Aspects of relating to implementing explosion protection in the chemical industry

The Explosion Protection Document - part of plant/company safety documentation

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Figure 1: Industrial plant of Bayer Industry in Ürdingen, at night

Directive 1999/92/EC [1] containing minimum requirements for ensuring health and safety in installations with hazardous areas, which was adopted by the European Parliament and the Council in late 1999, has now been adopted in national law by the Member States of the Community and determines explosion protection measures in practice. In Germany this Directive was adopted in German law, together with a number of other Directives on health and safety, by the Betriebssicherheitsverordnung [2] in 2002.

One of the essential requirements of Directive 99/92/EC, aimed at users (employers) of a hazardous installation, is elaboration of the ›Explosion Protection Document‹. This article focuses on the aspects related to implementing the Explosion Protection Document and practical experience in handling ›old‹ work equipment. To summarise, it can be stated that the Explosion Protection Document is documentation of all possible risk assessments within the framework of explosion protection with assessments and protective measures. It must also document that the quality requirements stipulated by law are complied with in the field of inspection of work equipment and with regards to qualification of personnel. This means that this document performs the same tasks as a QA Manual ›Explosion Protection‹.

Introduction

In relation to explosion protection, adoption of Directive 99/92//EC can be understood as a sort of ›quality assurance offensive‹ in which formal aspects must now also be taken into consideration to a greater extent. As ›QA documentation on explosion protection‹, the ›Explosion Protection Document‹ required by the Directive then represents a documentation with coherent content about all explosion protection-related aspects of a plant and its operation ›under one roof‹. For practical considerations, it is also expedient that this documentation be managed entirely analogously to a sort of QA documentation in the context of company safety management.

Requirements of Directive 1999/92/EC

Directive 1999/92/EC demands that the employer ensure that an Explosion Protection Document is drawn up and constantly updated. It must cover at least the following content:

- Determining the explosion risks and assessment thereof
- What measures are taken to prevent the risks of explosion
- What areas are hazardous and are thus classified into Zones
- Information on safe operation work place and work equipment, and on required maintenance (including warning devices).

Object and purpose

The Explosion Protection Document affords the operator more advantages than simply complying with legal requirements. It serves

- to verify compliance with rules and regulations,
- to safeguard against manangement fault liability,
- to ensure management of change,
- as an internal aid to organisation (as part of safety management) and
- to inform staff.

Requirements on the Explosion Protection Document

The Explosion Protection Document should record all risks within the framework of explosion protection, assess them and describes the counter-measures taken in the plants. Moreover, this should ensure what is called ›Management of Change‹. The Explosion Protection Document must be drawn up before work is commenced. It must be revised if changes, extensions or reorganisation of the workplace and work equipment, or workflow are implemented.

Like any documentation, the Explosion Protection Document should also be expedient and should not simply be a collection of platitudes and truisms. It should be able to be used in the plant for day-to-day work providing specific assistance. The process of drawing up should not require any major additional effort which, of course, means adopting as many existing documents of safety measures as possible (or better: simply citing them/referring to them). In addition, the updating process should be simple and performable at all times, preferably with one's own staff.

Like every type of documentation relevant to law, it must be up-to-date and must be kept constantly up-to-date. This can only be done when clear concepts and structures are kept as simple as possible for efficient updating.

The trick (or challenge) actually exists in structuring the document (or, better, the documentation) in such a manner that all relevant information is covered and can be located quickly and precisely on the one hand, and, on the other hand, that the Explosion Protection Document is kept concise and manageable, so that it does not form a separate Plant Manual with all possible workflow descriptions that can only be kept up-to-date with great effort.

The manner in which it is written and the level of detailing should be selected precisely such that all minimum legal requirements are covered but so that it is practical to work with. Too much redundant content should be avoided in order to facilitate the day-to-day work of keeping the content up-to-date at one location only. A clear distinction should be made between documents required only temporarily (e.g. permit-to-work sheet) and documents which apply throughout the entire lifetime of the plant (e.g. zone/area classification). The former, at most, should be a part of examples cited in an Explosion Protection Document and the latter are a ›must‹. So it may certainly be expedient to review what should not be documented in the Explosion Protection Document for the relevant plant, such as the details of maintenance procedures. In general, a simple reference indicating that a maintenance management system with basic procedures is in place will usually suffice. ➔

No specific format required

The contents of the Explosion Protection Document required by the Directive generally already exist in practice, but nowadays, they are typically scattered throughout various existing documents in the case of existing installations with explosion protection measures. The law explicitly does not prescribe one specific form of the document. It would thus be better to speak of an Explosion Protection Documentation. Existing risk assessments, documents or equivalent reports may be used. Thus, the Directive does not demand that the Explosion Protection Document now be put together from these to form a single document. Collating existing documents or even simply providing a comprehensive list of the other applicable documents and a reference to where they can be found (including electronic databases) will suffice, and is frequently a very practical option. What is important is completeness (level of coverage) in respect to explosion protection, adequate depth, and inherent consistency (no contradictions).
Even greater synergy can be gained if drawing up the Explosion Protection Document is taken as an opportunity to review the existing risk assessments available to date for covering other hazards areas beyond explosion protection, e.g. in order to meet the requirements of Directive 98/24/EC ›Risk related to chemical agents‹ [3].

If the Explosion Protection Document is established as a collection of existing documents, it is advisable not only to collect the applicable documents in a ring binder for instance but also to name them in a list. Individual documents may include the following:

- Operating instructions
- Safety assessments
- Safety analyses and reports
- Equipment and apparatus documentation
- Installation plans
- Emergency plans
- Risk assessments
- Plant licence documents
- Management-of-Change documents.

The similarity to quality management systems and integrated safety management systems is obvious. As for Explosion Protection Document, the documentation in any QA system may be created in a more or less clever way (e.g. excessive, over-determined or in a manner requiring major update effort etc.). Thus, an Explosion Protection Document should be drawn up free of contradictions. It should be as free of redundancies with other documents as possible to minimise additional in-company burden and to create as little effort as possible. In general, for companies without a general or integrated safety management system, external consultancy services may be helpful in order to save effort and, thus, money. Recommendation of Namur NE99 [4], also points out that it is expedient to elaborate the Explosion Protection Document in such a manner that the documentation in whole or in part allows multiple use.

Explosion Protection Document in company safety management systems

There are cases in which, for reasons of overriding importance, it is not practical to use existing heterogeneous safety documentation for the Explosion Protection Document in its existing form. Particularly in large companies, drawing up the Explosion Protection Document may be an opportunity to elaborate systematic, integral and structured safety documentation, which is typically saved electronically, e.g. in a database or a document management system. This allows locations, workplaces, installations, equipment and apparatus, recipes, formulations and processes, each separated in levels of detailing, to be recorded in a structured manner (Figure 1).

All these data can be interpreted as a ›coordinate grid system for plant premises and objects relevant to technical safety‹ will be formed. The risk assessments, together with the respective protective measures, can now be ›attached‹ at various ›levels‹ to a single premises or objects of the coordinate grid. Characteristics and risk discussions/assessments then relate to the premises or objects they are attached to and to all other sub-premises/objects. For for example they could relate to a building story (e.g. ›Platform 17 m is listed as Ex Zone 2‹), a part-installation (e.g. ›entire interior of granulation is inertised)‹ or a recipe specification (e.g. ›supply of solvent only cooled‹). This generates summary statements, which help to reduce the complexity of the documentation.

Figure 1 shows the information relevant to explosion aspects in pink in the general plant structure diagram. If electronically saved in a suitable documentation system [5] all information may then be retrieved from the totality of all risk assessments and protective measures to form the Explosion Protection Document, such as a report from the database or suitable XML-compliant document storage. Analogously of course, it is also possible to document other risk assessments, such as, risk assessments on general plant and process safety, on Directive 98/24/EC, on health and safety or on fire protection. The relevant ›view‹ onto this data pool supplies the appropriate document. Implementing this type of documentation with existing plant structures included, is in most cases practi-

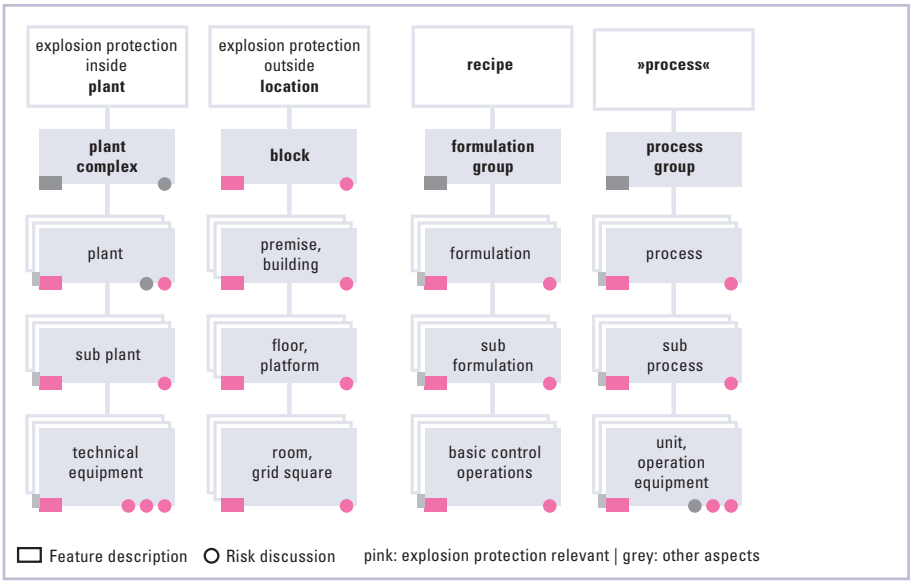

Figure 1: Example of structuring of a facility/site on the basis of plant, location, recipe and process aspects (multi-dimensional structure).
›Appended‹ boxes represent features (also: descriptions and parameters) and ›appended‹ circles represent risk discussions with risk assessments, protection measures and instructions.
Basically, features and risk discussions may occur on any technical object of this structuring, regardless of level.
Only the explosion-related aspects are coloured pink. Other information and risk discussions are coloured black.
Explosion protection inside and outside may both occur in the case of structuring in the recipe or process ›branch‹.

cal only if external consultancy services are involved. This should then be justified by the savings made in the updating effort.

Templates for the Explosion Protection Document

It is not practical to define the structure and form of the document on a general basis, e.g. in a Standard. Proposals on the content and structure (outlining) of the Explosion Protection Document can be found, by way of example, in the non-binding Guide [6], published by the European Commission, or, for instance, in the Explosionsschutz-Regeln (EX-RL) [7] and in Namur Empfehlung NE 99 [4]. A set of technical rules is currently being elaborated on in Germany by the ›Ausschuss für Betriebssicherheit‹ (Committee for Safety in the Workplaces) (TRBS 2154) [8] as a supplement to the German directive on the protection of health and safety in the workplaces ›Betriebssicherheitsverordnung‹ [2]. Many other publications on this topic, of varying levels of quality, can also be found on the Internet but in all cases the employer must still conduct the relevant risk analyses and assessments. Nevertheless, the checklists published may have a practical purpose, such as reviewing the quality of an Explosion Protection Document.

In practice, a breakdown of the Explosion Protection Document such as that in Table 1 has proven successful. A simple installation structure with 2 operating units has been assumed in this case for the purpose of the example.

Particularly in the case of plants or companies with several plants and subplants, it is advisable to split the document into one general part and several installation-specific parts. The general part explains the structure of the documentation and all aspects applicable jointly to all installations. This is followed, if applicable as a reference to the Annexes, by the installation-specific documents representing the ›Explosion Protection Document‹ of the plant/subplant only. Explosion protection is very location-specific and apparatus-specific, making a universal risk assessment more sensible than elaborating on a list of the points considered for each outline level. Other-wise, the relationships between the objects/premises described may be no longer easy-to-understand.

›Combing‹ the plant with the aim of comprehensive risk assessments should, practically, be based on the targets of the Commission's Guide [6]. Other sources of information may be obtained from well-elaborated manufacturer's documentation (operating instructions) for the work ➔

1 Introduction
- 1.1 Subject and purpose/task of the Explosion Protection Document
- 1.2 Scope of validity
- 1.3 Structure of the Explosion Protection

2 Information on the plant
- 2.1 Responsibility
- 2.2 Approval situation
- 2.3 Purpose of the installation
- 2.4 Location/geographical conditions
- 2.5 Structural conditions
- 2.6 General ventilation system
- 2.7 Installation plans

3 Procedures in the plant – process and construction parameters important for explosion protection
- 3.1 Operating Unit OU1: Installation for production of ...
- 3.1.1 General
- 3.1.2 Process/installation description
- 3.2 Operating Unit OU2: Installation for production of ...

4 Material data (safety parameters)

5 Risk assessment – fundamentals
- 5.1 General
- 5.2 Assessment of the explosion hazard, zones
- 5.3 Assessment of the ignition risk
- 5.4 Extent of damage

6 Risk assessment/explosion protection concept for plant
- 6.1 General
- 6.2 Measures to avoid/restrict the explosion hazard, zone classification – hazardous areas
- 6.2.1 Interior of apparatus
- 6.2.2 Environment of apparatus
- 6.2.3 Description of the hazardous areas
- 6.3 Identification and avoidance of ignition sources
- 6.3.1 Hot surface (steam lines and oil used for insulation/dielectrics)
- 6.3.2 Flames and hot gases
- 6.3.3 Mechanically generated sparks
- 6.3.4 Electrical apparatus
- 6.3.5 Stray electrical currents/cathodic corrosion protection/ equipotential bonding
- 6.3.6 Static electricity
- 6.3.7 Lightning
- 6.3.8 High frequency
- 6.3.9 Electromagnetic radiation in the optical spectrum
- 6.3.10 Ionising radiation
- 6.3.11 Ultrasound
- 6.3.12 Adiabatic compression and shock waves
- 6.3.13 Exothermal chemical reactions including self-ignition of dusts
- 6.3.14 Summary consideration of ignition for individual work equipment
- 6.3.14.1 Mixers
- 6.3.14.2 Agitator vessels
- 6.3.14.3 Pumps
- 6.3.14.4 Vehicles
- 6.3.14.5 ...
- 6.4 Mitigation of the effects of explosions (mitigation measures)
- 6.5 Organisational measures – plant
- 6.6 General administrative measures on explosion protection
- 6.6.1 General
- 6.6.2 In-company instructions and training courses on explosion protection
- 6.6.3 Explosion protection-specific working
- 6.6.4 Permit-to-work system
- 6.6.5 Change management system
- 6.6.6 Integration of outside companies in explosion protection
- 6.6.7 Inspection/checks
- 6.6.7.1 Initial inspection before bringing into service (Annex II 2.8)
- 6.6.7.2 Periodic inspections
- 6.6.8 Competent persons
- 6.6.9 Special measures for prevention of hazards

7 Measures to ensure the zones/avoidance of hazardous explosive atmosphere

8 Measures to avoid effective ignition sources

9 Standard cases for classification of the hazardous areas when handling flammable gases/vapours/mists and combustible dusts

10 Standard cases for the ignition source consideration

11 Inspection before bringing the first time into service and periodical inspection

Table 1: Proposed breakdown (outlining) of an Explosion Protection Document

equipment considered. Admittedly, the user is responsible for identifying Ex Zones after conducting the risk assessment. Nevertheless, the manufacturer's proposals for standard situations make it easier for the user to draw up his documentation. This certainly is a field where manufacturers initiatives could allow them to differentiate themselves from their competitors.

Interior of apparatus

The interior of apparatus is also subject to risk assessment by the user/operator. On a purely formal level, the legislative scope of the Directive covers only explosive atmospheres but not explosive mixtures under non-atmospheric conditions. For instance, a manufacturer of explosion protected devices is well-advised to restrict formal explosion protection requirements inside apparatus to a minimum of process related boundary conditions and measures in view of product liability, in order to meet the requirements of the Machinery Directive. This benefits the manufacturer in terms of formal safety documentation and also benefits the customer. After all, frequently no explosive atmosphere is present as defined by the Directive, or the user/ operator wishes to run the apparatus outside of the manufacturers process requirements (which are, perhaps very restrictive as a result of over-cautiousness on the part of the manufacturer). The user/operator must conduct a risk assessment either way for the interior of the apparatus. The same is generally also required for a process-orientated safety assessment. Expediently, there should be no formal Ex zone listing for the interior but implementing explosion protection analogously, indicated, for instance, by a description such as ›analogous to Ex zone...‹.

›Old‹ work equipment

The requirement of Directive 1999/92/EC for using apparatus compliant with 94/9/EC [9] in hazardous areas explicitly does not exclude the use of ›old‹ work equipment (so-called ›legacy devices‹), provided these are classified as adequately safe by the user. This may be verified, for example, by many years of operating practice, if applicable in conjunction with a risk assessment. However, significant care must be taken particularly to ensure the intended use in this case. Otherwise, all deviations must be documented precisely. All work equipment thus classified by the user must be covered in the Explosion Protection Document.

This clearly indicates that whoever has done his ›homework‹ in relation to explosion protection and manages a good set of maintenance documents should not have any problems using ›old‹ work equipment.

Operating Instructions as central equipment/device information source

One document which is quite essential for all work equipment in relation to company explosion protection is the Operating Instructions of the manufacturer. The Operating Instructions represent the formal interface between manufacturer and user. It states the conditions to be complied with by the operator, such as requirements applicable to installation location and operating parameters (e.g. max. pressure and max. temperature), maintenance, checking and inspection which, if complied with, will lead keeping up the product liability of the manufacturer.

In practice, the challenges exist in the fact that such Operating Instructions a) may be very manufacturer-specific in structure and layout and thus may be difficult to ›decipher‹, and b) are frequently published on a ›global‹ basis, i.e. for entire ›families‹ of similar apparatus/equipment and the specific reference to the individual apparatus/equipment may be incomplete. It is thus expedient, in particular for large companies with high organisational division of responsibilites, to deliver such Operating Instructions centrally in an up-to-date form to all departments affected. Even less recent versions (those no longer up-to-date due to technical progress) should still be kept centrally and archived in order to keep track of quotes from the manufacturer's documentation in the Ex-document. This may lead to a complex document management system with versioning, making this instrument only useful if the requirements from maintenance and other legal regulations (e.g. Directive 98/24/EC ›Risk related to chemical agents‹) can also be met with such a system.

Organisational measures

Particular attention must be paid to the presentation of the organisational measures. Conventional organisational measures are as follows:

- Written instructions and permit-to-work system,
- Workers instruction,
- Work coordination.

Specifically in the case of written instructions and permit-to-work forms, it is frequently practical to describe in general the processes and the corresponding forms in one document so that a reference to this document suffices in all Explosion Protection Documents (document hierarchy).

Special attention must be paid to coordination of work in hazardous areas. ➔

In particular, if work is outsourced to third parties, it must be ensured that all required information of appropriate depth is forwarded as the outside staff frequently does not have the corresponding knowledge available. It is practical to document the fact that this information has been forwarded. Here as well, the use of central document storage structures will pay off.

Procurement

Basically, all apparatus/work equipment must be purchased with an equipment category corresponding to the zone classification. The following assignment must be noted in this case (Table 2):

Deviations from this assignment are basically permitted by law even in the case of ›new work equipment‹:

»If the explosion protection document based on a risk assessment does not state otherwise, equipment ... must be elected on the basis of the categories set out in Directive 94/9/EC (escape-clause RL 1999/92/EC annex II B)«.

This equipment must be described in the Explosion Protection Document and, if applicable, modified use thereof must be substantiated. In this case, it is practical to manage the individual risk assessments so required in a separate ›Equipment/Apparatus Register‹ in order to be able to quickly make changes or review certain aspects at a later date.

Risk assessment of apparatus/ work equipment which were not specified by the manufacturer for the intended use are, however, correspondingly more complex and may require consultancy services since it contains a documentation of the ignition source assessment and the additional measures derived therefrom. This assessment is conducted by the manufacturer themselves in the case of explosion protected equipment. The need to use apparatus and work equipment without adequate equipment category is, however, frequently the result of the non-availability of appropriate equipment, such as devices for specific measurement tasks or equipment/apparatus used in a pilot-plant.

Zone	Category	Zone	Category
0	1G	20	1D
1	1G or 2G	21	1D or 2D
2	1G or 2G or 3G	22	1D or 2D or 3D

Table 2: Criteria for selection of equipment

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