

# **PREVENTION OF MAJOR INDUSTRIAL ACCIDENTS IN THE EUROPEAN COMMUNITY**

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**I. Foreword**

History

It was not the recent accidents in the chemicals industry in Bhopal, Mexico City or Basle which made us aware of the risks associated with chemicals. The realisation that chemical substances are dangerous is as old as the chemical industry itself. The very first people to realise this were the employees who suffered directly from them. Chemical works destroyed by explosion, release of poisonous gas and, last but not least, occupational illnesses caused by the chemicals themselves have cost tens of thousands of workers their health or even their life.

It is not surprising then that from the very beginning of the industrial era accidents were always seen as a source of knowledge to be used to avoid new accidents. Technical measures to avoid accidents were continually developed. The philosophy was based on the popular saying "You learn from your mistakes".

This happened at the beginning of the technological age as a result of chance events, i.e. those accidents which it was impossible to predict. Soon people realised however that learning from these accidents provided only very limited knowledge about the causes of accidents and how to avoid them. It became necessary to carry out systematic research. The key word for this stage of development of technology was the principle of trial and error. It did in fact serve the cause of safety research very well but reaches the limits of its usefulness in cases where the damage caused in the case of error are

not acceptable. What kind of damage can be accepted in the case of an accident and what kind cannot is a question of the values of society which have in turn changed over the years. They are expressed in the form of protection aims. The following factors must be taken into consideration when thinking about this:

- With growing industrialisation society's values concerning human life, health and an unpolluted environment rise.
- The tendency towards increasingly larger production units which goes hand in hand with industrialisation increases the potential damage which can arise in the case of a serious accident.

The consequence of this rise in values on the one hand and the increased potential for damage on the other is that the trial and error principle can no longer be used in the stage of development we are now in.

Serious accidents resulting in what we believe are catastrophic effects on the environment can no longer be accepted under a truly responsible policy. They have to be avoided at source.

What possibilities do we have for doing this?

In order to solve this problem we have to look at the history of accidents and the nature of major accidents.

#### The history of accidents

A look at the history of accidents reveals an almost exponential increase in the absolute number (cf. figure 1). The prime reason for this is the world-wide growth of industrial activity. If one analyses the data available on the nature of accidents it can be seen that



minor accidents (one death) and major accidents (several deaths) have not increased at the same rate. In the period between 1950 and 1978 an increase in the number of deaths per accident could be noted /1/ (cf. figure 2). The number of minor accidents (e.g. to workers) dropped in the same period.

What conclusions can be drawn from these trends?

- The hazard potential of industrial installations has increased;
- The preventive measures introduced in the field of worker protection have had a positive influence on the way minor accidents are dealt with;
- Minor and major accidents do not have the same causes;
- Preventive measures taken to avoid minor accidents are not adequate to prevent major accidents.

It was, in fact, possible to establish on the basis of an analysis of major accidents that they were mostly what are known as systematic accidents. This means that, often as a result of minor defects, a chain of events is triggered off which leads to a major accident. This is only possible because as a rule an industrial installation is a system of complex interlinked elements. (A precise analysis of these interconnections is described elsewhere and can only be indicated here /2/).

The consequence:

In order to avoid this kind of systematic accident a similarly systematic examination of the individual system is required.



Furthermore we have gradually come to realise that the high potential danger from industrial installations can best be countered by safety systems which comprise several stages within a hierarchical structure.

A safety system of this kind can be briefly described as having the following characteristics: (For details see /3/: (Figure 3)).

Stage 1 comprises all measures within in the installation which ensure the safe containment of dangerous substances and the prevention of impermissible operating conditions;

Stage 2 includes the on-site measures which in the case of an accident limit the effects of the release of dangerous substances, of a fire or an explosion;

Stage 3 consists of measures which are taken in the vicinity of an installation in order to limit the effects of harmful substances, heat radiation or an explosion (blast wave, flying debris) on the objects to be protected.

The logistics of the system are such that a hazard to the vicinity of an installation can only arise if all the safety stages fail in the course of a major accident. The laws of probability make simultaneous failure of this kind very unlikely. This is particularly true in cases where the systems used in the different safety stages function independently of one another.

In the course of a major accident, failure of the technical safety measures on site as a result of common causes cannot always be excluded. In other words both the measures intended to prevent a major accident (stage 1) and those designed to limit the effects of a major accident (stage 2) could fail. Stage 3 measures should however be viewed independently of any specific

accident, since the organisation of emergency plans which is the crucial element of stage 3 are based on resources outside the installation in question. A 3-tier safety system of this kind is based on the EEC Directive.

## **II Precautions to prevent major accidents in the European Community**

### Overview

In 1982 the "Directive on the major-accident hazards of certain industrial activities" (82/501/EEC) was adopted by the EEC commission /4/. Its purpose is to improve the protection of the immediate vicinity of an industrial installation and the environment in general from the consequences of a major accident. A major accident is defined as follows:

"An occurrence such as a major emission, fire or explosion resulting from uncontrolled developments in the course of an industrial activity, leading to a serious danger to man, immediate or delayed, inside or outside the establishment, and/or to the environment, and involving one or more dangerous substances."

(Article 1).

The Directive contains stipulations which the Member states are required to incorporate into their national legislation. They concern:

- Laying down the scope of application
- Requirements to be placed upon the manufacturer:
  - To take measures to prevent accidents and to limit the consequences of an accident,

- to submit information to the competent authorities on the commencement of an industrial activity or the modification of existing activities,
  - to inform the authorities immediately in the event of a major accident.
- Requirements placed on the authorities:
- To examine and analyse the information provided by the manufacturer,
  - to monitor the activities,
  - to draw up emergency plans for the area around the installation,
  - to inform the public.
- Requirements placed on the Member States to co-operate in the event of major accidents (exchange know-how and information, provide help if necessary )

The Directive must be implemented by the Member States within five years. The national requirements may be more stringent than those set out by the Directive (the Directive represents a minimum standard, Article 17).

#### Scope of application

In order to cover only those industrial activities during which major accidents can occur, the scope of application of the Directive was limited by a list of industrial activities and a list of substances. This means that a particular activity is subject to the provisions of the Directive if: (Figure 4)

- the type of activity is listed in Annexes I or II of the Directive,



- chemical substances are handled which fulfil the criteria set out in Annex IV or are listed in Annexes II or III and
- are handled in specified minimum quantities.

The Directive does not apply to the following:  
(Article 2)

- Nuclear installations and plants for the processing of radioactive substances and material
- Military installations
- The manufacture and separate storage of explosives, gunpowder and munitions
- Extraction and other mining operations
- Installations for the disposal of toxic and dangerous waste which are covered by Community Acts in so far as the purpose of those Acts is the prevention of major accidents.

#### Progressive scale of safety requirements

The kind and scale of safety requirements placed upon the manufacturer and the monitoring of them by the competent authority depends on the potential hazard associated with the dangerous industrial activity. The quantity of dangerous substances handled in the installation is decisive in this.

#### 1st threshold (application of Articles 3 and 4)

If substances are handled in only small quantities the manufacturer simply has the general obligation to provide assurance that he has (Article 4):

- established the dangers present,
- taken appropriate safety precautions,
- provided the employees with adequate information and training.

The competent authority is obliged to check this as part of the general legislation requiring the monitoring of industry (Articles 7, paragraph 2).

#### 2nd threshold (application of Article 5)

If the dangerous substances are handled in larger quantities (as defined in Annexes II and III), detailed requirements to be placed upon the manufacturer (in particular the preparation of a safety case) and more extensive requirements of the authorities to monitor and carry out checks on the installations (Articles 7,8) are defined.

The Directive also distinguishes between the use of dangerous substances during the actual manufacturing process and their (separate) storage. The threshold quantities at which the above mentioned obligations apply are in some cases considerably higher in the case of storage.

#### The safety case

The requirement that a safety case be prepared results from the realisation that major accidents as a rule result from a fault in the system and can therefore only be recognised and prevented by an analysis of the system in operation in the industrial installation. For this reason the safety case must include an analysis of all the possible dangers which could issue from an installation as well as a detailed description of the safety precautions taken to avoid a major accident and to limit the effects of such an accident. The safety case comprises therefore a comprehensive set of documentation on the safety of an installation taking into account the specific conditions of the site. A

safety case must therefore never present a general view but must always be based on the specific conditions of each individual case. In particular the safety case should contain details on:

- properties and quantities of the substances used,
- emergency measures to be taken if substances are accidentally released or if there is a fire or explosion (cf. Annex V),
- internal and external (i.e. caused by local conditions) sources of hazard which could cause a major accident,
- description of the installation and in particular of the parts of it which affect safety,
- on-site emergency plans (for alerting and protecting the employees),
- information on emergency plans for the vicinity of the installation.

The safety case must be submitted to the authorities and be constantly updated (Articles 5,6).

The Directive applies both to existing industrial activities (existing plants) and to new activities. In the case of the latter the safety case has to be submitted to the authorities before commencement of the activity (Article 9).

#### Duties of the authorities

Article 7 of the Directive requires the Member States to set up an effective system for monitoring hazardous industrial activities. The specific duties of the authorities are to:



- receive the safety case;
- evaluate the safety precautions taken and decide whether they are appropriate for avoiding major accidents and limiting the consequences of such accidents;
- propose further safety precautions if necessary;
- carry out regular inspections of installations;
- ensure that emergency plans are drawn up for the area in the vicinity of an installation
- inform the public of the dangers and of the correct way to behave in the case of a major accident, such as evacuation (Article 8).

#### Notification and analysis of accidents

The Directive contains stipulations on the organisation of accident notification systems and on the subsequent analysis of accident reports to ensure improved understanding of the subject. Manufacturers are obliged to report major accidents to the authorities without delay (Article 10) and at a later date to report on the circumstances of the accident, its causes and the measures taken to limit the consequences. The information is examined by the authorities and analysed in order to enable progress to be made in the field of safety technology. It has been agreed that the EEC Member States will participate in an exchange of information to this effect (Articles 11,12).

The EEC commission which is obliged to make periodic reports on major accidents within the Community (Article 18) is informed about the major accidents by way of an accident report form (Annex VI). The data is stored in a central data bank and analysed.

### III An evaluation of the Directive

The Directive has made an important contribution to the application of uniform criteria of risk management throughout the EEC. In June 1988 the last country to implement the Directive was Spain. In all there are approximately 1,800 sites within the EEC at which dangerous industrial activities are carried out. (Table 1) /5/.

Safety cases and emergency plans have to be drawn up for all of these installations. In a large number of cases this has not yet been done. One can assume that safety cases are available for all installations only in England, Holland, France and the Federal Republic of Germany. Shortcomings have to be expected with regard to emergency plans in these countries too.. (In the case of Greece, Spain and Portugal it must be taken into account that these countries did not join the EEC until after the Directive came into effect so that the deadlines have been extended accordingly.)

As well as the positive effect which the Directive has had on the harmonisation of risk management it must also be recognised that it has the character of a compromise in many points. This can be seen especially in:

- the vague wording of the requirements concerning the system analysis (safety case),
- the restricted scope of application,
- the restricted possibilities for international exchange of experience.

### Safety case

Only a general review of safety is required to be undertaken for the safety case (Article 5). It is left to a large degree to the states and in particular to their industry to decide upon the nature and scale of the safety review. When the Directive was drawn up it was not even possible to reach a consensus on the incorporation of a mandatory requirement for a general systems analysis. This meant that it lagged a long way behind the knowledge which had been gained even then from accident research.

The way this requirement as defined in Article 5 has been implemented in the individual Member States is therefore very diverse. In the Netherlands, for example, quantitative risk analyses are mandatory, whilst in France and the Federal Republic of Germany merely general descriptions of safety are accepted as being adequate.

Had the EEC made a clear cut requirement on this it would have been possible to avoid these disparities.

### Scope of application

It was in the fixing of the scope of application of the Directive that the most serious compromises were made. This is particularly true with regard to the establishing of the quantity thresholds which define whether certain industrial activities are subject to the Directive.

The values for the quantity thresholds in Annexes II and III are often the result of a negotiated compromise and have little to do with the actual hazard potential of the substances. Table 2 shows some values for



comparison. When quantity threshold A was fixed (cf. the German Regulation on Major-Accident Hazards, "Störfallverordnung" /6/) standard scenarios were used whereby given the conditions of release, the dispersion and the effects of the substances, no harm would be caused to human beings at a distance of 100 m from the installation.

(The determination of quantity thresholds using scenarios is tainted with a number of systematic mistakes. It provides moreover no absolute safety but only gives realistic orders of magnitude concerning the actual potential hazard. For details cf. /7/.)

As far as the qualitative selection of substances for Annexes II and III of the Directive is concerned, it should also be noted that a number of substances with similar properties were not included. After the accident in Basle in 1985, where a large chemical storage tank caught fire and extensive stretches of the Rhine were polluted /8/, considerable additions were made to the substances lists to include:

- pesticides,
- water-polluting substances,
- carcinogenic substances,
- caustic and irritant substances.

In all some 320 substances/classes of substance (a total of approximately 500 individual substances) are subject to the German regulations. The EEC list contains at present 180 substances/classes of substance /6/.

Time will tell whether the newly included substances, in particular the water pollutants which were included for environmental reasons, will be incorporated into the Directive which is at present being amended.

### Exchange of experience

It must be admitted that the confidentiality stipulations, some of which are at present very restrictive, have an extremely inhibiting effect on the exchange of information about accidents and their causes /9/. Manufacturers, and to some extent the authorities, tend to not pass on information which would be very important for the progress of safety technology, because the information is classified as a trade secret. This interpretation is based on national regulations on preservation of confidentiality which exists in a comparable form in virtually all the EEC States. A solution to the problem cannot at present be envisaged.

### **IV Summary and conclusion**

The development of complex forms of industrial production has led to new kinds of dangers for man and the environment. This necessitates special measures in the field of risk management. In order to prevent major accidents and to limit the consequences of such accidents, the "Seveso Directive" was adopted in the European Community in 1982.

By 1988 the provisions of the Directive had been incorporated into the national legislation of all the Member States. This has helped to harmonise risk management and the exchange of experience throughout the EEC. At present, dangerous industrial activities are being carried out at some 1,800 sites in the EEC.

The Directive has proved its worth in its basic philosophy but needs revising in terms of the requirements for systems analysis, the extension of the scope of application and the improvement of communication between states.

As far as the scope of application is concerned, the Regulation on Major Accident Hazards in force in the Federal Republic of Germany must be considered to be exemplary.

The basic philosophy of the Directive is suitable for setting up an effective risk management system in other countries or groups of countries.



## Bibliography

- /1/ Carson, P.A., Mumford, J.Haz.Mat. (3) p 160 (1979)
- /2/ Perrow, C. Normale Katastrophen, Campus Verlag Frankfurt/New York, 1987
- /3/ Uth, H.J. Ist Bhopal in der BRD möglich?, Sicher ist Sicher 37 (6), p. 298-306 (1986)
- /4/ Richtlinie des Rates über die Gefahren schwerer Unfälle bei bestimmten Industrietätigkeiten (82/501/EWG) v. 24.Juni 1982, ABl. L 230/1 v. 5.8.82, zul. geändert durch (85/C 305/07) v. 4.Nov. 1985, ABl. C 305/9 v. 26.11.85.
- /5/ Bericht über die Anwendung der Richtlinie 82/501/EWG v. 24.Juni 1982 in den Mitgliedsstaaten, KOM (88) 261 endg. Kommission der europäischen Gemeinschaften v. 18. Mai 1988
- /6/ Bekanntmachung der Neufassung der 12. Verordnung zur Durchführung des BImSchG (Störfall-Verordnung) v. 19. Mai 1988, BGBl. Teil I, S. 625, 1988  
  
1. Allgemeine Verwaltungsvorschrift zur Störfall- Verordnung vom 26. August 1988, BGBl. Teil I, S. 397, 1988
- /7/ KTI GmbH, Erarbeitung von Mengenschwellen für Stoffe nach Anhang II der Störfallverordnung Nr. 104 09 108/02, 1988, Kiel
- /8/ Bundesminister für Umwelt, Naturschutz und Reaktorsicherheit (Hg) Rhein-Bericht, Umwelt-Briefe Nr.34, 12.Feb. 1987
- /9/ Uth, H.J. Probleme bei Sicherheitsanalysen, gwf-gas/erdgas (127 (6), p. 229-236 (1986)

Table 1 Number of sites which fall under the stipulations of Article 5 of the Directive (5)

Number of sites which fall under the stipulations of Article 5			
Member State	As defined in Annexes I and III	As defined in Annex II (isolated storage)	Total
Belgium	68	25	93
Denmark	53	15	68
Spain			300
France	303	19	322
Greece			10
Ireland	45	5	50
Italy	284	67	351
Luxembourg	0	3	3
Netherlands	43	22	65
Portugal	22	11	33
Federal Republic of Germany	195	88	283
United Kingdom	200	83	283
Total			1861

Sources: (1) The inventory submitted to the Commission by the competent national authority  
 (2) Estimate by the competent authority  
 (3) Estimate by the Commission's advisors

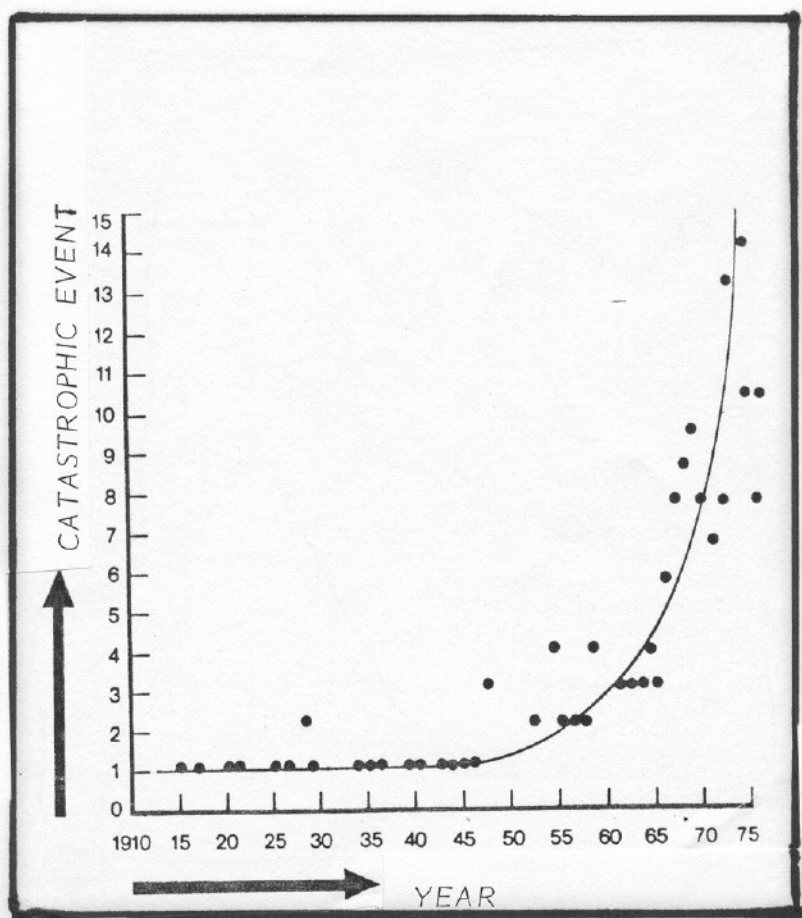
Note: The figures in this table refer to the number of sites. In some Member States the number of notifications exceeds the number of sites as one site can comprise several industrial activities which are subject to the provisions of Article 5.

Table 2 Comparison of some of the threshold limits set by the EC Directive /4/ and the German regulation on major accidents /6/

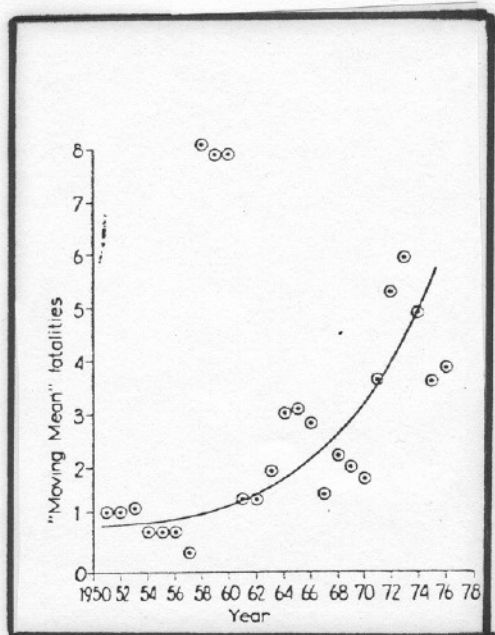
Substance	Amount in (kg)	
	Threshold A * (German regulation)	Threshold Annex III (EC Directive)
Dibromomethane	100	50 000
Acrylonitrile	10	200 000
Ethyleneimine	10	50 000
Bromine	10	200 000
Nitrogen oxide		
Nitrogen dioxide	10	50 000
Ammonia	5000	500 000
Hydrogen sulphide	10	50 000
Hydrogen chloride	200	250 000
(liq. gas)		
Phosgene	10	1 000

\* Threshold A is set so that no harmful effects can occur for man at a distance of 100 metres from the point of release.

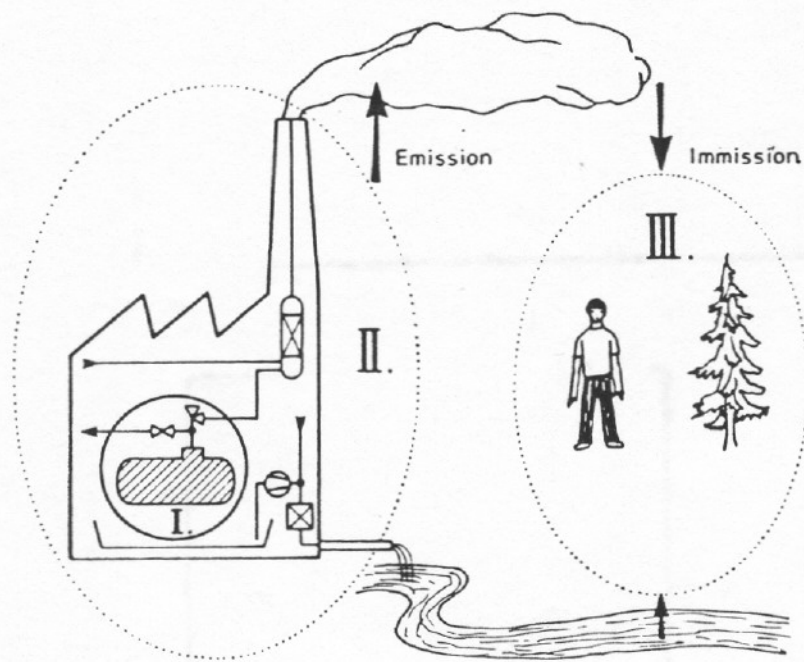




PICTURE 1 DEVELOPMENT OF CATASTROPIC EVENTS /1/

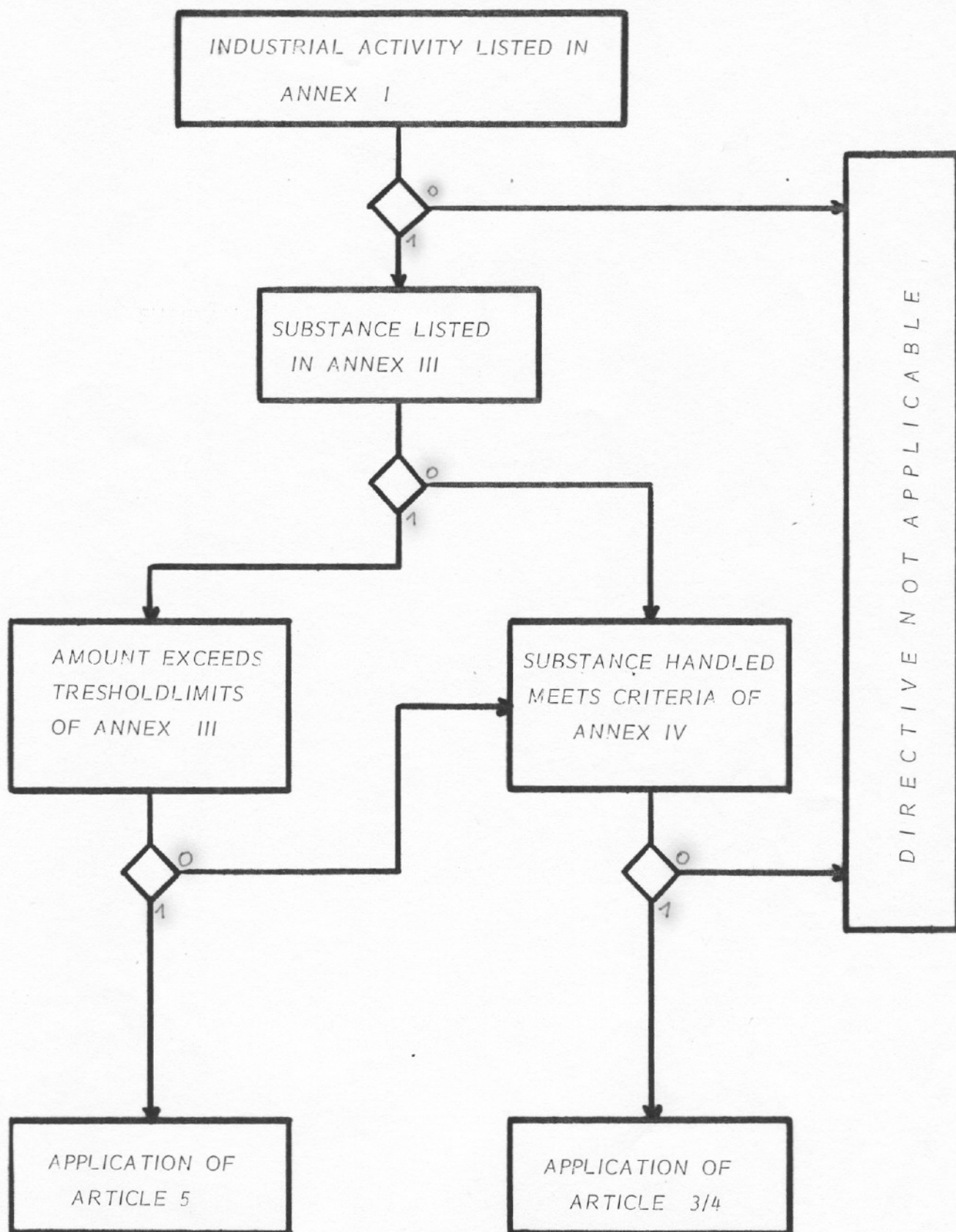


PICTURE 2 DEVELOPMENT OF THE AVERAGE NUMBER OF FATALITIES PER EVENT /1/



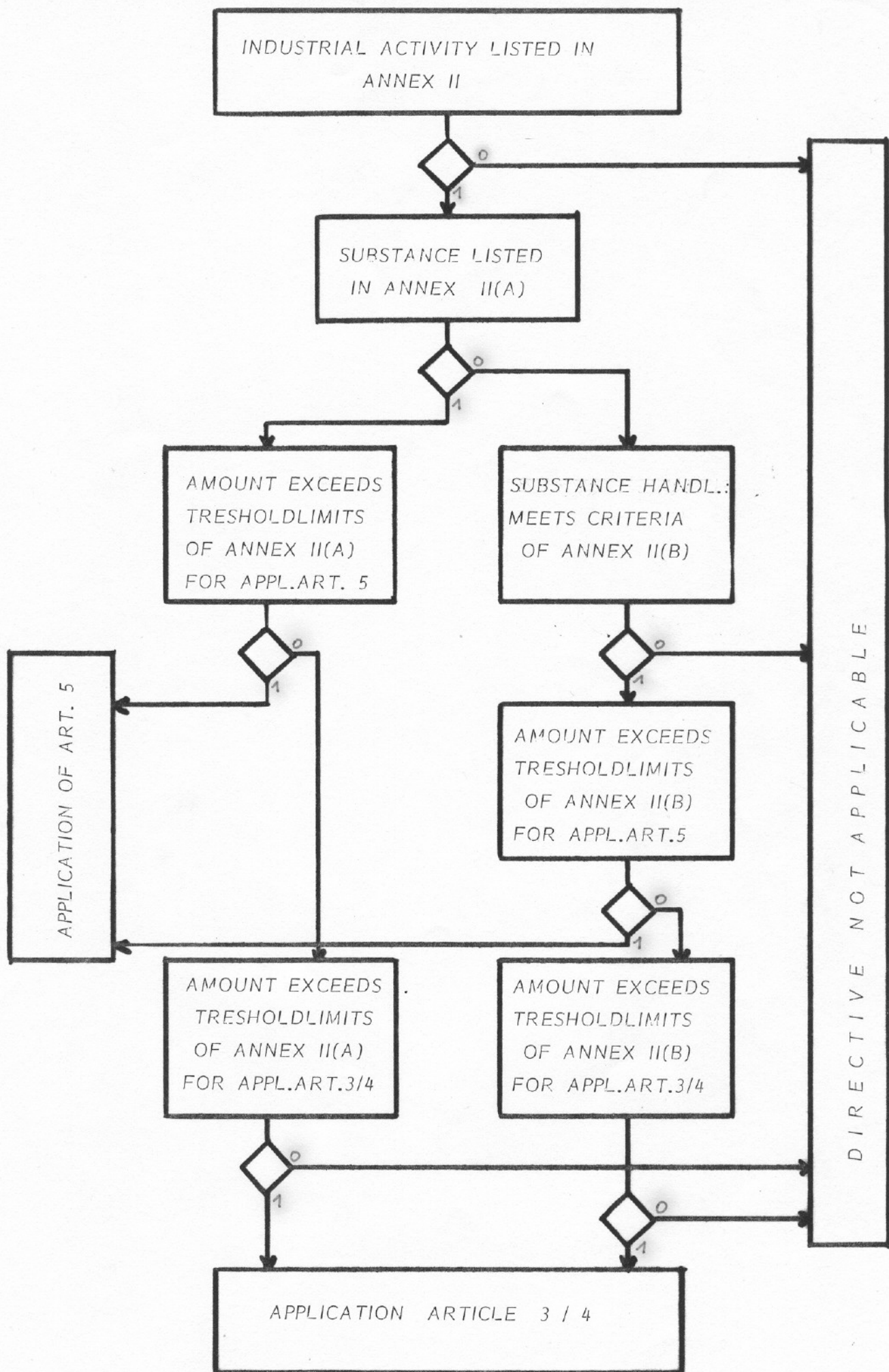
Spezifikation	Step
Safe enclosure of inventory	I
Restriction of emission	II
Restriction of Immission	III

Picture 3 Sheme of the 3 step security system



PICTURE 4a APPLICATION OF THE DIRECTIVE FOR SUBSTANCES HANDLED IN PROCESS PLANTS





PICTURE 4b APPLICATION OF THE DIRECTIVE FOR ISOLATED STORAGE