1 INTRODUCTION

1.1 The Scope of the Handbook

This Handbook is part of UNEP's Awareness and Preparedness for Emergencies at Local Level (APELL) programme.
APELL deals with technical and industrial accidents.
The programme is designed to promote local co-operative action in order to create and/or increase community awareness of hazards that are potential threats to people, property and the environment; and to create and/or improve emergency preparedness.

In the APELL-Handbook you will find on Pp.33-41 a ten-step approach to the process of planning for emergency preparedness at local level.

This Handbook deals with and expands STEP 2 of the APELL process:
" Evaluate the risks and hazards which may result in emergency situations in the community".

It deals with hazard identification, evaluation and ranking of risk objects, in relation to potential technical and industrial accidents in a local community It provides a method for carrying out this work.

The aims are to show how risk objects can be identified, evaluated and ranked by a basic "rough-analysis" method and to encourage an increased risk-consiousness and environmental awareness as development takes place in the community.

Accordingly, the accidents considered here are events such as : large fires, explosions, leakages of substances which are poisonous or harmful to the environment, and natural disasters which could cause industrial accidents, such as landslides or floods.
This Handbook does not go into the risks associated with long-term climatic conditions or with the various leakages of hazardous substances from "normal" production in industry (otherwise known as "normal operational emissions").
Its scope also excludes nuclear accidents and those of a strictly military nature.

Although the Handbook is concerned with industrial accidents and accidents with industry-related activities, the method presented can also be used for other types of accidents.

The Handbook is not intended to give examples of every kind of accident that could possibly occur.

It does not give detailed information on various substances and their possible accident risks and effects on-site or off-site. This type of information can be obtained from computerised databases, other handbooks (see references), etc.

What the Handbook does do is to give you a "toolbox" with which to get started on the work of analysing potential hazards to get an overview of the most serious threats to people, property and the environment in the area, in order to improve safety measures, allocate resources, etc.

It gives you the basics for hazard analysis. Various "tools" can be selected which are suitable for specific local conditions. They can be replaced or complemented by better ones when these become available, as a result of future studies or of increased hazard analysis know-how within the local community.

Some other risk analysis methods used by industry and other bodies are presented in Annex 3.7. They are outside the scope of this Handbook. However they could be of interest if and when you would like to go more deeply into Hazard Analysis.

The Handbook is intended for people from industry, the fire and rescue services, environmental protection and health authorities and others, who have only limited experience of working in risk-related areas.

"The heart of this process is a Co-ordinating Group of local authorities, community leaders, industry managers, and other interested persons."
(APELL Handbook, Introduction, P.11.)

This Handbook has been designed to help these people answer the following questions:

- Where are the risk objects and hazards in our community?
- How do we define the hazards?
- How do we evaluate the hazards and the risk zones, as against the threatened objects?
- How do we rank the risk objects?
- How could the result of the analysis be presented to serve as a basis for the next steps of the APELL process?

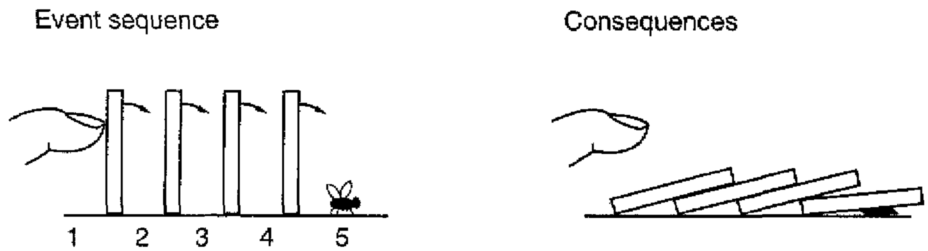
Later steps in the APELL procedure involve incorporating the results of hazard analysis into the overall emergency planning process. Emergency planning includes: developing appropriate warning systems; providing for personal protection (in-place protection or evacuation); developing procedures for fire-fighters and other responders; being familiar with the health effects of chemicals, and providing for safe control and cleaning of the release or spill (Detailed information about emergency planning is to be found in the US National Response Team's "Hazardous Materials Emergency Planning Guide" - see Annex 3.8.)

1.2 Some definitions

This section outlines certain terms used in the Handbook which are of importance for hazard identification and evaluation.

Accident - an unintended and unexpected event, occurring suddenly and causing damage to people, property or the environment.

Accident event sequence - a series of interdependent events leading to an accident.



Consequences - the results of an accident, expressed in quantitative or qualitative terms

Dimensioned damage estimate - an estimate of the level of damage which can be expected from a hazard in a certain kind of accident. The worst case event is often considered so improbable that a smaller and more probable event is chosen as the basis for hazard evaluation and decisions on safety measures. For example, large storage tanks are designed so that it is very unlikely that all the contents would escape in the event of an accident. A leak from a pipe or valve is considered a more likely event and this is therefore chosen as the dimensioned damage estimate, for classification of the risk object, preparation of response plans, etc

Disaster - is here taken from a local viewpoint to mean several deaths and tens of severely injured survivors, damage to property to a value of several million US dollars or long-term damage to the environment.

External events - e g lightning, extremely unusual weather conditions, earthquake, flooding, landslide

Good practice - means following all the laws and regulations , as well as applying the standards, methods and routines which, over the years, have been shown to be the best.

Hazard - a threat which could cause an accident (alternatively, risk source).

Incident - the result of a chain of events which could have led to an accident if it had not been halted (a "near miss").

Initiating event - the first step in a chain of events leading to an accident.

Knock-on effect - a consequence resulting inevitably but indirectly from another event or circumstance.

Malfunction - a deviation from the expected functioning of a system.

Maloperation - a deviation from the expected behaviour of an operating system. This can be caused by a lack of understanding, stress, badly designed systems, misinterpretation of information or negligence.

Probability - expected scale of events (accidents) within a certain period of time.

Risk - is here taken to mean the probability of an accident occurring within a certain time, together with the consequences for people, property and the environment.

Risk analysis - is the systematic identification and evaluation of risk objects and hazards.

Risk management - covers all work related to risk, i.e. administration, insurance, inventories, valuations, inspections, etc.

Risk object - an industry, warehouse, railway yard, etc., containing a hazard or risk source. N.B. There may be various risk sources within any one risk object.

Risk source - see "Hazard"

Risk zone - the area surrounding a risk object which could be affected by an accident there.

Safety survey - a detailed investigation and risk analysis of a system. Various courses of events are studied to show the effects of efforts to reduce risk levels by taking different preventive measures.

Safety zone - an estimate of the distance required between a risk object and surrounding threatened objects.

Threatened object - people, environmental objects or property which are at risk from an accident due to a risk object in the vicinity.

Worst case - the possible event with the worst consequences. There are three types of "worst case":

1. the consequences are so limited that the risk is unimportant, whatever the probability of the event;

2. the consequences are so serious that the probability of the event must be very small if there is to be a tolerable level of risk. In extreme cases the lack of effective safety measures makes the risk intolerable;

3. the worst possible consequences are irrelevant since the probability is so low that the risk is negligible. However, when this kind of judgement is being made, the effects of sabotage and terrorism should be considered. This may mean that type 2 is chosen.

1.3 Dealing with Risks

From a historical perspective, people have always been involved in risk management. If we go back in time, we can find a quotation from Pindaros, the Greek poet (518-442 BC), which is just as applicable today:

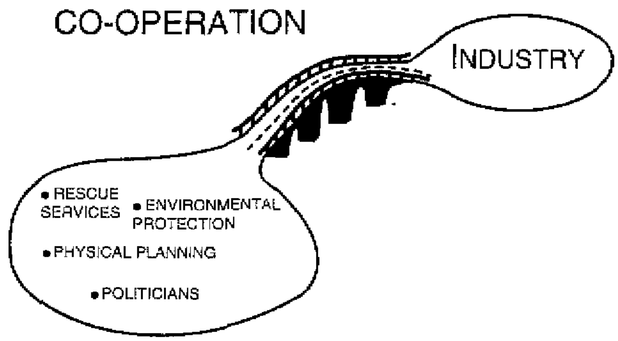
"Blind are the thoughts we cast to the future. Against all the odds, innumerable things will happen"

There is no such thing as zero risk. Nothing can be made100% safe - whether we mean packaging, equipment, routines, vehicles or installations. In addition, terrorism or sabotage could lead to an accident which would be unexpected, such as a dam collapse, multiple fires or simultaneous explosions. Society is becoming ever more vulnerable. We can no longer use trial and error methods to direct the shape society takes in the future.

The authorities responsible for environmental protection, health and town planning should know more about the hazards present in the area and the circumstances which could lead to a disaster.

Industry must know its products and the hazards associated with them which could lead to accidents. It should freely communicate adequate information to fire and rescue services, the public and others.

In many places both community and industry are aware of the need to predict and prevent accidents. Unfortunately, all too often they work independently of each other! Often their individual efforts could be enhanced by co-operation.



It is necessary for maximum benefits and effectiveness to cooperate, agreeing on what threats are present and what the relevant responses should be. An earthquake does not respect political or administrative boundaries, a barbed wire fence round a chemical plant cannot contain a cloud of toxic gas.
Resources, including trained people, should be organised and deployed where they will have the greatest effect.
Co-operation at the local level is very essential and should lead to co-ordinated, effective and economically practical risk management, influencing both existing hazards and the shape society takes in the future.
Systematic work to identify, evaluate and rank various risk objects will make the threats more visible. It will therefore assist in making judgements (as shown in steps 3-10 of the APELL process) on what preventive measures etc. will be most effective to protect people, property and the environment according to their vulnerability.

There are two aspects of the term "risk"here:
- the probability of an accident occurring within a certain time;
- the consequences for people, property and the environment.

Hazard analysis is an attempt to weigh the consequences of an accident against the probability of the accident occurring. The probability and consequences can rarely be calculated with mathematical precision. However, they can often be estimated with sufficient accuracy to provide the basis for practical measures to counter the risks
The probability of an accident occurring and causing damage is reduced if the danger is recognized by all those affected and the cause and effects of the event are understood. Studies of consequences of combined effects are also very important (eg fires causing poisonous gas, explosions causing leakages of poisonous substances,etc).

Developments in society are resulting in factories and housing areas being located nearer to each other. At the same time the transport of inflammable, explosive and environmentally hazardous chemicals is increasing. The demands for improved efficiency and increased capacity often lead to more sophisticated equipment and more dangerous processes being used in industry This implies that the need for an effective way of handling risks is growing within both industry itself and society in general.

The people responsible for making decisions in industries where the greatest risks of major accidents exist must recognize the need for effective handling of these risks.

There are several reasons for this. For example:

- the health and safety of employees and those living near the factory;
- the avoidance of damage to property and the environment;
- industry's need for good relations with the authorities and the general public, if it is to develop in a positive way;
- the need for uninterrupted production, in order to maintain reliable delivery and good customer relations,
- the cost of damage to its own factory, as well as those located nearby, which could jeopardize the survival of the company.

An accident can also affect the general public's attitude towards industry. The pressure of public opinion can force a company to close down. It is not enough for a company to rely on insurance payments as its only way to cope with hazards!

The management of these hazards to prevent accidents is therefore needed within industry, with the involvement of local authorities. This work should cover both practical and administrative matters, as well as management routines.
Efforts to prevent accidents demand full commitment and substantial resources, especially in "high risk" industries. Smaller companies, suppliers etc. may need to draw on assistance from larger companies. All the same, accidents can never be eliminated completely, however great the efforts to prevent them. A well trained and equipped rescue service, on-site and off-site, will always be required.

In working with hazard analysis, as well as communicating the results of the analysis, we must realise that people feel very anxious about a variety of threats to life, health, property and the environment. This anxiety is rarely based objectivly on the risks involved. As far as probability and consequences are concerned, some of the most serious sources of risk are travelling by car, smoking and drinking alcohol. However these risks do not cause much anxiety. This could be due to the fact that an individual has the ability to take in the significance of these risks, and experiences them in everyday life. In addition, the way a particular risk is judged is often affected by the opportunity an individual has to avoid exposing himself to it.

Car accident on the Boulevard Périphérique, Paris, April 1989.
Photo : Direction de la Sécurité et de la Circulation Routière.

It is vital that people are aware of the hazards to which they are exposed. They must know where the hazards are that could injure them and what the situation is really like there, if they are to know how to protect themselves Newspaper headlines concentrate on the sensational aspects of a story, giving less space to objective descriptions of an accident.

In the back of most people's minds there is a misplaced optimism that "an accident cannot happen to me" This is particularly obvious in relation to road accidents. The statistics are shocking In the last 30 years 5 1/2 million people have been killed in the Western world (including Japan). 230 million have been injured, a quarter of them seriously. Why aren't day-to-day road accidents regarded with the same degree of interest as (for example) chemical accidents? This is perhaps partly due to the fact that we are used to hearing about road accidents and we choose to expose ourselves to the risk.

The risks which people expose themselves by choice, in connection with activities such as rock-climbing, skiing, sailing, driving a car and cycling, are many times higher than the risks associated with nuclear accidents, large chemical leakages, fires and the like. (As far as the individual himself is concerned, the consequences of either kind of risk could be disastrous). The latter kind of accident is however viewed with much greater anxiety by the majority of people; an anxiety which is often based on a very imprecise knowledge of the probabilities, causes and effects of these accidents It is therefore most important to achieve a more accurate perception of actual threats.

When considering accident risk and ranking risk objects it is necessary to make comparisons in the knowledge that risk analysis is dealing with uncertainties. The greatest difficulty is in evaluating and comparing very small probabilities. Statistics can be useful when ranking risk-objects but the collective experience of the Co-ordinating Group is most important.

The problem with statistics is that they show what has happened, not when the next accident will take place Conditions vary greatly from case to case. An estimate of probability is, by definition, not the same thing as a firm prediction.

But we can use statistics to make comparisons, show trends and estimate the effects of preventive measures. The statistics must be up to date and consistent It is important that every country and local authority keeps its own collection of statistics, in order to be able to follow developments and gain understanding of these matters.

Both probability and consequences must be considered when drawing conclusions from comparisons. It is common to concentrate on the risks with the greatest consequences. When attempting to reduce risk levels systematically, however, it may be necessary to weigh an event with low probability but serious consequences against one which is more likely but causes less damage.

1.4 Benefits of Hazard Identification and Evaluation

Dialogue and co-operation between different authorities in a community, together with industry, is very important when evaluating threats, looking at the possibilities of reducing them and allocating responsibilities and resources

The analysis should also be followed up by preventive measures of various kinds. These will always be required, together with an effective emergency response system, since society can never be made completely risk-free. The knowledge and experience that communities gain from the analysis should be taken into account in work on:

- emergency planning
- choice of routes for the transport of dangerous goods
- information and warning systems
- civil defence
- physical planning
- environmental protection, etc

The Handbook contains several examples of accidents arising from planning decisions that were questionable from the risk standpoint. For example, residential areas have been built or extended around dangerous industrial plants, airports etc . Planning permission has been given for houses or factories on land liable to landslide or flooding New hospitals have been located beside dangerous industries New houses have been built near large petrochemical stores, etc.

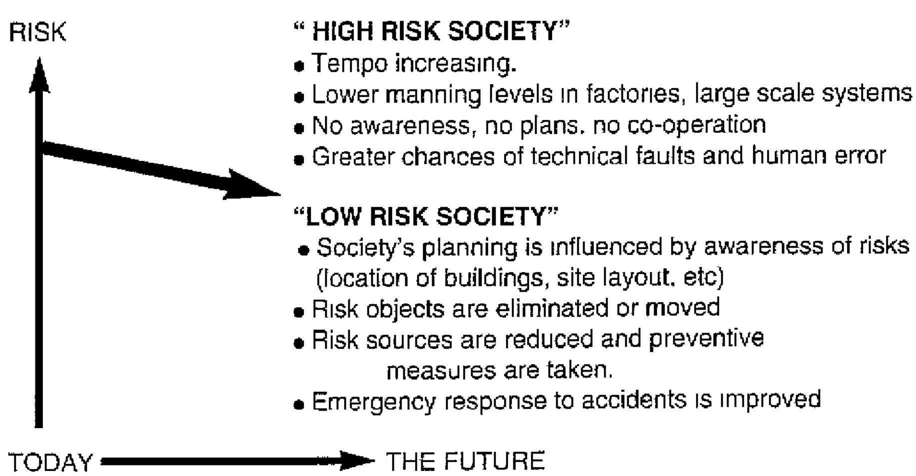
Chances of achieving a greater degree of risk-consciousness as society develops are improved by increased co-operation between the local authority's planning and executive bodies.

Co-operation is required not only within the community (industries included) but also between communities; so that each may produce its own co-ordinated picture of risks, and thereby improve risk-consciousness, in order to develop or to review its emergency plans etc. Several communities can share the same risk object - the effects of an accident there can reach across boundaries.

The community should judge which hazards can be reduced, or risk objects made safer, by moving people or industry to another location, and should decide whether this can be done in the short or long term. It is very expensive to move an industrial site once it has been built. It is therefore desirable that a risk object should be built in as safe a location as possible. When this has been done, a hospital, school or residential area should not be built next to it.

When considering hazards in society it is also wise to look at industrial and technological developments expected in the future.
"Progress" and "the future" are often considered only as an extension of what has happened in the past. Prediction of other possible scenarios and making plans for these are just as important for effective risk management. All forecasts soon become out-of-date. They must be reviewed regularly if they are to serve their purpose.

The experience, information and results obtained from hazard identification and evaluation can influence the shape society will take in the future.



1.5 How to Use the Handbook

APELL Step 1:

"Identify participants in the Co-ordinating group and establish communications".

APELL Step 2:

"Evaluate the risks and hazards which may result in emergency situations in the community"

In what follows, you will find an overview of the second step of the APELL process and a guide to this Handbook.

HAZARD IDENTIFICATION, EVALUATION AND RANKING: STAGES

WHERE are the risk objects and the hazards?

(Examples, see chapter 2, figure 2:2)

The risk objects and hazards can be found in
- industry
- terminals
- supplies
- transport lines
- public facilities (e.g. schools and hospitals), etc.

The local authorities and industries are the responsible actors here. Interaction between them and sharing the same perception of the risk objects and hazards are very important

DEFINE the hazards (Examples, see chapter 2, figures 2.1-2.4 and annexes 3 1-3.6)

Figure 2 1
COMMUNITY
OBJECT/AREA ......

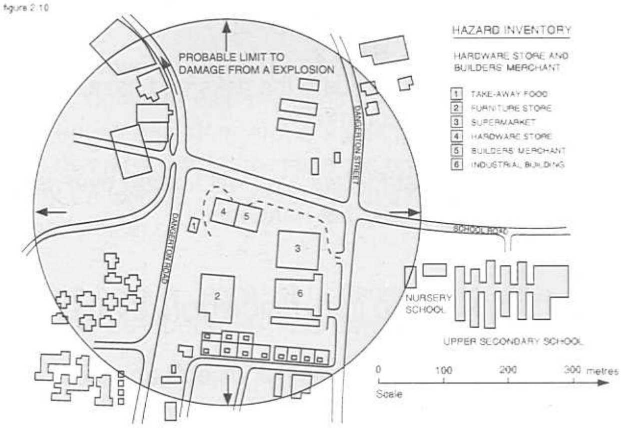
L = Life S = Speed
E = Environment Pb = Probability
P = Property Pr = Priority

1 Object	2 Operation	3 Hazard (quantity)	4 Risk-type	5 Threatened object	6 Consequences	7-10 Seriousness				Pb	Pr	Comments
						L	E	P	S			

The types of hazard present must be defined. These could be toxic, flammable, reactive, explosive, natural or a combination of several hazards.
It is also important to know the quantities of the products (See also information in the references, e.g. "Guide to hazardous industrial activities", Netherlands, 1988.)
INDUSTRY should know its products and give information about them freely to the community

EVALUATE the hazards and risk zones (on-site and off-site) in relation to the threatened objects. Information stored in computer programs or in other Handbooks (see references) may be needed here.
(Examples, see section 2, figures 2:1 -2.5 plus the examples in figures 2.9-2.15 and annexes 3.1-3.5)

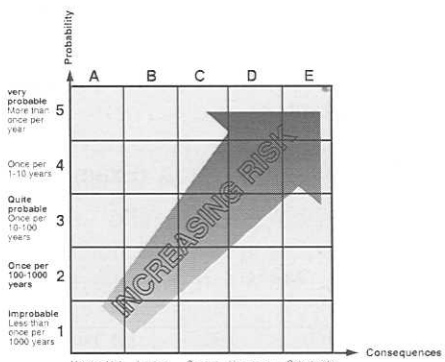
figure 2.10



The interaction between INDUSTRY and the COMMUNITY is also very important here.
At a later stage experts and computer codes could be useful.

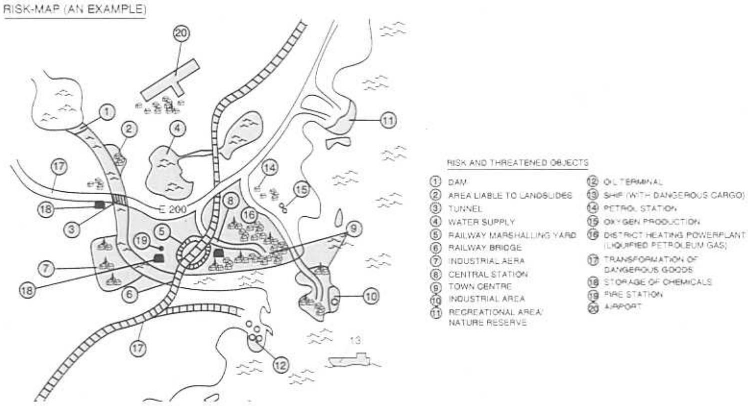
RANK the risk objects
(Examples, see risk matrix in figure 2.6 and the comments.)

RISK MATRIX



The Co-ordinating group should rank the risk objects, for purposes of resource allocation and of reviewing and/or developing rescue plans, tactics, etc.
The presentation of the results could be done using a map as shown in figure 2.8.

RISK-MAP (AN EXAMPLE)



COMMUNICATE the results of the analysis and the ranking, both within industry and in the community.