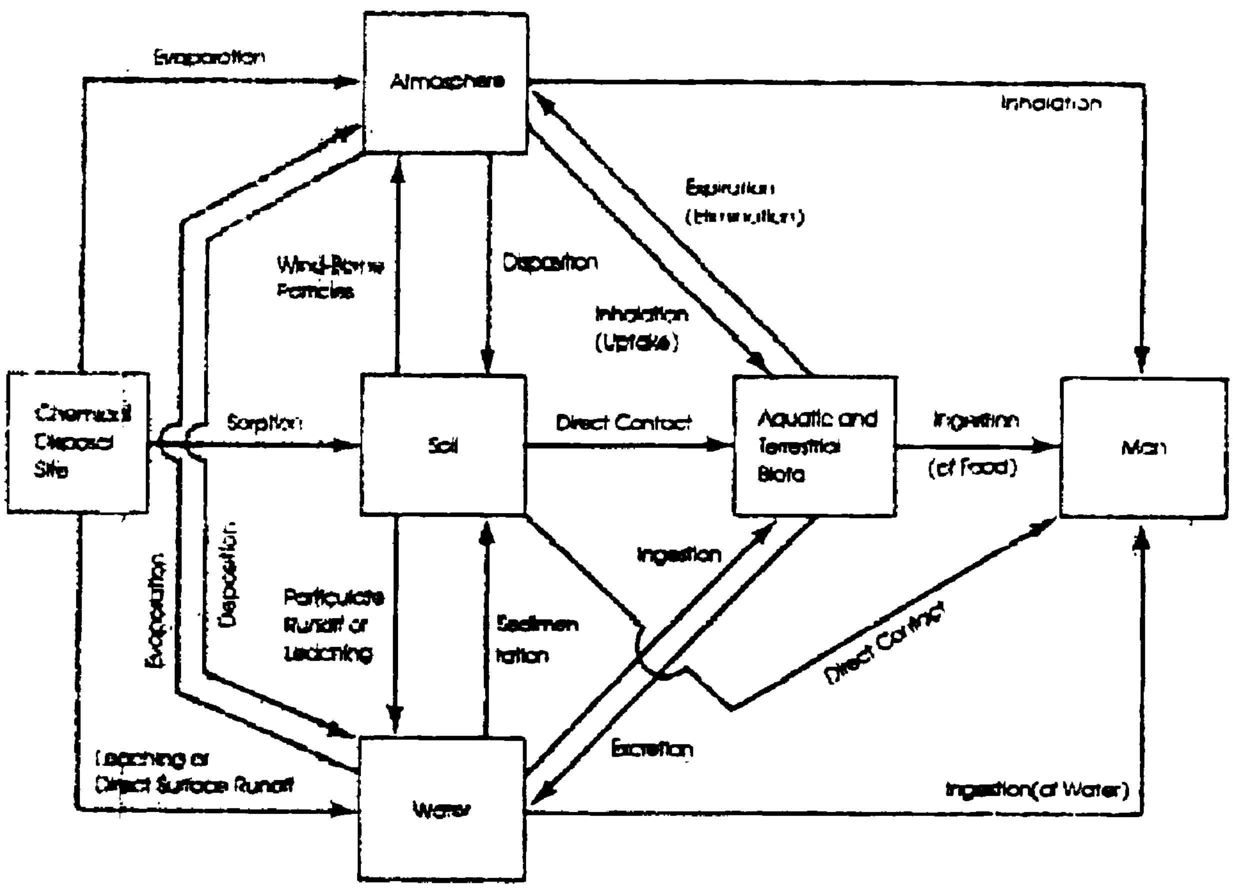


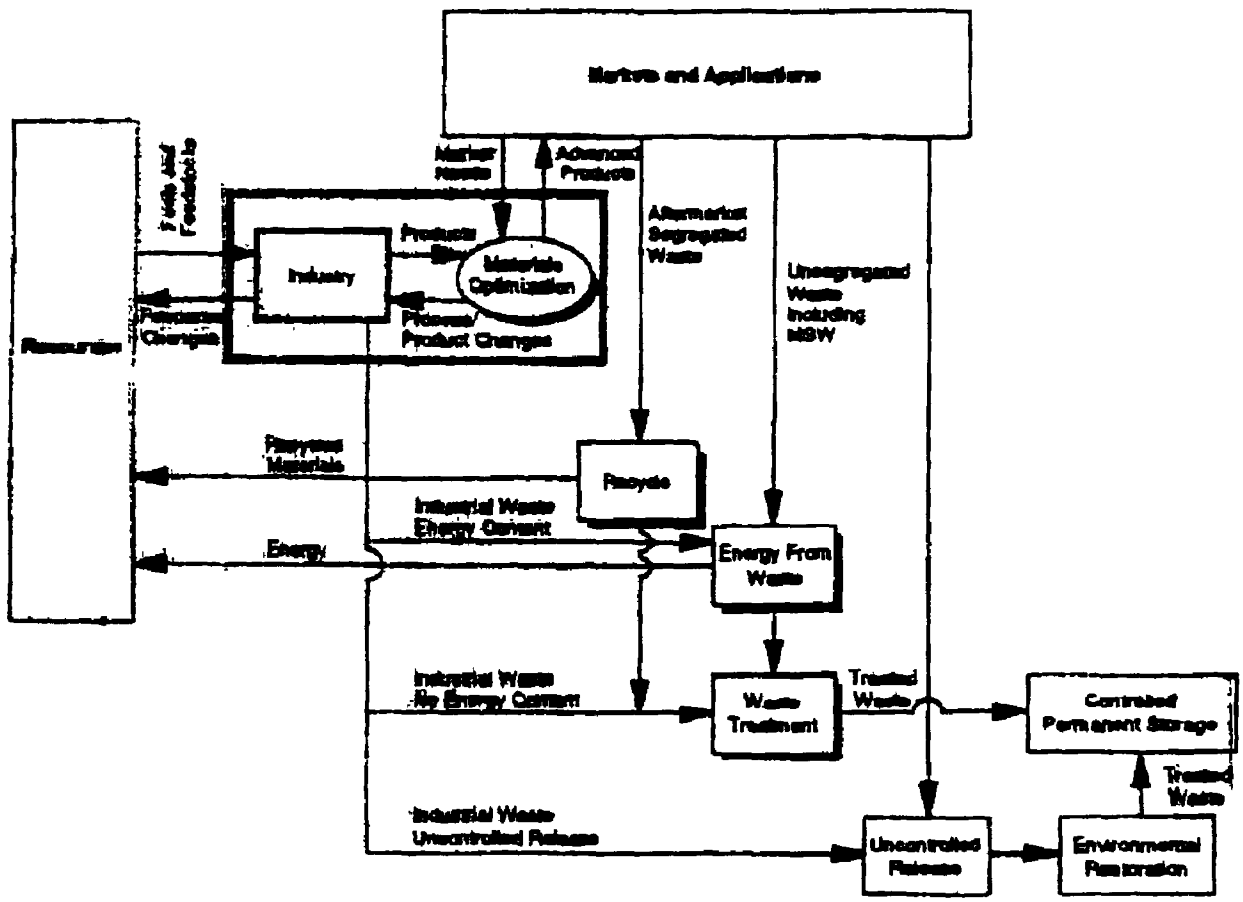
Figure 3. Physical and biological routes of transport of hazardous substances, their release from disposal sites, and potential for human exposure



Source: The Safe Disposal of Hazardous Wastes, World Bank Technical Paper No. 93

Figure 4. Waste Management Network

"Original ilegible"

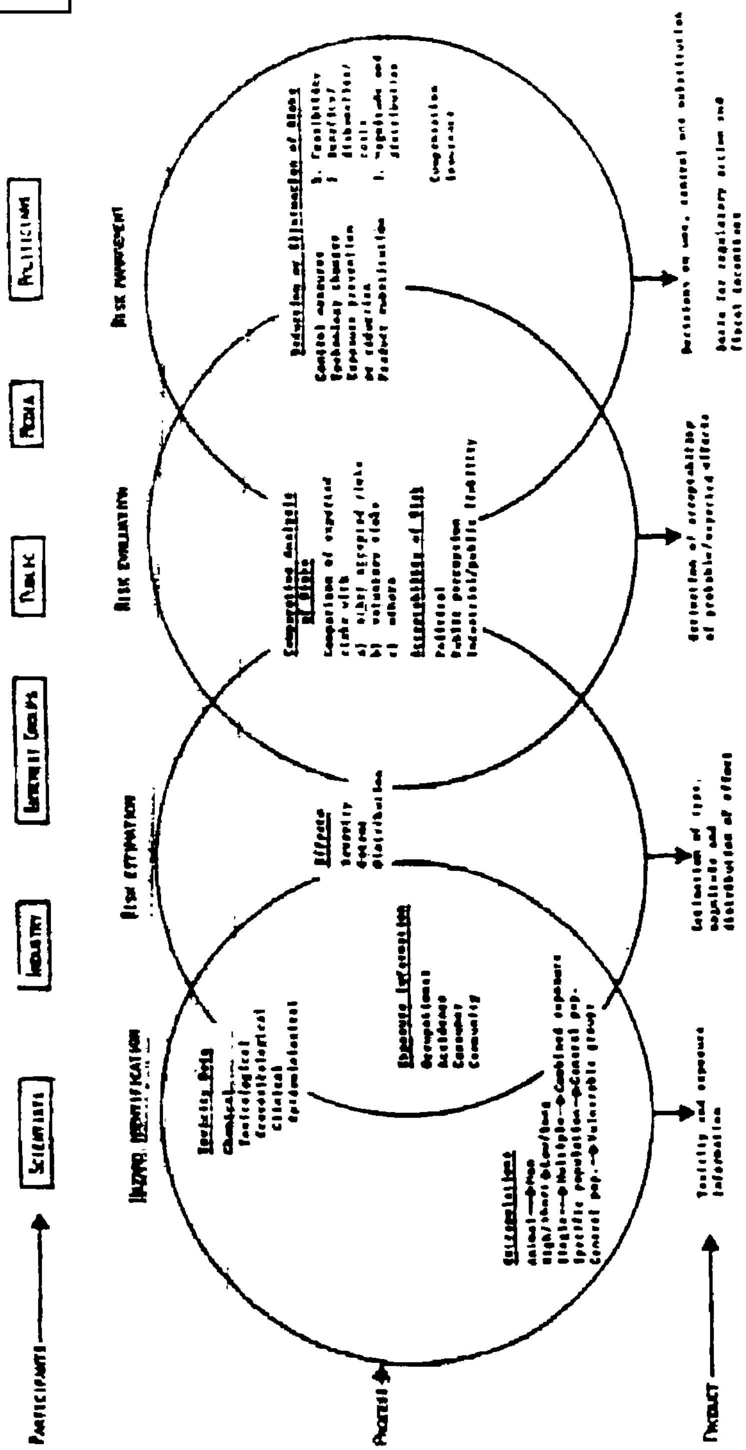


Source: U.S. Department of Energy Assistant Secretary, Conservation and Renewable Energy Office of Industiral Technologies.

Industrial Wste Reduction Program Under Contract No. DE-AC01-87CE 40762. September 3, 1991

"Original ilegible"

Figure 5. The risk management process



Source: Science of the Total Environment, 51 (1986), VII-X