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THE SAFETY REPORT LEGISLATION AND ITS APPLICATION IN THE NETHERLANDS

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Summary

In The Netherlands the health and safety of workers in industry is safeguarded by means of the Safety Act. Recently a paragraph has been added to this act, relating to the obligation to compile a Safety Report for potentially hazardous industrial installations. This applies to new installations as well as to existing ones. In this paper information is given on developments in society that have led to the enactment of this legislation, on the purpose of the Safety Report and its legal framework, on the system for designation and on the contents of the Safety Report and its evaluation. Obviously, only global information can be given in the context of this paper.

1. Introduction

By statute dated 23rd November 1977, a regulation concerning the compilation of a safety report was incorporated in the Safety Act of 1934. This regulation has been included in the Labour Conditions Act which will shortly replace the Safety Act. The obligation concerning the availability of a safety report will be applicable to categories of enterprises, establishments or parts thereof (installations) to be designated by ministerial order. In this categorial designation, installations in the chemical and petrochemical industries will be designated in the first instance.

In the following, the background and objective of the safety report regulation will be discussed. Attention will be given to the changing views in society in relation to the risks involved in large-scale industrial activities.

Furthermore, the legal framework of the safety report regulation and a few comparable international developments will be touched upon. In addition, more explicit information is given on the system for designation of industries for which a Safety Report is obligatory, and on the contents of the Report, including its evaluation.

2. Development of the chemical process industry

The past decade has witnessed a spectacular development of technology in

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general and chemical technology in particular. For a number of natural products, such as wool, cotton and rubber, synthetic substitutes have been found and introduced on a large scale. In some cases the substitutes have partly or wholly ousted the products of natural origin, because the available sources for these natural raw materials failed to meet the demand. In other cases the reason was that the properties of the synthetic products could be more closely controlled or better adjusted to the applications. Finally, a number of entirely new materials have been developed with characteristics that could previously not be realized.

Examples of such chemical products are: plastics, dyes, medicines, insecticides, fertilizers, fragrance and flavouring agents, detergents, lubricants and fuels.

The continuously growing demand for chemical products and the trend towards production at lower cost have given rise to the following developments:

- scaling-up of production installations;
- scaling-up of storage and transport facilities of raw materials, auxiliary materials and final products;
- more frequent use of dangerous substances;
- working under extreme and critical process conditions;
- increasing complexity of installations;
- integration and conglomeration of different processes.

3. Risks in the chemical process industry

The other side of the development described above is that the consequenses of unwanted events have substantially increased in volume, both from a social and an economic point of view. An unwanted event is interpreted here as a happening in which, through a certain cause, dangerous substances or energy escape from an installation and may present a serious threat to the health of a person in the vicinity of that installation, or may cause damage to a building, installation, etc., situated in that vicinity. Although the application of modern safety techniques can appreciably reduce the chance of occurrence of such unwanted events, there always remains a finite, if ever so small, chance of a calamity.

As far as safety is expressed in terms of probability of death per individual worker per annum, the petrochemical industry is one of the safest branches of industry [1]. Nevertheless the possibility of accidents with large consequences has — even though their probability is low — led to feelings of uneasiness within society with respect to the safety of large-scale industrial activities in general and the petrochemical industry in particular. These feelings are based on a sense of unsafeness experienced by society, which is also referred to as perceived risk, a sense that has also been enhanced by a number of dramatic events both at home and abroad.

A few salient examples are given in Table 1. These examples are limited to accidents in stationary installations. Transport and handling have not been taken into account.

TABLE 1

Examples of serious accidents in the (petro)chemical industry

Year	Place	Description of accident	Victims		Reference
			Dead	Wounded	
1944	Cleveland, U.S.A.	Fire and explosions, methane	128	200—400	[2]
1948	Ludwigshafen, Germany	Explosion of cloud of dimethyl ether	245	2500	[2]
1957	Dumas, U.S.A.	Explosion in gasoline storage tank	25	32	Newspaper
1966	Feyzin, France	Explosion of LPG storage tanks	18	81	[2]
1973	Potchefstroom, S. Africa	Escape of ammonia from storage tank	18	64	[2]
1974	Flixborough, U.K.	Explosion of cloud of cyclohexane	28	53	[2]
1975	Beek, Netherlands	Explosion of cloud of propane	14	107	[2]
1976	Seveso, Italy	Spread of TCDD after explosion of reactor	Unknown	250 people with skin disease	[2]
1977	Cartagena, Colombia	Escape of ammonia from chemical plant	30	22	[2]
1978	Santa Cruz, Mexico	Fire-ball of methane	52	Unknown	
1980	Badlagundu, India	Explosion in dynamite factory	40	50	Newspaper

Under the influence of the developments described, parliament decided upon an active accident-prevention policy towards the chemical industry.

A package of legislation and regulation was brought about in order to ensure that design, construction and operation of potentially dangerous installations are effected with utmost care.

Since the social margin for such large-scale events is becoming ever narrower, it is essential that foreseeable unwanted events are prevented in as far as possible by appropriate decisions and adequate provisions, using systematically performed safety studies as a basis.

4. Legal framework

The regulation concerning the safety report represents only a minor part of the total package of legislative rules and regulations serving to protect the life and health of the population. In The Netherlands there is an administrative separation between the legislation for the protection of people in their working environment (internal safety) and the legislation for the protection of people who are not related to the performance of labour (external safety). The latter includes the legislation for the protection of citizens against pollution of the environment and against hazards caused by industry.

Since the source of danger, i.e. the industrial installation, is the same for internal and external safety, it will be clear that co-ordination between all government authorities is essential. This co-ordination should prevent the imposition of conflicting requirements on the industry concerned by the government authorities involved, and should avoid the need for the industry to submit the same data to various government authorities. The safety report, which is sent to the government authorities concerned, can play a positive part here.

In some surrounding countries developments have taken place showing parallels with the Netherlands legislation with respect to the Safety Report. Notably, new or envisaged regulations in West Germany, the U.K. and in the frame of the EEC are worth mentioning in this context.

In West Germany the "Störfall-Verordnung" as part of the "Bundes Immissionsschutzgesetz" has been in force since 1980 and has the same tenor as the Netherlands Safety Report Regulation [3,4]. In the U.K. the Health and Safety at Work Act likewise shows significant parallels with the Netherlands regulation [5].

Finally, of paramount importance in this contect is the directive drawn up by the European Commission concerning the risk of calamities inherent in certain industrial activities: the Post-Seveso Directive [6]. This proposal, which was approved by the Environmental Council in December 1981, is in particular aimed at harmonization of the legislation in the various member states.

5. Purpose of the Safety Report Regulation

As appears from the explanatory memorandum to the legislation concerning the Safety Report, given by the Netherlands Minister of Social Affairs, the main object of the regulation is: the promotion of safety at work in enterprises, establishments or parts thereof, in which special risks can occur affecting the safety and health of workers in the event of irregularities in the process. The compilation of a Safety Report makes the entrepreneur more aware of the risks to which the workers in his industry are exposed and of his responsibility in this respect. In addition, the Report gives the Labour Inspection insight into the usually complex installation and the operating conditions, thus facilitating supervision.

When submitted to the works council, the Safety Report can play a stimulating part in the employer—workers relationship, which in turn may ultimately lead to an improvement in the safety level within the enterprise.

6. Designation of industrial installations for which a Safety Report must be drawn up

A Safety Report must be drawn up for installations where such quantities of dangerous substances are present that they may give rise to major accidents.

One of the main purposes of the drawing-up of a Safety Report is to give the Labour Inspectorate an insight into the nature and extent of the hazards caused by the installation concerned.

This implies that the designation to draw up a Safety Report cannot be based on quantitative risk studies or other procedures requiring detailed information about the installation. That information will only become available to the Labour Inspectorate after the designation.

The designation must therefore be based on simple data of a global nature, which can easily be collected and objectively ascertained. Specifically, the aspect of the probability of faults or accidents is not taken into consideration: the designation is based only on the size of possible accidents.

The data used in determining whether or not an installation is designated are:

- the quantity of dangerous substances present,
- the nature of these dangerous substances,
- the conditions under which these substances occur.

For each substance a threshold quantity has been fixed representing equivalent potential hazards caused by the substance when it is present under reference conditions. These hazards may be of a different nature, such as toxicity, flammability or explosivity.

In situations where hazardous substances are present under conditions differing from the reference conditions, the quantities of the substances actually present are multiplied by suitable correction factors. When the quantities thus corrected exceed the appropriate threshold quantities, the installation is designated for the obligation to draw up a Safety Report.

6.1 Threshold quantities

For a dangerous substance occurring under certain specified conditions, a minimum quantity can be derived below which, in the case of an accident, hazards to life or health are not expected to extend over a large area. This quantity is called the "threshold quantity". The basis for establishing these threshold quantities is the size of the area within which human life is seriously endangered by the physical effects of the accident. If this area extends more than 100 m from the point where the accident occurs it is considered a major accident.

The physical effects considered may include the air concentrations of toxic substances, the peak overpressure or the intensity of heat radiation in combination with the duration of its occurrence. The effects considered have been determined with the aid of the results of the study "Methods for the calculation of the physical effects of the escape of dangerous material" [7].

Apart from explosive substances, the severity of an accident is usually determined primarily by the quantity of the dangerous substance instantaneously dispersed in the atmosphere. This quantity depends not only on the quantity of the substance present in the installation, and its physical properties, but also on the specific conditions under which it occurs.

The threshold quantity of a dangerous substance is thus defined as the lowest quantity of that substance which, occurring under certain specified reference conditions, may give rise to a major accident.

The reference conditions used are:

- the substance is being processed (not passively stored or warehoused),
- the installation is situated in the open air,
- the substance is present in the liquid phase boiling under atmospheric pressure,
- the process temperature equals or exceeds ambient temperature (25°C).

Dangerous substances are subdivided into 4 categories:

- Flammable substances. Since flammable substances — such as petroleum products — provide roughly equivalent hazards, the threshold quantity for all flammable substances has been set at 10,000 kg.
- Explosive substances. There being no simple and practicable way to distinguish between explosives, a threshold quantity of 1000 kg has been set for all explosives. This figure is based on calculations and experiments with TNT.
- Toxic substances. Since the effects of toxicity are specific for each substance, and there are very large variations between substances in this respect, each toxic substance must have its own specific threshold quantity. Chlorine has been chosen as a reference substance and a threshold quantity. Chlorine has been set for it. The threshold quantity of a toxic substance is the quantity which gives hazards for life and health equivalent to those caused by 300 kg chlorine.
- Extremely toxic substances. These include substances which even in the smallest quantities may cause permanent effects on health — such as carcinogenic and mutagenic substances. A threshold quantity of 1 kg has been fixed for all substances of this category.

In Table 2 the threshold quantities of the 4 categories of dangerous substances are summarized.

TABLE 2

Threshold quantities of dangerous substances

Category	Quantity (kg)
Flammable substances	10,000
Explosive substances	1,000
Toxic substances	Variable
(chlorine	300)
Extremely toxic substances	1

6.2 Correction factors

When a dangerous substance occurs in an installation under conditions differing from the reference conditions, the quantity present is multiplied by one or more correction factors — smaller than unity when the conditions render the substance less dangerous than it would be under reference conditions, and larger than unity when the conditions present an extra hazard.

If the quantity of the substance thus corrected exceeds the relevant threshold quantity, the installation is designated. Table 3 gives the correction factors to be applied. In this table X and Y are variable factors with values depending on the relationship between process temperature and atmospheric boiling point, and on the values of these temperatures themselves.

From unity at the atmospheric boiling point of the substance, X increases by 1 for every 10°C which the process temperature exceeds that boiling point, up to a maximum value of 10. For processes below the atmospheric boiling point, X decreases by 0.1 for each 10°C by which that boiling point exceeds the process temperature, with a minimum of 0.1.

For processes below ambient temperature, a factor Y is applied with a value rising from 1, for processes at ambient temperature, increasing by 1 for each 50°C by which the atmospheric boiling point is below 25°C (ambient), with a maximum value of 4.

TABLE 3

Correction factors

Condition	Factor
The substance is in storage	0.01
The installation is situated within a building	10
The substance is in the liquid phase	X*
— process temperature above atmospheric boiling point	1—10
— process temperature below atmospheric boiling point	0.1—1
The substance is present as a refrigerated liquid at atmospheric pressure only	Y* (max. 4)
The substance is present as a refrigerated liquid under overpressure	$X + Y - 1$ (max. 10)
The substance is in the gas phase	10
The substance is in the solid phase (powder only)	0.1

*X and Y are variable factors explained in the text.

6.3 Phasing factors

Since it is impractical to simultaneously handle a large number of safety reports of existing installations, the Safety Report Regulation will be implemented in phases, starting with the installations with the highest hazard potential. This is done by designating in every phase only those installations where corrected quantities of dangerous substances occur which exceed the relevant threshold quantities multiplied by a phasing factor. Subsequent phases are then introduced by decreasing the phasing factor in steps.

If a Safety Report must be drawn up for an installation, it is preferable for all parties concerned to do that when the installation is constructed rather than after some time of operation. Therefore a lower phasing factor is applied to new installations than to existing ones. In the first phase for existing installations a phasing factor of 400 is applied as against 25 for existing ones.

6.4 Results of the designation

Summarizing: a safety report must be compiled for an installation when the amount of dangerous substances present in the installation multiplied by one or more correction factors exceeds the relevant threshold quantity multiplied by the prevalent phasing factor, or:

$$Q\,C \geqslant T\,F$$

where Q = quantity of substance present in the installation, C = correction factor(s), T = threshold quantity, F = phasing factor.

To give an impression of the existing installations to be designated in the first phase of the implementation (phasing factor F = 400), some examples of installations where the presence of one single dangerous substance is decisive for the designation are given in Table 4. The figures are for existing installations located in the open air. For existing installations within a building the quantities in Table 4 must be divided by 10 (C = 10). For new installations subject to the Safety Report Regulation, in the first phase of the implementation (phasing factor F = 25) the quantities in Table 4 are to be divided by 16.

TABLE 4

Quantities Q of some dangerous substances in existing installations for which a Safety Report has to be compiled in the first phase (phasing factor 400)

Substance	Storage		Processing	
	Refrigerated (10^3 kg)	Ambient (25°C) (10^3 kg)	25°C (10^3 kg)	100°C (10^3 kg)
Acetone	—	570,000	5700	800
Acrylonitrile	—	160,000	1600	265
Ammonia	100,000	28,500	285	200
1,3-Butadiene	200,000	100,000	1000	400
Chlorine	6,000	1,700	17	12
Ethylene	100,000	40,000	400	400
Phosgene	1,600	500	5	1.6
Carbon disulphide	—	150,000	1500	200

7. The contents of the Safety Report

In the relevant legislation the contents of the Safety Report are given in broad outline. In this paragraph more explicit information is given on the contents of the Safety Report, which must include a description of the installation, the substances used, the process, the hazards associated with the installation and its operation, the organization and the emergency provisions.

Prior to a further discussion of the contents of the report, it should be mentioned that the final compilation of a safety report should not take place before detailed information is available concerning the equipment, the operation of the process and the organization of the installation for which the report is to be compiled. The essential data required can be included in the report on the basis of this information. It is not the intention that detailed operating data, results of investigations, documentation of safety studies, directives, guidelines and norms, as used in the compilation of the Safety Report, are included in the Safety Report — it will suffice to mention this documentation in a list of references.

7.1 Description of the installation and the substances present therein

Description of the installation

The description of the installation can be subdivided into a general part and a specific part. The general description of the installation should give data on the location and arrangement of the site and on influences of a local nature that can be of interest for the safe operation of the installation concerned in relation to industrial activities in the surrounding area.

The specific description of the installation should contain data that are of interest for safety, including lay-out, plant and equipment (vessels, reactors, towers, heat exchangers, pumps, compressors, furnaces, lines, instrumentation, etc.) of which the installation is composed. In addition, a description should be given of the buildings forming part of the installation and how these buildings are protected against the physical effects caused by fire, explosion or escape of toxic substances in the vicinity of these buildings.

Description of the substances that occur in the installation

The substances occurring in the installation concerned may include:

- raw materials
- auxiliary substances, including catalysts, carriers, heat transfer media, adsorption and absorption agents, etc.;
- fuels;
- intermediate products;
- undesirable by-products, including those that might be generated in the case of malfunctioning;
- final products;
- waste products.

Mention should be made of the quantities and phases in which these substances occur in the installation. In addition, those properties of these substances which may under normal or abnormal conditions cause acute danger upon single exposure must be mentioned. In this context physical, chemical, as well as toxicological properties should be taken into account.

7.2 Description of the process

The Safety Report should include a description of the process taking place in the installation under normal conditions, with optimum values for the static and dynamic process parameters. An indication should also be given of what will happen in the event of the safe limits set for the process being exceeded. By process is meant here a physical or chemical conversion or a series of such conversions and the running thereof. The term also covers storage and transport.

Normal process conditions prevail when the various values of the process parameters are within pre-set limits from optimum values which are likewise predetermined. Start-up and shut-down are considered as part of the normal operation.

In the description special attention should be given to potential chemical or physical hazards inherent in the process, such as:

- de-mixing
- de-emulsification
- frothing
- stratification/roll over
- bump boiling
- liquid surge
- material attack by corrosion/erosion or combinations thereof
- material attack by cavitation
- vapour explosion (physical)
- thermal explosion (primary, secondary)
- dust explosion
- ignition as a result of electrostatic charging
- ignition/explosion caused by adiabatic compression
- generation of explosive or toxic by-products, decomposition products, intermediate products, waste products, etc.
- unintentional polymerization

Finally, it should be stated what special requirements the safety of the process imposes on the materials and the construction of the installation.

7.3 Description of foreseeable hazards and preventive measures taken to control them

The Safety Report should contain a description of the reasonably foreseeable hazards that can occur through failures in the process or through faulty actions in all phases of the process. On the basis of a systematic safety study, an attempt can be made to obtain a reasonably complete picture of these hazards and of the failures and faulty actions that may cause them. The safety study meant here may range from an identification based on a check-list to a detailed hazard and operability study. In view of the laborious nature of the methods to be applied and the complexity of the installations to be investigated, it is essential to proceed from general to detailed, verifying which potentially dangerous installation units require a more detailed safety study.

This selection of installation units takes place according to a hazard-indexing system, which is mainly based on the Fire and Explosion Index [8], developed by the Dow Chemical Company, U.S.A. On the basis of the hazard index thus established for each unit, the unit concerned is classified in one of three hazard categories.

For each hazard category certain specific safety studies are required, those for the higher categories being more extensive and detailed. The degree of detail in the description of foreseeable hazards for the various units is thus made dependent on the degree of potential hazard.

A distinction, with respect to the safety studies to be carried out, is made (apart from the hazard index) between:

- installations where existing technology is applied and for which sufficiently representative accident data can be available, and
- installations in which novel technology is applied, for which no representative accident data can thus be available.

For existing installations and new installations based on known technology, the safety studies are focussed on the identification of undesirable events. For new installations in which novel technology is applied, a hazard analysis should provide insight into the effects of undesirable events and the chances of their occurrence. Irrespective of the hazard indexing for installation units and the distinction between existing and new installations, the Safety Report should give data for the complete installation on emissions of dangerous substances resulting from safety release systems or venting systems becoming operative, and on the possible consequences of such emissions.

The safety report should also describe the provisions made to prevent as much as possible, failures and faulty actions that may lead to undesirable events, or to reduce their consequences to a minimum. Since these provisions are geared to the identified hazards, it is obvious that their description should be integrated with the safety studies mentioned here.

7.4 Description of the organization

The safety report should contain a description of the organization insofar as it can be of interest for the safety of workers. The contents of the description should be such that it provides a good insight into the policy of the enterprise with respect to the safety and health of personnel. This means that the description should not be restricted to indicating the presence of special safety services and their place in the organization diagram. The report should include a broad spectrum of policy aspects, clearly reflecting the involvement of management and staff vis-a-vis the safety and health policy and the functioning of the organization.

In the description of the organization a distinction can be made between general and specific information. The general description covers the organization of the complete enterprise and should include items such as:

- general safety policy;
- duties and responsibilities;

- consultation on safety matters;
- procedures;
- personnel policy, as far as this can reasonably be related to safety in the enterprise.

The specific description, which is the part dealing with the organization that is directly related to for the installation for which a Safety Report is compiled, may concern the following:

- policy aspects of a specifically organizational nature;
- policy aspects with respect to safe organization, including design, construction, operation, maintenance and inspection.

7.5 Description of the emergency provisions

The Safety Report should contain a description of the technical and organizational provisions that have been made to restrict as much as possible the severity of the consequences of undesirable events. Primarily, an indication should be given of what foreseeable consequences of failures or faulty actions have been taken into account in making emergency provisions.

In the description of the technical and organizational emergency provisions a distinction can again be made between general and specific information. The general description concerns emergency provisions available for the complete enterprise, such as:

- alarm system and emergency communication systems,
- common firewater system,
- fire fighting and gas fighting equipment,
- ambulances and medical aids.

The general description should further include the emergency organization which becomes operative in emergency situations. The structure of the emergency organization and the duties and responsibilities entailed should be indicated. In addition, it should be stated what instructions and procedures are in existence, how the communication functions and how exercises are organized. If available, reference can also be made to the enterprise's emergency scheme when describing the general organizational emergency provisions.

The specific description concerns the emergency provisions that are available for an installation subject to the safety report regulation. This description should include technical emergency provisions such as alarm systems and emergency shut-down systems, organizational emergency measures, as well as the way in which dealing with emergency situations in the installation concerned has been laid down.

8. The evaluation of the Safety Report

The Safety Report is submitted to and evaluated by the District Superintendent of the Labour Inspectorate, who may — if he finds the report wanting — require further information about matters not sufficiently described, or require provisions to be effected in order to improve the level of safety. In that case the company concerned is under statutory obligation to comply.

The evaluation of the Safety Report consists of two parts:

- an appraisal of the completeness of the report,
- an appraisal of the safety of the installation described.

8.1 Appraisal of completeness

The appraisal of the completeness of the Safety Report submitted is made on the basis of a publication [9], in which more concrete recommendations are made for use in practice with respect to the desired contents and the amount of detail of the descriptions required. It should be mentioned here that the contents of the safety report are dependent on the size and complexity of the installation concerned and on the hazard aspects associated with that installation. For example, the specific description in the Safety Report will be more concise for a storage tank than for a complex production installation.

8.2 Appraisal of safety

There is no single universally applicable standard available for safety appraisal. Quantitative standards are lacking and only a few qualitative criteria are available. In fact, the objective of the safety appraisal is to establish to what extent the potential hazards associated with the installation have been eliminated or reduced to a minimum, and what technical and organizational provisions have been made to control the remaining potential hazards. The problem here is to define what remaining risk is "sufficiently small" to be acceptable.

Apart from the fact that the risk in question cannot be defined accurately, due in part to the unpredictable nature of the human element, there is no generally accepted quantitative measure of the tolerable risk of injury to health. Many factors (technical, social, psychological, political, economical), some varying with time, determine this tolerable risk.

Which technical and organizational provisions are adequate to control the recognized potential hazards will therefore be a matter of "best practicable means" (bpm)*, indicating that a compromise must be found between the reduction of risk and the expenses involved in the technical and organizational provisions required.

A number of interpretations of the concept of "best practicable means" have been laid down in standards, codes, and guidelines, such as the reports, instruction and information pamphlets issued by the Directorate General for Labour [10—13].

A separate problem is formed by the existing installations that were de-

*"Best practicable means" are provisions that, according to the latest state of the art, are most suitable, having been tested under comparable conditions and in comparable size, and the extra costs of which are not such as to be unreasonable in relation to the effect achieved.

signed, constructed and put into operation before the relevant directives, etc., were introduced or for which now obsolete versions of these directives have served as a basis. In many cases it will no longer be possible, or it would entail substantial costs, to adapt these installations to more recent directives.

In view of the fact that the safety appraisal on the basis of a Safety Report will, as a rule, for each specific case be a matter of interpretation of the bpm concept, it is of paramount importance that the workers concerned should be involved.

Conclusion

The Safety Report legislation has obtained power of law as of February 1, 1982, and the first installations have been designated. For the existing installations designated in the first phase the reports must be submitted before February 1, 1984.

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