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Section on Prevention in the Chemical Industry
Section on Machine and System Safety

Identification and evaluation of hazards, determination of measures

Part 7
Hazards arising from explosions

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determination of measures

Part 7
Hazards arising from explosions

Introductory note

This brochure is intended to assist entrepreneurs in small and medium-sized enterprises (SMEs) to identify explosion hazards at the workplace. It provides assistance in assessing the associated risks and recommendations for preventive protective measures.

The brochure does not cover other types of explosions, e.g. uncontrolled reactions, detonations of highly explosive substances or the bursting of pressure vessels.

The brochure is structured as follows:

1. Fundamental considerations
2. Checklists for hazard identification
3. Risk assessment
4. Risk reduction, taking measures
5. Explosion protection document

Other brochures are available on the following topics:

1. Noise
2. Hazards arising from machinery and other work equipment
3. Chemical Hazards
4. Slipping and falling from a height
5. Mental workload
6. Manual handling of loads
7. Hazards arising from explosions
8. Hazards arising from whole-body/hand-arm vibrations
9. Hazards arising from electricity
10. Risk Assessment – General guide

Content

Foreword

The 1st edition of this brochure was published in 2010 under the auspices of the ISSA Metal Section as part of a series "Guide for risk assessment in small and medium enterprises".

Following the establishment of an "Explosion Protection Working Group" by the executive boards of the Section on Prevention in the Chemical Industry and the Section on Machine and System Safety of the ISSA, this group has undertaken the necessary revision and updating of the brochure.

This document focuses on hazards arising from explosions, aims to raise awareness of such hazards among small and medium-sized enterprises, and points out possible protective measures to enable safe working and prevent accidents. However, it is not possible to list all the measures required in individual cases, as these must be determined against the background of the specific operational situation and the current national legal requirements.

The brochure was carefully prepared by a working group of the ISSA. This does not release readers from the obligation and responsibility to check the information for completeness, timeliness and accuracy.

Thomas Köhler
President of the Section on
Prevention in the Chemical Industry

Jürgen Schulin
President of the Section on
Machine and System Safety

1 Fundamental considerations

1.1 What is an explosion?

An explosion is an abrupt oxidation or decomposition reaction producing an increase in temperature, pressure or both simultaneously (DIN EN 13237). A gas or dust explosion can therefore be described as the consequence of fast combustion of gas or dust mixed with air. Some of the effects of an explosion are loud bangs and pressure effects that can cause walls to collapse and windows to shatter. Heat radiation, smoke gases and flame fronts are other life-threatening effects of the sudden violent expansion of gases.

1.2 How is an explosion generated?

For an explosion to occur, a flammable substance (gas, e.g. hydrogen, vapors, e.g. from flammable liquids, or dust, e.g. flour), an oxidizer (e.g. the oxygen in the air), and an effective ignition source (e.g. a hot surface or an electrical spark) must be present. When the mixing of fuel and oxidizer is complete and the concentration of fuel is within the explosion limits, the resulting mixture can be ignited if a sufficiently strong ignition source is present.

1.3 Elements of an explosion

Explosive atmospheres can be created as a mixture of air and flammable gases, vapors, mists, or dusts under atmospheric conditions. If the concentration of the substances is within the lower and upper explosion limits, the combustion process can spread to the entire unburned mixture after ignition has occurred.

Lower explosion limit (LEL) – is the minimum concentration of a mixture of flammable gases, vapors, mists or dusts with air in which, after ignition, a flame independent of the ignition source just cannot propagate independently.

Upper explosion limit (UEL) – is the upper limit of a mixture of flammable gases, vapors, mists or dusts with air in which, after ignition, a flame independent of the ignition source just cannot propagate independently.

An explosion is excluded if the concentration is below the lower explosion limit. If the concentration is above the upper explosion limit, the mixture is too saturated and there is not enough oxygen for an explosion.

The explosion limits are also influenced by temperature and pressure. A higher temperature leads to a lower LEL and a higher UEL, whereas the behavior at higher pressure is not uniform.

The following table shows some examples of explosion limits:

Flammable substance	Lower explosion limit	Upper explosion limit
Natural gas	5.0 Vol-%	13.0 Vol-%
Propane	1.5 Vol-%	9.5 Vol-%
Acetylene	2.5 Vol-%	81.0 Vol-%
Sugar	30 g/m^3	–
Flour	30 g/m^3	–

In general, the explosion limits of gases or vapors are contained in the safety data sheets of the manufacturer or importer of the flammable substance/ product.

In practice, the UELs for dusts are hardly known because they are not useful for dusts due to the difficulty of controlling explosive mixtures by limiting the concentration. Information on the LEL of many dusts can be obtained from the GESTIS database, for example. It should be noted that dust deposits can create a dust cloud, e.g., due to a sudden movement of air caused by opening a door or window, a minor explosion, or dust deposits falling from a cable tray.

It is important to know that a layer of dust less than 1 mm thick can already create an explosive atmosphere.

Although the explosion lasts only a blink of an eye, several phases occur at that instant: the actual blast wave of the explosion, the flying fragments of the exploding container, and (depending on the pressure of the blast) the collapse of walls, roofs, doors, windows and ceilings. In addition, the heat generated can cause fires and destruction. Moreover, the blast wave can cause serious damage to gas, water, electricity and drainage lines. The effects of an explosion are severe in terms of personal injury and property damage.

Also very dangerous are the harmful reaction products developed during the explosion, and the consumption of oxygen from the ambient air needed for breathing, which can lead to a risk of suffocation for workers.

Figure 1: Outcome of an explosion

1.4 What can trigger an explosion?

There are a variety of different ignition sources that can potentially ignite a mixture of combustible substance and air. Typical ignition sources are hot surfaces, flames and hot gases, mechanically generated sparks (during grinding or cutting), electrical sparks and static electricity. Other ignition sources are lightning, electromagnetic fields and chemical reactions.

The European standard DIN EN 13237 describes different types of ignition sources.

Figure 2: Ignition sources

1.5 ATEX directives

The EC Directive 1999/92/EC, also referred to as the "ATEX User Directive", is the legal basis for the measures that must be taken at workplaces in potentially explosive atmospheres.

The ATEX User Directive specifies the minimum requirements for the safety and health protection of workers in the event of risks from explosive atmospheres.

To prevent explosions, the employer should take appropriate technical and organizational measures in the following order of priority:

- prevention of the occurrence of explosive atmospheres or, where the nature of the activity does not allow that,
- avoidance of ignition of explosive atmosphere and
- mitigating the effects of an explosion so as to ensure the health and safety of workers or other persons at risk.

EU Directive 2014/34/EU, formerly 94/9/EC, also referred to as the "ATEX Manufacturers Directive", describes the characteristics for equipment and protective systems intended for use in potentially explosive atmospheres. This directive defines the protection goal.

The implementation and details of the equipment and protective systems are not described, but are dealt with in ATEX guidelines and European standards.

1.6 Hazardous area classification

For the purposes of the ATEX User Directive, the location where explosive atmospheres may occur in such quantities that special measures are required to protect the safety and health of the workers concerned is designated as **hazardous area** and the corresponding atmosphere at this location is designated as **hazardous potentially explosive atmosphere**.

Figure 3: Warning of potentially explosive atmosphere

A special warning sign must be placed at such workplaces. The "EX sign" warns workers and other persons of a risk of explosion due to the presence of flammable substances in the area of the workplace. These flammable substances may be present in the form of gases, vapors, mists, or dusts.

Explosive atmospheres can occur in large-scale operations such as chemical plants, refineries, power plants, and gas utilities, as well as in small-scale operations such as wood processing, paint stores, agriculture, and food manufacturing.

Based on the above principles, a risk assessment should be carried out regarding explosion hazards at workplaces. Hazardous locations must be identified and divided into zones according to the frequency and duration of occurrence of the hazardous explosive atmosphere.

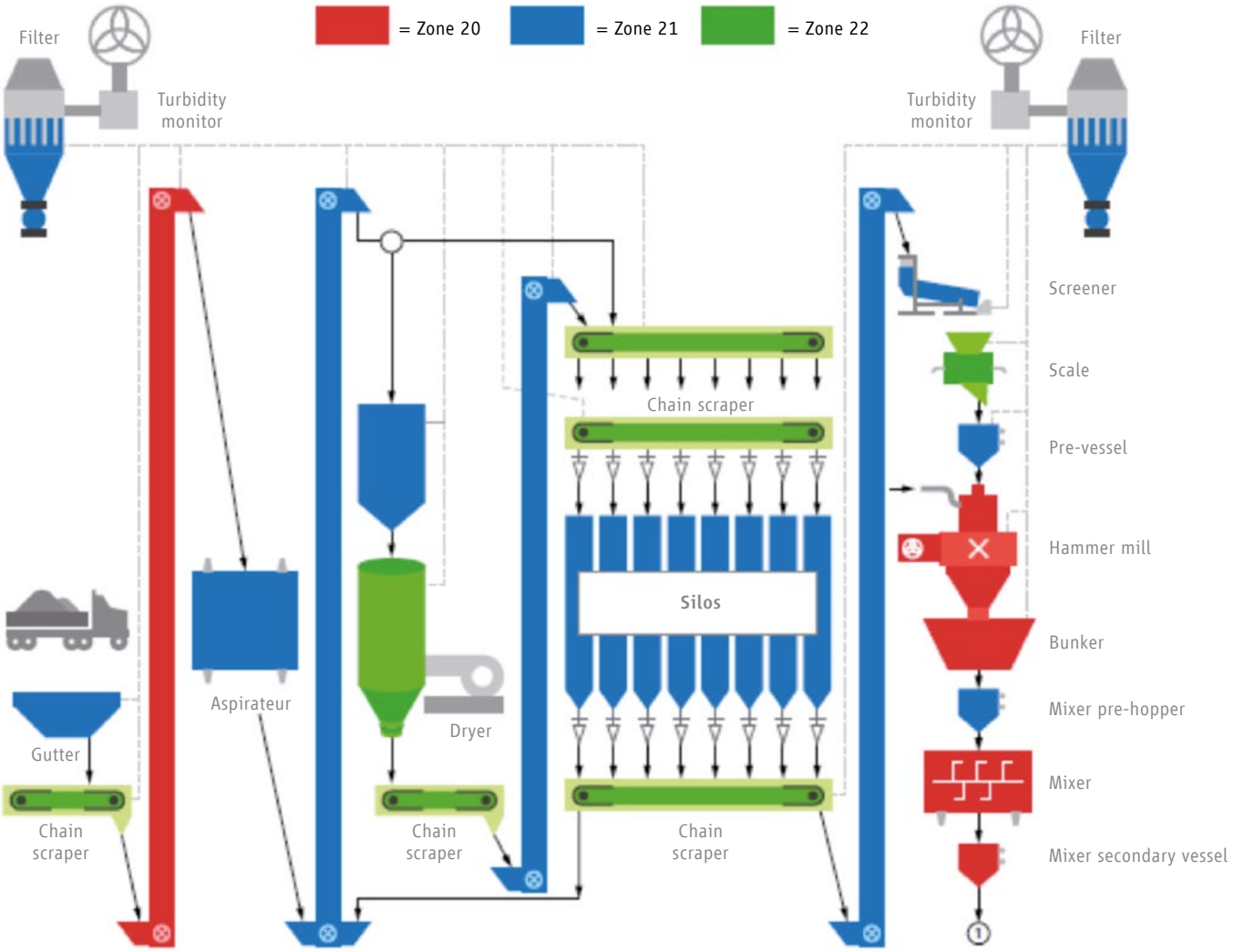

Figure 4: Example of a zoning map (plant for manufacturing concentrated animal feed). The different zones within the plant sections are highlighted in color. (Zones in the vicinity of the plant components are not indicated)

Zone classification (according to ATEX User Directive):

Zone 0
A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is present continuously or for long periods or frequently.

Zone 1
A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is likely to occur in normal operation occasionally.

Zone 2
A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Zone 20
A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently.

Zone 21
A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.

Zone 22
A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Note:
Layers, deposits and heaps of combustible dust must be considered as any other source which can form an explosive atmosphere.
"Normal operation" means the situation when installations are used within their design parameters.

DIN EN 60079-10 is often used to classify potentially explosive atmospheres and assess flammable gases and vapors. This standard provides a clear relationship between the amount of releasable flammable gases and vapors, ventilation measures, and zoning.

The zone is determined by the duration and frequency of occurrence of the explosive atmosphere. It occurs with a certain probability, which is expressed in the following terms:

Zone 0 / 20
Frequently or over long periods of time: time predominantly related to the effective operating time (e.g. in Germany > 50 %)

Zone 2 / 22
Usually not or only for a short time: few times a year for about half an hour

Zone 1 / 21
Occasionally: Duration and frequency between zone 0/20 and zone 2/22

The explanations of these terms are indicative only and should not be considered fixed. With these numbers, a quantification of the zone definition is possible (if desired), but for most situations a purely qualitative approach is appropriate.

Zoning may also be selected to define the scope of protective measures with respect to the equipment category of the protective system to be used at the hazardous location.

2 Checklists for hazard identification

A hazard arises when people come into contact with sources of danger. For example, workers can be put at risk by working with chemicals, on ladders, when working with a circular saw or when handling electrical current.

The term "risk" describes the likelihood (high or low) that someone can be harmed by the above or other hazards and at the same time indicates how severe the harm could be.

To assess a risk, it is therefore necessary to consider the likelihood of the occurrence of an explosive atmosphere and the possible consequences of the explosion resulting from a subsequent ignition.

The following checklist can be used to determine the explosion hazard. A procedure for assessing risk is presented in Chapter 3.

Explosion hazard	Measures	Remarks
General		
☐ Are flammable substances (gases, vapors, mists, dusts) present? ☐ Can an explosive mixture be created by sufficient distribution in the air (estimation of sources and quantities of the explosive atmosphere)? ☐ Is the formation of hazardous explosive atmosphere possible?	☐ Replace flammable substances by non-flammable or less flammable substances ☐ Limit storage quantities at workplaces to those required for progress of work ☐ Store waste, residues generated during the course of work at the end of each day's work/shift at a safe place ☐ Prevention or limitation of explosive atmospheres inside plants and plant components by means of • limitation of concentration • inertization ☐ Prevention or limitation of explosive atmospheres in the vicinity of plants and plant components by means of • Equipment tightness • Ventilation measures - For gases: ventilation (natural or technical ventilation) - For dust: technical ventilation and measures for the removal of deposits • Gas concentration monitoring	

Explosion hazard	Measures	Remarks
General		
☐ Is the formation of hazardous explosive atmospheres prevented by the above measures? **Note** If not, you must check which measures are applicable that avoid or reduce the ignition of hazardous explosive atmosphere	☐ Measures avoiding the ignition of hazardous explosive atmosphere ☐ Assessment of the frequency and duration of the occurrence of hazardous explosive atmospheres (classification into zones). According to the above-mentioned zone classification, electrical and non-electrical devices and protective systems containing ignition sources must be used in the respective equipment category.	
☐ Is the ignition of hazardous explosive atmospheres safely avoided by the above measures? **Note** If not, explosion mitigation measures must be taken.	☐ Explosion mitigation measures, which limit the effects of an explosion to a harmless level, are • explosion resistant design • explosion venting • explosion suppression • explosion isolation in connection with the above measures	
☐ Others	☐ Others	

Explosion hazard	Measures	Remarks
Ignition sources		
☐ Are ignition sources present?	☐ Do not allow ignition sources in the work area of highly flammable and extremely flammable substances ☐ Avoid ignition sources, prohibit the use of fire, open flames and smoking	
Ignition hazards can exist due to ☐ Hot surfaces (e.g. dryers, boilers, hot pipelines, mechanical processes due to friction and chip removal) ☐ Flames and hot gases ☐ Mechanically generated sparks (e.g. due to grinding, friction and impact processes) ☐ Electrical equipment (e.g. switches, relays) ☐ Electrical compensation currents, cathodic corrosion protection ☐ Static electricity (e.g. as a result of rubbing, pneumatic conveying, flow of liquids) ☐ Lightning strike ☐ Electromagnetic fields in the range of frequencies from 9 x 10^3 Hz to 3 x 10^{11} Hz ☐ Electromagnetic radiation in the range of frequencies from 3 x 10^{11} Hz to 3 x 10^{16} Hz or wavelengths from 1000 µm to 0.1 µm (optical spectral range) ☐ Ionizing radiation ☐ Ultrasound ☐ Adiabatic compression, shock waves, flowing gases ☐ Chemical reactions	☐ Ignitable sparks can be prevented, for example, by water cooling at the grinding point or limited by selecting favorable material combinations ☐ Select suitable electrical and non-electrical equipment (see e.g. ATEX) ☐ Monitor and limit temperatures of hot surfaces ☐ Safe charge dissipation by using conductive materials and earthing measures	
☐ Others	☐ Others	

Explosion hazard	Measures	Remarks
Maintenance		
☐ Hot work (e.g. grinding, flame cutting, welding) in areas with possible explosion hazards (general)	☐ Eliminate all flammable substances and remove dust deposits, if necessary ☐ Keep work area clean by regular cleaning using suitable cleaning equipment and material ☐ Regular maintenance of electrical and mechanical equipment according to the manufacturer's instructions ☐ Check that there really is no explosive atmosphere present or likely to occur before starting work.	
☐ Others	☐ Others	

3 Risk assessment

The selection of preventive and protective measures to be implemented can be made using the probability factor and the severity factor based on the matrix below:

		Severity factor			
		Minor (light injuries)	**Significant** (medium to severe injuries)	**Major** (life-threatening injuries or death)	**Catastrophic** (multiple fatalities)
Probability factor	**High** (likely to occur at least once a year during the plant lifetime)	4	5	6	7
	Medium (likely to occur more than once during the plant lifetime)	3	4	5	6
	Low (unlikely to occur during the plant lifetime)	2	3	4	5
	Very low (occurrence very unlikely to excluded)	1	2	3	4

The plant considered in the matrix above has an estimated lifetime of 20 years. Based on the identified values, the required action and the time frame in which it must be taken are indicated in the table below:

Measured value		Need for action and time frame
1 – 2	(Acceptable risk)	No additional protective measures required. Possible improvement measures should be considered, taking into account the cost/benefit ratio. Permanent monitoring to ensure implementation of protective measures.
3 – 4	(Risk reduction necessary)	Action should be taken to reduce the risk to an acceptable level within a specified time frame.
5 – 7	(Risk reduction urgently necessary)	Work may not be started until the risk has been reduced to a harmless level. The required improvement measures are important and should be applied immediately to work that is already in progress. If the risk cannot be reduced to a harmless level, the prohibition of the work must remain in effect.

4 Risk reduction, taking measures

4.1 Introduction

The characteristic that distinguishes a fire from an explosion is the speed with which the flammable substance reacts with oxygen. Many oxidation processes take place right before our eyes without us noticing them. During oxidation, energy is released in the form of heat. When a certain oxidation rate is reached, the released energy becomes visible in the form of a flame. Oxidation processes with such effects are called fire or combustion. In contrast, an explosion is a very rapid combustion process that results in a rise in temperature and/or pressure.

If the risk assessment reveals that there is a risk of explosion at the workplace, measures must be defined and implemented to

- avoid the risk or
- reduce the risk to an acceptable level.

These may be **preventive measures** or mitigation measures or a combination of both. In addition, these may be **technical and organizational measures**.

Important:

If no competent person is available who can determine these preventive protective measures, the entrepreneur must call on the services of a competent external service provider or other experts.

4.2 Preventive measures

The aim of preventive measures is to eliminate the risk of explosion by avoiding the creation of a dangerous explosive atmosphere or preventing the occurrence of ignition sources.

4.2.1 Avoiding or limiting the amount of flammable substances

Following the prevention principle, this type of measure is very high in the prevention hierarchy. In many cases, however, the flammable substances cannot be replaced by non-flammable substances, either because they are themselves the result of a specific process or because they are an essential component of it. In these cases, the amount of flammable substances stored at the workplace should be kept to the minimum necessary. Flammable substances should be stored in suitable closed and properly labeled containers, away from possible sources of ignition. It is important that the flammable substances are not stored together with incompatible substances that can react with each other and thus cause an explosion.

4.2.2 Keeping the concentration of the flammable substance/air mixture outside the explosion limits

The formation of potentially explosive atmospheres outside operating facilities should be prevented as much as possible. This can be achieved by closed systems. The system must be designed in such a way that no leakage can occur under the foreseeable operating conditions. This must also be ensured by regular maintenance and testing.

If leakage of flammable substances cannot be excluded, the formation of an explosive atmosphere must be prevented by suitable measures so that the concentration of flammable substances in the mixture with air remains outside the explosion limits. Possible measures include ventilation and cleaning.

Specifically for gases or vapors:

- natural ventilation (air exchange without technical measures)
- technical ventilation (air exchange within the working room or area by using technical means, e.g. fans, air injectors)
- object extraction (targeted collection and removal of flammable gases, vapors and mists at the point of origin)

Figure 5: Unsuitable process (left) and suitable process (right) for the removal of combustible dust

The flammable dust should always be extracted directly at the point of origin as a matter of priority. Keeping the workplace clean is also very important. The accumulation of flammable dust can be prevented by regular cleaning measures using suitable cleaning equipment. Stirring up combustible dust must be avoided, as it could generate a dust cloud. Wetting the flammable dust before removal prevents dispersion.

It should be noted that despite the effectiveness of ventilation systems and cleaning activities, there may always be a residual risk that must be reassessed and mitigated by further measures.

4.2.3 Determining the nature of dusts

By determining the characteristics of dusts (e.g. composition, particle size distribution, moisture, combustion number, lower explosion limit), it is possible to define important protective measures that are significant for explosion protection.

4.2.4 Preventing effective ignition sources

To prevent the ignition of hazardous explosive atmospheres, it is necessary to identify possible ignition sources and take measures to avoid them.

These measures include:

- Providing suitable work equipment
- Using work equipment in such a way that ignition sources do not become effective
- Assembling, installing and operating equipment and protective systems in such a way that ignition sources do not become effective

The effectiveness of the ignition source depends, among other things, on the energy of the ignition source and on the properties of the explosive atmosphere. The protective measures to be taken are intended to render ignition sources ineffective or to reduce the likelihood of their becoming effective.

The scope of the protective measures depends on the likelihood of occurrence of the hazardous explosive atmosphere (zoning).

Electrical and non-electrical equipment must meet the requirements of the ATEX Manufacturer's Directive. It should be noted that the equipment must be suitable for the particular environment of the hazardous workplace, e.g. equipment with gas certification may only be used in areas with gaseous explosive atmospheres.

4.2.5 Gas warning devices and equipment for explosive atmospheres

Suitable detection systems can be used for timely warning of the formation of an explosive atmosphere. These systems usually trigger an alarm when the concentration of the flammable substance/air mixture reaches about 20% of the lower explosion limit of this flammable substance. Systems of this kind can shut down non-explosion-proof equipment, turn on the technical ventilation, etc.

4.3 Organizational measures

Organizational measures must be taken if technical measures do not sufficiently ensure explosion protection at the workplace. Keeping up technical explosion protection measures through servicing and maintenance must also be defined organizationally.

The following organizational measures may be considered:

1. Preparing written operating instructions
2. Training the employees
3. Applying a work permit system
4. Inspections
5. Sufficient qualification of the employees
5. Marking of the hazardous areas

4.3.1 Preparing written operating instructions

Operating instructions are activity-related written instructions and rules of conduct which the employer gives to the employees.

They describe the workplace-specific hazards and specify protective measures to be observed. Employees must comply with the operating instructions.

4.3.2 Training the employees

Employees must be fully informed by means of training related to the explosion hazards present at the workplace and the protective measures taken. Furthermore, employees must be made aware of the personal protective equipment they must wear at work. The existing operating instructions must be included in the training. The date, content and participants of the training should be documented in writing.

4.3.3 Applying a work permit system

Maintenance activities that could potentially cause explosions must be performed within a work permit system. A work permit form signed by the person in charge should be handed out. The work permit form should indicate at least the following:

- the work location
- a description and duration of the work to be performed
- the number and names of the employees to whom the work was assigned
- the work equipment to be used
- identification of the hazards
- a list of all required protective measures and confirmation from the person in charge that they have been implemented
- the use of necessary personal protective equipment
- a confirmation that the employees concerned have received the required training

Experience has shown that maintenance work involves a high risk of accidents. Before, during and after completion of the work, it must be ensured that all protective measures have been observed.

4.3.4 Inspections

Before a workplace containing places where explosive atmospheres may occur is used for the first time, its overall explosion safety must be verified. Any conditions necessary for ensuring explosion protection must be maintained. An inspection is also necessary when changes affecting safety levels are made in this area. The explosion protection measures taken in a plant must also be checked for their effectiveness at regular intervals. The frequency of the inspection depends on the type of explosion protection measure. These regular inspections may only be carried out by a competent person.

4.3.5 Sufficient qualification

A sufficient number of employees should be available at each workplace who have the necessary training and experience for the assigned tasks in the field of explosion protection.

4.3.6 Marking

The access points to hazardous areas must be marked with the prohibition sign “Fire, naked lights and smoking prohibited”, the warning sign “Warning of explosive atmosphere” and the prohibition sign “Access for unauthorized persons prohibited”.

4.4 Mitigation measures

4.4.1 General

If the occurrence of an explosion cannot be ruled out, additional measures must be taken. These additional measures do not prevent explosions, but help to limit the effects (accidents and property damage) to a harmless level.

The effects of an explosion can be limited by **mitigation measures**, e.g.

- explosion resistant design,
- explosion venting,
- explosion suppression and
- explosion isolation.

4.4.2 Explosion resistant design

If this measure is applied, all affected parts must be designed to withstand an internal explosion without rupture.

Explosion pressure resistant containers, apparatus and piping can withstand the expected explosion pressure without permanent deformation. The design is based on the expected explosion pressure.

Explosion pressure shock resistant containers, apparatus and piping are designed to withstand the expected explosion pressure in the event of an internal explosion without rupturing, while permitting permanent deformation. After explosions, the affected parts of the plant must be checked for deformation before further operation is permitted.

Figure 6: Explosion venting

4.4.3 Explosion venting

Explosion venting includes all measures to divert the pressure from the originally closed vessels or equipment in a non-hazardous direction. The explosion venting devices are intended to ensure that the plant or operating equipment is not subjected to excessive explosion loads that exceed its design strength. Such pressure relief devices are, for example, bursting discs or explosion doors.

However, explosion venting must not be used if the escaping substances are hazardous, e.g. toxic or corrosive.

4.4.4 Explosion suppression

Explosion suppression systems are devices which, like those of explosion venting, prevent the buildup of inadmissibly high pressure in the course of explosions in containers. They function by detecting the pressure rise or flame propagation at the onset of an explosion and suppressing the explosion by releasing extinguishing agents.

4.4.5 Explosion decoupling

An explosion that occurs in one part of a plant can spread to downstream and upstream plant parts and areas, e.g. via connecting pipes or ducts, where it can generate further explosions. An extreme explosion pressure is caused by displacement, turbulence during the propagation of an explosion. The resulting explosion pressure can be much higher than the maximum explosion pressure under normal conditions and can destroy unprotected areas of the operating equipment or even parts of the plant that are designed to be explosion pressure resistant or explosion pressure shock resistant.

Therefore, it is important to limit possible explosions to single parts of the plant. This is achieved by explosion decoupling.

Explosion decoupling can be implemented by, for example:

- rapid-action mechanical isolation
- flame extinction in narrow gaps or by extinguishing agent injection
- arresting the flames by high counterflow
- water seals
- rotary valves

Figure 7: Explosion isolation using rapid-action valve

Figure 8: Explosion isolation using explosion diverter

5 Explosion protection document

The ATEX User Directive provides for the entrepreneur to prepare an explosion protection document.

This document should be prepared initially for each process and facility and updated in the event of changes.

Essentially, the explosion protection document contains much of the information described in this brochure.

For example:

- The risk assessment and the measures taken to mitigate the risk,
- The zoning of the different work areas,
- Training and maintenance procedures, and
- Information on how coordination of safety measures is be achieved.

National aspects

Germany

In Germany, the provisions of Council Directive 1999/92/EC are transposed:

- by the Ordinance on Hazardous Substances – GefStoffV "Ordinance on Hazardous Substances of 26 November 2010 (Law Gazette I p. 1643, 1644), last amended by Article 148 of the Act of 29 March 2017 (Law Gazette I p. 626)"
- with regard to the inspection obligations imposed by the Ordinance on Industrial Safety and Health – BetrSichV – "Ordinance on Safety and Health Protection in the Provision of Work Equipment and its Use at Work, on Safety in the Operation of Installations Requiring Monitoring and on the Organization of Occupational Health and Safety" of 3 February 2015 (Law Gazette I p. 49), as last amended by Article 5 (7) of the Ordinance of October 2017 (Law Gazette I, p. 3584)

Thematic focal points of the GefStoffV and BetrSichV:

- Hazard assessment (see § 3 BetrSichV or § 6 GefStoffV)
- Explosion protection document (see § 6 (9) GefStoffV)
- Inspection of work equipment (see § 14 BetrSichV)
- Special regulations for plants requiring monitoring (see section 3 BetrSichV)
- Zone classification of potentially explosive atmospheres (Technical Rules for Hazardous Substances – TRGS 722 – Avoidance or limitation of hazardous explosive mixtures Edition: February 2021 (Joint Ministerial Gazette 2021 pp. 399–415 [No. 17–19] amended Joint Ministerial Gazette 2022 p. 196 [No. 8]))
- Minimum requirements for improving the safety and health protection of employees who may be endangered by hazardous explosive mixtures (§ 11 GefStoffV in connection with Annex No. 1)
- Criteria for the selection of devices and protection systems (see Annex I No. 1.8 paragraphs 1–3 of the GefStoffV)

Contact

Germany

Contact persons are the staff of the responsible accident insurance institutions and the staff of the state occupational health and safety authorities.

Austria

If you have any further questions on this topic, please do not hesitate to contact the AUVA regional office responsible for you.

Note:

To deepen your knowledge in explosion protection you can use the brochures of the International Section of ISSA for the Chemical Industry:

- Gas explosions – protection against explosions caused by flammable gases, vapors or mists
- Dust explosions – protection against explosions due to flammable dusts
- Dust explosion prevention and protection for machines and equipment
- Dust explosion incidents – analyses of dust explosions in industry and commerce
- Practical assistance for the preparation of an explosion protection document

The following ISSA Prevention Sections participated in the brochure.
They are also your contacts:

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The ISSA

Providing social security

ISSA, the International Social Security Association is the world's leading umbrella organization for institutions, government agencies and authorities concerned with social security.

In a narrower sense, social security means protection against the consequences of "social risks". In addition to reduction in earning capacity due to occupational accident, occupational disease and occupational disability, this also includes illness, unemployment, assumption of family burdens, ageing and death of employed persons. In a broader sense, social security also includes an active labor market policy, a public education system and a balancing tax policy.

The ISSA was founded in 1927 by 17 European non-governmental organizations as the "International Conference of National Unions of Mutual Benefit Societies and Sickness Insurance Funds". Today, the ISSA has around 350 institutions, government agencies and authorities in more than 150 countries on all continents and is based at the United Nations International Labour Organization (ILO) in Geneva. The substantive work is carried out in 13 specialist committees, including those focusing on occupational accidents and diseases, health benefits and health insurance, employment policy and unemployment insurance, and family benefits and survivors' insurance.

Preventing occupational risks

The "Special Commission on Prevention" plays an important role within the ISSA. It consists of 14 international sections and deals with work-related risks in various sectors such as the chemical industry, mining, electricity and transport industry, but also with cross-cutting issues such as machine and system safety, information and prevention culture. The Special Commission coordinates the joint activities of the International Sections on Risk Prevention and other ISSA prevention activities.

As one of the first sections of the Special Commission, the International Section on Prevention in the Chemical Industry was founded in Frankfurt am Main in June 1970. It is committed to the prevention of occupational accidents and diseases in the chemical and allied industries, particularly in plastics and rubber, paints and coatings, pharmaceuticals and cosmetics, and specialty chemicals and petroleum refining. The chair and secretariat are held by the Berufsgenossenschaft Rohstoffe und chemische Industrie in Heidelberg.

In 1975, the ISSA International Section on Machine and System Safety was founded. Its objective is to increase safety and health protection at work worldwide in the field of machine and system safety. The chair and secretariat are held by the Berufsgenossenschaft Nahrungsmittel und Gastgewerbe in Mannheim.

Chemical Industry | Machine and System Safety | Transport | Construction Industry | Information | Mining Industry | Agriculture

Communicating expertise

A special thematic focus in the chemical industry is the handling of hazardous substances and the resulting health and explosion hazards. In 1978, therefore, the working groups "Hazardous Substances" and "Explosion Protection" were formed at the Section for Prevention in the Chemical Industry. In order to exploit synergy effects and increase efficiency, the "Explosion Protection" working group merged with the corresponding team of the Section on Machine and System Safety in 2008.

Intensive informal discussions are held in the working groups, and brochures and instructional media are also produced and workshops organized in order to promote an international exchange of experience among experts and to develop target-oriented solutions for selected problems.

In this way, the Section on Prevention in the Chemical Industry and Section on Machine and System Safety want to contribute to a high level of technology that is comparable among industrialized countries and also pass on their knowledge to countries that are still less developed industrially.

Legal Notice

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ISSA Section on Machine and System Safety

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Health Services | Electricity, Gas and Water | Research | Iron and Metal Industry | Culture of Prevention | Education and Training | Trade

issa | INTERNATIONAL SOCIAL SECURITY ASSOCIATION
Section on Prevention in the Chemical Industry
Section on Machine and System Safety

Identification and evaluation of hazards, determination of measures

Part 7: Explosion hazards

Safety and health at work are closely related to the social and economic development of our society and are one of the priorities in the member states of the EU. The directives issued for this purpose require that safety and health at the workplace must be ensured and continuously improved through necessary measures. The approach must be preventive, i.e. measures must be implemented before unacceptable risks endanger the safety and health of workers.

The EC Framework Directive 89/391/EEC requires the employer to carry out a risk assessment. In accordance with the requirements of the European Union, this framework directive must be transposed into the national law of each EU country. Often the terms "risk assessment" and "hazard assessment" are used side by side in different countries. Risk assessment is the central instrument for ensuring safety and health protection in the workplace. In doing so, the employer must inform himself about and take into account the respective state of the art, taking into account the existing hazards.

This Part 7 of the Guide for Risk Assessment in Small and Medium Enterprises focuses on hazards caused by explosions. It aims to raise the awareness in small and medium-sized enterprises to such hazards, to provide assistance for the corresponding risk assessment and to point out possible protective measures so that safe working is made possible and accidents are avoided. The measures required in individual cases must be determined in the respective company against the background of the specific operational situation and the current national legal requirements.

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