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INFORMATION USEFUL FOR THE IDENTIFICATION OF HAZARDS DURING THE MANUFACTURE, STORAGE, TRANSPORT, USE AND DISPOSAL OF SUBSTANCES

AN ANNOTATED CHECKLIST

The **International Programme on Chemical Safety (IPCS)** is a joint venture of the United Nations Environment Programme, the International Labour Organisation, and the World Health Organization. The main objective of the IPCS is to carry out and disseminate evaluations of the effects of chemicals on human health and the quality of the environment. Supporting activities include the development of epidemiological, experimental laboratory, and risk-assessment methods that could produce internationally comparable results, and the development of manpower in the field of toxicology. Other activities carried out by IPCS include the development of know-how for coping with chemical accidents, coordination of laboratory testing and epidemiological studies, and promotion of research on the mechanisms of the biological action of chemicals.

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INTRODUCTION

A WHO Task Group on "Information useful for the identification of hazards during the manufacture, storage, transport, use, and disposal of substances" met at the Istituto Superiore di Sanita, Rome, Italy, from 20 to 22 September 1988. Dr Marcella Checchia opened the meeting on behalf of the Ministry of the Environment of Italy. Dr K.W. Jager of the International Programme on Chemical Safety (IPCS) welcomed the participants on behalf of the Manager, IPCS, and the three IPCS co-operating organizations (UNEP/ILO/WHO). The Task Group reviewed, revised, and finalized the Annotated Checklist.

The first draft of this document was prepared by Professor V. SILANO, then of the Istituto Superiore di Sanita. The second draft was prepared by the IPCS secretariat, incorporating comments received following circulation of the draft to the IPCS Contact Points for Environmental Health Criteria documents.

Financial support for the meeting was provided by the Ministry of the Environment of Italy and the Istitute Superiore di Sanita, Rome, contributed to the organization and provision of meeting facilities.

The effort of all who helped in the preparation and finalization of the document is gratefully acknowledged.

ABBREVIATIONS

CAS	Chemical Abstracts Service
EEC	European Economic Community
IATA	International Air Transport Association
IEO	Industry and Environment Office, UNEP
ILO	International Labour Organisation
IMO	International Maritime Organization
IPCS	International Programme on Chemical Safety
IUPAC	International Union of Pure and Applied Chemistry
OECD	Organization for Economic Co-operation and Development
UNEP	United Nations Environment Programme

1. SCOPE AND PURPOSE

This document relates to substances which may, in certain circumstances, have the potential for one or more of the following types of hazard:

- major accident (to man or the environment);
- pollution (routine emissions or deviations from routine);
- worker health and safety.

Chapter 1 comprises a brief review of the three conceptually distinct stages in the assessment of risks. Chapter 2 consists of a checklist indicating the information that may be needed to identify, assess, and control the hazards. Expert analysis and judgement may be required to satisfy some of the items on the checklist. A more detailed treatment of the subject is given in the ILO manual on Major Hazard Control [16] and the UNEP/IEO guidelines on Storage of Hazardous Materials [37]. This document is also a complement to be used when implementing the UNEP/IEO Awareness and Preparedness for Emergencies at Local Level (APELL) programme, the process for responding to technological accidents [36].

The document aims to provide a checklist covering the production, distribution, industrial use, and disposal of hazardous substances. It is intended to assist interested bodies and authorities in establishing their information requirements (either in a national context or a case-by-case basis) when assessing the safety of activities involving hazardous substances. The checklist may be of use when planning new activities or for identifying hazards that may be associated with existing activities. The many existing checklists/questionnaires [21, 27, 28, 35, 38, 39, 45] have been taken into account in constructing this document. Explanatory notes have been inserted where appropriate. The checklist must be used with discrimination to avoid including unnecessary information with no safety significance.

The references included in this brief review and in the checklist are not intended to provide a comprehensive coverage of the literature in this field. Most of them are chosen to illustrate the particular points being made in the text. There are also many useful databases in the field. If a point needs to be pursued more deeply, expert advice should be sought, for example through the competent national, international, or UN organizations.

It should be noted that not all items in the checklist may be essential for any particular assessment. Care is necessary to define the scope of the assessment.

1.1 Hazard Identification and Risk Assessment

Whatever the type of hazard and scope of the assessment, there are three conceptually distinct stages [27, 38, 39]:

- **identification and analysis of hazard sources,** i.e. of any situation that has the potential to cause damage to life, health, property, and/or the environment

- **identification and analysis of vulnerable areas,** i.e. the susceptibility of life, health, property, and/or the environment to damage if a hazard manifests it potential

- **assessment of hazards and risks,** i.e. the probability that a hazard manifests itself and that damage to life, health, property, and/or the environment occur

Various terms used in the assessment of risks from hazardous substances may cause confusion. For some compilations of definitions, references [12-16] should be consulted.

1.1.1 Identification and analysis of hazard sources

The aims of this phase are four-fold [45]:

1.1.1.1 Identification of potential releases of hazardous substances from containment

In assessing a major accident potential, the following questions should be answered:

- Where might a major accident occur within a plant or operating system (as a result of malfunction, fire, explosion, error, or external impact) that would result in a large-scale accidental release of hazardous substances during normal operating procedures?

- If an incident occurred, is the source sufficiently far away from neighbouring industrial installations to prevent a "domino" effect occurring, i.e. a failure at one point leading to failures elsewhere?

- To what extent does the plant or operating-system design enable the effects of minor accidents to be contained without serious risk of the hazard spreading to the rest of the plant or surrounding area?

- To what extent is the plant equipped and prepared to re-establish control over accidentally released hazardous substances and to minimize the effects of the release?

To answer these questions, it may be helpful to review relevant process engineering literature [35], which is based on the many documents that are normally prepared when designing a chemical plant. Such documents include process flow diagrams, equipment specifications, layout drawings, and plant construction specifications and regulations. An

operating manual is also normally available to provide details of plant operation, including procedures for safe plant shut-down in the event of malfunction and the arrangements and procedures for dealing with emergencies. A detailed critical review of these documents should enable potential hazards to be identified even before the plant starts up. If the plant is already operational, a review of the relevant process engineering can also be based on operating experience. A methodical and systematic procedure, known as the "Hazard and Operability Study", has been developed for the study of plant process engineering in detail [28].

1.1.1.2 Estimation of the nature and amount of possible chemical emissions

The key information concerns the nature and hazard properties of the substances involved [4, 9, 14]. An estimation should be made of what substances might be released, and in what forms and quantities. Such substances could be classified into the following categories: flammable liquids and solids; combustible liquids; oxidizing materials; explosives; toxic substances; corrosive materials; etc. Radioactive materials should be specified with their hazard classification. Attention should be paid not only to the original substances but also to the possible reaction products that may form as a result of accidents and/or during dispersion into the environment.

1.1.1.3 Forecast of possible emission patterns

Emissions and the resulting environmental concentrations of released substances may depend not only on the processes involved but on accident dynamics, local climatic conditions, prevailing winds, prevailing currents in adjacent waters, and terrain characteristics. Where suitable, it would be appropriate to use existing simulation models, and dispersion models in particular, that include a prediction of changes in toxicity or concentration levels. Various dispersion models have been developed to assist in establishing the expected range of accident effects. This is a matter for expert analysis and calculation.

1.1.1.4 Assessment of vulnerable areas

It is useful to consider at an early stage whether any population or sensitive environment would be exposed within the likely hazard range. For example, a very large escape of flammable gas would be of little significance over the ocean, but a smaller escape might cause severe local damage and fatalities in a city. If there is no problem at present, it may still be necessary to establish controls to prevent sensitive new developments on land near the chemical installation. The extent of such controls might be determined by a basic hazard or risk assessment [24].

Before the assessment can begin, it is necessary to identify those installations where more detailed qualitative and/or quantitative assessments are probably required. Many countries have produced definitions of "major hazards" where the concern is with the potential for major accidents: For example, EEC Directive 82/501 (with first and second amendments) [13] lists a number of chemicals (with quantities) which require special consideration and precautionary measures. Other similar listings are given by the World Bank [49] and OECD [23]. When such an installation has been identified, there are procedures which allow a rapid qualitative assessment to focus attention on the most significant features, which can then be given more detailed qualitative or quantitative assessments [11].

1.1.2 Identification and analysis of vulnerable areas

The aims of this phase are to determine the potential sizes and hazard ranges of accidental releases. For example, for a major accident hazard, it would be necessary to know whether serious effects could extend beyond the facility directly concerned and what injuries might then follow [25, 30, 31]. This requires:

- identification of the community areas that could be affected by a chemical release;
- examination of these areas to determine their population and facilities.

The impact range of a hazardous release depends on the quantity and nature of the chemical(s) spilled and the dynamics of release. For vapours released in a chemical spill, there are several Emergency Action Guides [2, 3, 6, 29, 41, 42, 43] that provide guidance on evacuation distances from various-sized spills of a large number of hazardous substances from outdoor containers. It should be noted that the injury criteria used in emergency planning may be different from those used for other purposes, such as judging the safety level. It may be very difficult to establish the relationship between the level of exposure and the likelihood or degree of injury, particularly for toxic substances, and expert advice should be sought.

This approach can be applied to both stationary facilities and to routes used for the transport of hazardous substances. The vulnerable area for transportation routes is defined as the area lying within the specified hazard range of an accident and extending for the entire length of the route. Moreover, if there is a pollution hazard, the area that could be affected by run-off into a waterway or drain may also need to be evaluated by examining the terrain and potential flow patterns at specific sites. Information on the frequency of handling or movement of hazardous substances, records of previous chemical accidents [30, 31] and truck and rail accident data will all increase confidence in the identification of vulnerable areas. However, it should

be noted that previous accidents may not reveal the full potential of a hazard in adverse circumstances.

The calculation of the hazards range from a major release of a hazardous substance is a matter for experts who are aware of the uncertainties. It is often necessary to extrapolate from experiments on a smaller scale than that of the potential release and to make assumptions about the reactions of people to the event. In recent years great progress has been made in this field, and manuals and suites of computer programs are available [49]. Summaries of correlations may be useful to gain an impression of the potential scale of the problem [48].

1.1.3 Assessment of hazards and risks

The assessment of hazards and risks involves first determining what the hazards are and then estimating the chances of their occurrence (i.e. the risk) and how the resulting accident would effect the vulnerable areas. Assessment methodologies may be qualitative and/or quantitative. The former includes procedures based on expert judgement [11, 18, 20] whereas the latter includes methods such as Fault and Event Tree Analysis [10, 17, 19, 26]. Quantitative methodologies may extend to Human Error prediction studies [12] and Epidemiological Approach Studies [17, 44].

In the assessment of major accidents, the most difficult part is to quantify the probability of an accident occurring. Statistics from previous major accidents are very sparse and do not provide a good basis for predictions. The sophisticated techniques mentioned above have been developed to try to provide alternative routes to prediction. The value and difficulty of the techniques vary from case to case. They can be very time consuming if pursued in detail. Also there is some controversy about their validity, particularly for quantifying probabilities of rare events [6, 33]. Experts should be consulted to determine the extent to which quantification of consequences and probabilities might be practicable and useful.

It might seem that the probability of an accident occurring could be estimated more easily in terms of qualitative categories such as "low/medium/high" or "likely/unlikely." It would of course be necessary to define such words with care so that they are used with the same meaning by the different parties in a discussion and do not have too much evaluation implicit in them.

2. THE CHECKLIST

2.1 Fixed Facilities Including Storage

2.1.1 Name and complete address

2.1.2 Category

Categories of fixed facilities include:

- chemical process industry
- pharmaceutical
- hides, leathers, and footwear
- textiles and clothes
- wood and related items
- metallurgic, automotive, electronic, and electrotechnical
- extraction and manufacture of minerals
- electricity, gas and liquid fuels; water refrigeration or heating
- food and associated items
- agriculture
- storage (warehousing)
- service industries
- waste handling industry

2.1.3 Personnel

2.1.3.1 Personnel employed

A table should be available showing:

- number of permanent staff workers (according to qualifications)
- number of temporary workers (according to qualifications)
- number of shifts per 24 hours

2.1.3.2 Organization of personnel

A flow chart should be available showing hierarchical connections between the various levels of management.

2.1.3.3 Services contracted

The following information is needed:

- types of services and activities contracted and developed at facility
- average number of persons present at the facility to carry out contracted activities

2.1.3.4 Duties and responsibilities

Details of the following staff should be available:

- technical manager in charge
- the person(s) responsible for the overall safety of the plants
- the person(s) authorized to set emergency procedures in motion, both on and off the plant site
- the person(s) authorized to inform outside authorities, etc.

2.1.4 Location

(a) Location of the site, its topography, and its adjacent waters. There should be a map of the site and the surrounding area, the size of which depends on the hazard, at a scale large enough to show any features that may be significant in the assessment of the hazard associated with the site.

(b) Climatic factors and natural disasters that may affect the hazards associated with the site. The following should be considered:

- statistics on speed and direction of winds, and weather stability categories
- frequency of electrical storms, tornados, snow, freezing conditions, and other weather extremes
- seismic conditions and the potential for floods and other natural disasters endemic in the area

(c) Information about the use of the land surrounding the facility (e.g., crops grown) and the size, distribution, proximity, and direction of the population in the vicinity of the facility. Particular attention should be paid to other activities that may significantly affect the hazard or exposure to an incident, e.g., neighbouring facilities and surrounding geography such as rivers.

(d) Hydrographic data (e.g., depth, currents, salinity, seasonal differences, and drinking- and ground-water problems downstream, where appropriate).

2.1.5 Design and layout of facility

A scale plan of the facility is necessary showing clearly:

- layout of the facility including the plant area enclosed by fences and gates
- distance from boundary to nearest plant unit and to neighbouring population
- proximity of process areas to utilities, storage, office and laboratory areas

- proximity of hazardous units to critical areas, such as control rooms or process computer installations
- locations of equipment in consideration of the properties and quantities of materials, operating conditions, sensitivity to outside influences and fire-fighting prerequisites
- loading areas
- administrative buildings and warehouses
- storage tanks
- waste disposal systems
- vehicle roadways for entrance and exit in the event of emergency
- pipelines, cables, ducts, etc., that run underground
- utilities (e.g., water, electricity, telephone services, sewers, fuel and gas lines)
- drainage system for fire-fighting water and chemicals from accidental release, and facilities to retain contaminated effluents for treatment or removal to avoid environmental contamination
- chemical lines between process units within the facility

2.1.6 Structures within the facility

(a) Conformity of all buildings to national building codes (including the anti-seismic and anti-lightning ones) and to national electricity usage codes

(b) Foundations and subsoil for all loadings

(c) Insulated (fire-resistive) structural steel members and supports

(d) Extent of openings in floors, walls, elevator shafts; air conditioning and ventilation ducts, which might affect the spread of fire

(e) Fire walls to separate hazardous process areas

(f) Ventilation according to standards for explosion-hazard buildings, where necessary

(g) Ventilation of all buildings to limit levels of toxic and flammable substances including those that might be released in case of accidents

(h) Position of exits in all buildings

2.1.7 Equipment

(a) Detailed checklist for each piece of equipment whose malfunction could present a hazard

(b) Equipment design according to recognized standards

(c) Consideration of the possibility of over-pressurisation or over-heating, and of measures to deal with this problem

(d) Safety-related instruments and controls

(e) Servicing and inspection programme for equipment

(f) Automated units, such as sprinklers

2.1.8 Substances involved and their hazards

(a) List of substances (to be identified where applicable by IUPAC chemical name and CAS registry number), e.g., raw materials, intermediate products and impurities (when known), solvents and adjuvants, catalysts, primary finished products, secondary finished products employed in the manufacturing process, produced or stored in facility warehouse[a].

(b) Types of hazards associated with each substance at each stage of production, e.g., flammability, explosivity, corrosivity, toxicity (acute and/or long-term toxicity, carcinogenicity, ecotoxicity, etc.), where possible with hazard classification (see for example references [5, 15, 40, 47]).

(c) Maximum amount retained in the whole facility for every hazardous substance, as well as average quantities utilized or produced daily.
In cases where the substance may escape from process vessels, its concentration, and the impurities and their concentrations (within reasonable limits).
A flow chart indicating amounts of hazardous substances entering and leaving the facility daily.

(d) A scale plan of the site showing the locations and quantity of all significant inventories of hazardous substances. (The term "significant" may depend on the situation; expert advice should be sought to define a cut-off level.)

(e) A general description of the analytical methods available to the occupier of the site for determining the presence of the dangerous substances, or references to such methods.

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[a] *Most countries have an enforced mandatory labelling systems of marketed chemicals providing information on types of possible hazards associated with each chemical.*

2.1.9 Chemical processes involving hazardous substances

(a) Schematic description of main process routes, indicating connections existing among the apparatuses and components involving hazardous substances

(b) Indication of process chemical and/or biochemical reactions, specifying whether combustion, oxidation, nitration, halogenation, or other reactions occur (noting particularly if reactions are exothermic)

(c) Batch or continuous process

(d) Length and frequency of production cycle

(e) Indication of foreseeable anomalies, especially with respect to formation of dangerous substances, and diagrams of the parts of the plant(s) likely to be involved

2.1.10 Waste and effluent

2.1.10.1 Hazardous waste

- Nature of solid, semi-solid, and liquid wastes
- Average daily amounts
- Temporary storage
- Disposal procedures (including a mention of whether disposal is local or by removal to a distant site, and agreements to accept the waste)

2.1.10.2 Hazardous effluent (i.e. pollutants)

- Location of discharge point
- Composition of liquid and gaseous effluents
- Average daily volumes
- Methods of containment
- Equipments, procedures, and monitoring

2.1.10.3 Arrangements for handling hazardous waste and effluents after an accident, including contaminated fire-fighting effluent

2.1.11 Unit operations

(a) Maintenance to avoid hazardous situations, specifying type and frequency of maintenance by adequately trained staff

(b) Precautionary measures that need to be taken in the event of:

- abnormal temperatures
- abnormal pressures

- runaway reactions
- abnormal reactions
- equipment leaks or spills (systems available for rapid detection and containment of possible release need to be indicated)
- control valve breakdowns
- fire/explosion
- improper addition of reactants
- loss of electrical power, water, and nitrogen and other service gasses (auxiliary or back-up supplies need to be listed)
- material flow stoppage
- formation of chemicals that may occur under anomalous process conditions
- damage of plant parts due to collision with mobile vehicles
- damage due to flooding or earthquakes

(c) Time required to shut down a unit if an abnormal situation arises (and relating this to the time to evacuate unit and any danger area)

(d) Detection and reporting of deviations

(e) Design, instrumentation, and control of process components (e.g., distillation columns, heat exchangers, adsorbers and strippers) to minimize losses

(f) Procedures for storage, transfer, and loading or unloading of substances within the site (including vehicles, pipework, etc.)

(g) Safety significance of maintenance and modification of plant and operating procedures, and their relationship to the original situation

2.1.12 Safety management

2.1.12.1 General and legislative requirements

- Company health and safety policy
- Health and safety committee
- Training programmes for employees to recognize malfunctions, understand labels and data sheets, and learn routines and emergency safety procedures
- Standard operating procedures
- Compliance with legislation requirements
- Hazard information (in local language) on substances handled
- Emergency response and contingency plan
- Accident and incident record-keeping; investigation, reporting, and follow-up of fires, explosions, poisoning, spills, and other accidents

- No-smoking policy (to prevent fires and explosions)
- Medical and first-aid programme (e.g., worker training, availability of emergency medical facility)
- Industrial hygiene programme (e.g., personal protective equipment, exposure monitoring, etc.)

2.1.12.2 Operating procedures

- Medical surveillance (e.g., physical examinations, biological monitoring)
- Segregation and separation of hazardous substances depending on their compatibility
- Labelling of and warning systems for hazardous substances and mixtures
- Analytical methodology for the determination of hazardous substances in the facility
- Workplace exposure monitoring
- Pollution control monitoring
- Safety inspections (leakages, operating procedures, equipment)
- Maintenance of facility
- Housekeeping in facility
- Permit to work (flame permit, equipment lock-out, etc.)
- Procedures for handling and storing hazardous substances
- Measures to prevent access of unauthorized people to the facility and to the most sensitive sectors
- Fire protection procedures (e.g., initial training and drills)
- Start-up and shut-down procedures

2.1.13 Authorizations

- Date of facility start up
- Completion dates of substantial extensions or modifications (expert advice is needed to define the term "substantial" in each particular case)
- Classification according to relevant legislation and specification of transaction dates
- List, and corresponding terms, of authorizations issued and in the possession of interested parties
- Rules for changes in procedures and equipment
- Data on new plant or proposed extension or modification of existing plant, as required for the authorization

2.1.14 Communications

- Adequately protected communication (always available and with proper back-up) with emergency services outside the site boundary
- Telephone and/or radio communications within the plant
- Clear system of hand or other signals for noisy areas
- Emergency information stored on the site, and a parallel store held by the emergency services off-site

2.2 Transportation of Hazardous Substances

2.2.1 International laws and codes

There are many international laws and codes for the safe transportation of hazardous substances, which should be considered. The most important are indicated below.

2.2.1.1 Road/Rail

- Unidroit draft (mandatory insurance for land transport)
- EEC Directive on insurance for motor vehicles
- European Agreement concerning the international carriage of dangerous goods by road (ADR) (1957).
- International Regulations concerning the carriage of dangerous goods by rail (RID)

2.2.1.2 Sea

- International Maritime Organization (IMO, London)

- International Conventions
  - oil (1969, 1971)
  - liability in general (1957, 1976)

2.2.1.3 Air

- International Air Transport Association (IATA) (Warsaw plus amendments Montreal)
- Organisation de l'aviation civile internationale (OACI) Rome Convention, etc.
  Annex 18 to the Chicago convention concerning civil aviation

2.2.1.4 UN committee on transport

- Recommendations on Transport of Dangerous Goods

2.2.1.5 Rhine navigation

- European Agreement concerning the transport of dangerous goods by navigation on the Rhine (ADNR)

2.2.1.6 Hazardous waste

- OECD decision on trans-frontier movements of hazardous wastes [C (88) 90 (Final)], May 1988

2.2.2 Manufacturer, supplier, shipper, and receiver of the substance

The names of the manufacturer, supplier, shipper, and receiver of the substance(s) should be indicated, where relevant.

2.2.3 Transportation system

2.2.3.1 Type

- Tanker, i.e. any ship, hydrofoil, or other watercraft carrying liquid or gaseous cargo in bulk
- Carrier, i.e. any ship, barge, hydrofoil or other watercraft carrying solid cargo in bulk
- Tank truck, i.e. any vehicle (except aircraft, rolling stock, and watercraft) carrying liquid or gaseous cargo in bulk
- Transport, i.e. all other non-passenger transportation vehicles, excluding aircraft, rolling stock, and watercraft
- Rolling stock, i.e. any vehicle that runs on rails
- Aircraft, i.e. any vehicle that flies, excluding hovercraft operating over land or water
- Pipeline[a], i.e. any bulk transportation line, regardless of size (excluding local "in-plant" piping)

2.2.3.2 Permits and authorizations

- Construction date
- Most recent overhaul inspection date
- Insurance against damage caused by hazardous substance

2.2.3.3 Equipment

- Compliance with recognized design and construction standards
- Operation and servicing reliability and ease
- Fail-safe instrumentation and controls
- Spare parts on hand

2.2.3.4 Transit depots, warehouses

2.2.3.5 Loading/unloading sites (see also section 2.1)

2.2.4 Substances transported

- Substances transported (to be identified by chemical names)
- Quantities, by substance name and type of vehicle

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[a] As pipelines are not mobile, they can be dealt with in the relevant items of section 2.1.

Types of possible hazards associated with each chemical transported (e.g., flammability, explosivity, corrosivity, toxicity).

2.2.5 Container content identification

- Clarity
- Visibility

2.2.6 Warnings

- Clarity of hazard level
- Pictorial representation to avoid language difficulties
- Visibility

2.2.7 Unit operations

- Servicing and maintenance to avoid hazardous situations (type, frequency, and standard)
- Precautionary measures against:

  - abnormal pressures and/or temperatures
  - equipment leaks or spills
  - control valve breakdowns
  - fire

- Handling procedures to minimize pressure, shock, or friction

2.2.8 Operator practice and training

- Standard operating procedures manual
- Licensing system for crews
- Training programmes for crews
- Monitoring of compliance with rules
- Safety record of each driver (if relevant)

2.2.9 Safety devices and measures

- Availability of an emergency coordinator
- Types of devices available and modes of operation
- Personnel protection measures
- Emergency contingency plan
- Disposal procedures for waste from tank cleaning, etc.
- Training programmes for crews to deal with emergencies
- Routing
- Travel schedule (times, places)
- Inclusion of specific emergency information, e.g., transport emergency (TREM) card [8] with each shipment

2.2.10 Emergency notification procedures in the event of an accident

2.3 Vulnerable Areas and Population at Risk[a]

2.3.1 Site

The size of the vulnerable area and/or the population at risk around the facility depends on the hazards within the plant, the topography of the surrounding area, etc.

2.3.2 Proximity to area type

- Drinking-water sources including underground and surface waters
- Natural reserves
- Fishing and recreational areas
- Political boundaries, e.g., state, provincial, international
- Others

2.3.3 Climatic factors and natural disasters that may affect the hazard

See section 2.1.4 (b)

2.3.4 Population at risk

2.3.4.1 Factors

- Location of buildings and other facilities used by people, relative to hazard sources
- Number of people likely to be present in a building or locality (this may vary with time of day)
- Length of time, and time of day, that any individual is present (e.g., resident, transient, etc.)
- Ease of evacuation
- Vulnerability of people to the particular hazard
- Effect of building structure (e.g., degree of protection against the hazard)

2.3.4.2 Categories of population

- Residential, e.g., housing, hotels, holiday accommodation
- Institutions, e.g., schools, hospitals, old people's homes, prisons
- Workplaces, e.g., factories, offices, agriculture
- Commercial, e.g., shops, supermarkets, local markets

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[a] *A population "at risk" consists of people who could be present at the time of the accident within the vulnerable area.*

- Leisure, e.g., sports facilities, theatres, cinemas, museums, marinas, parks
- Others

2.4 Emergency Response and Planning

This concerns the capability at the local, regional, and national levels of government to provide medical care and evacuation for inhabitants in the event of an emergency.

2.4.1 Human resources and facilities to cope with emergencies

- Specialized emergency personnel
- Fire-fighting facilities
- Police
- Emergency medical facilities
- Evacuation capabilities
- Poison control centres
- Means to contain and remove released chemicals (e.g., boom, skimming apparatus, solvent, etc.)
- Emergency public alert system
- Mutual aid among companies
- Rapid evacuation of the injured
- Timely evacuation of the general population at risk

2.4.2 Contingency plan

- Cooperative planning involving facility management, police, fire emergency, and medical units, together with arrangements for training, practices, and informing the public
- Assessment of potential emergency events
- Information for the public on recommended immediate action
- Designation of emergency co-ordinator within the facility
- Official outside the facility in command of emergency operations
- Modes of transport for the movement of large numbers of people
- Arrangements for back-up assistance from other towns if local emergency facilities are overwhelmed

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