Contents

1. FIRE SAFETY PROCEDURES

Thoughtlessness and carelessness are often the reason that billions in material assets are burnt in Germany every year.

For this reason, fire is of particular importance in the accident prevention regulations. Consider where and when there is a risk of fire within the company.

The following are common causes of fire:
(a) defective, overloaded electrical equipment and installations
(b) improper fireplaces
(c) spontaneous combustion of oily materials, rags
(d) careless welding and soldering
(e) careless handling and storage of flammable liquids and materials, ignorance of the dangers
(f) lack of or failure of fire-fighting equipment
(g) neglecting the daily removal of combustible waste
(h) sparks
(i) construction methods which do not impede fire or are not fire-retardant
(j) overheating of machines and engines

If, despite all the relevant precautions having been taken, a fire should occur, then sensible operational fire-safety procedures need to ensure that it cannot progress into a fully developed fire.

This is regulated by § 43 of the VBG 1:

Measures against incipient fires

§ 43 Para. 1:
At or in the vicinity of work places, highly flammable or spontaneously flammable substances may only be stored in quantities necessary for the progress of the work.

This provision includes the removal of waste, leftovers and cleaning materials no longer needed for the work.

§ 43 Para. 2:
If flammable materials or those liable to spontaneously combust are stored in a quantity which in the event of fire may result a destructive fire (the area is at risk of fire), then this area is to be marked as such clearly and permanently (see Fig. 1).

Fire, naked flames and smoking prohibited
Shape: Round
Colour: White background, red border and diagonal line, black symbol

Warning of flammable materials
Shape: Triangular
Colour: Yellow background, black symbol and contrasting edge

Additional text for ex-areas "Explosionsgefahr" (Danger of Explosion)
Shape: Rectangular
Colour: White background, red border and black writing

Figure 1: Signs indicating areas at risk of fire and explosions

Open fire, naked flames and smoking are prohibited in these areas.

§ 43 Para. 3:
Open fire and other sources of ignition must be kept away from areas at risk of fire. Smoking in these areas is prohibited. This prohibition is to be signposted clearly and permanently.

No smoking
(Shape: Round; Colour: White background, Border and diagonal line: red; Symbol: Black)

Figure 2: Sign indicating prohibition of smoking

Fire extinguishers and fire-fighting equipment

Every company needs to have fire-fighting equipment and this must be protected against damage which could affect its ability to function.

Fire-fighting equipment of the type and size appropriate to the company must be provided and ready to use. Bad weather, vibration or other external influences must not affect their functionality.

Manually operated fire-fighting equipment must be quickly and easily accessible at all times. This rule is not only contained in VBG A1 but also in the directive on work places ASR 13/1 and 2 "fire-fighting equipment" and in the rules for equipping workplaces with fire extinguishers ZH 1/201.

According to Article 39 Paragraph 3 of VBG A1, safety devices to prevent or eliminate hazards, such as emergency lighting, fire-fighting equipment or extractor systems, have to be serviced and tested for their ability to function regularly. The tests must be carried out by "competent personnel" in the sense of DIN 14 406-4. Further, these tests must be carried out at least once a year for safety equipment, with the exception of fire extinguishers. Fire extinguishers and ventilation equipment must be tested every two years. States' goods and business premises regulations require the testing of fire extinguishers at least once a year.

Table 1: The following number of fire extinguishers must be provided are

Extent of the fire	Number of extinguishers size IV	Sufficient for workplace with an area of	Additional extinguishers for larger workplaces
(a) low risk of fire, such as mechanical workshop etc.	1	50 m²	-
	2	150 m²	1 extinguisher for each extra 250 m²
(b) medium risk of fire, such as office space and storage of materials with low fire load	1	50 m²	
	2	100 m²	1 extinguisher for each extra 250 m²
(c) greater risk of fire, such as operational areas and storage of metal with a high fire load, flammable liquids and gases, woodworking etc.	2	50 m2	2 extinguishers for each extra 250 m²

Fire classification DIN EN 2:

Fire class A: solid ordinary combustibles	Materials to be extinguished
Fire class B: liquids	
Fire class C: gases (also pressurised gasses)	
Fire class D: metals	

Special protective measures are to be taken when electrical equipment is present, according to VDE 0132.

Figure 3: Fire extinguishers

§ 43 Para. 5:
The places where fire-fighting equipment is kept are to be clearly and permanently marked as such, unless the equipment is automatically or centrally controlled.

This requirement is met if a fire safety sign F 04 "Feuerlöschgerät" (fire-fighting equipment) as of VBG 125 is in place.

In the following figure, 4, the fire safety signs are shown according to VBG 125.

The symbols are shown in white on a red background.


Fire hose


Fire escape


Fire extinguisher


Fire alarm


Directional arrow


Equipment for fire fighting

Figure 4: fire safety signs (Background: Red; Symbol: White)

Behaviour in case of fire

According to BGV A1 § 43 Para. 6,
There must be enough persons who are familiar with the use of the fire-fighting equipment.

An emergency plan must be made in case of fire! This also applies to small and micro-enterprises.

The company's fire safety regulations must also be available!

Figure 5: Emergency plan

Figure 6: Company fire safety regulations

Figure 7: Instructions in case of fire

§ 43 Para. 7:
Automatic fixed fire-fighting equipment which can be hazardous when in use must be fitted with automatic warning devices.

§ 43 Para. 8:
A written record is to be kept of the fire-fighting equipment tests described in § 39 Paragraph 3.

The written record of such an examination is to take the form of a test certificate or a test report.

The following workplace fire prevention measures have proven their worth in normal working conditions:

Workplace fire protection measures

1. Keeping the company and in the workplace orderly and clean
2. Storing flammable materials securely
3. Installing all electrical installations correctly
4. Taking care when using an open fire
5. Inspecting the plant after work has finished by employees and by the supervisor
6. Provision of manual fire extinguishers
7. Training in the use of fire extinguishers
8. Fire detection and alarm systems
9. Informing and supervision of employees
10. Fire safety regulations
11. Preventing the accumulation of flammable and inflammable substances
12. Eliminating and avoiding sources of ignition

Where a workplace is not constantly occupied and so detection of fire cannot always be guaranteed, detection can be offered by automatic alarm systems. A range of systems is available, primarily distinguished by the way the fire is detected:

- Ionization detectors respond to invisible and visible smoke
- Optical detectors respond to visible smoke
- Maximum detectors respond when a predetermined maximum temperature is reached
- Differential detectors respond to a given temperature increase per unit of time

- Maximum-differential detectors respond to a given temperature increase per unit of time or when a predetermined maximum temperature is reached
- Infrared detectors react to infrared radiation
- Flame detectors respond to the infrared radiation of the flame in connection with their specific flicker frequency
- and there are also others

The following is a list of fixed fire extinguishing systems, which may function automatically:

- Sprinkler system
  fixed pipeline network fitted to the ceilings of the rooms to be protected with closed water spray nozzles (sprinklers) which open when exposed to heat

- Deluge and water spray systems
  similar to the sprinkler system, but the nozzles are always open, the water being held back by the deluge valve

- Foam system
  admixture panel with the tanks for the foaming agent and water supply; pipelines to transport the water / foam mixture, foam nozzles to form the foam with air, foam pipes to take the foam to the target to be protected

- CO2 system
  fixed pipes from carbon dioxide storage containers (high pressure systems: CO2 cylinder banks; low pressure systems: refrigerated container) to the protected premises or objects; piping system with open nozzles; shut-off valve on the CO2 storage containers; after the initiation systems activate, there is a delay of at least 20 seconds before the CO2 starts to flow, during which there is an audio signal, in order to aid personal safety

- Powder plant
  similar construction to carbon dioxide systems; but instead of the CO2 bottles, it has a container for powder and foaming agents

Smoke and heat venting systems also play an important role. In case of fire, they are triggered, either manually or automatically, to conduct smoke and heat away.

There are similarities with preventing explosions.

Measures for the prevention of explosions:

§ 44 Par. 1:
Measures must be taken if, when dealing with combustible material, there is a danger of explosion through the creation or release of gases, vapours, mists or dusts, or an explosive atmosphere. These measures must

- prevent or restrict the formation of explosive atmospheres in hazardous quantities, or
- prevent the ignition of the explosive atmosphere.

§ 44 Par. 2:
If it cannot be ruled out that explosive mixtures of gases, vapours, mists or dusts may collect inside of containers and equipment in hazardous quantities and that there may be sources of ignition, measures must be taken to prevent dangerous effects should an explosion take place in the interior.

Article 44 Paragraph 3:
In potentially explosive atmospheres, ignition sources must be avoided; the use of an open fire, the use of an open flame, and smoking shall all be prohibited. This prohibition is to be signposted clearly and permanently.

§ 44 Par. 3:
Areas in danger from explosions are to be signposted clearly and permanently.

Escape and rescue routes

All paths, stairs, rescue hatches and other openings within the workplace via which employees can bring themselves of be brought to safety in case of danger are termed the escape and rescue routes.

In some cases, escape and rescue plans are required, which must be indicated in the company - for example by signposting. Furthermore, in such cases, regular drills are required (at least once per year). Escape and rescue routes are to be clearly marked with standardised escape signs according to VBG 125.

Emergency exit / fire escape

Emergency route / escape route

Hazard dury point

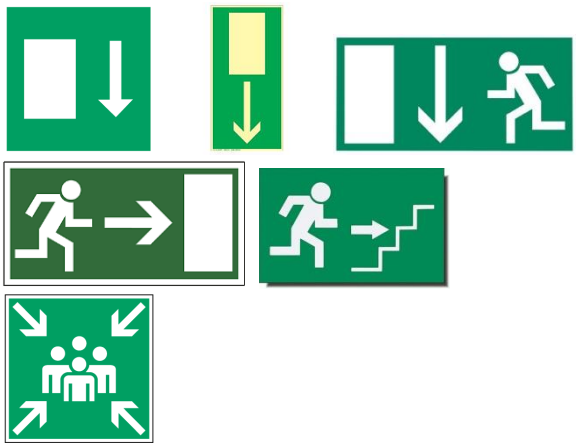


Figure 8: Escape signs for escape routes and emergency exits (Background: Green; Symbols: White

2. REVIEWING AND ENSURING HEALTH AND SAFETY PROCEDURES

According to the law on company doctors, safety engineers, and other professionals for safety at work of 12 December, 1973 (Federal Law Gazette I, Para. 1885), last changed on the 19 December, 1998 (Federal Law Gazette I, Para. 3843), an employer has to appoint a company doctor, in addition to people responsible for health and safety at work. The appointment must be made in writing.

The appointment must be made, if required by:

1. the type of operation and associated risk of accident and danger to health for the employees,

2. the number of workers and the composition of the workforce, and

3. the business organization, in particular in terms of the number and the type of the persons responsible for occupational health and safety and accident prevention.

Alongside the rules contained in the Industrial Safety Act (ArbSichG) mentioned above, the requirements of the Industrial Protection Act (ArbSchG) and the rules of trade associations must also be kept in mind.

3. TASKS OF COMPANY DOCTORS AND OF HEALTH WORKERS (FIRST RESPONDERS)

The extensive tasks of company doctors can be found in Section 3 of the Industrial Safety Act.

The following is an extract:
(1) Company doctors have the job of assisting the employer in the fields of occupational health and safety, and the prevention of accidents, and for all questions regarding health protection.

In particular, they must

1. advise the employers and anyone responsible for occupational health and safety and accident prevention, in particular about
   a) the planning, execution, and maintenance of equipment and of social and sanitary facilities,
   b) the procurement of technical equipment and the introduction of working methods and agents,
   c) the selection and testing of body protection,
   d) psychological and psychological issues at work and other ergonomic and work hygiene issues, in particular working pace, working hours and breaks, design of working areas, the procedures and the working environment,
   e) the organisation of "first aid" in the company,
   f) questions regarding changing of jobs, as well as the integration and reintegration of people with disabilities into work processes,
   g) the assessment of working conditions;

2. examine workers, medically assess and advise them, and record and evaluate the findings,

3. observe the implementation of occupational health and safety and accident prevention and in connection with this
   a) inspect the workplaces at regular intervals and inform the employer or person responsible for occupational health and safety and accident prevention of any shortcomings found, to propose measures to eliminate these shortcomings and to work towards their implementation,
   b) ensure the use of body protection,
   c) investigate the causes of work-related illnesses, record and evaluate the results, and propose measures to the employer to prevent these illnesses.

4. work towards all those working in the company behaving according to the requirements of the health and safety and accident prevention rules, in particular instruct them on the risks of accident and health risks, which they may be exposed to at work, as well as on the equipment and measures to prevent these risk, and involve themselves in the operational planning and training of "First aid" assistants and medical personnel.

(2) By request of an employee, the company doctors must advise them of the results occupational health studies; § 8 Para. 1 Sentence 3 shall remain unaffected.

(3) Checking sick notes does not belong to the tasks of the company doctor.

Of course, only those entitled to practise as doctors may be appointed. The doctor appointed must but also have the necessary occupational health expertise (see § 4 of the Industrial Safety Act). In their field of work, the company doctor is to be free from direction.

Figure 9: Emergency telephone directory

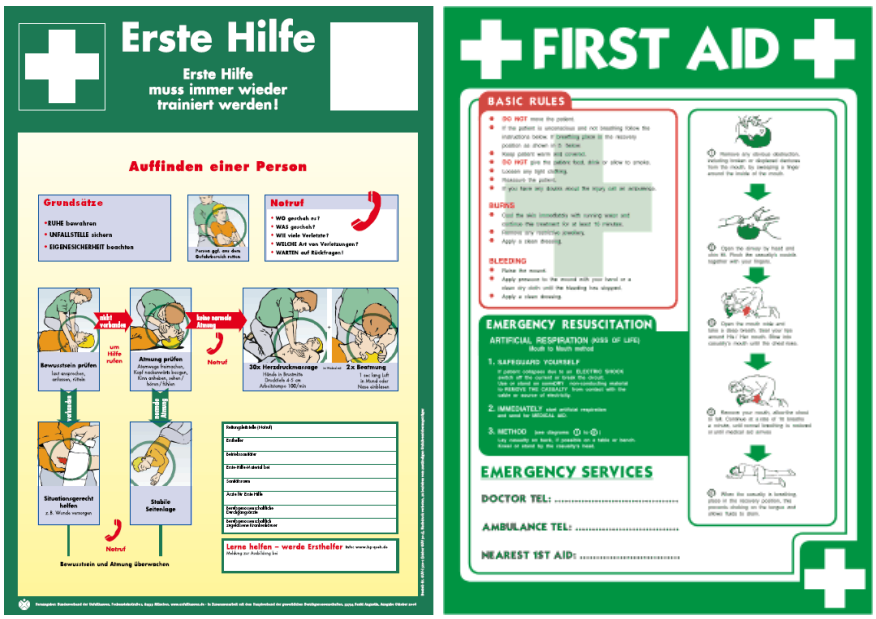


Figure 10: Emergency telephone directory

§ 12: Labelling:

The entrepreneur has to ensure that the first aid facilities, and the places where first aid supplies, equipment for rescue and transporting the rescued are kept are identified by the correct signs.

§ 12 says:

For labelling, see the rules for prevention of accidents (UVV) "Safety signs at the workplace" (VBG 125). With regard to the obligations on labelling, see § 38 Para. 2 Sentence 1, § 39 Para. 3 and § 49 Para. 1 and 2 of the workplace regulations and also the directive on work places ASR 39/1,3 "means and facilities for first aid".


Emergency – first aid


Stretcher


Emergency telephone


Emergency/safety shower


Eye shower


Doctor


Directory of first aid equipment

Figure 11: Signs for first aid facilities (Background: Green; Symbols: White)

Identifying places where first-aid kits are kept

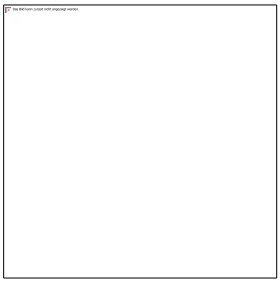
The places where dressings are kept are to be permanently labelled with a white cross on a square rectangular green background with a white outline, so as to be clearly visible.

Company first-aid kit C/D
DIN 13164, small
Container: Plastic, 260 x 160 x 70 mm
(otherwise similar to DIN 13169, large)

Company first-aid kit E/F
DIN 13169, large
Container: Steel, painted green with a rubber seal,
350 x 250 x 100 mm

First-aid cabinet - small
Content is equivalent to C/D - DIN 13164
Cabinet made of sheet steel, white, lockable,
one door, fixed shelf
Size: 360 H x 290 W x 140 D mm

First-aid Cabinet - large
Content is equivalent to E/F - DIN 13169
Sheet steel, white, lockable, two-door,
4 shelves, 2 drawers, 6 door shelves on the inner side of the doors
Size: 450 H x 400 W x 170 D mm



4. TRAINING PROCEDURE VIA AN EXAMPLE

4.1 The importance of regular and systematic training

For labelling, see the rules for prevention of accidents (UVV) "Safety signs at the workplace" (VBG 125). With regard to the obligations on labelling, see § 38 Para. 2 Sentence 1, § 39 Para to be carried out with a certain **regularity**.

The advantages of this are:

- The employees are always kept up-to-date with the state of the art and thus loses their fear of change.
- Being always informed, they can share this information with workers and/or colleagues.
- They feel important and that interest is being taken in them and are therefore motivated.

Instruction is the main tool of this training. This should be systematic, which here means "according to a plan" or "methodically".

The word **"method"** comes from the Greek and means: deliberately embark on a path, to achieve a specific goal.

What path do we mean here?

It concerns the way in which the "instructor" leads the employee to the educational objectives. This path can be prepared carefully; individual steps and objectives should be set so that the amount of material remains manageable and in this way can gradually be better understood.

It is, however, also possible to instruct spontaneously, without necessarily laying out an accurate plan. Unfortunately, this is likely to be at the expense of a systematic method of education staff. In this way, it is easy to lose sight of the goals.

4.1.1 Advantages of systematic instruction

The staff are guided step-by-step to their objectives.

One talks about the

- The systematic approach
  - one topic based on another

and the

- educational system
  - from light to heavy
  - from simple to composite
  - from near to far

In this way, the employee trained is not overwhelmed and so demotivated.

- The person trained can create precise concepts in advance and is ideally prepared. It is true that it takes a great deal of time to create these documents.

However, you should bear in mind that you can access the documents at any time to train someone.

- With the help of systematic instruction, the staff are better able to
- set themselves up for the topic, know to what awaits them.
- The sequence of the educational procedure has been thought about carefully and in context before the training takes place.
- By instructing systematically, one can avoid forgetting or skipping parts of the concept.

4.1.2 Choosing where the training takes place

There are various places to learn depending on the theme.
Taking a company involved in batch production in metal work, in many cases instruction at the work place will be possible which, as one remembers from the instructor's training, takes place directly next to a machine or device.
Theoretical content can be usefully dealt with in a seminar room. Practical instruction can also take place here with the help of media of various kinds such as computer, Hi-Fi and TV, projectors, flip charts and so on.

We will include both possibilities here to explain different training techniques. Firstly,

4.2 Training at the workplace

which is direct practical training.

We assume a training course with a practical subject.

In your company there are 20 trained and 10 untrained employees. Those which are not trained need to be taught as aspiring master craftsmen.

The method of instruction will be explained, based on following topic:
"Handling a fire extinguisher"

The content of the training should be chosen carefully. It should not be to extensive and not too short. It should be understandable and clearly expressed, the employee should know in advance what theme will be addressed on the day. In this way, he or she has the ability to adapt and to think about the subject in advance.

4.2.1 Preliminary considerations

Before we consider how the instruction is carried out, we should conscious of who we want to train.

These considerations will certainly seem redundant to some. However, the success of the training depends on the composition of the staff.

Consider the following questions:

- How many employees can I train at the same time on the subject chosen?
  - When handling a tricky machine: one or two people
  - When training in health and safety: up to 20 people
- What should be considered when putting together the team?
  - Background: Differences in understanding
  - Age: Generational conflict?
  - Gender: Differing reserves of strength available
- What are the participants' family situations?
  - Such as someone who may be a candidate for divorce: handle with particular care
  - Death in the family...
- What is already known from the material?
  - Individual knowledge on the themes
- What time of day and which day of the week is best for the training?
  - Taking into account the daily and weekly performance curves.

4.2.2 Success from employee activity

To train the day's topic most successfully, look again at the statistics from the instructor's training. See Figure 12:

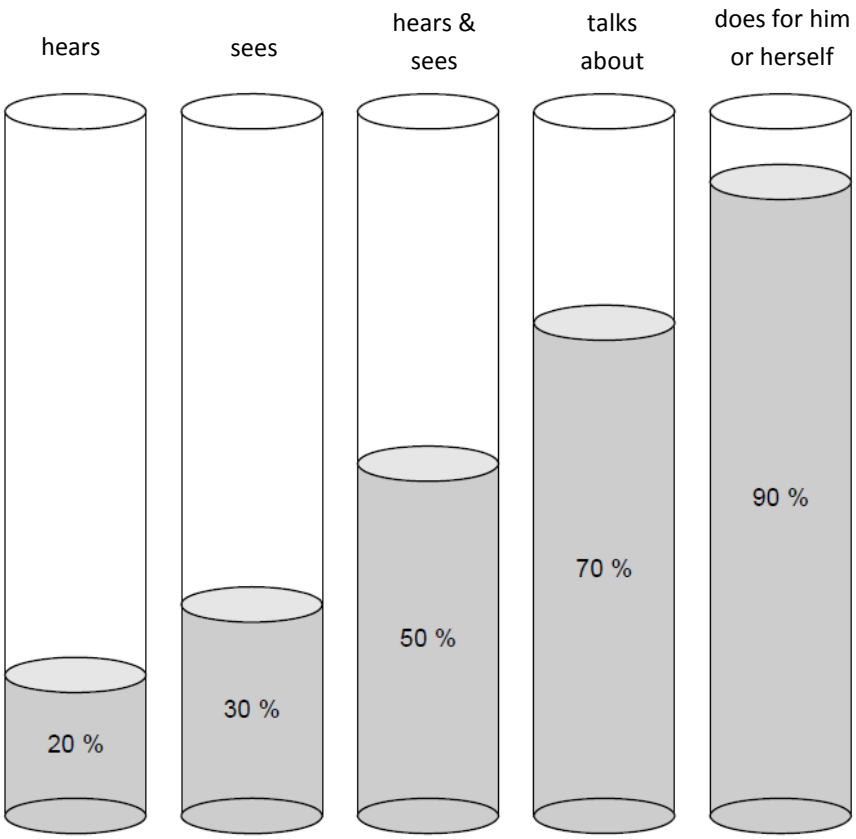


Figure 12: A person remembers….

It therefore follows logically that the more I involve the participants in the activity, the faster they will understand the subject matter and the less necessary it will be to repeat the training – saving the managements time!

4.2.3 Instructing by the “four-step method”

A common way of training is the four-stage method, which we briefly explain.
The trainees proceed through the following steps:

1st Step: Preparation
In this step, all everything necessary, objects, rooms and training materials are set-up. The participants have already been invited, agree on the topic, and are introduced to the subject in a professional way.

2nd Stage: Demonstrate
Now, the trainer goes through the subject matter step by step. He takes each individual point slowly, ensuring that the staff are watching carefully; explains the procedure; and asks questions about each step, making sure that the point has been understood. The staff are also allowed to ask question, keeping them active and aiding their memories. It is recommended that demonstration and imitation (listed here as the third stage) are alternated. In this way, course participants can follow the contents step by step so that they have no unanswered questions remain before going to the next step. Thus, the objective is split into manageable parts, and the participants are not overwhelmed by a big block of material all at once.

3rd Step: Imitate
Here the group slowly imitates the steps made consolidating the knowledge learned with their own practice. While imitating, they should explain what they are doing, in what way and how. The participants are active and concentrated. The trainer can eliminate errors and answer questions immediately. At the end, the participants should summarise the process once more.

4th Step: Practice
After all the steps have been completed, the trainer should have prepared material with which the participants can practice unaided. Although the coach is still available, he or she is only turned to in an "emergency", making the participants more independent.
Social skills are also promoted within a group of workers such as "working with one another", tolerance and other virtues.
Here, they can practise themselves and remember (see Figure 12!) up to 90% of what has been covered, as a result of having done it on their own.

4.3 Written lesson plan

Here is a concrete example of written lesson plan showing how it can be constructed ideally. As above, it is for training in the workplace!

4.3.1 Lesson plan

Theme:	"Handling a fire extinguisher"
Day of training:	for example, Tuesday, 9:00 am
Place of training:	Company's courtyard, or other open area
Number of participants:	2
Age:	18 to 48
Educational background:	Trainees with Certificate of Secondary Education
Sex:	1 male and 1 female
Duration:	20 minutes
Duration:	9:00 am to around 9:20
List of equipment:	Paper/wood scraps Metal containers Fire extinguisher Protective clothing etc.

The most important considerations necessary for this training session have already been taken in this document.
As already mentioned, the coach has thought about the composition of the training group, and planned the location and the time required precisely. A checklist can be used for this and is often helpful when preparing.

4.3.2 Objectives

After training, the participants should be able to decide independently on whether a fire extinguisher is needed in a given situation.
They should learn and practice handling the extinguisher. They should recognise the need to keep the devices maintained, so that they are ready for use in an emergency. All training needs to be assigned goals, objectives or training objectives, for every stage. These help the seminar participants to see where they are and where they are going.

Once these objectives are specified, they can then be pursued with a particular strategy. The training system mentioned would be lost without them. The trainer also knows what needs to be mastered in the training.

4.3.2.1 Learning area, aims and objectives

To systematically formulate the objectives of the course, it is necessary categorise them in terms of precision.

These are easy to explain in our example:

Learning area: Accident prevention

Here we only specify the general area which the training will treat. This is made more precise by the aims which follow.

Aims: Behaviour in emergency situations,
Remedial action in case of fire or other situations

These initial topics have now been roughly classified into more specific topics. They are, however, still too extensive for implementation as educational measures. The students would get too much material at once to be able to understand it.

Objectives: To operate an extinguisher
To take measures in case of vapours escaping
To use a respirator
And other topics

Here, we filter out topics from the aims which are particularly suitable for instruction. Their precision allows this content to be conveyed in about 15 to 20min. This strategy prevents one from losing the systematic approach. The trainer can put the objectives in a logical order.

4.4 The procedure and its educational methological justification

4.4.1 Step 1: Preparation

Procedure	Educational-methodological justification
The work/training location	
The courtyard will be shielded enough for this training, with flammable items removed. Paper/wood for combustion will be made ready, next to a metal container to hold the combustion. The fire extinguishers should be functional and tested according to the latest standards.	By organising and preparing the materials effectively, smooth flow of the training session is ensured contributing significantly to the achievement of the learning objectives. The participants will also prepare similarly well, as the example given plays a large role in this.
The participants	
At the start, personal, topics, independent from the topic of training, will be discussed to build personal contact reduce inhibitions and awkwardness.	A relaxed introduction to the training reduces the participants' inhibitions, the conversation receives a personal touch, the trainer takes an interest in the participants.
The topic	
The participants understand the need to know how to handle a fire extinguisher, there having been a fire in the company in the past few years in which many lives could only have been saved by the use of these skills.	By recalling accident prevention measures which have already been discussed, the participants are brought round to the topic. This stresses the importance of the training. The participants will be invited to participate actively.

4.4.2 Step 2: Demonstrate

1. Objective

WHAT?
Take a look at a fire extinguisher 43 A – 12 kg ABC powder 233 B

Cover the most important information as regards
- Functional parts
- Maintenance, etc.

Why is it coloured red?

HOW?
The device is passed to the trainees in the hand one after the other so that other senses are used in addition to vision.

WHY?
The most important data is read, each participant should have had the extinguisher in the hand to ensure an identification with the device.
This step is used as an introduction to the topic. By touching and holding the device the participants get an idea of the weight and the strength needed to handle it. He or she has the ability and the time to look more carefully at the extinguisher and to read important information on it. The trainees, who may have

already had to use an extinguisher, are allowed to speak to and discuss with each other and to ask questions about handling it. Thus a good practical reference point is set up. Also at the same time, right at the beginning,
the participants are encouraged to be actively involved.

2. Objective

WHAT?
Remove the safety pin

HOW?
The trainer pulls the safety pin out (demonstrating) with the appropriate force, this releases the seal (this is explained!). The pin is to be replaced in the device the process is repeated by the participants.

WHY?
The "safety pin" serves as a built-in "safety block", when the extinguisher is moved, problems occur during handling or when it is hung in position. The participants should perform this process themselves (imitating), to get a feel
for the correct force.
Again the participants are actively involved in what is happening. First they watch, then complete the activity themselves in order to get an immediate experience of the process. Explanations are given alongside this, such as on what the safety pin is for.
The trainee asks as many questions as possible in order to let them consider and think for themselves.

3. Objective

WHAT?
Light a fire in the prepared fire container.
Hold the hose and press the lever, keep it aimed at the fire

HOW?
The foam should, be aimed from about 1 – 2 metres away, depending on the heat, and sprayed in bursts. You should walk around the fire in a circle and always extinguish it from the outside.

WHY?
The contents of the extinguisher should not be discharged in panic, but in aimed bursts onto the fire to avoid emptying the extinguisher with the fire still burning! You should circle the fire, because this deprives the flames of oxygen most effectively. Thus, the fire can be suffocated very quickly.

The trainer ignites the fire in the container provided, taking safety into account, the staff keep at a safe distance. Then, the participants should perform the process themselves. The coach demonstrates first, the staff follow afterwards. So they get the total experience of how extinguishing a fire is carried out.

4. Objective

WHAT?
Let the extinguished materials cease glowing, if necessary ensure safety. After the extinguishing procedure arrange for refilling.

HOW?
To ensure that sufficient distance is kept from where the fire has been burning, stop the participants and ask them to take a step back. Participants should discover the manufacturers notice on the fire extinguisher and make proposals for how to proceed.

WHY?
Risk of injury is avoided by backing away from the fireplace. The fire extinguishers should be refilled promptly, so that a functioning extinguisher is to hand immediately in case of another emergency.

At the end of this training, the participants are make active agents again as they make suggestions about refilling the extinguisher. For this purpose, the extinguisher is looked at very carefully again and the address of the manufacturer for refilling is extracted. The importance of immediately ordering a refill is also repeated, and stressed.

4.4.3 Step 3: Imitation

The trainees independently perform the extinguishing procedure

This level is unnecessary in this proposal, as the training consists of demonstration and imitation steps one after the other.

One possibility is to get the participants to complete the whole procedure in one from the first step through to the last step, here Step 4.

The participants should be allowed to do it themselves, collecting their own experience, as far as possible, so that using such a device is a matter of course for them.

The trainer stays near, intervening only when a hazardous situation might arise.
Course participants should explain what they are doing as they do it, so that the trainer can correct immediately any errors.

If the operation is successfully completed, the performance and the quality of their work will be acknowledged, so that the employees feel confident about using a fire extinguisher immediately and without panic, even during an emergency.

Educational-methodological justification

By independently performing the procedure, the individual employees deal with it in detail and gain confidence.
The skills and knowledge which have been passively learnt are consolidated by immediate application.

The trainer only intervenes to assist, letting participants work independently including make mistakes (as far as possible while still avoiding accidents).

Practical application brings two positive results: Success is sustainably secured, because we store 90% of what we do, permanently.

The instructor has the ability to directly control the learning outcomes and where necessary correct individual parts.

4.4.4 Step 4: Practice

The participants are given the opportunity to extinguish material with a fire extinguisher again. Once more in the container. Now the participants are left alone to practise, supporting each other and correcting any mistakes.

The trainer is nearby and can be reached at any time for questions. At an agreed time, the coach will discuss the results and give them constructive feedback.

He acknowledges the attention of the trainees and their good, independent work.

Educational-methodological justification

The skills learned prior to Step 4 now need to be deepened and consolidated. The learning outcomes achieved must be secured.

Through practice, the individual employees gain confidence and skill in dealing with the fire extinguisher.

The largely independent approach increases the self-esteem of the participants and their motivation.

In addition one has an **impact on social skills** with the exercise:
The participants have contact with different personalities, learn tolerance for example, for clumsy colleagues, supporting helpfulness and further key skills. Also they get to know each other by working together like this, which should help the working climate.

For the practical implementation of this training, it is a good idea to have a short, concise script. You should be able to look at the whole thing without having to turn over any pages, and it should contain the key steps and ensures a smooth and seamless process.
The trainer can use this document to keep track of the training and thus ensure that no important details are forgotten.

5. TUTORIAL

Using a fire extinguisher

If no fire extinguisher is available to carry out the training at the workplace, then it is also possible to explain during a tutorial.

In a tutorial, the topic is treated theoretically, i.e. in a classroom. This room should be fitted with educational equipment, for example:

- Overhead projector
- Flip chart
- Blackboard, whiteboard, pin-board
- Cards for meta plans with Braille writing equipment
- Multi-media equipment, such as TV, video, slide projector, etc.

The fire extinguisher is only used as a demonstration object.

In our case, the tools are

- Overhead projector with handmade or photo-copied slides,
- Blackboard with chalk or whiteboard with appropriate pens.

The considerations made previously do not need to be repeated because the participants in our example have not changed.

The training can still proceed in a four-stage method, even if the use of the extinguisher cannot be demonstrated directly. The trainer can still show the use effectively.

5.1 Objectives

After the tutorial, the participants should know about the different fire extinguishers, and recognise the extinguisher present as a powder extinguisher. They understand the various fire classes that must be indicated on the devices.

In addition, they recognise the need to handle the extinguisher correctly and to refill it so it is ready for an emergency. They also understand how to use an extinguisher in case of fire, and that it is necessary to keep to the principles of its operation.

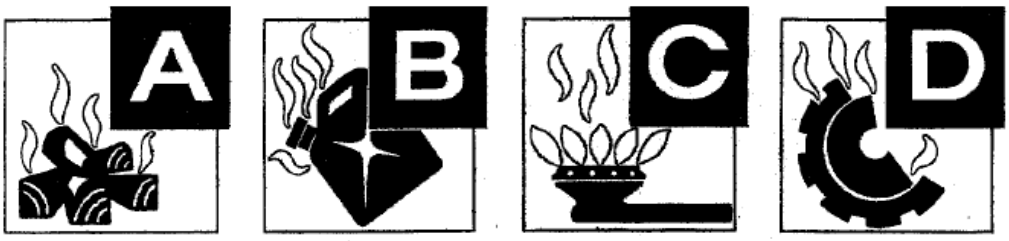
5.1.1 List of equipment

- Slides for overhead projector
- Overhead projector, plastic pointer
- Fire extinguisher 43 A – 12 kg ABC powder 233 B

5.2 The procedure and its educational methological justification

5.2.1 Step 1: Preparation

Procedure	Educational-methodological justification
The work/training location	
The seminar room to be used is prepared in this way: - Overhead projector is operational, - Board is equipped with chalk or pens, - Copies of slides are available, - handmade slides The invitations have been given out, the participants are present.	Organising the resources effectively ensures the smooth flow of the training session is ensured, contributing significantly to the achievement of the learning objectives. The participants will also be prepare similarly well, as they are able to discuss their experiences of the fire which took place recently.
The participants	
The trainer goes into personal matters in the introductory discussion in order to create a good atmosphere. Inhibitions will also be broken down here, which could otherwise interfere with the training.	The relaxed introduction strengthens the relationship between the trainer and the participants. This gives their interaction a personal note.
The topic	
Due to the recent, the employees understand the importance of knowing about fire extinguishers. Thus, the trainees link day's topic with the event.	The repetition of the accident prevention measures using this example introduces the subject in a practical way and thus reinforces the participants' interest in fire extinguisher via their own experiences.



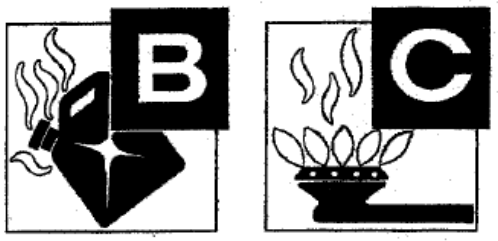
Flammable solids and those form flames or smoulder

Flammable fluids

Flammable gasses

Magnesium, aluminium and their alloys, and sodium and calcium

Fire classification pictogram



Label of a fire extinguisher which is only to be used for fire classifications B and C

Figure 13: Labels

5.2.2 Step 2: Demonstrate

1. Objective

WHAT?
Introducing the fire classes A B C D

HOW?
The fire classes must be indicated on the extinguisher. Examples are shown to the participants on slides. The participants find the icons on the extinguisher.

WHY?
This labelling helps you see which fires a fire extinguisher can contain.

The trainer starts off by introducing the important classes of fire, a theme necessary for the correct handling of an extinguisher. He uses slide copies, which may be coloured. The participants can visually perceive these images, speak
about and find this classification on the extinguisher presented. This means that the knowledge acquired is implemented in practice straight away. So we have a large learning effect. They also understand why is is not possible to use every extinguisher with every type of fire.

2. Objective

WHAT?
Structure and composition of powder fire extinguishers

Stored pressure powder fire extinguisher (total)

1 Test valve
2 Operating lever
3 Operating valve
4 Carry handle
5 Safety pin
6 Container for extinguishing material
7 Ascending pipe
8 Hose with spray-jet

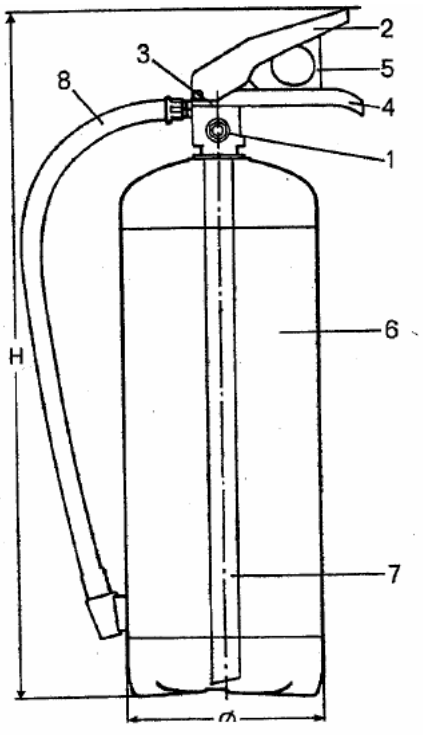
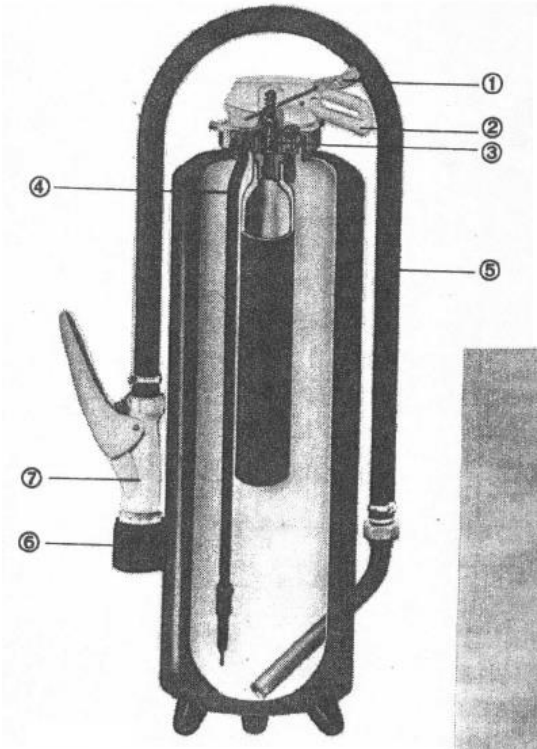


Figure 14: powder fire extinguishers

HOW?
Explanation of the parts of a powder fire extinguisher using a slide or drawing. The participants listen to the explanation.

WHY?
To fully understand this device, you need to know the main parts. Only then can the employees handle the extinguisher properly in practice.

See Figures 14 and 15!!!



1. Release
2. Carry handle
3. Puncturing spike
4. Blowing pipe
5. Hose
6. Spray-jet container
7. Spray-jet

Cartridge-operated extinguisher with internal expellant container (Gloria)

Cartridge-operated extinguisher

Figure 15: Fire extinguishers

The participants now learn theoretically, what they will have to do later in a training at the work place. The schematic drawing on the slide prepared shows them the most important components for handling the device. The slide should have these marked in colour, thus emphasis is put on what the participant really needs to know.

3. Objective

WHAT?
Operational readiness of the equipment, regular maintenance carried out by the manufacturer.

HOW?
Look at where the maintenance company is noted on the extinguisher and consult the safety documentation to see whether maintenance is needed! Note, that the date of the last maintenance needs to be indicated on the extinguisher (theme for a specialist training session at a later stage).

WHY?
To recognise the need for regular maintenance. Otherwise no functional fire extinguisher would be available in the event of a fire.

Here we are very much in the area "learning through understanding". Considering last year's fire, the trainer can point out the importance of maintaining fire extinguishers. What would have happened if there were no functioning extinguisher available at that time? This knowledge is immediately put into practice by the participants as they search on the extinguisher for the manufacturer's notice and compare with the list (see Table 2).

Table 2: Example of a check list for maintenance of fire extinguishers!

	Date	Signature
Production department Extinguishers: PG 6 (TOTAL)		
Warehouse Extinguisher: ABC powder		
Administration Halon extinguisher		

4. Objective

WHAT?
The use of powder fire extinguishers in an emergency
See Figure 16.

HOW?
By comparing "correct"and "incorrect", the participants see how one should proceed, and what mistakes can be make.

WHY?
To avoid recklessly risking ones own life, a tactical approach is necessary.
The potential mistakes that can be made when trying to extinguish a fire are shown on a slide or a large prefabricated graphic. By asking the participants questions, the individual cases can be discussed and supplemented with their own experience and thus be transferred into practice.
Questions are a very important tool, here, to keep the course participants actively involved. This in turn provides excellent preparation for any subsequent training at the workplace.

Fire extinguishers

How are powder fire extinguishers used correctly

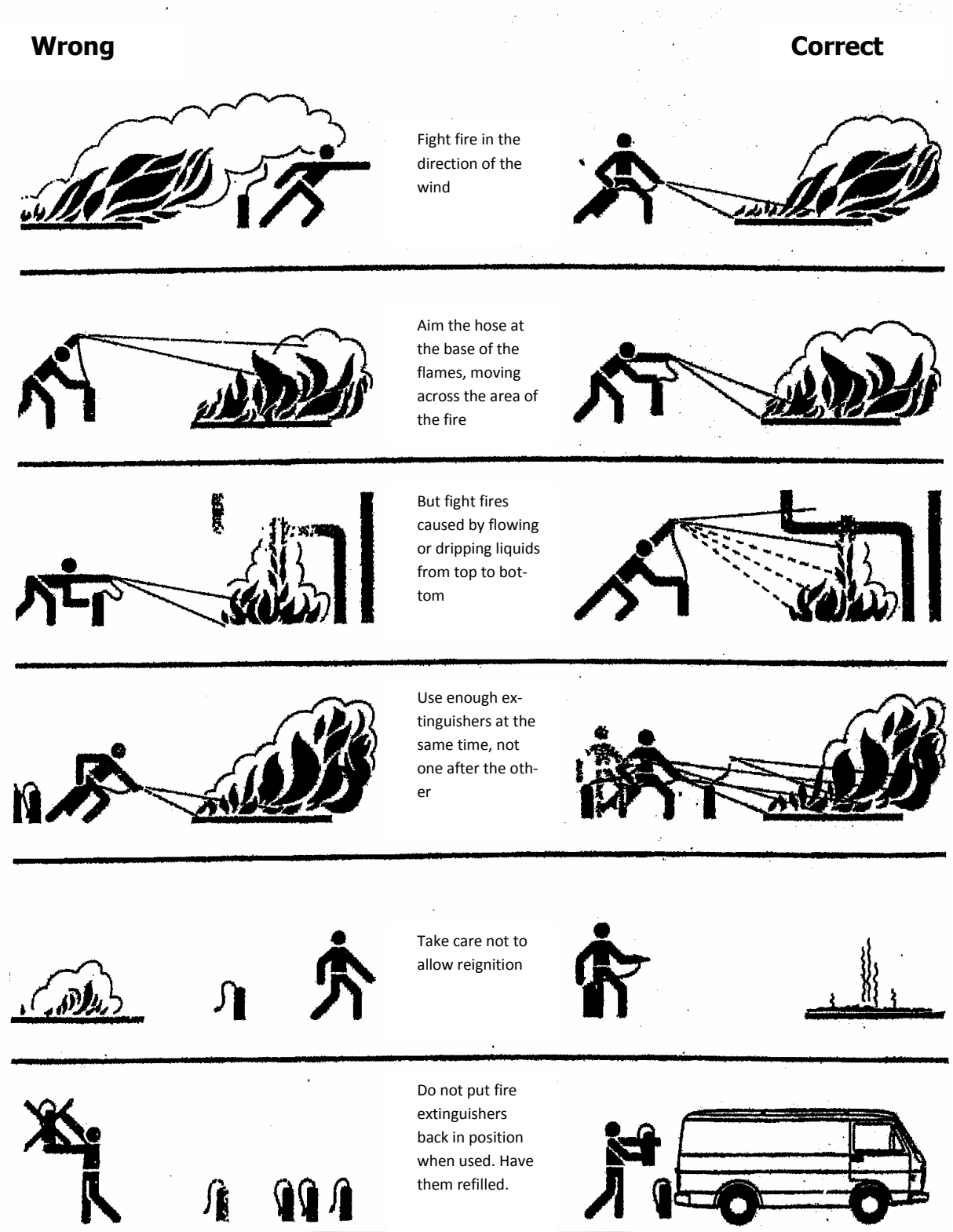


Figure 16: How to use powder fire extinguishers correctly.

5.2.3 Step 3: Imitation

Mental reproduction of the material to be learned
It is also proposed here that, the demonstration and imitation steps are taken in small increments one after the other to make this third step useful. The imitation or mental reproduction is more meaningful as the content is better able to be understood.

It is important however, that the participants can express themselves during the training, the means describing their own experiences too and therefore partake actively in the tutorial.

The trainer can accelerate this process with questions, as mentioned above. They should also be able to analyse the situation, and answer question on the basis for their analysis.

When employees express themselves and their experiences, it is useful pedagogically to acknowledge this. (Praise, recognition, thanks for the idea etc.)

Educational-methodological justification
The participant gain confidence in the theoretical principles that are taught them. They may not only get to know how an extinguisher works, but also the background knowledge to this.

This process, which is usually quite dry, can still be made quite active and interesting, by supporting imitation, i.e. "mental reproduction", via

- "Question- and -answer games"
- Suggestions for discussion
- their own experiences, etc.

Designing the tutorial to be active has two positive aspects:

- The learning outcomes are sustainably retained like in training at the workplace (70% by "talking about it")
- The trainer has the possibility to influence and correct false interpretations in the discussion directly.

5.2.4 Step 4: Practice

Practice is here very difficult, as this tutorial's content is markedly theoretical. Direct practice is practically impossible.

Educational-methodological justification
Here, we should note the difference of whether the training involves trained adults or whether it involves pubescent apprentices.

The latter one can and should insist, that the material be "practised", i.e. learned at home. Because after all, this training is used to prepare for the final exam. It is very helpful to have the training recorded in the final certificate.

In adult education, there is generally no testing on safety. Thus, the "tracking" of learning is almost non-existent. It is important that the objective is revisited practically in a class at the workplace.

The trainer can ask the participants to looking at the graphics again by highlight the importance of this issue.
It is of course clear that such a topic has to be practised. The theory is certainly important, but the practical application needs to be trained.

6. THE USE OF HAZARDOUS SUBSTANCES

6.1 Introduction

Today, there are a variety of hazardous substances which play an important role in our lives. This means we deal with hazardous materials every day:

- in the home,
- in the garden,
- in our spare time,

but also, or even particularly, in the workplace.

Some of these substances are not very dangerous. Others, however, can entail significant risks to people and the environment if handled improperly.

These dangers can be, for example:

- Poisoning
- Chemical burns
- Fires
- Explosions
- etc.

In order to counter these dangers and their negative effects on people and the environment, especially in the execution of technical activities, standardised rules for using dangerous "agents" in the workplace safely have been around for a long time already.

Due to the ever increasing amount of hazardous substances used at different workstations over the last few decades, these rules were starting to be insufficient.

It was necessary to adapt the inadequate legal provisions on handling dangerous agents to the current requirements of dealing with these materials. This legal transition took place in 1980 for industry and commerce.

This was the start of the today's dangerous substance law! The term "agent" was replaced by the term "hazardous substance".

Today, approximately 5,000 hazardous substances with a production volume of more than 15 tons are produced annually in the Federal Republic of Germany. These range from pesticides, through the production of pharmaceutical hazardous substances up to the solvents used every day in industry and in commerce.

The total number of hazardous substances manufactured today is in the hundreds of thousands. The production of these hazardous substances is carried out not only in the Federal Republic of Germany, but around the world. That is why there is a network of legal requirements around the world relating to the handling of hazardous materials. The most important international jurisdiction for the Federal Republic of Germany is that of the European Union.

This is because the European Union's laws heavily influence those of the member states.

The following applies here: European law is to be implement in the Member States of the EU!
The most important legal norm of the European Union is the directive. Directives must be incorporated in the national laws of the Member States within a certain period of time. So this policy instrument is how European law determines national law too.

The rules for the safe use of hazardous materials in the Federal Republic of Germany are the same in each state. They are enshrined in a separate area of the law, the Chemicals Law, as part of German Administrative Law. This law is to protect people and the environment from the harmful effects of dangerous substances, in particular to identify these effects, to avert them and to prevent their occurrence. Federal Chemical Law consists primarily of the following legislation:

- Law on the protection against dangerous substances - Chemicals Act (ChemG)
- Ordinance on Hazardous Substances (GefStoffV)
- Chemical Prohibition Ordinance (ChemVerbotsV)
- Technical Regulations for Hazardous Substances (TRGS)

6.2 The contractor´s responsibility when dealing with dangerous substances in the workplace

Businesses' obligations when dealing with dangerous substances in the workplace
are aimed at:

- Manufacturers of hazardous materials
- Dealers or importers of hazardous materials
- Employers where the work involves the use of dangerous substances.

Under the Chemicals Act, manufacturers and dealers have the following obligations. These obligations include:

- the registration of new dangerous substances,
- the classification of new dangerous substances,
- the packaging of hazardous materials for transport and storage,
- the labelling of dangerous substances and
- the notification requirements of the production and use of old hazardous substances.

The Ordinance on Hazardous Substances (GefStoffV) applies to the placing on the market of substances, preparations and products. It is intended to protect workers' health and safety from exposure to dangerous substances and to protect the environment from substance-related damage. It is a regulation from the Health and Safety Act.

As you have just read, the law divides hazardous substances conceptually into three groups: substances, preparations and products. Therefore we want you to see the most important terms first of all:

Definitions:

Substances
are chemical elements and compounds, whether in a natural state or obtained by any manufacturing process, including any additives necessary to maintain its stability and any impurities arising from production.

Preparations
are mixtures or solutions composed of two or more substances.

Products
are materials or preparations which are produced to have a specific shape, surface or design. This classification is determined more by their function than by their chemical composition.

Classification
is an assignment of hazardous characteristics

Use
is the application, consumption, storage and keeping, processing and handling, bottling, transferring, mixing, disposal, destroying and forwarding within the company.

The Ordinance on Hazardous Substances (GefStoffV) regulates the handling of hazardous substances. For those who manufacture or market hazardous substances, Paragraph 2 (Information on Hazard-substances) and Appendix II (Special Regulations on Information, Labelling, and Packing) particularly relevant. These specify if and from what concentration the substances or preparations must be classified and labelled. Sections 3 (General Safety Measures) and 4 (Further Safety Measures), on the other hand, are of particular importance for the businessman (employer) as a user of dangerous substances and preparations. We find here what are known as the "employer's responsibilities", i.e. the responsibilities which arise for an employer when dangerous materials are handled at the workplace. This also applies to the foreman in his or her role as supervisor. He or she also takes responsibility here!
The terminology is slightly different for the two groups in German: for those who manufacture or bring such goods onto the market we use the term "hazardous substances" whereas for employers, the term used is "hazard-substances".

Hazardous substances
are those substances or preparations that exhibit one or more of the following 15 categories of danger, according to § 3a of the Chemicals Law.
This danger are:
easily flammable, flammable, explosive, oxidising, extremely flammable, very toxic, toxic, harmful, corrosive, irritant, sensitising carcinogenic, toxic to reproduction, mutagenic and dangerous for the environment.

For the employer/user the determination of hazardous substances is significantly wider:

Hazardous substances
According to §3a of the Chemicals Act, hazardous substances are those substances or preparations which have at least one of the following 15 properties. These properties are: explosive, oxidising, extremely flammable, highly flammable, flammable, very toxic, toxic, harmful, corrosive, irritant, sensitising, carcinogenic, toxic to reproduction, mutagenic, harmful to the environment.

For the employer/user, the determination of hazard-substances is significantly wider:
Substances and preparations are called hazard-substances if they display at least one of the 15 hazardous characteristics. However, the classification also includes any substances, preparations or products which

- could explode,
- are chronically damaging in any other way,
- when handled produce or give off hazardous substances or preparations, or
- have been shown to be able to transfer pathogens (germs and other causes of disease).

Two important aspects of the Ordinance on Hazardous Substances (GefStoffV) are risk assessments carried out by the employer and the protection degree (see below). According to §7 of GefStoffV, the employer or supervisor is responsible for determining whether the working conditions present any danger due to hazardous substances.

§7 Ordinance on Hazardous Substances (GefStoffV) – Determining information and risk assessment

When evaluating working conditions according to §5 of the Industrial Protection Act (ArbSchG), the employer firstly has to determine if those employed carry out activities with hazard-substances or if hazard-substances arise or are given off. If this is the case, he or she must judge all hazards to the health and safety of those employed which arise from this considering the following factors:

1. Any dangerous properties of the substances or preparations,
2. Information on health and safety from the manufacturer or distributing company, in particular that contained in safety data sheets according to §6;
3. Amount, type and duration of exposure, considering all exposure pathways and considering the results according to §9 Para. 4 and §10 Para.2;
4. Physico-chemical effects;
5. The possibility of using a substitute (note: "substitute" here means a substance whose use is not or is less dangerous);
6. Working conditions and procedures, including the equipment used and the amount of the hazard-substance;
7. Occupational exposure limits and biological limits;
8. Effectiveness of the safety measures which are relevant or to be taken;
9. The conclusions of occupational medical checks taken.

The employer must only allow activity with hazard-substances to start after a risk assessment has been carried out and the safety measures necessary have been implemented.

The risk assessment must be carried out by a competent person.

Here, the following chemical risks must be taken into account:

- Those arising via inhalation (via the respiratory tract);
- Those arising via contact with the skin and
- Physico-chemical hazards (in particular fire and explosion hazards).

If more than one hazard-substance is present during an activity, any possible interaction between or combined effects of the hazard-substances affecting the health and safety of the employees must be considered in the risk assessment.

The employer may adopt a risk assessment, provided that it comes from an expert agency (manufacturer or distributing company) and fits the conditions in the company. (Caution: Risk assessments must be documented in writing and produced on demand. The document should contain details of which hazards could arise in the work place and which measures need to be taken.)

Ordinance on Hazardous Substances (GefStoffV) §7 continued

(7) The risk assessment may only be carried out by a competent person. If the employer does not have the ability to carry out the risk assessment, then he or she must obtain expert advice. Company doctors and occupational safety specialists are examples of competent persons. The employer may adopt a risk assessment from the manufacturer or distributing company as long he or she carries out the activities according to the specifications and determinations contained within it.

The risk assessment helps the employer to carry out a classification into a protection degree and fix a plan for the measures necessary.
As mentioned earlier, alongside the risk assessment, the protection degree model is important. In this, the works are divided into four degrees of protection, starting from the labelling of hazard-substances: This concept is contained in Paragraphs 8 to 11 of the Ordinance on Hazardous Substances (GefStoffV):

The protection degrees are designed so that they build on each other. So need to for example, in level 4 all measures of the previous stages 1, 2 and 3 are applied.

- **Ordinance on Hazardous Substances (GefStoffV) §8**
  "General principles for prevention of hazards; activities with low danger (protection degree 1)"

  This level concerns the "lowest protection degree" for preventing hazards. These include the following measures:

  - Heeding the requirements of the Technical Regulations for Hazardous Substances (TRGS) and the guidelines of the Commission for Hazard-substances (AGS, established in accordance with §21 of the Ordinance on Hazardous Substances (GefStoffV)).
  - Designing the workplace and organising the work so they are safe.
  - Using only that equipment and those methods and procedures which are suitable.
  - Limiting the number of employees who handle the hazard-substances.
  - Limiting the duration and the extent of the exposure.

- Limiting the number of the hazard-substances present at the workplace to the necessary level.
- Making sure of the safe handling, storage and forwarding of hazard-substances.
- Labelling the hazard-substances with the information essential for the user.
- Labelling of equipment and pipes containing hazard-substances.
- Handling the containers which might contain left-overs safely too.

If the employment consists of activities involving substances or preparations with protection degree one, i.e. low danger, then he or she must take basic protection measures but is free from further responsibilities. He or she need not, for example, record the hazard-substances in the Inventory of Hazard-substances (Register of Hazard-substances) or create operating instructions for them. Personal protective clothing is also not required.
The protection degrees are conceived one on top of the other. So, for example, in Degree 4, all measures contained in the previous degrees, 1, 2 and 3, must be taken too.
In comparison with Degree 1, Protection Degree 2 (normal hazard) requires more extensive measures. The amount of protection for Degrees 3 and 4 increases again and requires further packages of measures.

- **Ordinance on Hazardous Substances (GefStoffV) §9**
  "Basic measures for protecting employees (Protection Degree 2)"

  This is the "standard protection degree" for activities involving hazard-substances. According to the exclusion principle, all materials not contained in Degree 1 but not having the demands of Degree 3 are contained here. The following guidelines must be followed here, for instance, in addition to those above:
  - Making the substitution of dangerous substances with less dangerous ones a priority in order to lower the danger.
  - Keeping a register of hazard-substances.
  - Creating operating instructions.
  - Prohibiting eating and drinking in the danger zones.
  - Offering or requiring medical check-ups.
  - In order to lower the dangers, the following safety measures are required:
  - Suitable procedures and technical furnishings at the state of the art;
  - Collective safety measures at the source of danger, for example reasonable ventilation, including organisational measures.
  - The use of individual safety measures (personal protective equipment...);
  - It must be established whether occupational exposure limits are observed, for example by measurements or other equivalent methods of determination.
  - For activities with hazard-substances without occupational exposure limits (AGW), the efficacy of the safety measures must be shown.

- **Ordinance on Hazardous Substances (GefStoffV) §10**
  "Further safety measures for activities with higher danger (Protection Degree 3)"

This degree is valid for "supplementary measures" when working with toxic and very toxic substances. For example, the following guidelines are to be heeded here:

- Making the substitution of dangerous substances a priority here too, in order to lower the danger.
- The manufacture or use of hazard-substances should take place in a closed system.
- If a closed system is not possible for technical reasons, the danger must be made as low as possible according to the state of the art. This is the case, in particular, for danger of explosions.
- The use of containers that can be closed and sealed during storing, handling and forwarding. Substances and preparations marked with T (toxic) and T+ (very toxic) are to be stored under lock and key [Note: These substances are now labelled according to GHS with "acute toxicity (skull, poisonous), Category 3" and for "T" and "acute toxicity (skull, highly poisonous), Category 1, 2" for "T+"].
- Access to the danger zones must be limited for non-authorised persons.
- The occupational exposure limits must be adhered to.
- Measurements necessary for this are to be taken. They are also to be taken when a change in conditions occurs which could affect the exposure of the employees.
- The results of the measurements are to be recorded and kept, and to be made available to the employees and their representatives.

Ordinance on Hazardous Substances (GefStoffV) §11

"Further safety measures for activities with carcinogenic and mutagenic hazard-substances and those endangering fertility (Protection Degree 4)"

This degree is for use when working with carcinogenic or mutagenic substances or those harmful to fertility. Here is a list of just some of the rules in force here:

- Measurements of these substances must be taken, in particular to determine higher exposure resulting from unpredictable events or accidents in good time.
- Access to the danger zones must be restricted.
- Warning and safety signs including the sign "No Smoking" are to be displayed.
- If it is not possible to keep to the occupational exposure limit, for example in case of break-down, renovation or servicing, then the exposure of those employed must be limited (for example with personal protective equipment or respiratory equipment).
- There is a general responsibility for medical care.

However, if

- the occupational exposure limits fixed by the Commission for Hazard-substances (AGS) are adhered to and
- the activities are carried out in accordance with the Process and Substance Specific Criteria of the Commission for Hazard-substances (AGS), then the requirements are limited to those of Protection Degree 3.

The protection degree can be determined by firstly checking the agreement with the conditions of the relevant protection degree, in order to assign the protection degree given the appropriate coverage.

- For low danger:
  Are hazard-substances only used in small quantities and can no danger be expected? → Protection Degree 1
- For "normal", and not high, danger:
  Might there be hazards due to activities with hazard-substances?
  → Protection Degree 2
- For high danger:
  Are toxic or very toxic substances used? → Protection Degree 3
- For further dangers:
  Are carcinogenic or mutagenic substances used, or those endangering fertility?
  → Protection Degree 4

The assignment of protection degrees is not based solely on the type of hazard-substances, i.e. on their innate hazards. The way in which they are handled during the activities plays an important role when making the decision. Only by considering these factors together can a definitive decision be reached.

The measures mandated by the protection degree are applicable for the safety of the people concerned. The protection degree model aims to ensure that employers determine the danger level of the substances worked with themselves, via the risk assessment, and then take the measures necessary.

So it is not just the labelling of the hazard-substances, but mainly the activities within which the hazard-substances are used, appear or are created which are decisive. The tasks of the employer and therefore of his or her representatives is not limited to determining the risk and implementing the protection concept.
There is also a responsibility to provide information ant this is a further important task for the employer. This information needs to inform the employees handling hazardous substances in the workplace of the potential dangers of the substances and about the measures that can be taken to avert them.

This requirement means that from Protection Degree 2, written company directives need to be created, amongst other things. These instructions need to be understandable both in terms of their structure and language.

Company directives are binding, written directives and rules of conduct concerned with work areas and substances. They are created by the employer for the employees for their activities involving hazard-substances for protection against dangers to health and those stemming from accidents, fires and explosions.

The company directives must contain at least all the following:

1. Information about the hazard-substances present in the workplace, like for example descriptions of the hazard-substances, their labelling and the dangers to health and safety.
2. Information about appropriate precautions and measures which the employees should take to ensure their own safety and the safety of others at the workplace, in particular:
   a) Hygiene regulations,
   b) Information on measures for preventing exposure,
   c) Information on wearing and using protective equipment and clothing,
3. Information on measures to be taken by employees in particular rescue teams, in case of operational disruptions, accidents and emergencies, and measures to prevent such occurrences.

These instructions are to be made available to the employees. Hence they must be made as widely known as possible through leaflets or posters at the workplace. The same is true for all important safety data sheets. The company directives must be kept up to date if there are applicable changes to the working conditions.

Company directives are binding and are mandated by differing regulations, for example GefStoffV, ArbSchG, the Biological Agents Regulation, the Industrial Safety Ordinance and the Accident Prevention. Further remarks on company directives can be found in German Technical Regulations for Hazardous Substances (TRGS) 555 "Company directives and information for employees".

Furthermore, oral training must be carried out with the company directives at the workplace before employment is started and, following this, at least once a year. This training is to be about hazards and safety measures, is to be documented and signed by those trained. This documentation needs to be kept for at least two years. It is almost always the job of the direct supervisor to create these company directives. The responsibility for their being correct is carried by the employer or the executive commissioned by him or her, generally the manager.

Figure 17: Example of company directive

The following should be considered particularly when creating company directives:

1. Local conditions at the workplace
2. Ordinance on Hazardous Substances (GefStoffV) and its appendices
3. Safety data sheets (according to DIN 52900, which may be obtainable from the supplier or manufacturer)
4. Technical rules for hazard-substances and other generally recognised safety, medical and hygiene rules. In addition, manufacturer's information can also be useful, e.g. technical notes and data sheets.

According to the suggestions made by professional associations, which go further than the guidelines of the Ordinance on Hazardous Substances, company directives should contain the following contents:

1. Working area (description of the company, the area of work, the workplace or the activity)
2. Hazard-substances (description)
3. Dangers for people and the environment
4. Safety measures and rules of conduct
5. Behaviour in the event of danger
6. First aid
7. Proper waste disposal/maintenance (for machines/technical equipment)
8. If necessary, consequences of non-compliance

As a company directive has to be based on both the work carried out and the substances used, creating one requires specialist information from both areas. Thus, knowledge of the activities that will be carried out, of the dangers coming from the hazard-substances and that of behaviour during accidents or breakdowns is necessary. Because it is easy to overlook something here, professional associations offer help for creating company directives:

Company directives are divided into those which deal with handling hazard-substances and those which deal with machines and equipment. In both cases, only dangerous activities or those that are relevant for the safety of the employees are regulated.

The Professional Organisation for Raw Materials and the Chemical Industry (BG RCI) has made an interactive computer program available on its website which helps to lead you on your way, from safety data sheets to company directives as regards the Ordinance on Hazardous Substances (GefStoffV).

The program is called "GisChem-Interaktiv" and will help you on your way, from safety data sheets to company directives. You navigate through the safety data sheets with the help of question-answer dialogues. Additional help texts enable you to deal with the individual points in more detail. At the end, you receive your company directive as a Word or PDF document and can save this on your PC.

6.3 The properties of hazard substances

One of the most important prerequisites for taking responsibility for the handling of hazardous substances in the workplace as an industrial foreman is precise knowledge of the properties and the possible dangers of handling these materials.

Official statistics and those from the professional organizations show how necessary this is vividly. In the Federal Republic of Germany, more than 3000 fatal accidents occur when handling dangerous materials. This number is for all accidents, not only those involving commercial activity. Nevertheless, this number is alarming. Also, 180,000 people are treated as outpatients and 7,000 as inpatients for accidents involving toxins, according to the records. There are also 10,000 accidents subject to registration in the commercial sector alone.

These numbers show that the person responsible (= supervisor or foreman) must exercise particular care. And this is not only for his or her protection, but also for that of his or her colleagues and employees.

But what exactly are hazard-substances in the sense of the Chemicals Law?

This question is answered by the Chemicals Act. According to Section 19 Paragraph 2 of ChemG, hazard-substances are:

1. Hazardous substances and preparations with harmful properties for people and the environment and substances and preparations which have any other chronically harmful properties.
2. Substances, preparations and products which can explode.
3. Substances, preparations and products which, when produced or used, can lead to substances fitting the description from Point 1 or Point 2 arising or being released.
4. Substances and preparations which do not fulfill the criteria of Numbers 1 to 3, but due to their physicochemical, chemical or toxicological properties and the way in which they are used or are present at the workplace can present a danger to the health and safety of those employed. ChemG Section 19 Paragraph 2, then, gives us a partial answer to the question we asked at the start of the chapter. However, it does not give us a complete answer.

The next question has to be: What exactly are the harmful properties of substances named in Point 1?

To answer this question, we will need to leaf through the Chemicals Act a little more. Because this question is answered in §3a!

According to §3a ChemG:

(1) Hazardous substances and hazardous preparations are substances or preparations which are

1. explosive,
2. oxidising,
3. extremely flammable,
4. easily flammable,
5. flammable,
6. very toxic,
7. toxic,
8. harmful,

9. corrosive,
10. irritating,
11. sensitizing,
12. carcinogenic,
13. toxic for reproduction,
14. mutagenic or
15. dangerous for the environment;

This excludes the hazardous properties of ionising radiation.

(2) Substances or preparations are harmful to the environment if they or their transformation products can change the character of the ecosystem in relation to water, soil or air, climate, animals, plants or micro-organisms to such an extent that then or later dangers for the environment might arise.

Substances, preparations and products which have one or more of these hazardous properties are to be:

- categorised,
- labelled,
- packaged appropriately

Danger symbols are assigned to hazard-substances for labelling to provide information on the type of danger. However, European chemicals law is currently in upheaval. The Globally Harmonized System of Classification and Labelling of Chemicals (GHS, EC Directive No. 1272/2008) has been in force since January 2009.

This directive gives new regulation to the classification and labelling of hazard-substances and builds upon a global labelling system. This should mean that hazard-substances are categorised and labelled the same way across the whole world. This brings extensive changes.

Manufacturers and users need to say goodbye to the old pictograms and also to the old R and S Statements. Additionally, the hazard-material labelling under GHS is clearly differentiated from the previous system due to the Ordinance on Hazardous Substances. The new elements are:

- GHS pictograms
- Signal words
- Hazard statements
- Precautionary statements

The new GHS pictograms consist of a black symbol on a white rhombus with a red border. The pictures are similar to the previous danger symbols except for three new ones. The pictograms "Gas cylinder", "Exclamation mark", and a symbol for "Health hazard" are new.

The potential level of the danger is indicated with two extra words, "Warning" and "Danger".
The EU commission's draft regulation on GHS allows for a transition period of many years.

Pure substances had to be newly classified and labelled as of 1/12/2010. For preparations (to be known in the future as mixtures) the date is 1/6/2015.

Table 3 shows the new symbols/pictograms according to GHS and Fig. 17 compares the previous hazard symbols to those according to GHS.

Table 3: The new symbols/pictograms according to GHS from 12/2010

GHS hazard pictograms and notes		
For physical/chemical hazards:		
Pictogram/signal word	**Notes**	**usage**
 Danger	GHS01 pictogram: Exploding bomb	■ Unstable explosives ■ Explosives, divisions 1.1, 1.2, 1.3, 1.4 ■ Self-reactive substances and mixtures, types A, B ■ Organic peroxides, types A, B
 Danger	GHS02 pictogram: Flame	■ Flammable gases, category 1 ■ Flammable aerosols, categories 1, 2 ■ Flammable liquids, categories 1, 2, 3 ■ Flammable solids, categories 1, 2 ■ Self-reactive substances and mixtures, types B, C, D, E, F ■ Pyrophoric liquids, category 1 ■ Pyrophoric solids, category 1 ■ Self-heating substances and mixtures, categories 1, 2 ■ Substances and mixtures, which in contact with water, emit flammable gases, categories 1, 2, 3 ■ Organic peroxides, types B, C, D, E, F
 Danger	GHS03 pictogram: Flame over circle	■ Oxidizing gases, category 1 ■ Oxidizing liquids, categories 1, 2, 3 ■ Oxidizing solids, categories 1, 2, 3

 Warning	GHS04 pictogram: Gas cylinder	■ Compressed gases ■ Liquefied gases ■ Refrigerated liquefied gases ■ Dissolved gases
 Danger	GHS05 pictogram: Corrosion	■ Corrosive to metals, category 1 ■ Skin corrosion, categories 1A, 1B, 1C ■ Serious eye damage, category 1
Health hazards		
 Danger	GHS06 pictogram: Skull and crossbones	■ Acute toxicity (oral, dermal, inhalation), categories 1, 2, 3
 Warning	GHS07 pictogram: Exclamation mark	■ Acute toxicity (oral, dermal, inhalation), category 4 ■ Skin irritation, categories 2, 3 ■ Eye irritation, category 2A ■ Skin sensitization, category 1 ■ Specific target organ toxicity following single exposure, category 3 ■ Respiratory tract irritation ■ Narcotic effects
 Danger	GHS08 pictogram: Health hazard	■ Respiratory sensitization, category 1 ■ Germ cell mutagenicity, categories 1A, 1B, 2 ■ Carcinogenicity, categories 1A, 1B, 2 ■ Reproductive toxicity, categories 1A, 1B, 2 ■ Specific target organ toxicity following single exposure, categories 1, 2 ■ Specific target organ toxicity following repeated exposure,

		categories 1, 2 ■ Aspiration hazard, categories 1, 2
Environmental hazards		
 Warning	GHS09-pictogram: Environment	■ Hazards to the aquatic environment ■ Acute hazards to the aquatic environment, category 1 ■ Chronic hazards to the aquatic environment, categories 1, 2

Fig. 18: A comparison of the previous hazard symbols and those according to GHS.

The hazard and precautionary statements are comparable to the old R and S-phrases they replace. However, they have been reformulated as H and P statements. Here, "H" stands for "hazard" and "P" for precautionary.

While the previous R and S-phrases were not subject to a rigid system, the new hazard and precautionary statements are ordered. The numbers have three places

The H-statements are numbered in the following way:

H 2 xx	Physical hazards
H 3 xx	Health hazards
H 4 xx	Environmental hazards

The P-statements are numbered in the following way:

P 1 xx	General
P 2 xx	Prevention
P 3 xx	Response
P 4 xx	Storage
P 5 xx	Disposal

6.4 The Register of Hazard substances

Employers have further responsibilities alongside those involving reporting and supervision which we have already looked at. According to §7 of the Ordinance on Hazardous Substances (GefStoffV), "Gathering information and assessing risk", the employer is obliged to determine if employees carry out activities with hazard-substances or if hazard-substances can arise or be released during these activities.

If a certain degree of danger is exceeded, then the employer is compelled by law to keep a "register of all hazard-substances used in the company". This is generally called an "Inventory of Hazard-substances" or "Register of Hazard-substances".

However, an inventory is not necessary if the hazard-substances do not present a danger for the employees, when their properties and quantity are considered (for example only small amounts).

The inventory of hazard-substances is a list of the hazard-substances used in the company with reference to the relevant safety data sheets.

§7 (8) GefStoffV says:

(8) The employer has to keep an inventory of the hazard-substances used in the company, which refers to the relevant safety data sheets. This is not the case for hazard-substances which according to §7 Paragraph 9 only present a slight danger to the employees. The inventory must be accessible to all relevant employees and their representatives.

Note: According to GefStoffV §25, it is an administrative offence incurring a fine to fail to keep an Inventory of Hazard-substances, or to keep it incorrectly or incompletely.

The inventory must contain at least the following details:

1. Details of the hazard-substance
   - Description of the hazard-substance
   - R-phrases (H-statements)
   - Hazard symbols

2. Quantity range (average quantity at the workplace/work area)
3. Work area (room)
4. Safety data sheets (reference to the safety data sheets with indication of the source and status. The safety data sheets must be on paper or CD-ROM. Currently, a reference to the manufacturer's internet site is not enough.)

It is advisable to also reference the company directives and/or the existing disposal instructions.

The details can be kept in writing or electronically, e.g. on a CD.

The inventory is to be updated to reflect substantial modifications and shall be verified at least once per year.

It shall be kept readily available and submitted to the relevant authorities on request.
Table 4 shows the design of an inventory of hazard-substances.

Table 4: The design of an inventory of hazard-substances (Source: BG RCI)

Gefahrstoff - Verzeichnis

Unternehmen / Betrieb: ..... Erstellt/Überprüft von: .....

Arbeitsbereich: ..... am: .....

Regelmäßig aktualisieren !

Lfd. Nr.	Bezeichnung des Stoffes / Produktes	Ggf. abweichender Handelsname / betriebsinterner Name	Kennzeichnung, Einstufung (Symbol, R-/S-Sätze)	Menge	Lager-/ Verarbeitungsort	Sicherheitsdatenblatt von: (Hersteller, Datum)
1	1,2-Diaminocyclohexan		C * R 34-43 S 26-36/37/39-45-51			
2	Aceton		F Xi R 11-36-66-67 S 9-16-26		!	
3	ISOPAR (KW-Gemische, Gr. 1 (TRGS 900), leichtentzündlich)		F Xn N * R 11-65-66-67-51/53 S 9-16-23-24-33-61-62		!	
4	Kaliumhydroxidlösung, ab 2 % bis 5 %		C R 34 S 26-36/37/39-45			
5	TDI-Isomerengemisch		T+ R 26-36/37/38-40-42/43-52/53 S 23-36/37-45-61		!	

*: Die Einstufung des Stoffes/Produktes kann abweichen – bitte anhand des Sicherheitsdatenblattes ggf. ändern!
!: Zusammenlagerungsbeschränkungen beachten!

The safety data sheet conveys information on safety regarding substances and mixtures, and further information from the relevant chemical safety report about the delivery chain to the user.

It is intended to give the professional user the information necessary about the potential danger and how to handle the substances, so that the necessary health and safety measures and measures to protect the environment can be taken. The structure and contents are set by the REACH regulation {Regulation (EC) No. 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals}.

The safety data sheets must be kept in the company. This can be done on paper or electronically, for example on a CD, or on the company's intranet. A reference to the internet site containing suppliers' safety data sheets is not sufficient.

6.5 Information and regulations for the storage of hazard-substances

Hazard-substances are to be stored so that they do not endanger people's health or the environment.

According to the Ordinance on Hazardous Substances, "storage" means to keep for later use or delivery to others. Storage also includes "making available for forwarding", when this does not take place within 24 hours of the materials being available. This means that the storage regulations are often valid for materials "made available for forwarding". If this working day is a Saturday, then the deadline ends at the end of the next working day.

If, for example, more of a product is made available at a workplace than is used in a day, then the storage regulations must be obeyed.

There are, however, too many regulations on the storage of hazard-materials for us to deal with them all (see Table 5: Overview of the most important legal norms on the storage of hazard-substances).

Table 5: Overview of the most important legal norms on the storage of hazard-substances

Chemicals Act (ChemG)
Chemical Prohibition Ordinance (ChemVerbotsV)
Ordinance on Hazardous Substances (GefStoffV)
Technical Regulations for Hazardous Substances (TRGS)
Technical Regulations governing Combustible Liquids (TRbF)
Ordinance on Industrial Safety and Health (BetrSichV)
Water Resources Act (WHG)
Ordinance on Installations Handling Materials Hazardous to Water (VAwS)
Federal Soil Protection Act (BBodSchG)
Federal Emmission Control Act (BImSchG)
Waste Avoidance, Recycling and Disposal Act (KrW-/AbfG)
relevant state regulations

This is particularly obvious when hazardous substances have several dangerous properties for which there are stand-alone regulations from other areas of law. This is the case, for example, for substances which are flammable and also water-polluting. If one material is "water-polluting" alongside being flammable, then the requirements of the laws for business and chemicals are joined by those from the law on water. This effects, for example, the arrangement of the storage area (floor) which needs to prevent contamination of groundwater with the water-polluting substance stored.

Furthermore, the warehouse has to be set up so that persons not working for the company do not have direct access (for example visitors, thieves, arsonists, vandals or even children playing). In addition, it may not be stored in passageways, stairwells, halls or attics.

As most products have more than one dangerous characteristic but the regulations generally only deal with individual characteristics, the storage area must normally meet the requirements of various regulations. In addition, some regulations have been passed by state authorities, so that there can be different regulations in different states. Just this simple example shows that taking responsibility for lawful storage of different hazard-substances requires extremely extensive expertise. This expertise needs to cover not only the substances themselves but also the legal requirements for storing hazard-substances.

In addition to the statutory provisions for the storage of hazardous materials from the areas of chemical, commercial, water law and other areas, professional associations, federations, associations, etc. have their own rules, which must also be considered, such as. the "Guidelines for Storing Chemicals Together" of the German Chemical Industry Association (VCI storage guidelines).

If you are to take responsibility for the storage of hazard-substances in a company as an industrial foreman, it is recommended to speak with competent specialists in detail about this.
Examples of such specialists would be members of staff of the Trade Supervisory Board, the Technical Inspectorate Agencies or the associations themselves.

6.6 Regulations for handling hazard-substances by special persons

Special groups of people are, for example, young people, pregnant women, or breast-feeding mothers, employees without sufficient knowledge of German, disabled people, temporary workers, interns and entrants. However, the Chemicals Law also contains special regulations for when specific persons or groups are handling hazard-substances. This is because the employees are generally most intensively exposed and the first to be exposed when using industrial chemicals.

The industrial use of these hazard-substances occurs:

- in the manufacturing of the chemicals themselves,
- when preparing products by mixing substances with dangerous properties,
- when using raw materials with dangerous properties as resources.

For this reason, on the basis for the Chemicals Act, the legal protection of certain people has been incorporated into the further development of existing legislation.

The responsibilities of the employer which we have already covered in Chapter 6.2 are part of this.

There are also special regulations here too, which restrict or ban certain activities for certain groups because people react differently to hazard-substances.

These groups are:

- young people,
- pregnant women,
- breast-feeding mothers,
- home workers.

The way that the different areas of law interlock is particularly clear in this example (protection of special groups).

In order to ensure this protection for such groups, not only the regulations of the Chemicals Law, the Chemicals Act and the Ordinance on Hazardous Substances are involved, but also the legal requirements from other areas like the protection of young people via the law on protecting working young people, the Youth Employment Protection Act (JArbSchG), the Directions on Protection Against Child Labour (KindArbSchV) and the extensive area of employment law, for example the Maternity Protection Law (MuSchG) and the Home Work Act (HAG).

This list is not complete as alongside it come the regulations of the professional organizations and the announcements of the Federal Ministry of Labour and Social Affairs and the individual state ministries for labour and social affairs.

There are special prohibitions on manufacturing and using substances according to the Ordinance on Hazardous Substances §18:

- Ordinance on Hazardous Substances §18 (Prohibitions on Manufacturing and Using Substances)

(1) In accordance with Appendix IV, the manufacture or use of certain substances, preparations and products is prohibited. In particular this applies to those which:

1. are carcinogenic or mutagenic,
2. are very toxic or toxic,
3. can damage the environment.

Exceptions are made to Sentence 1 for the following, as far as nothing else is decided in Appendix IV:

1. research, analysis and scientific educational purposes, in the quantities necessary for this;
2. demolition, reconstruction and maintenance work and
3. waste disposal commensurate with the public good.

As far as nothing else is determined in Appendix IV, the prohibition on use according to Sentence 1 does not contain a prohibition on disposal of substances, preparations or products which have been used legally before the prohibition came into force. Sentences 1, 2 and 3 are also valid in the home.

(2) The employer is only allowed to let home workers undertake activities with low risk in the sense of §7 Para. 9.

It is particularly important in these cases that the prohibition is kept.

The prohibition on the activity means that the employer is really not allowed to deploy the employee in this way. Prohibitions on activities can be found in various places including the Youth Employment Protection Act (JArbSchG), around §22 or §25.

For a young person, moving from school to the workplace is a significant transformation. Their daily routine is suddenly primarily arranged according to the requirements of adult life.

The sense and aim of the Youth Employment Protection Act is to protect children and young people in the world of work from excessive demands, overstraining and dangers to their physical and psychological well being.

The Youth Employment Protection Act is valid for activities carried out by persons under 19 years of age, i.e. children and young people. According to this law, a child is anyone under 15 years of age. Young people are those at least 15 but not yet 18 years old.

The restrictions and prohibitions in the Youth Employment Protection Act are found in §22, §25 and §27.

6.7 Exposure limits for the handling hazard-substances

The failure to observe the many legal regulations on handling hazard-substances of all types damages the health of the employees and damages the environment.

The damage to the health of the employee depends not only on the acute dangers of the hazardous materials for example the toxicity, but also on the long-term effects of these dangerous substances and the duration of the exposure.

Paracelsus, a doctor and natural philosopher from the middle ages (circa 1500 A.D.) understood the dangers of handling hazardous substances. He wrote the following sentence:

> Poison is in everything, and no thing is without poison.
> The dosage makes it either a poison or a remedy.

This means that every substance can become a poison, in the necessary dose. So, we can poison ourselves with water when we drink 15 litres at a time.

This remains true today.

Today's Chemicals Law fit with this knowledge by defining limits for harmful materials both in the air at the workplace and in the organism. These limits form a basis for the evaluation of the measurements taken at the workplace. However, exposure limits do not offer a safe boundary between dangerous and safe areas.

Small amounts of dangerous substances are often completely harmless. The concentration of the dangerous materials is an overriding factor ("The dose makes the poison", Paracelsus).

Because, however, the duration of exposure also plays an important role, one talks about the "dose-response relationship". The dose corresponds to the product of the concentration (K) and the exposure time (t). The exposure limit is set below the concentration by which no detrimental effects can be observed.

With the new version of the Ordinance on Hazardous Substances from the 1st of January 2005, a new health-based plan for exposure limits has been set. This contains the occupational exposure limit (AGW). It replaces the maximal workplace concentration (MAK) and the technical reference concentration (TRK).

The occupational exposure limit is a limit for the air. It states the maximum average concentration of the substance in the air at the workplace allowed. The occupational exposure limit indicates at which concentration acutely or chronically damaging effects should generally not be expected.

It is the highest concentration of an agent allowed, whether it be as gas, vapour or suspended matter, in the workplace which does not impair the health of the workers. This is according to current knowledge and refers to repeated and long-term exposure. In particular it considers eight hours exposure within the working day (while keeping to a weekly working time of 40 hours or 42 for shift work). Alongside the occupational exposure limits, biological exposure limits have also been created.

According to the Ordinance on Hazardous Substances (GefStoffV), the occupational exposure limit is the limit for the temporally-weighted average of the concentration of a substance in the air at the workplace in a given reference period.

It indicates the concentration at which acutely or chronically damaging effects are generally not to be expected (GefStoffV §3 Para. 6). Peaks of exposure during a shift are evaluated with an appropriate short-time value.

Biological exposure limits are limits on the toxicological and occupational health concentration of substances. They also apply to their intermediate products ("metabolic" or "intermediate") and to changes of biochemical factors in a biological material caused by the harmful substance or its intermediate products. They are set to levels which do not impair the health of the employees (Ordinance on Hazardous Substances §3 Par. 6).

The values are compiled by the Commission for Hazard-substances (AGS) at the Federal Ministry of Labour and Social Affairs and published in the "Technical Regulations for Hazardous Substances" (TRGS).

For example, TRGS 900 contains occupational exposure limits according to GefStoffV §3 Para. 6 and TRGS 903 the biological exposure limits

6.8 General and work-specific problems

Dangerous substances can have negative effects on the environmental matrices, i.e. the air, water and soil generally and on the employee active in specific work.

6.8.1 General problems of hazardous substances

The general negative effects of hazardous substances on the environmental matrices are shown here via the example of the industrially highly-praised substances chlorofluorocarbons, often called CFCs.

Chlorofluorocarbons (CFCs)
CFCs were developed in 1930 by chemists in the American car industry.

These substances did not appear naturally and so could not be discovered. They were created during experiments by taking hydrocarbons and replacing some of the hydrogen atoms with chlorine or fluorine atoms.

Substances were created for industrial use with unique properties.

The substances were excellent because they were:

- non-flammable;
- non-toxic for people, animals and plants;
- odourless and tasteless;
- thermal insulators;
- excellent for use in refrigeration.

Applications ranged over almost all sections of industry due to their excellent industrial properties. Production increased immeasurably and

CFCs were being used as:

- propellants in spray cans for cosmetics, hair styling and medicine;
- refrigerants in refrigerators, for example, air conditioning and large-scale industrial refrigerating plant;
- blowing and release agents in the car, furniture and shoe industries, for example for foam for car seats, upholstery etc.;
- cleaning agents in metal work, electronics, and the textile and optical industries.

It was only in the 70s that scientists started to understand the relationship between the enormous use of CFCs in industry and their general harmful effects. These scientists found out that these CFCs destroy the ozone layer after being released into the atmosphere. The ozone layer is vital for the life, both flora and fauna, on our planet. Furthermore the CFCs are greenhouse gases.

This takes place because the CFC molecules dissociate as they rise into the atmosphere and are hit by solar radiation. This creates individual atoms, in particular free chlorine atoms, which are known as radicals. These radicals split the ozone molecules, destroying the ozone layer.

In about 1980, the first world climate conference was convened in order to talk about the effects of CFCs on the climate.

In 1985, scientists discovered the hole in the ozone layer which allows significantly more ultraviolet rays to bypass the upper atmosphere, bringing health risks for life on Earth.

At the same time, scientists proved the relationship between CFCs and the anthropomorphic greenhouse effect. The greenhouse effect is well known as raising the average temperature on our planet and thus the atmosphere. This has long-term effects for life on Earth. In particular the melting of glaciers, the polar ice caps and so on leading to floods and a raising of the sea level. In 1987, representatives of 43 countries met in Montreal (Canada) to

take on the problems caused by CFCs and signed the Montreal Protocol to discontinue the production of CFCs.

In 1990, temporary solutions were adopted for discontinuing CFC production. Hydrochlorofluorocarbons (HCFCs) were produced.
In 1993, the use of fluorohydrocarbons in chemical cleaning companies was prohibited.
The production of CFCs was prohibited across the EU in 1995!

6.8.2 Work-related problems from hazardous substances

Political activity is not only concerned with general problems associated with the use of dangerous substances, but also work-related problems for employees and the negative effects on their health.

Handling hazard-substances has significant risks for employees.
Dealing with hazard-substances improperly can lead to health risks for the employee, both directly and also indirectly via the management of the substances. This damage to health can often be fatal.

Damage to the health of employees due to dealing improperly with dangerous substances can take the forms of

- poisoning
- chemical burns
- burns
- and so on

In the long-term, such damage can take the forms of:

- occupational diseases
- amputation, for example due to tissue dissolving in degreasing agents
- allergies
- skin diseases
- damage to the lungs
- cancer
- and so on

We will show the dangers to health by considering some examples of selected hazardous substances.

Cutting fluids

Cutting fluids or cooling lubricants are used in the metal industry. They are used in metal working and cutting to cool and lubricate the metals and tools. In particular, the use of these materials prolongs the life of the tools and also increases the operating speeds.

They are divided into two main groups by DIN 51385:
1. non-water-miscible (for example grinding oil)
2a) water-miscible (concentrated) and
2b) water-mixture cutting fluids (liquid preparations either as solutions or "oil-in-water emulsions").

They consist of a basic material (basic oil), generally mineral oil, with further hazardous substances as additives.

These additives can be surfactants, "nitrosable secondary amines which may give rise to N-nitrosamines during use", polycyclic aromatic hydrocarbons (PAHs), phenols, biocides, alcohols etc.

Both temporary and permanent damage to health can occur when working with cutting fluids. For example, direct contact with cutting fluids or their degradation products can lead to irritation of the eye, skin diseases and allergies. Cutting fluid vapours or aerosols can lead to diseases or irritation of the respiratory tract when inhaled, such as allergic bronchial asthma, and via the hydrocarbons (PAH) or N-nitrosamines can lead to systemic diseases. (Systemic diseases are diseases which affect the whole organ-system, such as the whole muscular system, the blood (leukaemia, anaemia), or the central nervous system.

Furthermore, the use of cutting fluids that are not soluble in water can present a risk of fire, or even of creating an explosive atmosphere.

Many cases of fatal cancer have already been recognised by the professional associations as having followed long-term contact with cutting fluids containing amines and nitrates.

Asbestos

Asbestos is not produced artificially like CFCs but is mined, either underground or open-case. Raw asbestos is a dense, compact material which is then loosened mechanically and finally worked like textile fibres.

Because of its low thermal conductivity, non-flammability and extremely good chemical resistance against acids, bases and water, asbestos is particularly good for manufacturing friction linings, thermal and electrical insulation, fire-resistant clothing, seals and asbestos cement.

Inhalation of asbestos fibres can, however, lead to lung cancer and to asbestosis. Fibres of a size that can be inhaled and so enter the lungs have been shown to be particularly problematic.

Due to the health risks, the manufacture and use of a range of asbestos products, like asbestos cement lightweight building board, toys, paints, insulators has been forbidden.

In 1990, asbestos was placed into Group 1 as a very strongly carcinogenic hazard-substance. Following this, marketing it was prohibited and in 1996 it was included in the Chemical Prohibition Ordinance (ChemVerbotsV).

Formaldehyde

Formaldehyde is a natural product, like asbestos. However, in contrast to asbestos, it has also been manufactures synthetically since about 1900.

As an inexpensive raw product, formaldehyde is used in a variety of manufacturing processes. Products made using formaldehyde range from plastics through various wood products and textiles to cleaning agents and conserving agents.

Formaldehyde is also created by all incomplete combustion and by photochemical decomposition of organic substances.

The effects of formaldehyde on people include allergies, and irritation of the eyes, skin and respiratory tract. In 2004, formaldehyde was classified as "carcinogenic for humans" (CMR hazard-substance) by the World Health Organization (WHO). The problem is made worse by the fact that many of the uses of formaldehyde are in products that are used within the home or that involve contact with the skin. The manufacture of chipboard and the textile industry are two important examples.

Restrictions were brought in for the most important uses with connections to the home and contact in 1986. In this way, wood products (whether coated or not) could no longer be placed on the market if their emissions of formaldehyde as a gas exceeded a certain level.

Benzene

Benzene is a raw material, additive and solvent. It was often used in the past as a solvent for paints, wax, resins and oils. Is it still used today as an additive for fuel.

Fig. 19: Benzene danger symbol

It has been shown that the use of benzene has led to an increase in leukaemia (blood cancer) in the users. For this reason, it is categorised as carcinogenic.

Today, the use of benzene is prohibited almost everywhere – with the exception of the manufacture of fuels and manufacturing occurring in closed systems. For this reason, it has been largely replaced as a solvent by less dangerous (methyl-substituted) compounds toluene and xylene.

7. REDUCING OCCUPATIONAL ACCIDENTS AND PROBLEMS FOR THE HEALTH AND THE ENVIRONMENT

Reducing or avoiding accidents at work and problems for health and the environment is an inherent goal of employers. It can be considered during the planning of work processes. To do this, potential causes of accidents can be established and measures developed to minimise the risk of accidents and dangers to health where they exist.
Existing knowledge of causes of accidents can also be used to introduce measures. They can then be used to improve occupational health and safety at the company, to avoid occupational accidents and to prevent damage to the environment and health problems for the employees.
Nevertheless, the risk of using hazard-substances or technical equipment cannot be reduced to zero. The point is – for those that make the law too – the responsibility of the company to ensure that the worker is protected during the activities carried out for their job. The protection depends, of course, of the type of activity and the resulting possibility of danger or problems. It would make no sense to insist that office workers always wore safety footwear at work. Thus, in this chapter we want to go a little deeper and consider the dangers and problems for employees together with the relevant safety measures in more detail.

7.1 Work-specific measures for preventing accidents due to known causes

Work-specific measures for preventing accidents or damage to the environment, or health problems for the worker can be introduced due to all sorts of experiences.
They can be taken by the use of safety technology, by better organisation or through changing behaviour during certain activities.

7.1.1 Technical measures for prevention of accidents due to known causes of accidents

Occupational accidents and employee illness lead to bottlenecks in work processes which can be catastrophic in small and medium businesses. The usual work sequence is disrupted. Often it is not only the individual employee who is affected but the whole organisation. The absence must be caught up. Accident costs are carried by the company. These include material damage, for example damages from destroyed equipment or motor vehicles. If accidents have already taken place in a company which can be traced back to problematic equipment, then this knowledge can be used to create specific measures. If the cause of the accident is accounted for by imperfect technical factors, then measures to prevent accidents should be introduced.

Imperfect technical factors contributing to the accident could be:

- rotating, unsecured masses, for example V-belt pulleys, flywheels, cogs and gears
- uncovered machines;
- electricity with inadequate fusing;

- physical influences such as noise, dust or shocks;
- improper handling of hazard-substances;
- inadequate preventative measures against fire or explosion;
- improper design of workplace.

If the cause of the accident is inadequate technical equipment, then measures must be taken without delay to improve the occupational health and safety.
Where necessary, the general management are to be informed immediately.

Here, the technical measures could be, for example, measures which take effect right at the start of the manufacturing of a product. These are predominantly constructive measures. They include changes in working processes or equipment, for example covering rotating parts or cordoning off machinery.

Checklists for technical safety checks have proved to be very useful here. These list the possible problems, the possible dangers, the necessary improvements and the legal background or information.

Table 6: Checklist for technical security checks

Potential Problems	**Potential Dangers**	**Improvements**	**Directives and regulations**
Machines with unprotected moving parts during normal operation, for example agitators	Contact with moving parts possible	Encase moving parts Safeguard to prevent unauthorised start-up Safeguard to check equipment is functioning properly before start-up Provide rods for clearing faults Do not clean while running etc.	BGV D18 BGR 117-1 BGR 107 BGI 801 Ordinance on Industrial Safety and Health (BetrSichV) TBRS 2111
Damaged or defective electrical equipment	Danger of electric shocks	Check for visible defects before use Do not use defective equipment Regular testing of electrical equipment	BGV A1 BGV A3 BGR A3 BGR 104 BGR 117-1 DIN norms VDI directives
Use of compressors	Health hazard from noise	Introduce low-noise compressors Spatially separate sources of noise Use sound-absorbent wall and ceiling linings Use silencers Make hearing protectors available Label noisy areas etc.	BGV A8 BGV B3 BGR 194

7.1.2 Organizational measures for preventing accidents due to known causes

Checklists similar to that for technical measures can also be created in the organisational area. Examples of organisational measures could be changes in sequencing and timing, or the spacial separation of sources of danger.

Table 7: Organizational checklist

Potential Problems	Potential Dangers	Improvements	Directives and regulations
Employees are pressed for time	Excessive demands on the employee Danger due to work not being carried out thoroughly	Create shift and work plans Recruit replacements Recruit temporary employees Keep to rest periods Carry out occupational health and psychological consultation	
Incorrect behaviour in an emergency	Danger through lack of knowledge in first-aid, alarm and rescue plans	Instruct employees on first-aid measures and equipment Make first-aid kits available and label their locations Nominate people responsible for first-aid Conduct training sessions about behaviour in an emergency Do not use defective equipment Regular testing of electrical equipment etc.	BGV A1 BGV A5 BGI 503

7.1.3 Measures for preventing accidents due to known causes with personal protective equipment (PPE)

Accidents can also be prevented with suitable personal protective equipment. These should be used when technical and organisational measures would be ineffective at protecting the employees.

This is the case if, for example, workers need to handle dangerous substances and direct contact cannot be avoided. A checklist is also useful here to increase occupational health and safety in the company.

Table 8: Checklist for preventing accidents with personal protective equipment (PPE)

Potential Problems	Potential Dangers	Improvements	Directives and regulations
Working with and using hazardous substances	Contact with hazard-substances through the skin, respiratory tract and gastrointestinal tract	Use skin protection Make protective gloves, protective clothing and breathing masks available Use safety footwear	ChemG GefStoffV TRGS „X“ BGV A „Y“ 1) BGR A „Z“ 1) depending on the hazard-substance
Working with hot liquids or gases	Danger of scorching or scalding	Introduce safeguard against unintended contact Make first-aid kits available and label their locations Nominate persons responsible for first-aid Conduct training sessions about behaviour in an emergency Test hose connections for safety Pay attention to the design of machines Introduce fixed piping for steam Distinguish piping by marking with colours	GefStoffV DIN norms

7.1.4 Measures to prevent accidents due to known causes through changing behaviour

Changing thoughtless behaviour around hazards can also prevent accidents. A checklist is also useful here to get an overview of measures to increase occupational health and safety.

Table 9: Checklist for measures to prevent accidents by changing behaviour

Potential Problems	Potential Dangers	Improvements	Directives and regulations
Tense atmosphere within the company	Conflicts between colleagues and/or supervisors leading to outbursts and fits of rage, and thus to lower levels of attention	Motivate the employees Go through problems individually Make information open and available Consider management and leadership tech-	

		niques Check organisation etc.	
Thoughtless handling of hazardous substances	Danger due to lack of ability, flippancy or failure to use personal protective equipment	Check safeguards against unintentional contact Make first-aid kits available and label their locations Nominate people responsible for first-aid Carry out training Choose personnel according to the conditions under which they will work Instruct employees Motivate employees to be safety-conscious Promote the acceptance of safety precautions	GefStoffV DIN norms BG I 527

7.2 Personal protective equipment (PPE)

According to §29 of the Employers' Liability Association Regulations, BGV A1, the employer has to make personal protective equipment available whenever danger of accidents or danger to the health of employees during their working activities cannot be ruled out. In particular, the employer has to provide protective headgear and footwear, protection for the eyes and face, respiratory equipment and body protection.

Before deploying personal protective equipment, it is necessary to check whether other methods could be used to cover the dangers to the employees, for example the technical and organisational measures discussed above.

In general, the personal protective equipment must be able to withstand the demands placed on it for the protection planned. It must be properly designed and made. This is to be shown by testing the personal protective equipment and assigning it a quality mark (CE mark).

The CE mark says that the personal protective equipment has been tested according to European standards for some protective use and is suitable for this use. The superior, the industrial master craftsman or foreman has the responsibility of requiring the employees to use the personal protective equipment. If an employee does not follow this instruction, he or she must be removed from the danger zone.

The following tendencies are taken from statistics of accident insurance companies:

- 40% of all injuries are to the hand
- 18% of all injuries are to the foot
- 10% of all injuries are to the head

On its own, the professional association of the construction industry recorded about 14,000 head injuries in 2007. Of these people injured, 55 did not survive. In general commerce, there were more than 95,000 head injuries in the same period of which 165 were fatal.

Personal protective equipment must me provided by the employer free of charge.

Let us not look at the individual types of personal protective equipment.

7.2.1 Protective headgear

Fig. 20: Prescriptive sign: Use safety helmet

The requirements for wearing protective headgear come from the previous regulations. Specifically, this means:

1. Safety helmets are to be worn during all work and activities which might result in head injuries upon impact with falling or flying objects or those thrown out of machines. These safety helmets, called hard hats, consist of an outer shell and inner suspension.
2. The employer has to provide enough safety helmets in flawless condition.
3. Those insured (the employees) have to wear the safety helmets provided and keep them in flawless condition.

4. Safety helmets are generally to be coloured as noticeably as possible to provide contrast with the working environment.

In addition, different colours can be used to differentiate different groups of people.

5. People with long loosely hanging hair must protect themselves from head injuries (scalping) when working with machines containing rotating parts. Caps, hoods and hairnets are suitable for this.

The professional organizations' rules "The use of protective headgear" (BGR 193) regulates the area of application, choice and use of industrial safety helmets and bump caps, and also combinations of these with other personal protective equipment, for example, hearing protectors, eye protectors and respiratory equipment.

We differentiate between the following protective headgear:

1. Industrial safety helmets (according to DIN EN 397 "Industrial safety helmets") are head covers made of resistant material for protection against falling objects, suspended loads and impact with fixed objects.
2. Industrial bump caps (according to DIN EN 812 "Industrial bump caps") are head covers for protection against injuries from impact with hard, fixed objects. They are not to be used as replacements for industrial safety helmets.
3. A helmet's outer shell is
   - the external part of an industrial safety helmet, made from a hard material which absorbs the incoming force and transfers it to the inner suspension. The helmet outer shell can be shaped in various ways, for example with a wide brim all the way around, with a brim that channels rain conveniently, or with a low neck part.
   - the part of an industrial bump cap which absorbs the incoming force and transfers it as far as possible to the inner suspension. The shell can be supplied with external fittings to ensure the bump cap fits the head.

Please see Figs. 21 to 26.

Fig. 21: An industrial safety helmet with a brim that channels rain conveniently away, air vents and slit pockets for fixing accessories such as hearing protectors
(Source: BGR 193)

Fig. 22: Industrial safety helmet with low neck part, air vents and slits for
fixing accessories (such as hearing protectors), without rain-channelling brim
(Source: BGR 193)

Fig. 23: Industrial safety helmet with shortened peak, shown here with lamp and cable holders, and chin strap.
(Source: BGR 193)

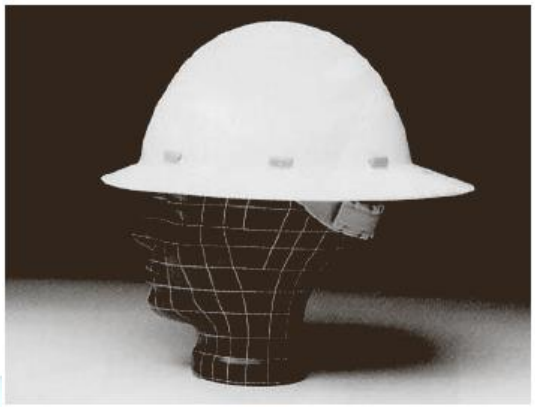


Fig. 24: Industrial safety helmet with brim running all the way around.
(Source: BGR 193)

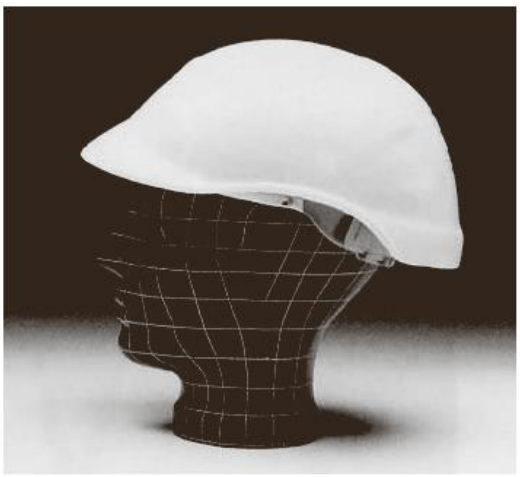


Fig. 25: Industrial bump cap, with polyethylene peak (Source: BGR 193)

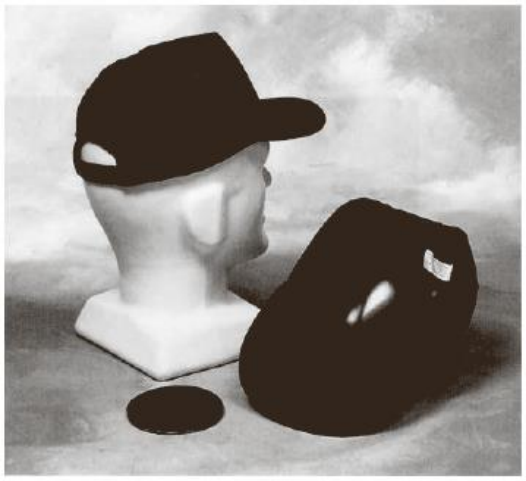


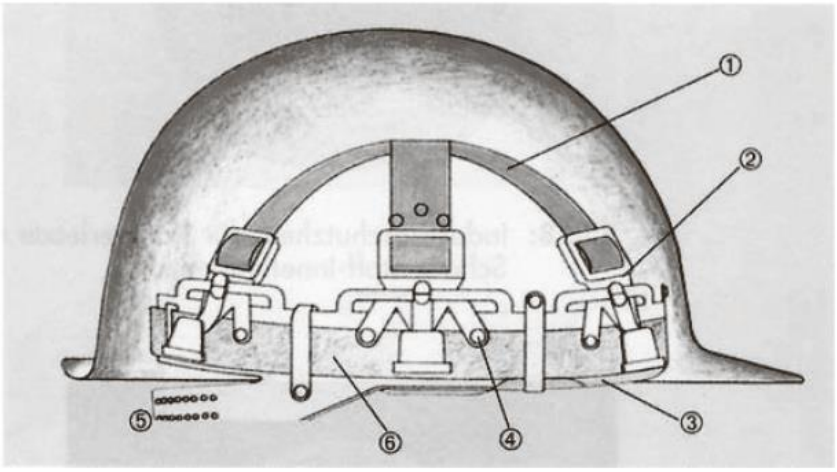
Fig. 26: Industrial bump cap with textile covering as peaked cap
(Source: BGR 193)

The protective headgear must be chosen either to fit the individual or so that it can be adjusted to fit. As industrial safety helmets can be manufactured in differing sizes, they can be made to fit with only a slight adjustments (see Point 5 in Fig. 27).

Helmets are sold in three different sizes:

- Helmet size 1 = head size up to 55cm
- Helmet size 2 = head size between 54cm and 59cm
- Helmet size 3 = head size greater than 59cm

Safety helmets need to be comfortable to wear, even when used with other accessories like neck protection, safety glasses, hearing protectors and respiratory equipment.



1 Cloth suspension
2 Movable clips
3 Sweatband made from material which is gentle on the skin
4 Attachment for chin strap, neck protector
5 Adjuster for head size – well-fitting and good grip with all head sizes via a low-lying neck band
6 Extra padding with foam stripes
Fig. 27: The design of a helmet – example of an industrial safety helmet (Source: BGR 193)

Industrial safety helmets must be type-approved and fulfil the minimum conditions of DIN EN 397. This allows them to fulfil the following functions:

- Shock absorbance (through both plastic and elastic deformation)
- Resistance to penetration (against sharp spikes and spiky objects)
- Resistance to fire
- Guaranteeing and optimal fit

(A good fit to the head cannot be guaranteed with just an adaptable inner suspension, but rather – depending on the work done – an additional chin strap may be necessary.

The European norm (DIN EN 14052), "High-performance industrial safety helmets" has also been compiled. This became a German norm in March 2006. According to this norm, industrial safety helmet should offer improved protection for those industries which have a higher than normal risk of head injury.

Such helmets are not to replace the tried and tested industrial safety helmet according to DIN EN 397, but rather to be used where conventional industrial safety helmets reach their limits. The employer decided which of the industrial safety helmets to be used with the help of a risk assessment.

General labelling of helmets

When an industrial safety helmet corresponds to a norm, it must be labelled as such. The labelling is either cast or engraved. The general labelling for industrial helmets must contain the following information (see Fig. 28)

Legend
1 and 2: CE mark (and where necessary, the identification number of the authorized representative (four place), who carries out the production control.
3: the European norm (EN 397 for industrial safety helmets)
4: The name or icon of the manufacturer
5: Year and quarter it was manufactured
6: Manufacturer's type code (helmet type)
7: Size or size range (circumference of head in cm)
8: Abbreviation of the helmet material

9: Field of application (see note)

Fig. 28: Example of an industrial safety helmet's labelling (Source: BG BAU)

Note for Point 9 of the legend:

In some fields of application, and for some special hazards, industrial safety helmets with special properties need to be used. In this case, they may also carry the following information as required:

a) Use in very low temperatures: (e.g. "-20°C" or "–30°C")
b) Use in very high temperatures: (+150°C)
c) Electrical insulation for danger from short term, unintentional contact with alternating current: (e..g. "440V AC" or "1000V AC")
d) Danger from splashes of melted metal: (MM)
e) Danger from lateral stresses (retains shape under lateral stress): (LD)

The operational life of safety helmets

Because plastics age with exposure to the weather or UV radiation, mechanical stress, air pollution and so on, industrial safety helmets should be replaced at the end of the operational life specified by the manufacturer. However, keep in mind that this date of expiry can only be used as a guide.

Experience has shown that safety helmets made from thermoplastic polymers should be replaced after 4 years of use (or after the date of manufacture), whereas for thermosetting plastics the period is 8 years.

Inspecting all helmets visually is recommended. This should be done at specific intervals, about once a year. To get a rough idea about the embrittlement of outer shells of helmets made from non-fibreglass reenforced thermoplastics, one can use the "click test".

Push the helmet's outer shell lightly from the side with your hands or bend the peak slightly. Place your ear on the material as you do this. If you hear cracking or popping noises, then the helmet should be withdrawn from further use.

If defects are found during the visual inspection or the "click test", then the helmets concerned are no longer to be used. They must be taken from the users and new helmets must be given out.

Hairnets type: L
Hairnets for men and women. Super elastic, closely fitting, high air-permeability.

Hair nets type: BL
For women with crochet-look head-band for work and leisure. Flexible, elastic, suitable for any size head and fullness of hair.

Protective hair cap type: LM
Women's and men's cap for work and leisure. Complete hair protection made of breathable fabric protects the hair from dust and dampness.

Fig. 29: Hairnets and protective hoods

7.2.2 Foot and knee protection

What we said above also applies here: If technical or organisational measures cannot eliminate danger enough, then foot or knee protection is necessary as a personal measure. This must comply with the 8th regulation of the Equipment and Product Safety Law.

Fig. 30: Use of safety footwear

The feet are endangered in almost all areas of industry. This is primarily due to:

- slipping, sliding;
- falling objects;
- lowering loads;
- impact with objects or barriers;
- puncturing by spiked objects (needles, turnings, cuttings);
- being run over by vehicles (fork lifts, transport trolleys, electric trucks etc.);
- contact with hot floors, objects or liquids;
- flying sparks, for example when welding or grinding;
- chemicals such as acids, fats, oils, emulsions;
- electricity

Many foot injuries can be avoided or made less severe when safety footwear is worn.

As above, the employer has to provide safety footwear and knee protection marked with the CE mark when danger is present. These products generally meet the norms valid. As a basic principle, the employer has to bear the costs of this foot protection. In many companies, there is a company agreement that the employees also bear a small amount of the costs as these shoes may be worn out of working hours and also after a certain time become the property of the employees.

Important norms, rules and regulations:

- Accident Prevention Regulations "Principles of Prevention" (BGV A1)
- BG rule everywhere "Principles of Prevention" (BGR A1)
- BG rule "Use of Protective Clothing" (BGR 189)
- BG rule "Use of Foot and Knee Protection" (BGR 191)
- Regulation on Marketing Personal Protective Equipment (8. GPSGV)
- DIN EN ISO 20345 (Personal Protective Equipment: Safety Footwear)
- DIN EN 14404 (Personal Protective Equipment: Knee Protection for Work in the Kneeling Position)
- DIN EN 50321 (VDE 0682 331), (Electrical-insulating Shoes for Working with Low-voltage Equipment)

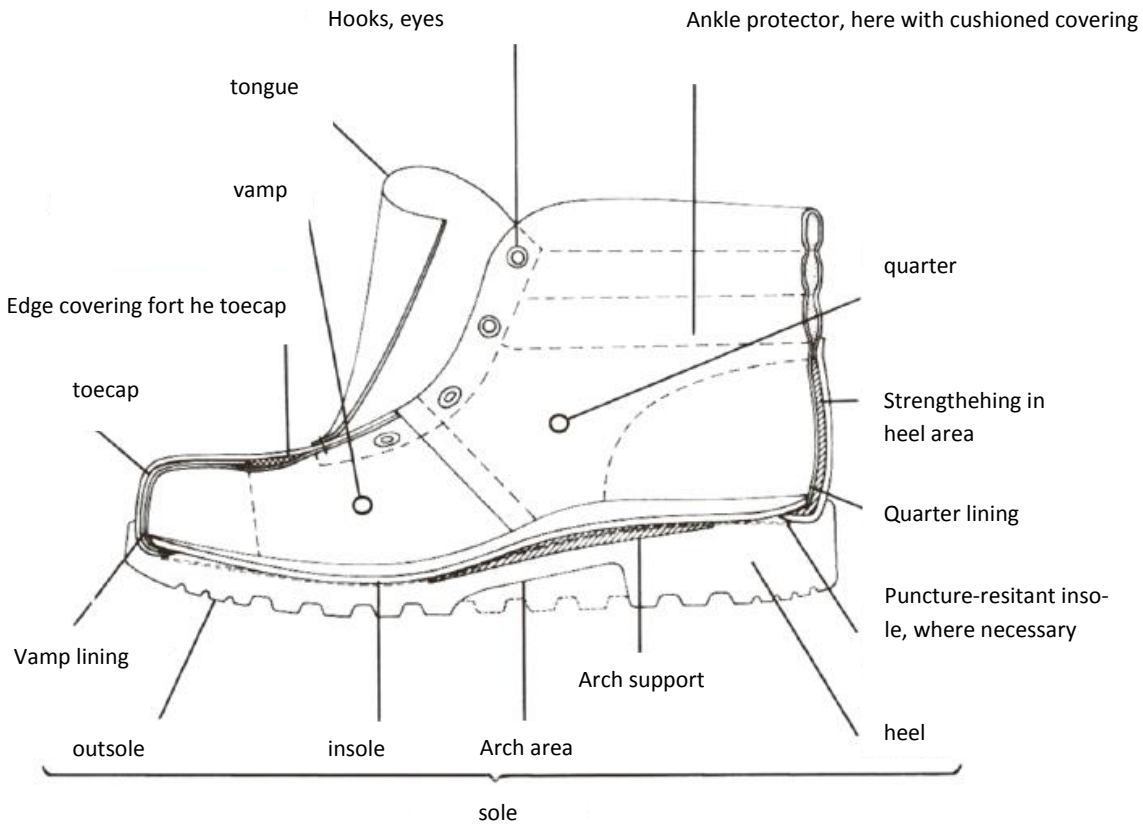
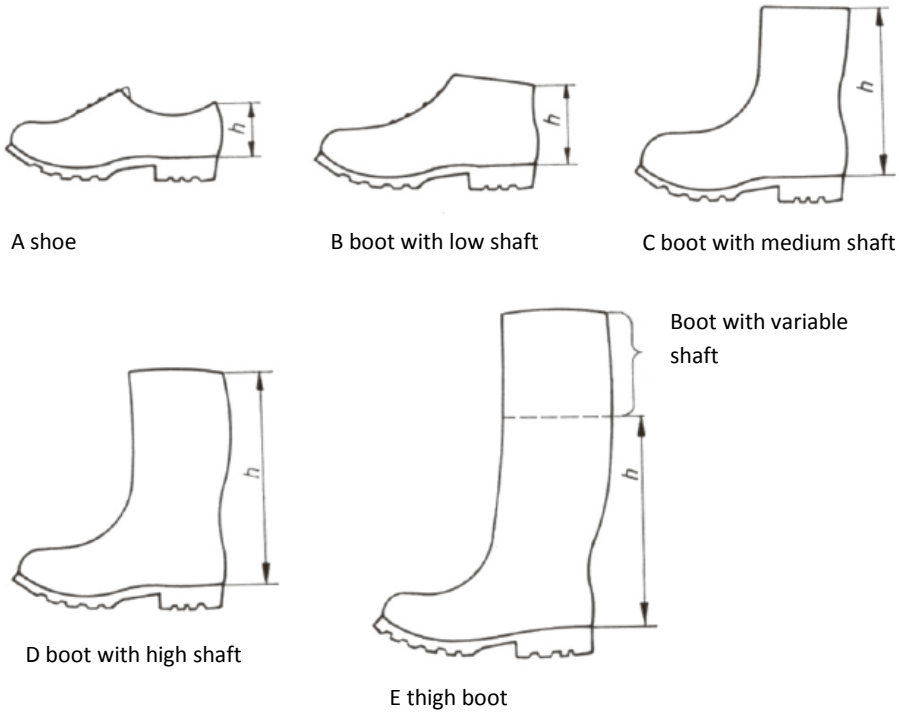


Fig. 31: Example of the components of a shoe (Source: BGR 191, BGFE)

According the European norms, shoes are as

- Occupational shoes (abbreviation: O)
  These are shoes that do not necessarily have toe-caps but which do have at least one protective component. If a toe-cap is included, there are no conditions put on it. They are for working areas with a low risk of injury due to impact.

- Protective shoes (abbreviation: P)
  These are shoes which fulfill the safety requirements. They have toe-caps designed for medium stresses.
- Safety shoes (abbreviation: S)
  These are shoes which fulfill the safety requirements. They have toe-caps designed for high stresses. Safety shoes are different from protective shoes in that the toe-caps have to withstand twice the test energy and significantly higher pressure.



A shoe | B boot with low shaft | C boot with medium shaft

D boot with high shaft

E thigh boot

Fig. 32: Shoe shapes (Source: BGR 191, BGFE)

The three types of shoes (protective, safety and occupational) are further divided into two classes:

Class I: Shoes made from leather or other material by normal manufacturing methods (e.g. leather shoes)

Class II: Shoes moulded in one piece or vulcanised (rubber boots, plastic boots, for example made from polyurethane for wet areas).

Basic safety demands are made on the uppers, lining, straps and soles and in terms of fire-resistance for all types (O, P or S). This depends on whether they are Class I or Class II. See Table 10:

Table 10 Labelling categories of safety footwear (S) according to DIN EN ISO 20345
(Source: BGR 191, BG Bau)

Category	Basic requirement	Additional requirement
SB	I or II	(None, see above under occupational (O), protective (P) and safety shoes (S))
S 1	I	Closed heel, anti-static properties, energy-absorbent heel, hydrocarbon-resistant sole
S 2	I	As S 1, good waterproofing and low water-absorbance
S 3	I	As S 2, puncture-resistance and studded sole
S 4	II	Anti-static properties, energy-absorbent heel, hydrocarbon-resistant sole and uppers
S 5	II	As S 4, puncture-resistance and studded sole

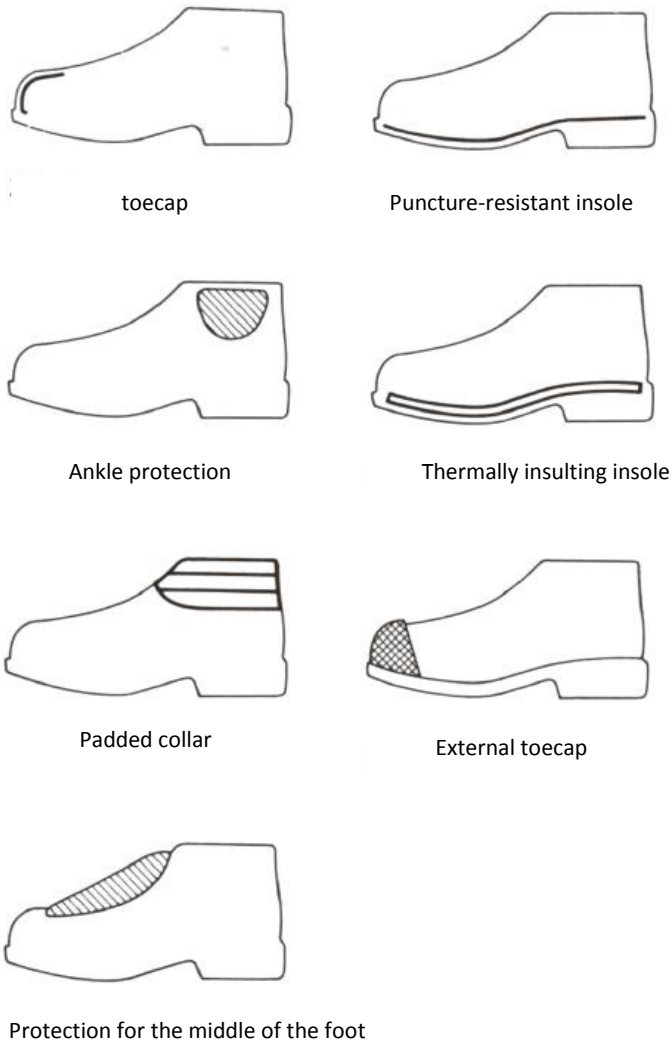


Fig. 33: Examples of safety equipment for protective footwear (Source: BGR 191, BGFE)

Operational life

The period of time over which foot and knee protection may be used depends on the stresses it is subjected to and its maintenance. Foot and knee protection must not be used if it is not in good condition.

Notes on the operational life and on what constitutes good condition can be found in the information provided by the manufacturer. Foot protection would not be in good condition if, for example, it is misshapen, the toe-cap is exposed or if the seams are coming apart

Shoes with electrical insulation for working near electric potentials

Shoes with electrical insulation for working near parts of electrical equipment should be used alongside other insulating personal protective equipment to protect the wearer from electric shocks and dangerous currents passing through the feet.

Insulating shoes are divided into two classes, depending on the voltage of the equipment:

- Electric class 00 (equipment with an operating voltage of up to 500V AC or 750V DC)

and

- Electric class 0 (equipment with an operating voltage of up to 1000V AC or 1500V DC).

The safety shoes must fulfil both types of conditions: On one hand the electrical ones (safety for AC voltage/safety for DC voltage/insulation) and on the other the non-electrical ones (just like "normal" safety shoes). They are to be further labelled according to their electrical properties. This labelling is to be permanent, easily visible and on the outside of the shoes and consists of

- the double triangle,
- the electrical class (class 00: red; class 0: beige),
- the serial number

and

- the month and year of manufacture.

The labelling should also show the date of the first use, and the date of testing or retesting.

Fig. 34: Labelling of electrically insulating shoes for work with low-voltage equipment

Knee protection

Knee protection is personal protective equipment for work in the kneeling position for protection of those parts of the body, for example the bursae (fluid sacks surrounding the joint cavity), menisci (thin oval plates of cartilage dividing the joint space), from forces on the kneecap, from injuries to the skin.

The comfort of wearing knee protection is significantly affected by:

- The position of the knee protection
  The knee protection should be able to be fixed so that it keeps its position on the knee during normal use e.g. when kneeling.
  They are not to be fixed in the area of the hollow of the knee.
- The weight of the knee protection
  As far as possible given the need for its protective function and durability, the knee protection should be as light as possible.

7.2.3 Eye and face protection

The eye is our most important sense organ. Because it is also easily damaged, it has to be particularly well protected.

The following sources of damage to the human eye and can be found in workplaces:

1. Mechanical damage (e.g. turnings, splinters, dust)
2. Chemical damage due to corrosive liquids or gasses (e.g. acids, bases, cooling agents)
3. Optical damage due to visible light, ultraviolet light, lasers (e.g. when welding and cutting)
4. Thermal damage due to extreme heat or cold

Often, several of these types of damage must be dealt with at the same time. For example, welding can cause damage optically but also mechanically and thermally.

Fig. 35: Prescriptive sign: Use eye protection

Eye protection can be safety glasses or goggles, protective screens, visors or protective masks. Which is used depends on whether it is only the eyes or the eyes and face that need protection and whether respiratory equipment is also needed.

Eye protection equipment basically consists of a main body and transparent screens (which might be called a lens) which, depending on the protection provided, may be "transparent safety screens" or a "transparent filtering screens".

The main body may be a glasses or goggles frame, or a protective screen or cover.

- Safety glasses and goggles have transparent screens and are different:
  - Safety glasses have hooks to fit over the ears. They protect the eyes from objects or radiation from the front.
  - Goggles fully enclose the space around the eyes, protecting them from all sides.

- Protective screens protect the face and neck as well as the eyes from flying splinters, turnings, chemicals or radiation. The screens have a sufficiently large right-angled window in which the transparent screen can be placed. Protective screens are held in the hand by the user.
- Protective helmets encompass the whole head and neck. They have a window in the face fitted with the transparent screen necessary.
- Visors, however, have a transparent screen or wire mesh which covers the face, and is fixed to a headband or industrial safety helmet.

Please see Figs. 36 to 43.
The following requirement are placed on the eye protection. These can be found in DIN specifications and other regulations.

Important standards, regulations and directives:

BGV A1	General Regulations
DIN EN 166	Personal Eye Protection – General Description, Requirements
DIN EN 169	Filters for Welding and Related Processes (Welding Filters)
DIN EN 170	to DIN EN 172 Filters for Safety Glasses
DIN EN 175	Face and Eye Protection for Welding and Related Processes (Welding Masks)
DIN EN 207	Filters and Glasses for Laser Protection
DIN EN 379	Automatic Welding Filters
DIN EN 1731	Mesh-type Eye and Face Protection
DIN 58214	Protective helmets; Terminology, Types and Safety Requirements
BGR 192	The Use of Eye and Face Protection

Safety glasses with ear pieces

Safety glasses with ear pieces have a modern design and are particularly comfortable. They feature slip-on transparent plastic side-protectors. They can be worn comfortably and look and feel just like ordinary glasses.

Fig. 36: Safety glasses with slip-on side-protectors

Version with colourless lenses (DIN EN 166)
Version with welding filters (DIN EN 166/169) with protection degrees:
- For welding assistants and associated workers
- For rust removal, oxy-fuel cutting, welding of light metals and sheet steel
- For all gas welding

Tried and tested nylon safety glasses with additional adjustable earpieces for eye protection guaranteed to correspond to the regulations. Side-protectors come with colourless lenses.

Fig. 37: Nylon safety glasses

- Version with colourless lenses (DIN EN 166)
- Version with colourless shatterproof lenses (DIN EN 166)
- Version with welding filters (DIN EN 166/169) with protection degrees:

- For welding assistants and associated workers
- For rust removal, oxy-fuel cutting, welding of light metals and sheet steel
- For all gas welding

Welding goggles

Special fold-out welding goggles for soldering, gas welding and oxy-fuel cutting.

Fig. 38: Special welding goggles according to DIN EN 170 / 171

Features:

- Frame made from supple and yet hard-wearing plastic
- Can be folded up to give clear sight during beaks in the welding or preparatory work.
- Fits over ordinary glasses with an adjustable band
- Generously proportioned special ventilation nozzles

3-lens security Ø 50 mm:

Site 1: 100-h special lens to protect the welding filter
Site 2: Welding filter with Protection Degrees 3 and 5
Site 3: Acetate-plastic lens to protect against splinters etc. when folded up

Glare-protection goggles – not according to DIN, export model

Tried and tested fully-plastic frame as HE standard with indirect ventilation.
Against UV radiation (Lens Protection Degree 5)

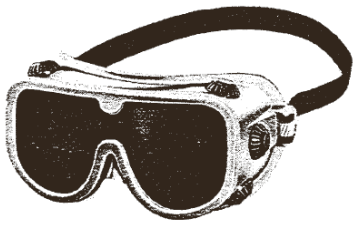
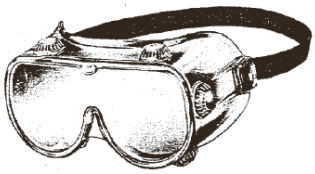


Fig. 39: Glare-protection goggles

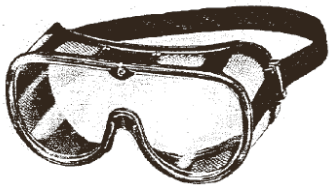
Version with acetate lens – Protection Degree 5
Version with anti-fog acetate lens – Protection Degree 5

Wide-vision goggles

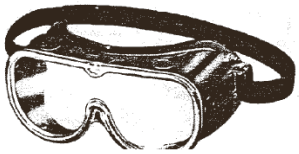
Full vision goggles with all-round vision for personal safety. Super-flexible, fitted safety frame, special ventilation by indirectly acting nozzles.
Use: Heavy exposure, coarse dust, liquid



With direct ventilation (perforation in the frame);
particularly pleasant to wear over long periods



As HE-standard, but without ventilation, especially for use in the chemical industry. With anti-mist lens.



This universal frame

- protects against splinter, etc.;
- has a particularly large field of view due to its wide lens area;
- is extremely transparent;
- can be fitted with a variety of lenses;
- consists entirely of polycarbonate which makes it highly scratch and shock resistant

and it has a modern design

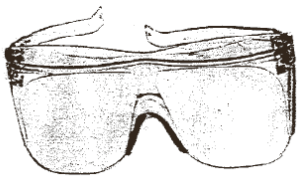
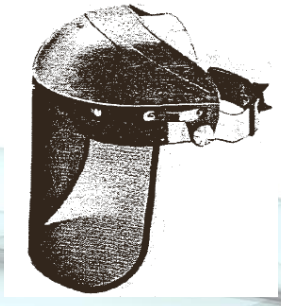


Fig. 40: Wide-vision goggles DIN EN 166

Visor mounts

Visor mount for use without helmet
Comfortable helmet-mount with head protection, from wear-resistant and highly flame-resistant nylon, for any head size – height and width; with adjustable headband



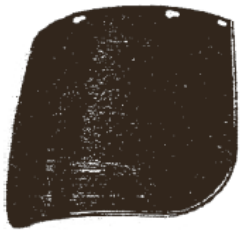
Visor mount for use with helmet
Practical aluminium helmet-mount, fits on most helmet types with stable spring
Multiple positioning settings

Fig. 41: Visor mounts

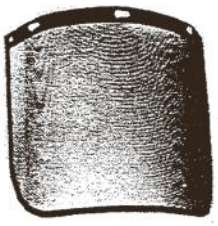
Visors

Thermoguard visor – clear
Material: Polycarbonate (5-ply)
Features: Heat-resistant, largely flame resistant, impact resistant and scratch-resistant, completely shatter-proof
Shape: curved with edge-facing
Transparency: Transparent

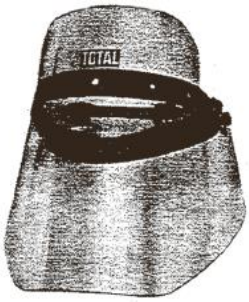
Thermoguard visor – tinted
effective against splinters etc., radiation and glare.
as above, but tinted green.



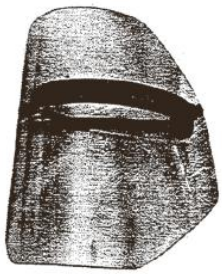
Wire mesh visor
high temperature works-
Material: Corrosion-resistant wire mesh
Shape: Curved with aluminium edge-facing, blackened



Standard visor
for use without helmet
fold-up, screen made of fire-resistant glare-proof plastic, excellent protection against splinters, shavings, acid splashes etc., frame made from
vulcanised fibre with soft foam padding.



Electrician's visor
for use without helmet
as standard visor, but without any metal parts
for work in areas with live parts
up to 1,000 V according to VDE 0680-1, DIN 57 680-1



Electrician's visor
for use with helmet
without any metal parts
produced according to VDE 0680-1, DIN 57 680-1, fold-up with plastic spring retainer
and rubber pull cord. 1.5 mm strong crystal clear screen.

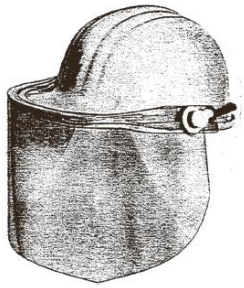
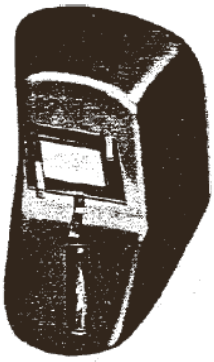


Fig. 42: Visors

Welding screens

Hand-held screen
shock-resistant, fibreglass reinforced plastic
self-extinguishing, weather resistant, angled shape, very light with colourless glass and athermal welding protection glass



Hands-free screen
very shock-resistant, fibreglass reinforced plastic
self-extinguishing, weather-resistant 1,000 hourglass as safety glass and athermal
welding protection glass

Special head shield
made of fibreglass-reinforced plastic, with ad-justable
plastic head band, protective glass as in the hands-free screen

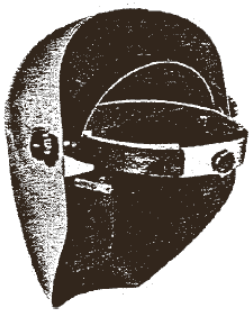


Fig. 43: Welding screens

7.2.4 Body protection (torso protection)

The accident prevention regulations from the professional associations proscribe special protective clothing for particular work. (You can find more on this in BG Rule 189 "Use of Protective Clothing".)

Fig. 44: Use protective clothing

Thus, when working at machines, an employee must wear close-fitting work clothes.

For this reason, for example, a special safety suit (DIN EN 510) has been developed for areas in which there is a risk of being caught in moving parts. It is close-fitting, the arms and waist are kept closed with a waistband and similar bands on the arms. The buttons at the front are hidden. There are no jacket pockets so that they cannot hang out.

In general, one can say that protective clothing is there to protect people from external sources of harm coming from work processes or the environment. Thus, for example, they are to protect against:

- Machines (stab and cut wounds)
- Heat and cold (metal working, fire protection, welding, high temperature works, cold storage)
- Wetness (rain, electroplating, slaughterhouses, laundries etc.)
- Gasses, dusts, vapours (chemical works), radiation (labs, welding)
- Flames and sparks (welding, casting, grinding)
- Chemicals (bases, acids, oils)
- Electrical energy (insulating clothes)

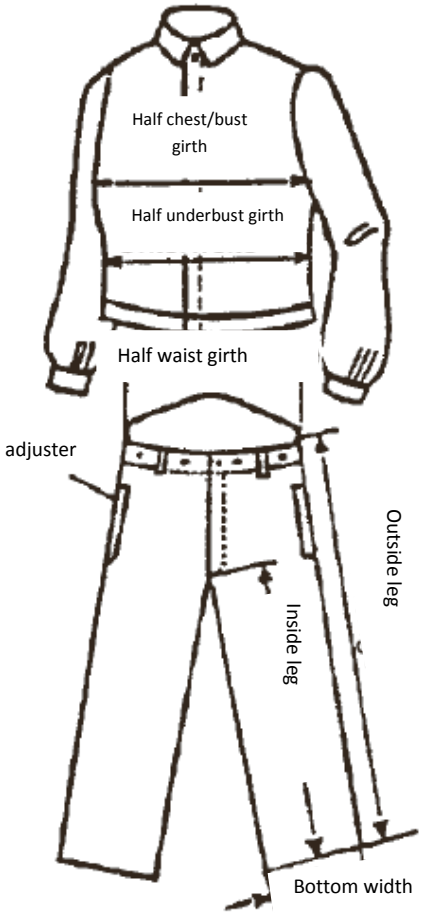


Figure 45: Safety suit according to DIN EN 510

In addition, protective clothing is also used to warn others, for example roadmen, police, firemen, salvage workers.

Important norms, rules and regulations:

BGV A1	General Regulations
BGR 500, Chap. 2.26	Welding, Cutting and Related Processes
BGR 500, Chap. 2.29	Handling Coating Materials
BGR 500, Chap. 2.33	Equipment for Handling Gases
BGI 5037	The Choice of Warning Clothes
DIN VDE 0680	Equipment for Protecting the Body in Low-voltage Areas
DIN EN 340	Protective Clothing, General Requirements
DIN EN 342	Clothing Protecting against the Cold
DIN EN 343	Clothing Protecting against Heat
DIN EN 465 to 467	Clothing Protecting against Chemicals
DIN EN 470	Protective Clothing for Welding and Related Processes
DIN EN 471	Warning Clothing for Dangers from Traffic
DIN EN 510	Protective Clothing for Mechanical Hazards
DIN EN 531	Protective Clothing for Industrial Workers Exposed to Heat

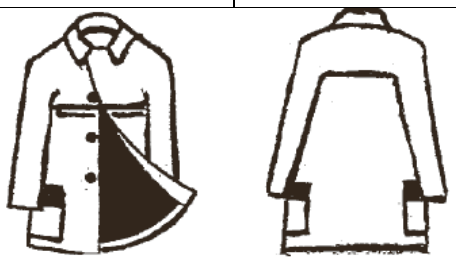
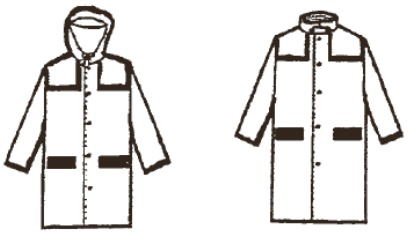
			
Protective suit, one-piece DINE EN 470-1, DIN 61506	Protective suit, two-piece DIN 61501	Boilersuit DIN 61506	Dungarees DIN 61512/61513
Thermal-protection clothing DIN EN 342			
Waterproof clothing DIN EN 343			
Welding suit DIN EN 470-1			

Figure 46: protective clothing for the abdomen

Apron
from leather with bib and full leather strapping.
Suitable for welders, etc.

Apron
Front tie leather apron leather with leather straps

Canvas apron
with abdominal reinforcement and textile harness
Canvas apron – impregnated
Quality apron with impregnated with permanent spark-safe material Abdominal reinforcement

Plastic work apron
Secure and long-lasting protection against dirt, water, acids, oils and fats. Very wear-resistant. supple and resistant to ageing.
Very robust synthetic leather construction. Specially
designed for harsh industrial and business use.

Lab apron
PVC on cotton fabric, smooth and
attractive plastic apron with string and eyelets.
Application: Laboratories, food industry etc.

Figure 47: Protective apron

Welder
Protective suit DIN EN 470-1
Leather apron
Leather sleeve protectors
Welder's protective gloves
Half-mask with plug-in filter
Security laced boots
Special welding head shield

Chemical worker
Acid protection cover
Special boots
Plastic apron
Heavy industrial gloves

Electrician
When working in the vicinity of live parts
Electrician's helmet
DIN EN 5365/DIN EN 397
Electrician's protective cover
VDE 0680-1/DIN 57680-1
Electricians gloves
VDE 0680-1/DIN 57680-1
Handle with protective cuff
VDE 0680-1/DIN 57680-1
to pull out NH fuses

Winter construction workers
Winter construction suit
DIN EN 342/343/DIN EN 14058
Thermal vest
Winter gloves
Safety boots DIN EN 345
Thermal socks
Construction helmet DIN EN 397

Figure 48: Protective equipment

Acid protection suit

Application:	Industry, fire brigade, tank cleaning, shipping, etc.
Quality:	tear-resistant mesh coated on both sides, resistant against acids, alkalis etc. seams sealed inside and out
Colour:	yellow

Acid protection suit

with cut-out suitable for panoramic mask

Quality: from special tear-resistant fabric coated on both sides resistant against acids, alkalis etc. Seems sealed inside and out

Colour: yellow

Gas-tight chemical protective suit

Quality: One-piece full protective suit to wearing over all types of respirators. Made from special tear-resistant fabrics coated on both sides, of different qualities. Resistant against acids, alkalis etc.

Colour: yellow

Figure 49: Acid protection suit

7.2.5 Hand and arm protection

The hand and fingers is the part of the body most likely to be hurt in accidents. In fact, they receive 40% of all injuries.

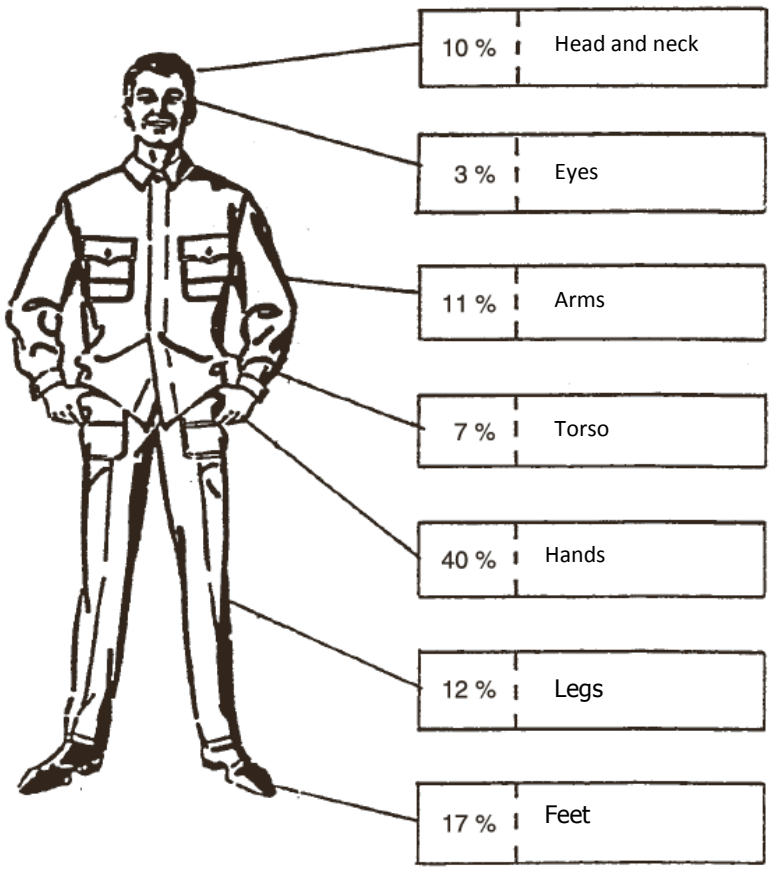


Figure 50: Body parts injured by accidents (approximate values)

Protecting the hands, our most natural tools, is therefore a top-priority of occupational health and safety. However, one must also make sure that gloves do not impair manual dexterity too much.

When there is danger of injury to the hand, wearing gloves is compulsory (see Table 11).

Fig. 51: Prescriptive sign: Use gloves

Table 11: Types of gloves, ordered by the type of activity

Type of activity	Type of gloves
Installation work	Mittens or three-fingered gloves
Repair work	Three-fingered or five-fingered gloves
Work with heavy pollution	Mittens or three-fingered gloves
Transport work	Mittens or three-fingered gloves
Warehouse work	Mittens or three-fingered gloves with padding on the back of the hand
Work requiring sensitive touch	Five-fingered gloves from nappa leather
Work requiring good grip	Plastic gloves with roughened inner surface
Work involving machines with surfaces requiring gentle handling	Cotton gloves
Grinding	Three-fingered or five-fingered gloves
Welding and firing	Three-fingered or five-fingered gloves
Chemical treatment of metal surfaces, working with solutions	Rubber gloves
Working with solvents	Rubber gloves, solvent-resistant, impermeable, inflammable
Handling chemicals and chemical fluids	Five-fingered plastic gloves chosen for the type of chemicals involved
Working with oils	Five-fingered gloves, e.g. from neoprene-covered material
Work in areas with radiant heat	Mittens or three-fingered gloves made from heat-reflecting material
Handling hot or liquid metals	Mittens or three-fingered gloves, mittens made from inflammable material

There is, however, a list of jobs in which wearing gloves is not allowed. For example, gloves are prohibited when working with drilling machines, circular saws, free-standing machines and on machines that might catch the hands in moving parts.

Work gloves leather

Welding glove

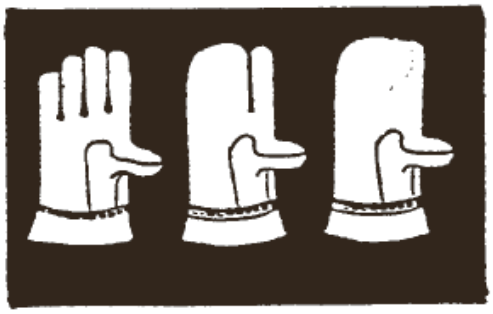
Work Gloves

All purpose gloves
Use: drivers of vehicles and fork-lift trucks
crane and machine operators
technicians, assembly worker

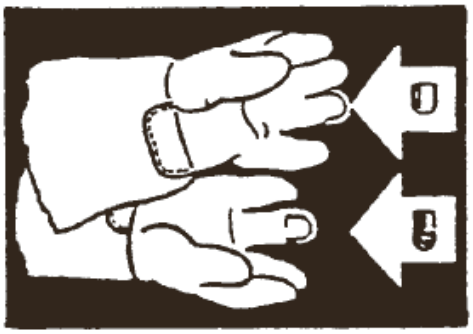
Leather textile glove

Protective gloves made of rubber and plastics
Use: Paints and coatings industry,
Mechanical engineering, galvanising
Quality: pure latex; resistant against
many acids, alkalis, cleaning
fluids, good cut resistance,
resistant to abrasion
Design: exterior: fully anatomical shape,
non-slip special grip
rolled cuff

Fig. 52: Protective gloves



53 a) Glove shapes: 5 fingered glove, 3-fingered gloves, mittens



53 b) safety gloves with steel finger-caps

There are also forearm protectors for work in which the forearm is at risk.

Important norms, rules and regulations:

BGVA1	General Regulations
BGR 500, Chap. 2.26	Welding, Cutting and Related Processes
BGR 195	The Use of Protective Gloves
DIN EN 388	Protective Gloves for Mechanical Risks
DIN EN 407	Protective Gloves for Thermal Risks
DIN EN 420	Protective Gloves – General Requirements and Testing Procedures
DIN EN 12477	Protective Gloves for Welding
DIN EN 60903/A11/VDE 0682, Part 311	Gloves made from insulating material for working on live parts

7.2.6 Hearing protection

Hearing is the most important warning mechanism for people. We hear noises when awake but also when asleep. Our hearing is under great danger from the conditions of modern life. This is true both in private life and also due to noise at work.

Noise-induced hearing loss is one of the most common occupational illnesses. In 2008, the professional associations recognised about 5200 cases of occupational noise-induced hearing loss.

According to the Noise and Vibration Occupational Safety Regulation (LärmVibrationsArbSchV), noise is any type of sound which can lead to impairment of hearing or to other direct or indirect dangers to the health and safety of workers.

We cannot get used to noise. Damage to health caused by noise, such as noise-induced hearing loss, is incurable: The direct damage is caused by the sound waves entering the ear. There, in the inner ear, there are about 20,000 hair cells which are overloaded by the high-pressures of the sound waves which kills them.

Noise-induced hearing loss:

- does not normally cause other complaints,
- is not recognised early on,
- is not curable

Noise can also lead to accidents as acoustic warnings (horns, gongs, bells, alarms...) or threatening noises (screeching, crashing, banging...) are not noticed when they are masked by other noise. In addition, we can be so shocked by sudden noise that we react in an uncontrolled and unconscious way which can put us in hazardous situations.

Noise is measured by the acoustic pressure with the unit being the decibel (A) [dB(A)]. (A) means that the sound is measured using A-weighting, which adjusts the measurements to consider human hearing and the damage or strain on the human ear.

The human ear responds more to higher tones than lower tones at the same acoustic pressure.

The average level at which the ear can hear (auditory threshold) of a healthy ear is 0 dB (A). The pain threshold is at about 120 dB (A). However, a noise level of just 85 dB (A) can be dangerous if the exposure is over many years. Sometimes damage can occur even at 80 dB (A). Please see Fig. 54.

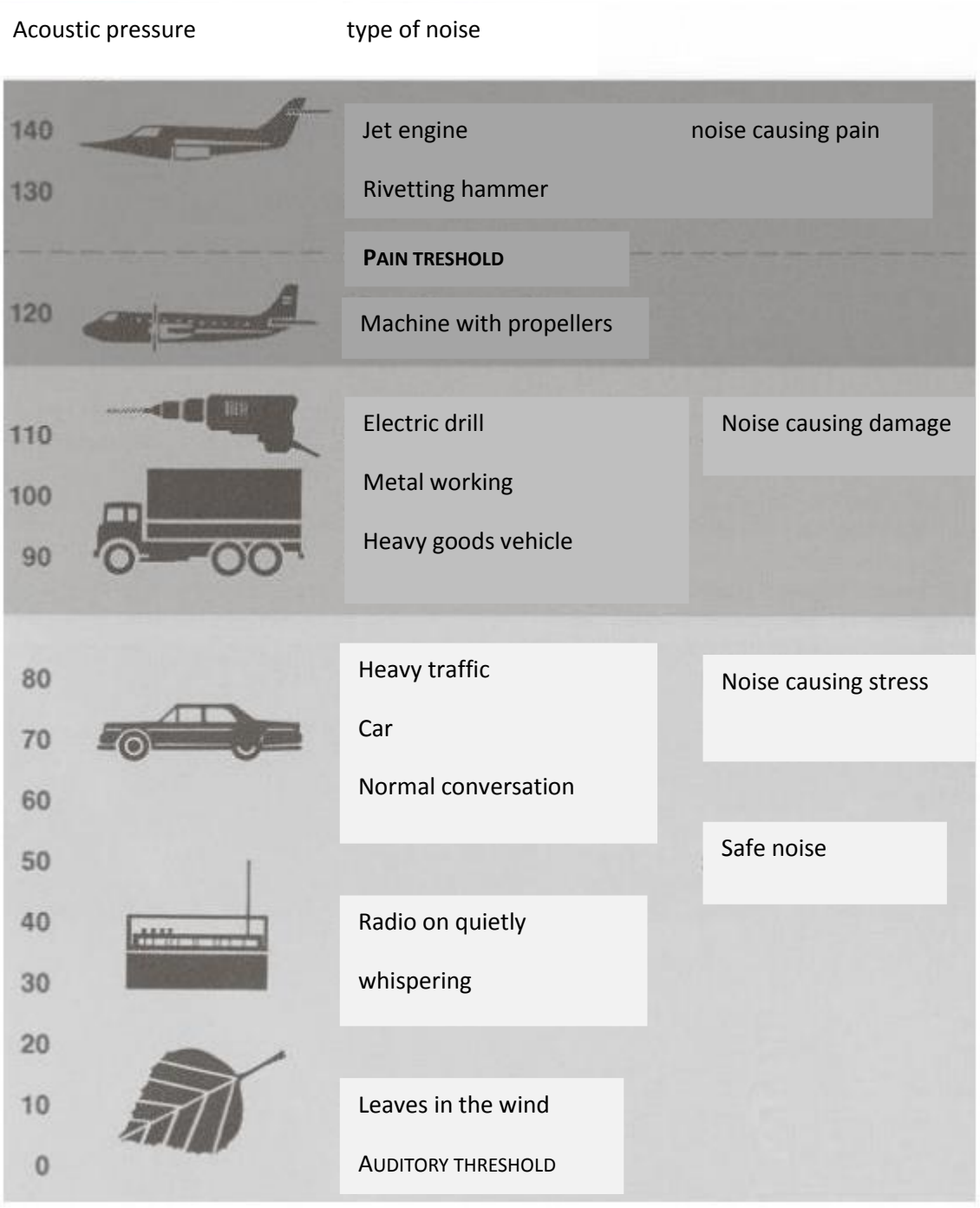


Fig. 54: Examples of different acoustic pressure levels (Picture company Bilsom, source BGI 523)

When the noise level increases by 3 dB (A), then the danger to the hearing doubles. Every further increase of 3 dB (A), means another doubling of the danger! However, we only perceive an increase of 10dB (A) as being double as loud.

Rule of thumb
A 3 dB(A) **in**crease means double the danger.
A 3 dB(A) **de**crease means half the danger.

Attention! Particularly high sound levels can lead to damage even with single one-off sounds.

According to the Workplaces Ordinance (ArbStättV, 3.7 Noise), the acoustic pressure level is to be kept as low as possible for the type of company.
The test level at the workplace in work rooms may have a maximum of 85dB (A), including the effects of external noise; when it is not possible to keep to this, even after reasonable measures have been taken to minimise the noise, it may be exceeded by 5bD (A).

Trigger values for noise

The trigger values with regard to the noise exposure level $L_{EX,8h}$ and the peak acoustic pressure $L_{pC,peak}$ are:

1. Higher trigger values: $L_{EX,8h}$ =85dB(A), $L_{pC,peak}$ =137dB(C)
2. Lower trigger values: $L_{EX,8h}$ =80dB(A), $L_{pC,peak}$ =135dB(C).

Attention: When using trigger values, damping from personal hearing protection is not taken into account.

Measures to deal with noise can take the following forms:

1. Technical measures
   Sound emission must be stopped or made as low as possible according to the state of the art.
   Technical measures have priority over organisational measures.

2. Organisational measures
   e.g.
   - alternative working methods, which reduce the exposure to the noise;
   - choice of, and use of new or existing equipment primarily to reduce noise;
   - design and set-up of work stations and workplaces to minimise noise;

   Technical and organisational measures have priority over personal measures.

3. Personal measures
   These safety measures are necessary when the noise exposure level cannot be brought under 80dB(A) with technical and organisational measures.

From a noise exposure level of 80dB(A) and a peak acoustic pressure of 135dB(C), the employer has to provide hearing protection.

From a noise exposure level of 85 dB(A) on, or a peak acoustic pressure of 137dB(C) or more, the employees are required to use the hearing protection. The work areas must be labelled with the pre-scriptive sign "Use hearing protection".

Fig. 55: Prescriptive sign: Use hearing protection

Hearing protectors have differing sound insulation. The sound insulation depends upon the frequency, i.e. they are less effective for deeper tones than higher ones. For particularly loud noise, only hearing protectors with particularly high sound insulation are effective.

Hearing protection is always to be worn, and worn constantly when noise is present (e.g. in marked areas): Even short periods when it is not worn significantly lower the protection.

Now let us consider hearing protection as a further type of body protection.

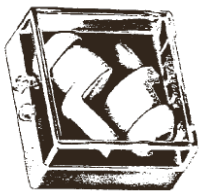
One differentiates in principle between:

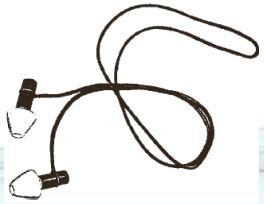
- Sound-proof padding
- Earplugs
- Banded earplugs
- Ear muffs
- Sound protection helmets
- Sound protection suits for extreme areas

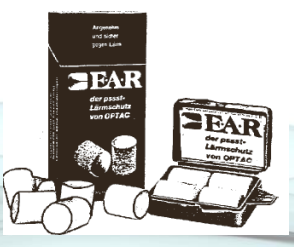
Fig. 56: Hearing protection

Ear plugs / ear protectors

These earplugs are available in 3 different sizes and come in pairs in a square carry case with keychain.







Sound-proof padding

Fig. 57: Earplugs and sound-proof padding

Important norms, rules and regulations:

BGV A1	General Regulations
ArbStättV	Workplaces Ordinance
LärmVibrationsArbSchV	Noise and Vibration Occupational Safety Regulation
BGR 194	The Use of Hearing Protection
DIN 45641	Average Sound Level
DIN 45645-2	The Determination of Test Levels from Measurements – Sound Emission at the Workplace
BGI 5024	Hearing Protection Information
BGI 5053	Noise Techniques; Determining Noise Exposure at the Workplace
BGI 674	Worksheet on Protection from Noise LSA01-234: Lowering Noise on the Shop Floor; Principles and Criteria for Choosing Sound Absorption Equipment
BGI 523	People and Work
BGI 688	Noise at the Workplace in the Metal Industry

7.3 Preventative measures against fire and explosions

Every year companies and fire-insurance companies must pay out enormous sums to deal with fire damage. It is not only financial factors, but also that production is stopped or, even worse, damage to people.

For this reason it is easy to see why every fire or explosion which is stopped helps secure the future of the company: When orders cannot be filled because the production areas and work stations are not in operation, it can cause the economic collapse of the company.

Thus it is in the best interests of every company to recognise and eliminate every possible cause of fire or explosions.

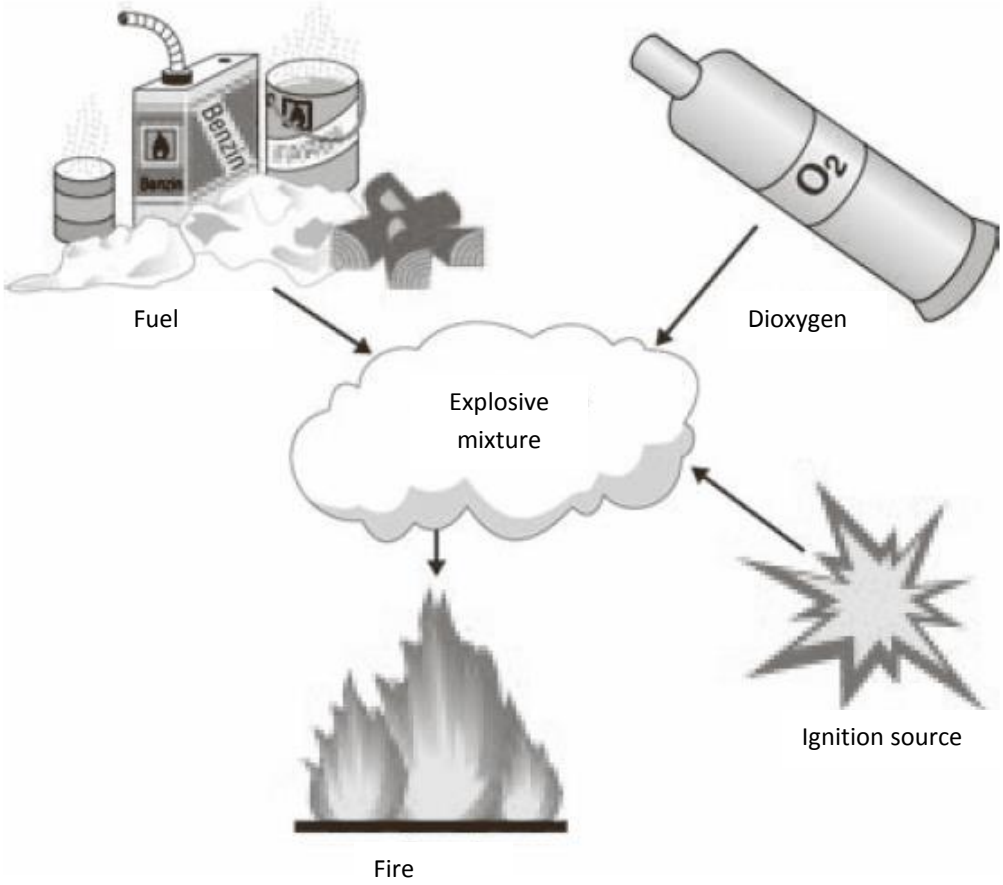


Fig. 58: Prerequisites for the combustion process (Source: BGI 560)

Alongside the guidelines given by the states in their building regulations, there are those of the professional organisations, for example BGI 560 "Occupational Health and Safety by the Prevention of Fire" or BGI 563 "Fire Safety when Working with Fire Hazards".

Figure 59: Emergency exist in an administration building, with sign and fire extinguisher (Source: BGI 560)

Fig. 60: Rolling shutter gate for fire safety (Source: BGI 560)

Introducing and monitoring measures to prevent fires and explosions is part of every supervisor's job. The following measures can all be relevant here:

- Providing fire-fighting equipment and making it accessible (e.g. fire blankets)
- Installing fire alarms
- Setting up and labelling escape routes and keeping them clear
- Training personnel to use fire fighting equipment
- Labelling areas at risk of fire
- Keeping sources of heat at a distance
- Prohibiting smoking
- Creating fire safety regulations
- Installing smoke detectors etc.

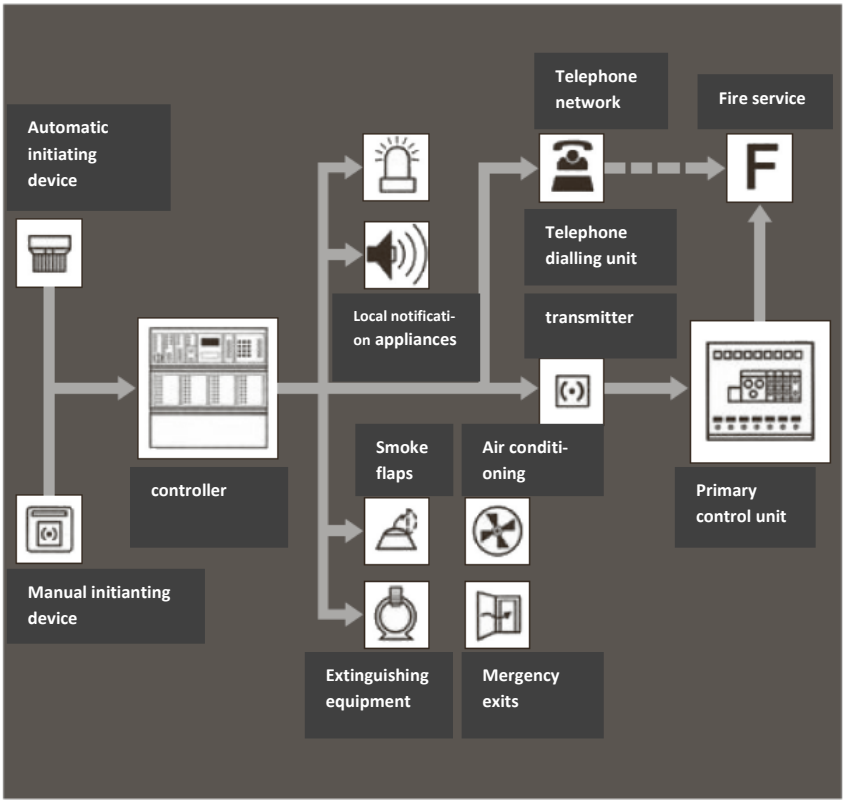


Fig 61: The design of a fire alarm system (Source: BGI 560)