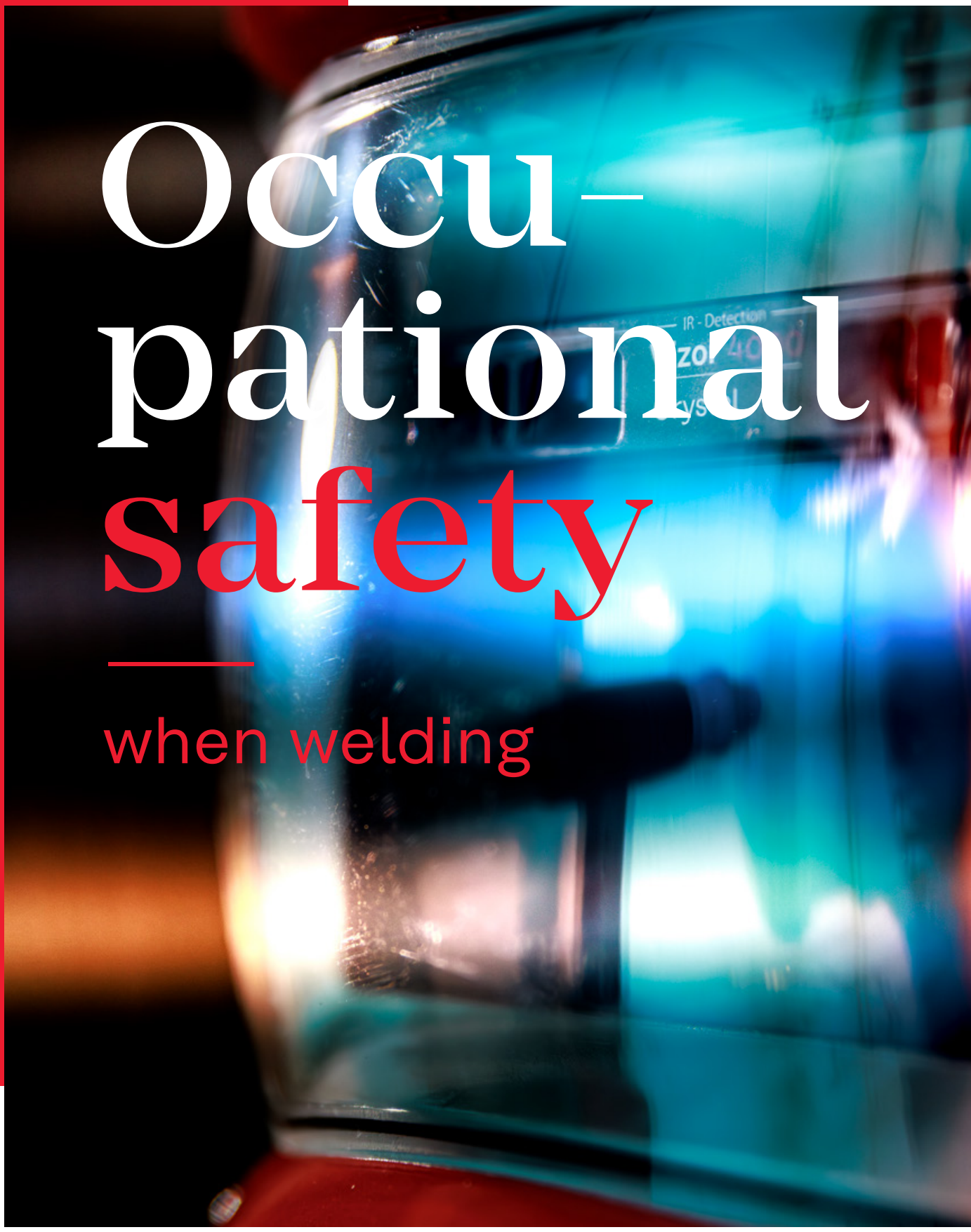
Fronius



Occu–pational safety

when welding

AUVA

Contents

Occupational safety
when welding

1. Introduction Occupational safety

Health and safety at work is no longer just an optional extra for responsible companies. In many countries, employers are even mandated by law to carry out a risk assessment. Effective protective measures must also be put in place and action taken to ensure that they are complied with.

European safety symbols

Warning signs
Warning of a general danger

W001 EN ISO 7010

Labeling regulation
Austria

S

Substitution

S = Substitute measures

Replace a dangerous process with a harmless one.

The basic principle behind health and safety at work is that

of eliminating hazards at source.

If this is not sufficient or not at all possible, the STOP principle provides guidance. STOP outlines the order of priority given to the individual protective measures, known as the hierarchy of measures. It is one of the most important cornerstones of current occupational health and safety legislation.

T

→ Technik

T = Technical measures

Minimize or eliminate the danger by putting technical measures in place.

O

→ Organisation

O = Organizational measures

Limit exposure to a hazard.

P

Person

P = Personal protective measures

Use personal protective equipment.

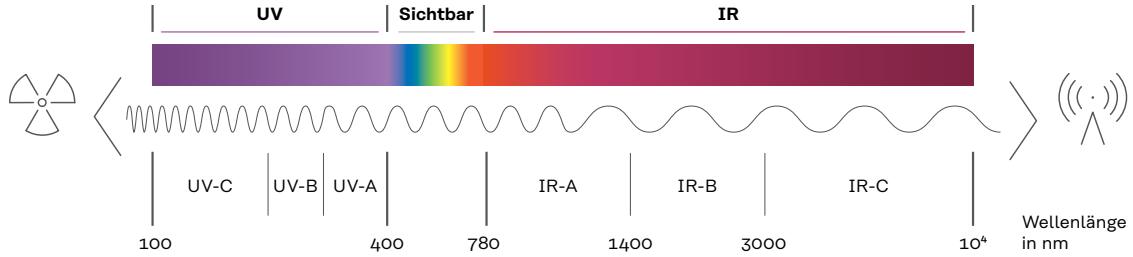
2. Hazard due to arc radiation

General:

During arc welding, the air (shielding gas) between the electrode and the workpiece is ionized by an electrical voltage and plasma is formed.

It is several thousand degrees Celsius hot and emits electromagnetic radiation of varying wavelengths. In addition to visible light, this produces infrared radiation and ultraviolet radiation, which are hazardous to the eyes and skin.

It is important to protect not only welders but also other employees who may be in the vicinity of welding work. Welding helmets, protective clothing, and gloves are all used to protect the eyes and skin. Welding protection curtains or welding protection walls must also be used to shield welding workstations and protect against optical radiation.



2.1. **Visible light**

It dazzles the eyes. In the electromagnetic spectrum, light occurs in the wavelength range of 400 (violet) to 780 (dark red) nm.

2.2. **Infrared radiation (IR radiation)**

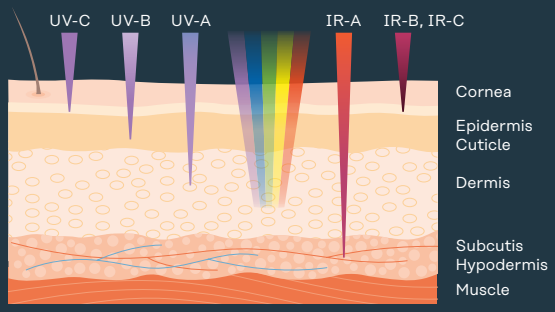
This is in the wavelength range from 780 nm to 10 µm (10,000 nm) and is perceived as heat radiation by the skin. If the body is exposed to infrared rays for an extended period of time, there is a risk of burns that can cause eye damage. Short-wave IR radiation can cause clouding of the lens of the eye (cataract); long-wave radiation can burn the cornea.

2.3. **Ultraviolet radiation (UV radiation)**

UV radiation is invisible to humans. We need small amounts of UV to produce vitamin D, but excessive exposure is harmful. During welding, it causes "flashing" to the eyes and can lead to conjunctivitis. Short-term exposure to high doses on unprotected areas of skin will cause sunburn. Long-term high doses can lead to skin cancer and cataracts.

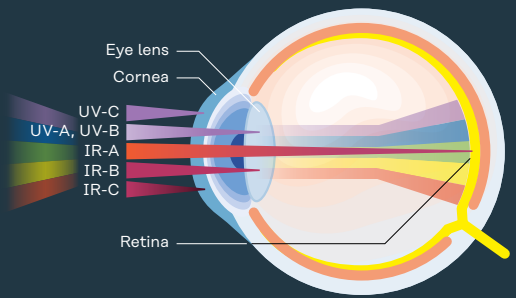
UV radiation is divided into three categories, depending on the wavelength:

- **UV-A radiation** (320-400 nm) penetrates deep into the skin. It causes tanning and premature aging of the skin.



- **UV-B radiation** (280-320 nm) penetrates the uppermost layers of the skin. It causes sunburn and poses a high cancer risk.

- **UV-C radiation** (100-280 nm) has shorter wavelengths and higher energy than UV-A and UV-B radiation. The natural UV-C rays emitted by the sun are largely absorbed by the earth's atmosphere. They do not reach the Earth's surface and are therefore harmless to humans. However, when generated artificially, for example during welding, they can cause sunburn and skin tumors.



2.4.
How you can effectively protect yourself against UV/IR radiation

In order to protect yourself effectively, your entire body must be shielded from the arc radiation. The basic principle behind health and safety at work is that of eliminating hazards at source. If this is not sufficient or not at all possible, the STOP principle provides guidance.

S
Substitution

2.4.1.
Substitute measures: Choosing another welding process

In some cases, it is possible to replace arc welding with a process that either does not use an arc or shields it (friction stir welding, submerged-arc welding, etc.).

T
Technik

2.4.2.
Technical measures: Shield the danger

All people in the vicinity of welding work must be protected from reflections and glare. Every welding workplace must be equipped with screens; lamellar welding curtains are a suitable choice. Such curtains absorb a large part of the radiation and, depending on the degree of coloration, make it possible to see the welding process. Generally speaking, the darker the color of lamellar curtains, the better they absorb UV radiation. Sheet metal partitions should not be used because they reflect excessive levels of UV radiation.

2.4.3. Organizational measures: Limit exposure to a hazard

Short arc times also pose a risk to the human eye.

So shortening the welding time in order to protect the eyes is, in effect, pointless.

2.4.4. Personal measures: Use "personal protective equipment"

The best way to protect yourself against arc radiation is by shielding your entire body—usually with personal protective equipment. This usually consists of a welding helmet, protective goggles, protective clothing, and protective gloves.

Light-colored or glossy walls are unsuitable for welding workstations.

White walls reflect arc radiation and are to be avoided at all costs. The best way to shield the arc during automated welding is in welding cells, as their enclosures keep all the arc radiation away from welding personnel.

3. Hazard due to harmful noise

General:

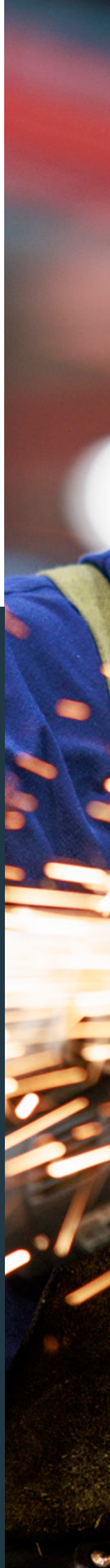
People carrying out welding work such as gas shielded arc welding (MAG/MIG) can expect to be exposed to noise levels of up to 90 dB(A)—even before taking other sources of noise into account.

This often results in limit values being exceeded and causes situations that can impair and damage hearing.

Trigger value = warning limit. Exposure limit value = maximum value to which employees may be exposed.

Possible sources of noise

- **Gases exiting the nozzle at high speeds** (e.g., arc air gouging, etc.)
- **Cooling of the welding machine**
- **Work before and after welding** hammering, grinding, etc.
- **Ambient noise** in the building
- **Welding process** sound generated by the arc



3.1.

Health effects

3.1.1.
Short-term impairments

Exposure to noise can have various effects on the human body. In many cases, noise is often overlooked or not recognized as the cause of the following impairments, which often occur briefly in the initial stages.

- **Distraction**
- **Trouble concentrating**
- **Tinnitus**
- **Dizziness**
- **Increased heart rate**
- **High blood pressure**
- **Dilated pupils**
- **Increased muscle tone**

3.1.2.
Long-term impairments

Some of the short-term consequences can also have a long-term impact.
The most well-known are:

- **Noise-induced hearing loss**
- **Permanent tinnitus**
- **High blood pressure (cardiovascular impairment)**

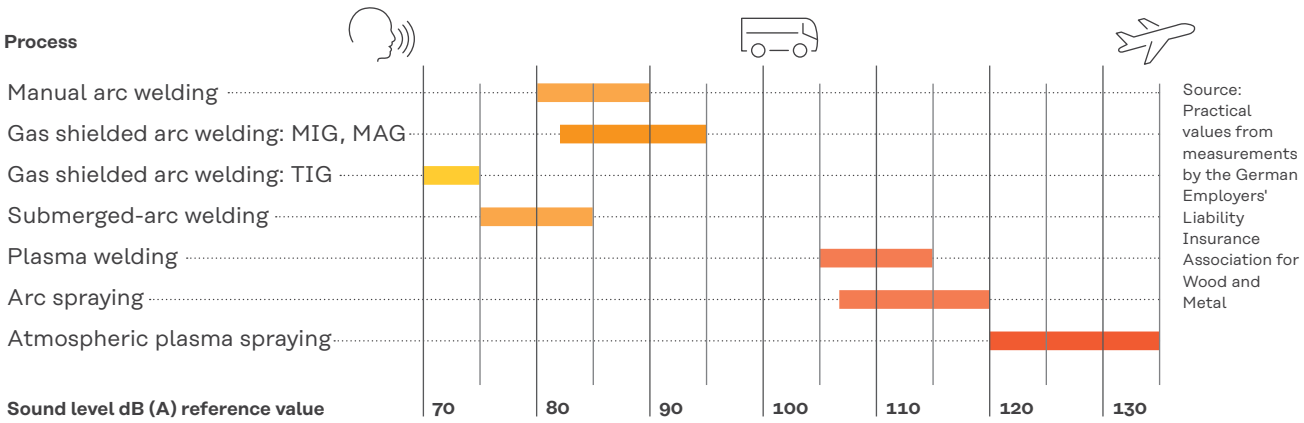
3.2. At what point does noise become dangerous?

3.2.1. Limit values

The level of noise exposure results from the interaction between the intensity of sound and the exposure time. The key factor when determining how long employees may be exposed to noise that is hazardous to their hearing is the average continuous noise level they are exposed to for a period of eight hours. It can be assumed that noise at a level of 85 dB(A) and above will impair hearing. Measures to reduce noise must be put in place if this limit value is exceeded.

3.2.2. Suitability and follow-up examination

When starting work involving high levels of noise for the first time, workers must undergo a suitability examination and then a follow-up examination every five years. Rules may vary from country to country.



3.3. Protective measures

The welding supervisor must ensure collective safety precautions—substitute, technical, and organizational—are in place before personal protective measures are used. This must be done according to the STOP principle (page 1).

S → Substitution

Substitute measures, use other joining processes.

O → Organisation

Minimize working time in high-noise areas, increase distance to the noise source, leave high-noise area after finishing work.

T → Technik

Carry out activities in purpose-optimized rooms (sanding booth, welding booth, possibly with sound-absorbing elements, etc.).

P → Person

Hearing protection
Flame-retardant hearing protection must be used when welding above shoulder height.

4. Mechanical hazards

4.1. Hazards due to flying sparks and particles

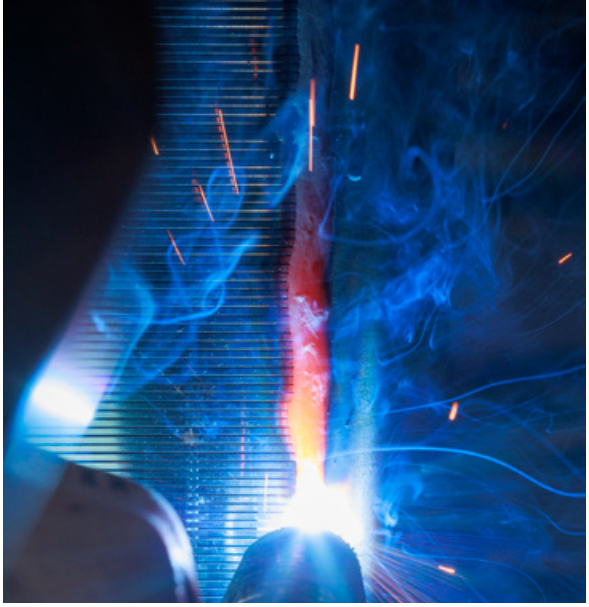
Arc welding results in flying sparks and particles both during welding work as well as during prep and finishing work on the weld. If slag is removed mechanically after the welding process, parts of slag flying off the weld pose a risk to the eyes. The potential for risk is higher when welding in cramped spaces or in forced postures.

4.1.1. **Protective measures**

- Suitable eye protection must be worn
- Protective measures also apply to any other people in the danger zone
- Welding helmets with auto-darkening visors offer optimal protection—not only during welding, but also during prep and finishing work.

General:

Mechanical hazards can arise from slag, spatter, sparks, and wire electrodes.



4.2. Hazards due to the wire electrode

The welding wire can result in puncture injuries during cleaning and maintenance of welding torches. If the welding wire is trimmed, flying parts can cause eye injuries.

4.2.1. **Protective measures**

- Suitable eye protection must be worn
- Carry out cleaning and maintenance work on the welding torch only when the welding machine is switched off
- If a new wire is inserted when replacing the rollers, a low travel speed should be selected
- Caution when cutting the welding wire! The shorter the wire end, the higher the speed at which the cut-off bit flies away.

4.3. Hazards due to hot surfaces

Hot workpiece surfaces and high arc temperatures both pose a risk of burns.

4.3.1. **Protective measures**

Wear personal protective equipment (PPE): welding helmet, welding gloves, protective welding apparel, safety shoes.

4.4. Secondary hazards

Steps must be taken to ensure that no persons are at risk during welding or joint preparation work. This applies not only to welders but also to those present in the immediate vicinity.

4.4.1. **Protective measures**

Persons who are in the immediate proximity of welding work must also be protected—ideally by separating off the space or using curtains and similar measures.

5. Hazards due to non-ergonomic work environments

General:

Creating an ergonomic workplace means that the task and working environment are adapted to the people—specifically to the welders.

Their height and motor skills must be taken into account when setting up workplaces.

There are situations in which not all ergonomic risk factors can be eliminated and workers are exposed to health risks. For example, the duration of welding in forced postures due to workpiece requirements should be kept as short as possible.

Tools such as fixtures, mounting frames, and part holders can make welding work more ergonomic, making the work significantly easier and reducing the risk of injury.

5.1.
Health effects

Many potential causes of injury are not related to the industry or occupation but rather result from unergonomic patterns of personal behavior.

5.1.1. Risk factors

- **Repeated gripping/turning**
- **Repetitive movements**
- **Static postures**
- **Fatigue due to monotonous work and lack of rest breaks**

These risk factors can cause job-related musculoskeletal disorders (MSDs) if they occur with sufficient frequency and/or in combination. MSDs are injuries and diseases that affect muscles, nerves, tendons, ligaments, joints, intervertebral discs, skin, subcutaneous tissue, blood vessels, or bones.

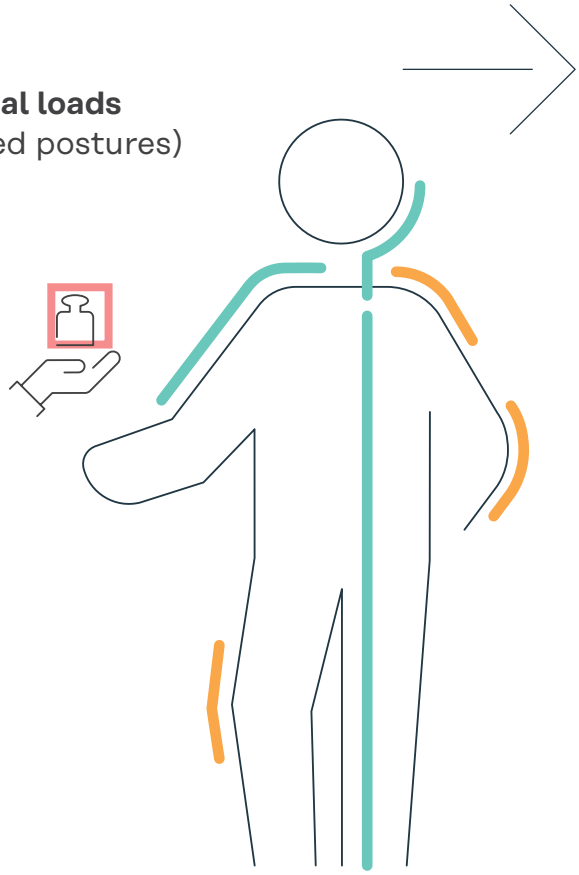
5.1.2.

Frequent complaints among welding specialists

- **Back injuries**
- **Bursitis**
- **Carpal tunnel syndrome**
- **Inflammation of tendons and tendon sheaths**
- **Chronic shoulder pain**

5.1.3.

Typical loads
(forced postures)




01


02

Welding with the arms extended to the front (01)

Posture that causes compression: supporting the arms on a hard surface

Unfavorable, rigid posture: the arms are extended to the front for a longer period of time.

Welding at ground level (02)

Posture that causes compression: supporting the arms on a hard surface

Unfavorable, rigid posture: working with the back bent forwards.

Welding in confined spaces (03)

Posture that causes compression: using hard surface for support

Unfavorable, rigid posture: hot work in a cramped environment and in a static posture

Welding above shoulder height (04)

Unfavorable, rigid posture: neck is stretched, static load on the arms and shoulders

Lifting and moving heavy components (05)

Heavy strain on the musculoskeletal system

03

04

05

5.2. **Protective measures**

Use lifting aids

Lifting aids (05) (cranes, etc.) are designed for moving loads. They help to avoid physical strain caused by heavy lifting.

- **Moving, carrying, or storing heavy components**
- **Wide range of manipulation systems and grippers**
- **Systems and equipment must be designed for the weight of the load**

5.3. Ergonomic equipment and positioning aids

- **Height-adjustable welding tables (06)**
- **Various positioning aids (turntables, etc.)**

06

6. Hazard due to electrical current

Beware of open circuit voltage!

General:

While live parts of commercially available electrical appliances are protected against contact, in arc welding the open circuit voltage can become contact voltage if the workpiece (ground) and the electrode or non-insulated parts of the electrode holder are touched at the same time. In this case, the current travels through the human body.

There are permitted maximum values for the open circuit voltage (see 6.4), which depend on the operating conditions. There is an electrical risk to humans starting at voltages of more than 25 V AC (RMS) or 60 V DC and if there is the potential for a sufficiently high current to flow at the same time.

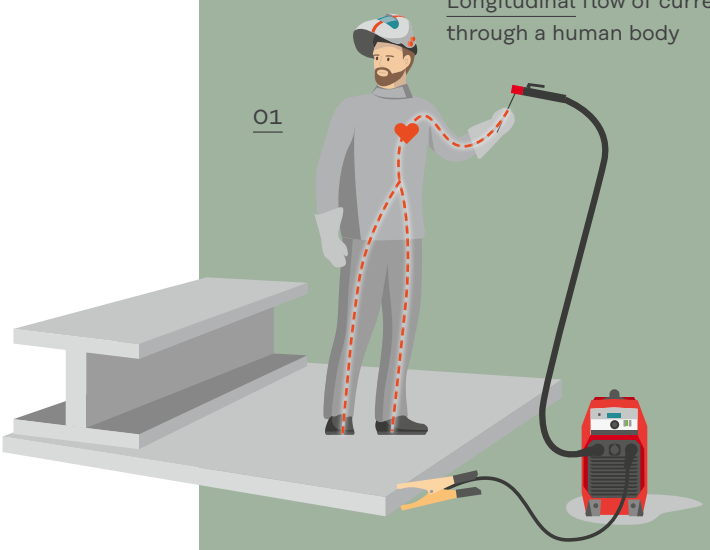
The electrical current has an irritating effect on muscles (heart) and nerves, which can cause the muscles to cramp. This is known as the let-go current. Lower currents can trigger reflex movements that lead to secondary accidents, such as falls. The duration and amount of current flowing through the body are therefore crucial. An equally important aspect is whether you are working with direct or alternating voltage.

The amperage (I) is dependent on the applied voltage (U) and the resistance (R) and follows Ohm's law (U = R x I). If you want to determine the amperage, a human resistance (without protective equipment) of 1,000 ohms can be assumed from hand to hand or hand to foot. If the welding machine has an open circuit voltage of 50 V, a current of 50 mA (without protective equipment) can pass through the body according to Ohm's law (I = U / R).

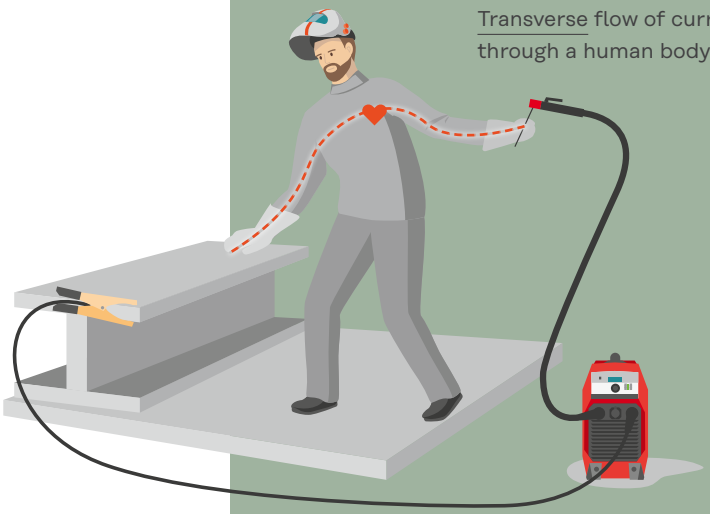
Examples:

Longitudinal flow of current through a human body

01



Transverse flow of current through a human body



02

Welders are at risk if they become part of the circuit themselves. The current flows through the human body by the shortest route (lowest electrical resistance). If the connection to the circuit is made, for example, via both hands, the current flows through the hands, arms, upper body, and thus also vital organs such as the heart.

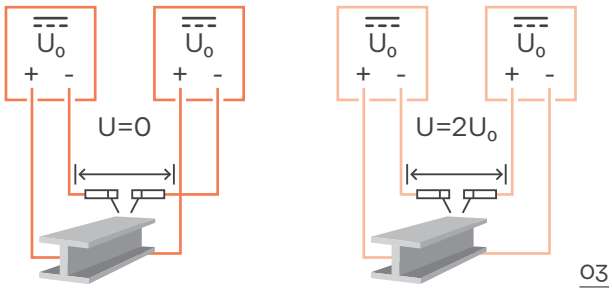
6.1.

Arc welding with multiple welding machines on one workpiece or workpieces with an electrically conductive connection to each other

If several welding specialists are using multiple welding machines to weld on the same workpiece or on workpieces that have an electrically conductive connection to each other, the contact voltage (open circuit voltage, see above) that occurs may be unacceptably high. This condition is not easily recognizable.

6.1.1. Direct current (DC)

If welding takes place simultaneously using two different welding circuit polarities, the open circuit voltages of both welding machines are added together to produce an overall total.



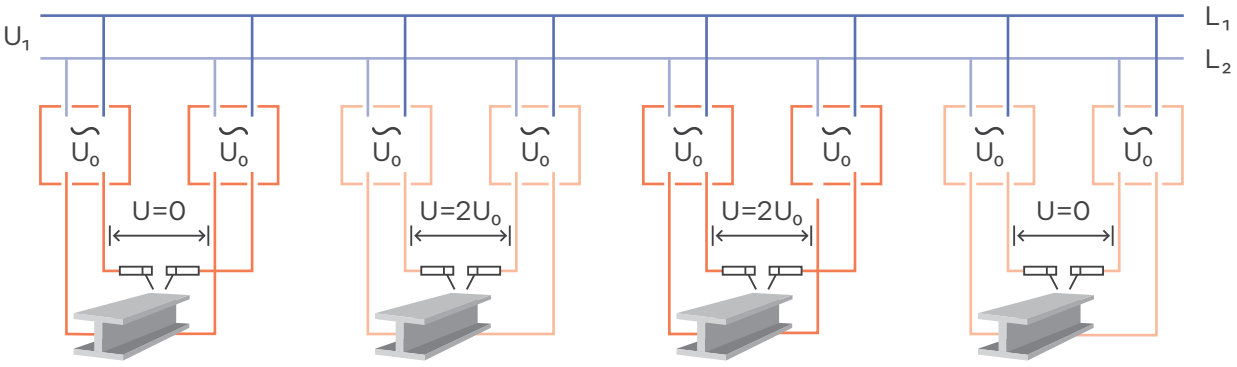
03

Identical polarity Different polarity

6.1.2. Alternating current (AC)

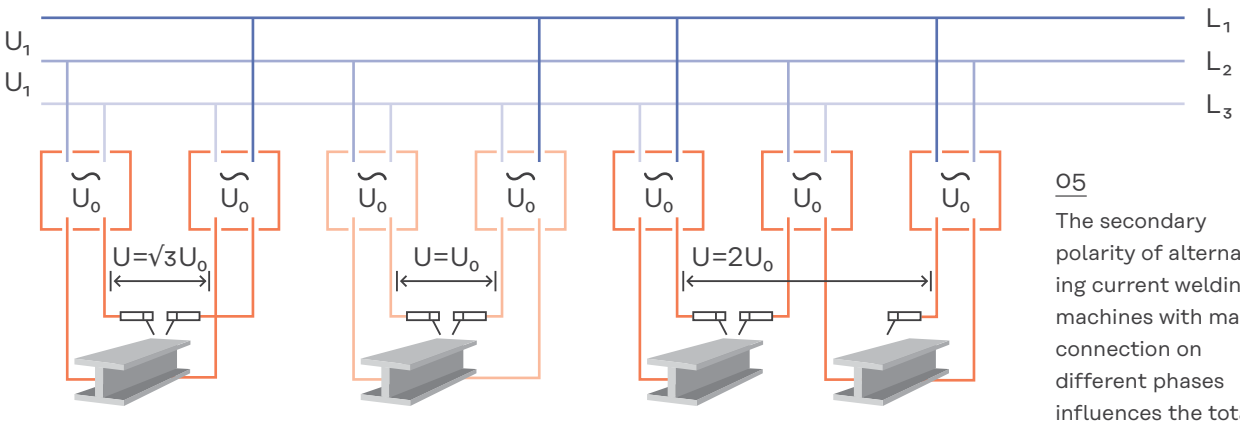
In addition to the polarity of the welding circuits, the grid-side connection of the welding machines also influences the resulting open circuit voltage. A contact voltage can occur up to the sum of the open circuit voltages of all individual welding machines.

Since the mains connection has an influence on the sum of the welding voltages, the voltage between the welding torches (electrode holders) must be measured before welding begins.



04

The secondary polarity of alternating current welding machines with mains connection on the same phases influences the total voltage. This only applies to 50 Hz transformer devices. Inverter welding machines are decoupled from the grid and are never in phase with the mains voltage or with neighboring devices.



05
The secondary polarity of alternating current welding machines with mains connection on different phases influences the total voltage.

6.2.
Protective measures

- Welders must be made aware of the danger.
- Increase distances so that two welding torches or electrode holders cannot be touched at the same time. If this is not possible, their working areas must be separated by insulating walls.
- Take measures to ensure that the total voltage does not exceed the maximum level of the maximum permitted open circuit voltage (see graphics 04 and 05).

6.3.
Safety Instructions

- Welders must ensure that welding machines (electrical equipment) are in perfect condition before starting their work.
- Switch off unused welding machines; disconnect unattended welding machines from the grid.
- Set up and operate the welding machines in accordance with the protection class shown on the rating plate. Information provided in the operating instructions must be followed. welding machines according to IP21 may only be used in dry areas. Unprotected welding machines used outdoors must have a protection class of IP23 as a minimum.
- In the event of faults, switch off the voltage immediately or unplug the device. Immediately inform the electrician of damage to welding machines (electrical devices), the power cable, or welding power-leads. Do not continue to use the device or system.
- Never open protective covers on welding machines (electrical devices).
- Clamp the return lead cable to the workpiece or to the workpiece support and as close as possible to the welding point.

6.4.

Maximum permitted values of the open circuit voltage

Operating conditions	Voltage type: DC voltage	AC voltage: Peak value	AC voltage: Effective value
Increased electrical risk	113	68	48
No increased electrical risk	113	113	80
Limited operation without increased electrical hazard [1]	113	78	55
Mechanically-guided welding torch [2]	141	141	100
Plasma cutting	500	–	–
Underwater with people in the water [3]	65	Prohibited	

Tab. 6-01 Max. permissible open circuit voltage in volts

1 | The output of welding machines for limited operation in accordance with DIN EN 60974-6 is limited by the duty cycle (temperature monitor) and the amperage (up to 160 A). These are DIY equipment for laypersons.

2 | Welding torches are considered to be mechanically controlled if the following conditions are met:

1. The welding torch must not be held by hand.
2. The open circuit voltage must switch off automatically when not welding.
3. Protection against direct contact with live parts must:
   - Meet protection class IP2X as a minimum
   - Or be guaranteed by a hazard reduction device

3 | The welding point, welding process, and person welding underwater are in contact with the surrounding water. Welding machines must be located in a dry environment.

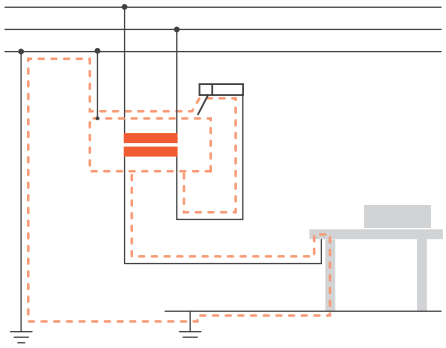
6.5.

Hazards due to stray welding current

With welding machines, there is a potential that the return lead cable of the welding machine or other electrical devices could burn away, particularly because the ground conductor is not properly connected or the electrode holder is incorrectly positioned.
These breaks in the ground conductor are not evident from the outside and thus lead to considerable risks for people who use equipment damaged in this way.

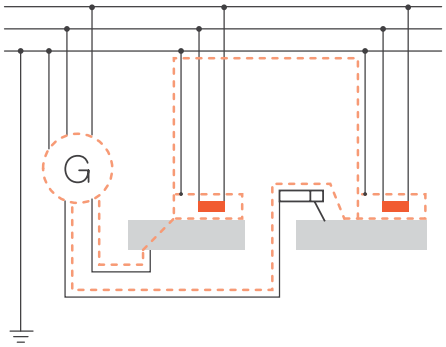
6.5.1. **The most common types of ground conductor breaks**

Prohibited placement of the electrode holder on the welding machine without insulation.



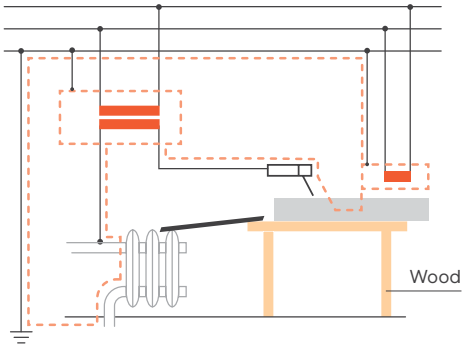
06

Electric hand tools connected on the welding work tables.



07

Prohibited extensions of the welding current return cable, e.g., in the form of an iron rod and electric hand tool on the welding work table.



08

6.5.2. **Protective measures**

The welding current return cable must be connected directly to the workpiece or to the support (by clamping it or using adhesive magnetic poles). Other parts such as steel structures, tracks, pipes, rods, crane carrying ropes, chains, etc., must not be used as a welding current return.

If, in exceptional cases, workpieces need to be welded while being suspended from the crane hook, the workpiece must be carefully insulated from the crane, e.g., using dry textile ropes or an insulated swivel hook. Work baskets used by people must be insulated when suspended during electrical welding work.

If other electrical equipment is used on the same workpiece during electrical welding work, it is advisable to use insulated tools.

6.6.
Working in conditions with high electrical voltage

6.6.1. **Examples of increased electrical hazards:**

– In workplaces where freedom of movement is limited, so that welding specialists have to weld in a forced posture (e.g., kneeling, etc.) while touching electrically conductive parts.

Caution when working around electrically conductive parts in confined spaces!

– In workplaces that are completely or partially delimited by electrically conductive parts and which pose a hazard to welders due to exposure to current if the welders cannot avoid touching them or this occurs by accident.

In order to aid the assessment of whether there is an increased electrical risk during arc welding, always ensure that there is at least 2 m of free space for welders to move freely between electrically conductive parts positioned opposite one another. If this is not met in even just a single dimension (length, width, height, or diameter), there is an increased electrical risk.

Caution in damp and warm conditions!

– In wet, damp, or hot workplaces where the resistance of human skin, protective clothing, and protective equipment may be significantly reduced by moisture or sweat.

– Wet workplaces are those where work clothing becomes soaked with moisture and can therefore conduct electricity. This also applies to outdoor workplaces. Hot workplaces are those where work clothing becomes soaked through with sweat and can therefore conduct electricity.

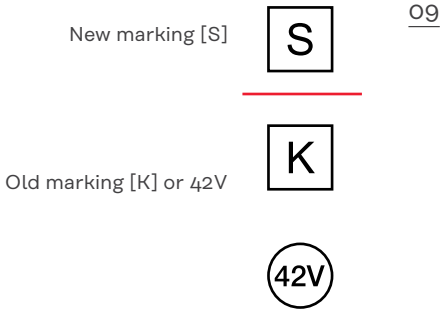
6.6.2. **Protective measures**

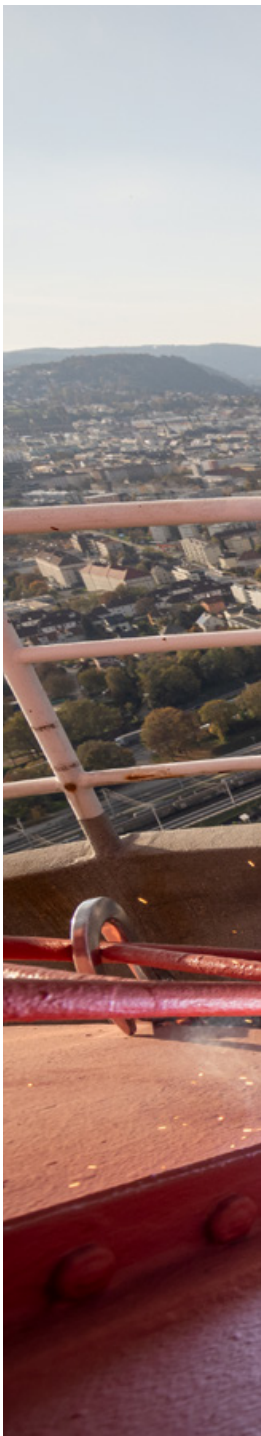
Special precautions must be taken when working in conditions where there is an increased electrical risk. Only use welding machines intended for this work, which are specially marked with the following characters (09): [S], older devices may also still be marked with [K] or 42V.

Welding specialists must be protected against contact with electrically conductive parts as well as damp floors and walls by means of insulating underlays or intermediate layers of material.
If this insulation cannot be put in place due to the associated additional hazards, in particular the risk of falling, or due to the space available at the specific workplace, work may only be carried out while wearing dry and undamaged work clothing.
If it is not possible to wear clothing that remains dry for the entire duration of the welding work in these cases (e.g., in hot rooms), then only DC arc welding generators, converters, and arc welding rectifiers may be used for manual arc welding.

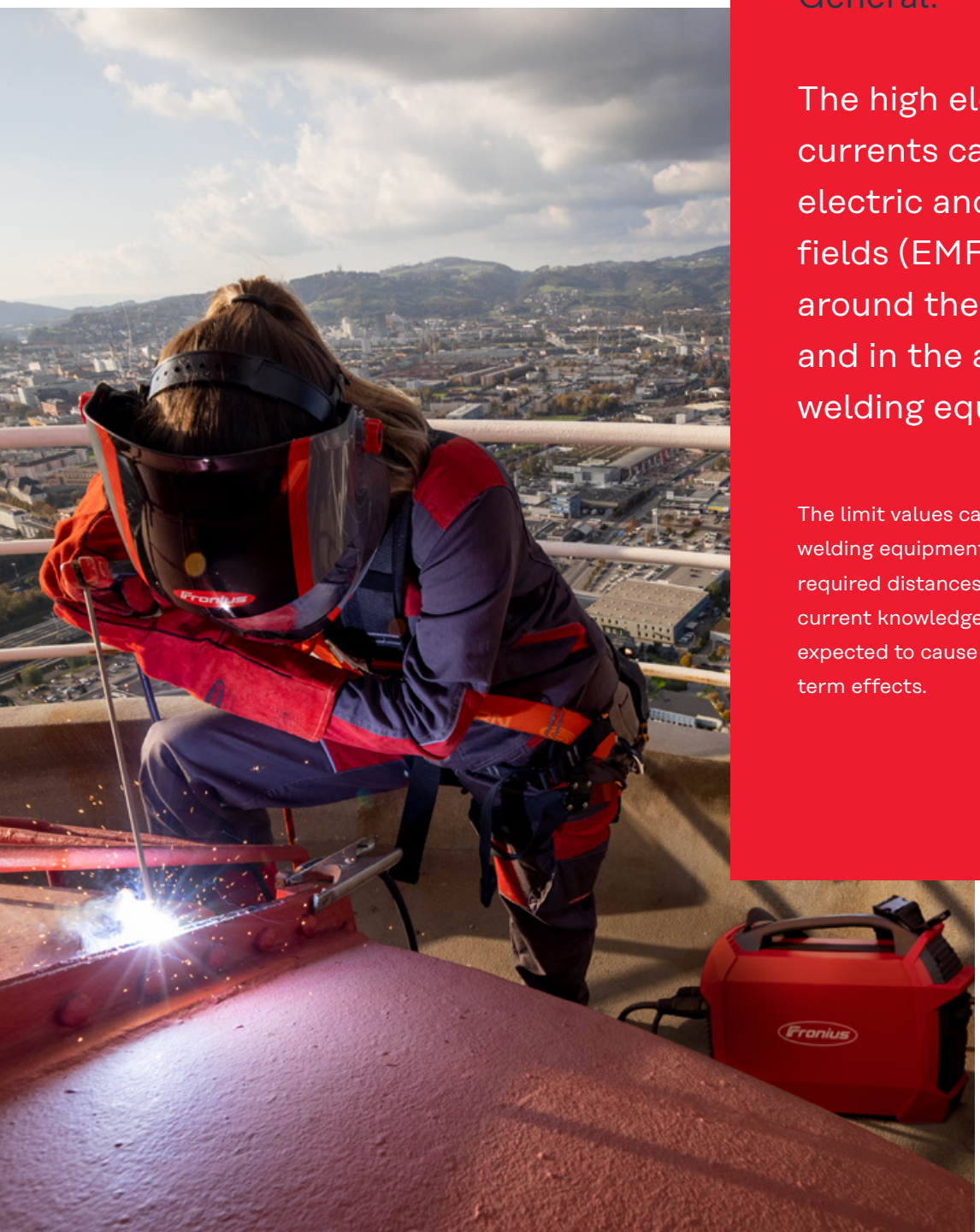
The open circuit voltage of the welding machine should be kept as low as possible, taking into account the welding task and the characteristics of the device type being used, and must not exceed 75 V. Only a specialist may carry out this work.

It is forbidden to set up the welding machine in areas where there is an increased electrical risk; i.e., it must not be taken into danger zones. Protective extra-low voltage must be used for remote control of the welding machine. Welders must not work alone and must be supervised.





7. Hazard due to electromagnetic fields



01

General:

The high electrical currents cause local electric and magnetic fields (EMF) when welding around the welding circuit and in the area of the welding equipment.

The limit values can be maintained if the welding equipment is used properly and the required distances are observed. Based on current knowledge, EMF exposure is not expected to cause any hazardous or long-term effects.

Remember:

Persons who are in the immediate vicinity of welding work (including those behind walls) are exposed to potential hazards and therefore must be briefed. This also applies to visitors.

People who wear implants, jewelry, prostheses (metal parts in and on the body), and active physical aids (hearing aids, etc.) must consult the attending physician about potential health hazards.

People who wear active implants such as pacemakers or insulin pumps must consult the attending physician.

Prevent electrode hand cables and hosepacks from creating large cable loops.

- Bundle the welding power-lead (hosepack) and grounding cable together and secure with adhesive tape
- Both cables must run along the same side of your body (02)
- Connect the grounding cable as close to the area of the workpiece being welded as possible

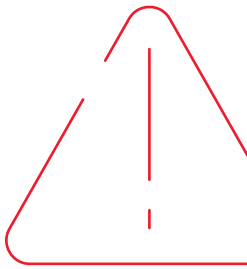
Keep distances to electrode hand cables and hosepacks as large as possible:

- Do not wear the welding machine on your body during welding work
- Do not run cables over your shoulders or rest them on your thighs
- Do not wrap cables around your arms or body (03)
- Notes and recommendations can be found in EN IEC 60974-9:2018 and the Mplus 666 leaflet from AUVA (Electromagnetic fields during welding).

02

03

7.1.
Effects on passive and active medical implants



7.1.1. Types of medical implants

- Metallic parts located on or in the body, such as screws, plates, and jewelry
- Electrically conductive and ferromagnetic prostheses or parts thereof
- Active medical implants such as pacemakers

7.1.2. Hazards

Electrical and magnetic fields can influence implants in a variety of ways and the effects felt by wearers vary in such cases. They are sometimes barely perceptible and often perceived to be unpleasant when they are. In some cases, they prove to be life-threatening. People who wear such aids or implants on or in their body must be informed of the hazards posed by EMF. Exposure to EMF sources must be avoided wherever possible. If this is not possible, protective measures must be taken to proactively counteract the effects of electromagnetic fields.

7.1.3. Electrical field

- Shielded by the skin—the inside of the body is almost field-free

7.1.4. Magnetic field

- Penetrates the human body partially to completely
- It is difficult to effectively shield these fields
- Forces can act on ferromagnetic parts (strong static fields)
- Electrically conductive parts can become extremely hot due to the current flow
- Implant electronics may be affected with malfunctions or even complete failure

7.1.5. Electromagnetic field

- Penetrates the human body partially to completely
- Contact currents from electrically conductive parts can flow through the body
- Noticeable irritation may occur
- There may be localized overheating (burning) and electronics can malfunction

7.2. Statements and recommendations

Employees who wear active or passive implants must inform their employer before starting welding work. A workplace evaluation must then take place. Appropriate measures are required if exposure limit values are exceeded, such as maintaining a certain distance from welding work.

8. Hazard due to risk of fire and explosion

General:

Welding generates large amounts of heat, which can ignite flammable material in the immediate vicinity. Sparks or hot metal particles can start fires even at a significant distance from the welding point.

Welding work is particularly dangerous in areas with openings, air gaps, or cracks, where sparks or hot metal particles can be projected into cavities or adjacent environments.

8.1. Sources of danger

- **Flammable substances in the immediate vicinity of welding work**
- **Lack of or inadequate fire protection measures at the workplace**
- **Welding work that is carried out without approval (hot work permit)**

Note: Temperatures during welding exceed the ignition points of most flammable substances. Important: Use non-combustible hydraulic fluids for clamping devices.

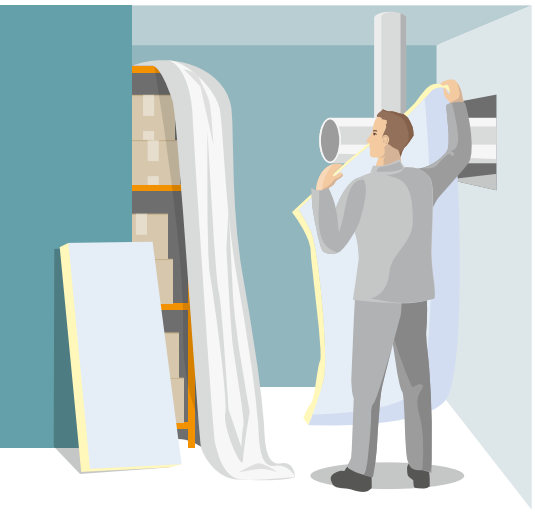
8.2. Fire protection measures

8.2.1. **Organizational measures to protect against fire**

If the risk of fire cannot be completely eliminated for operational reasons or due to the building layout, welding and flame cutting work must be approved by plant management or their representatives. In such cases, welding may only be carried out under the supervision of competent experts. The safety measures to be applied must be listed in the written approval, i.e., the welding permit or hot work permit.

01

02



03

04

05

Rules of conduct

If the risk of fire cannot be completely eliminated, approval to carry out the work must be obtained from the employer before starting welding and flame cutting work. (01)

Flammable materials must be removed from the workplace and the surrounding area (sparks and particles can fly up to 10 m). (02)
Examples include highly flammable objects such as paper, textiles, pressure vessels, and containers with flammable liquids or combustible gas.

Flammable items that cannot be cleared away must be covered with fireproof coverings or panels.

Note: Hot metal particles can fly up to 10 m during welding or cutting!

Air gaps, wall openings, ceiling openings, as well as pipe openings in walls, floors, and ceilings must be fitted with fireproof sealing. This also applies to electricity cable ducts and escalator interior spaces! (03)
Heat that could cause ignition can also be channeled into neighboring rooms through pipes!

A fire guard must be on duty if flammable objects—including those that are covered—are in the vicinity of the workplace. (04)

Suitable extinguishing equipment must be available at the workplace. (04)

After completing the work, the area around the workplace must be searched and checked for possible embers and the smell of burning—do this several times, depending on the situation. (05)

Note: Embers can still cause a fire hours later!

8.3.
Explosion protection measures

The organizational fire protection measures are also essential with respect to explosion protection. It is also essential to rule out a hazardous explosive atmosphere that can be ignited by welding work.

The following must be taken into account when identifying hazards:

- **System components that can release flammable working materials**
- **Dust deposits**
- **Depressions such as channels or shafts**

This applies in particular if the working area cannot be sufficiently ventilated during maintenance work or if flammable substances (e.g., dust) cannot be sufficiently removed before starting work.

Before starting work, the employer must determine whether a risk of explosion can occur during welding work. If the answer is yes, the risk must be evaluated. The work processes and activities as well as their effects on operation must be taken into account in a risk assessment. The valid explosion protection document (Directive 1999/92/EC) serves as the basis for the assessment.

You must determine which substances and mixtures could occur while carrying out the work—in what quantity, at what location, and in what concentration. If an area (zone) has already been designated as potentially explosive, a qualified person must take clearance measurements in the area and declare it safe for the duration of the work (and possibly longer). This requires that the work be approved in writing.

If an area is determined to be hazardous, the circumstances and ventilation conditions at the site must be taken into account. Poor ventilation conditions are to be expected in rooms, containers, or areas where there is little air exchange (tanks, silos, shafts, pits, etc.).

If areas in which a hazardous explosive atmosphere can occur are openly connected to adjacent areas, you must determine on a case-by-case basis whether a hazardous explosive atmosphere is also possible in these areas. Rooms located below these areas are at particular risk if gases, vapors, or mists are heavier than air (e.g., liquid gas, solvent vapors). Rooms located above these areas are at risk if the explosive substances are lighter than air (e.g., hydrogen). Also take into account whether deposits of combustible dust could be stirred up or combustible dust released.

Ignition sources that occur during maintenance work or can originate from adjacent areas must be taken into account as part of a risk assessment and evaluated with regard to their effect and duration as well as whether they can be switched off (e.g., hot surfaces during welding work through walls).

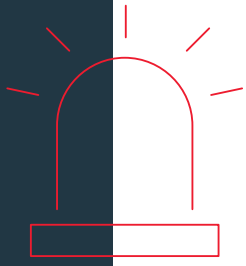
8.3.1. **Preventing explosive atmospheres**

Hazardous explosive atmospheres must be prevented from forming during maintenance work wherever possible. Flammable substances must be sufficiently removed—especially in the welding area.

Suitable measures:

- **Cleaning the working areas and removing all flammable residues**
- **Removing deposits of combustible dust**
- **No spraying or misting of flammable liquids**
- **Concentrations of flammable substances must be sufficiently diluted.**
- **Hazardous explosive atmospheres that may be formed by aerosols during cleaning or coating processes must be prevented.**
- **A flame-retardant protective filler is required for containers that have held, for example, explosive or flammable substances. The protective filler may consist of water, nitrogen, or carbon dioxide.**

Welding may only be carried out on closed containers if precautions have also been taken to prevent dangerous excess pressure from forming.



8.3.2.
Clearance measurements

Before carrying out welding work, the area (zone) must be checked based on a clearance measurement.

Measuring the atmosphere answers two extremely important questions:

1. **Is the level of flammable gases or vapors well below the warning level (10% of the lower explosion limit; LEL)?**
2. **Has the alarm level (50% LEL) been reached? This value is the last threshold. If it is reached, all work must be stopped and the hazardous area must be exited immediately.**

The supervisor (fire guard) is responsible for ensuring protective measures are implemented correctly and for approving welding work.

9. PPE
Personal protective equipment

General:

Personal protective equipment (PPE) must be worn when welding to protect welders from safety concerns and health hazards. This equipment must be made available by the employer and must be worn by employees.

Note:
The PPE must be in a proper condition and must:

- Comply with the requirements of regulation (EU) 2016/425 on personal protective equipment
- Provide protection against the hazard without posing a hazard itself
- Be suitable for the conditions prevailing in the workplace
- Meet ergonomic and health requirements

Criteria to be met by PPE worn during welding

- **Fire and heat resistant (flame retardant)**
- **Low thermal conductivity**
- **No electrical conductivity**
- **UV resistant**
- **Highly resistant to mechanical stress**

Note: The employer must brief employees on how to use the personal protective equipment correctly to ensure safety and provide the necessary documentation.

Personal protective equipment at a glance:

9.1. **Hearing protection**

There are many ways to protect yourself from noise. Due to the general conditions during welding, the following systems should be used as a matter of priority:

- Pre-formed earplugs (01)
- Earmolds or earpieces (02)

Earpieces should be given preference over disposable expanding foam plugs due the hygiene advantages they offer. Earmolds made of malleable plastic are adapted to the wearer's ear. A cast of the auditory canal must be made for this purpose.

9.2. **Work clothing**

During welding, flame-retardant clothing must be worn that meets the requirements of DIN EN ISO 11611 and is certified accordingly.

Note: The clothing must be fastened up to the top and must not be contaminated with flammable substances, such as oil or grease.

9.3. **Gloves for welding specialists**

Welding gloves protect against metal and slag spatter, UV radiation, heat, and brief contact with hot surfaces. Specifications for them are set out in standard DIN EN 12477:2005-09 (protective gloves for welders).

In accordance with the requirements, welding gloves are available in different versions:

Type A gloves:
For gas metal arc welding (MIG/MAG) and arc welding—thick material for protection at high welding power
(03, 04)

Type B gloves:
For tungsten inert gas welding (TIG)—thin material for good dexterity
(05)

9.4. **Safety shoes for welding specialists**

Safety shoes (04) for welders must meet the requirements of DIN EN ISO 20345, the standard for safety shoes. In addition to this standard, DIN EN ISO 20349-2:2017 sets out important requirements relevant to safety during welding:

- Resistant to the effects of spatter and molten metal (height of the shoe upper)
- Protective toe cap that protects the foot from risk of crushing
- Resistant to mineral oils and hydrocarbons
- Heat-resistant and thermally insulated outsole
- Puncture-resistant sole
- Compatible with other items of PPE (e.g., pants or gaiters)

9.5. **Eye and face protection**

During welding work, the eyes must be protected by a light filter. The following protective equipment is available:

- Passive visors (05) that are held in the hand or worn on the head.
- Active welding helmets (06) that automatically darken to the individual pre-set DIN light protection level when the arc ignites.
- The requirements are specified in standard DIN EN 169:2003-02 (Personal eye protection—Filters for welding and related techniques—Transmittance requirements and recommended use). The eye protection (welding helmet) usually protects the face as well.

04

05

06

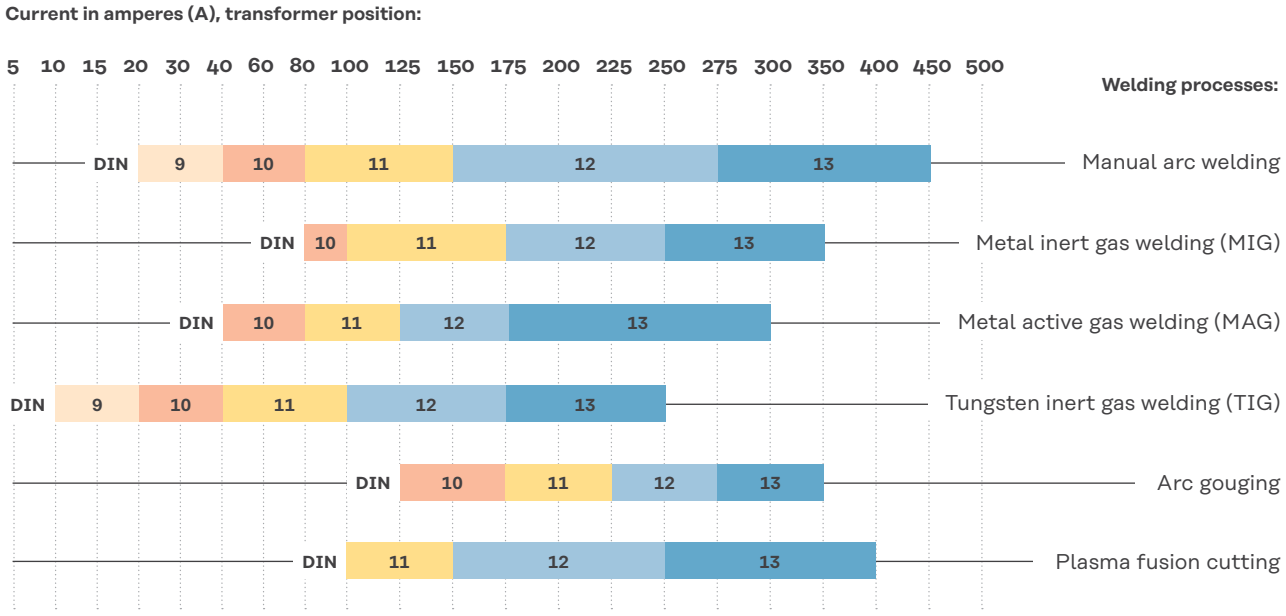
9.5.1. **Passive hand shield and passive visor**

Passive welding helmets (05) have a permanently installed protective filter that protects against optical radiation. The level of darkening cannot be adjusted.

9.5.2. **Automatic welding helmet**

Automatic welding helmets (06) have an automatic darkening system that activates the protective filter at the beginning of the welding process and protects against glare. Darkening takes place within fractions of a second and the level of darkening is usually infinitely adjustable.
These high-grade helmets use special UV/IR filters that block all harmful optical rays.

Levels of protection and recommended use during arc processes



Tab. 9-01

9.5.3. **Breathing protection**

Welding fume and gases are the source of substances that are hazardous to health during welding. If possible, these harmful substances must be extracted directly where they occur. Good results are achieved with welding helmets with forced ventilation (06, 07).


07

10. Hazard due to Welding fumes

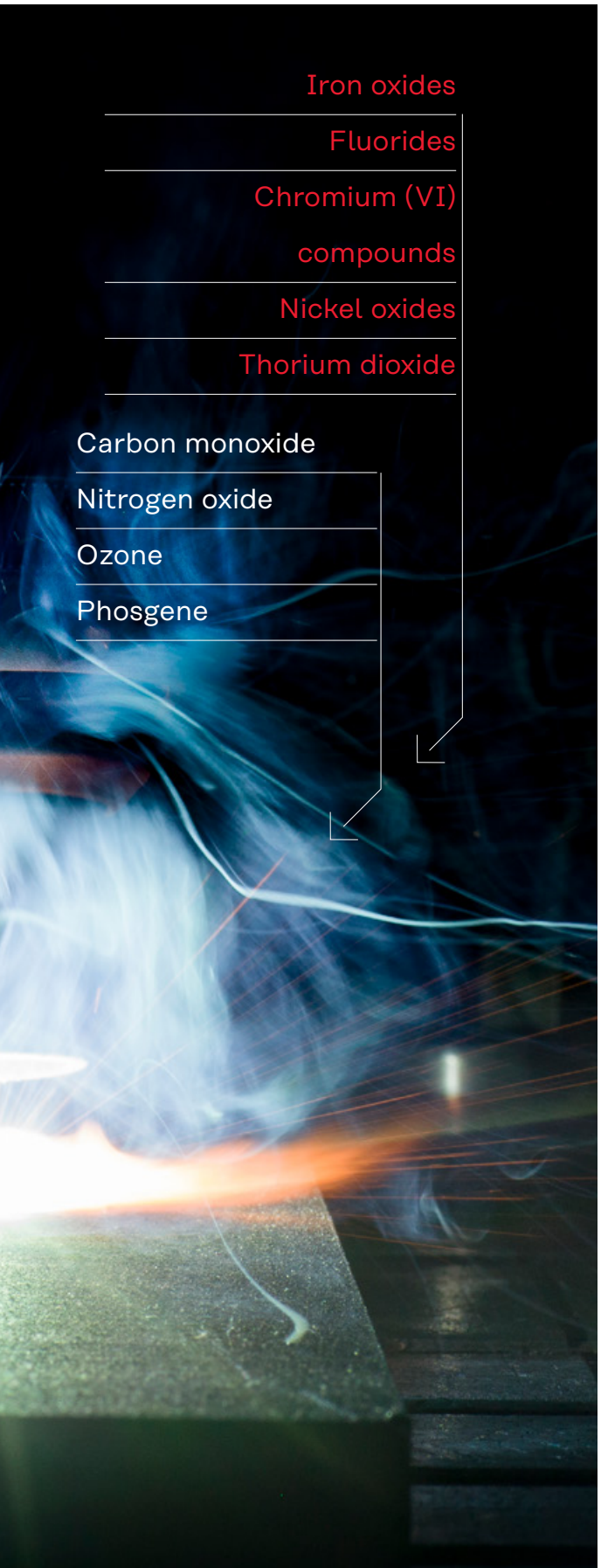
Figure: Fume extraction torch

General:

Harmful gases and particulate substances are produced during all arc welding processes. These can endanger the health of welders and other employees in the working environment.

Harmful particulate substances are mainly caused by metal (mostly from melting filler metal) evaporating from the weld pool. The metal vapor condenses in the ambient air, creating welding fume particles.

Note: Around 95% of the fume particles result from the filler metal, 5% from the base material.



The harmful gaseous substances result from the shielding gases used (argon, carbon dioxide) as well as from the gases generated during welding (by paint, oil, solvents, ozone, or nitrous gases, etc.).

10.1.

Composition of welding fume

Various harmful substances such as nickel oxides are produced, depending on the materials to be processed.

Particulate substances in welding fume

- Lead oxides
- Iron oxides
- Nickel oxides
- Beryllium oxide
- Chromium (VI) compounds
- Thorium dioxide
- Manganese

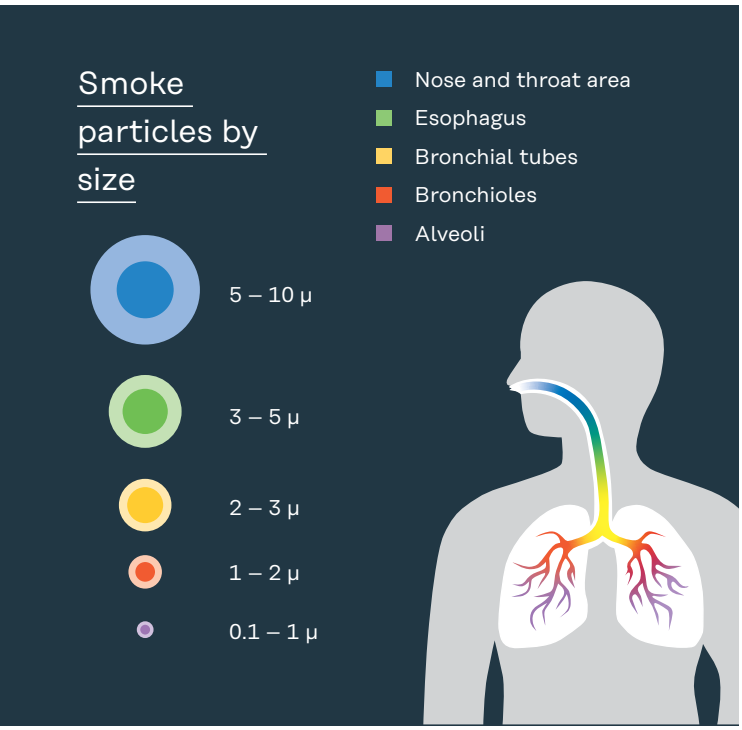
Gaseous substances in welding fume

- Phosgene
- Ozone
- Carbon monoxide
- Carbon dioxide
- Nitrogen oxide
- Formaldehyde
- Hydrocyanic acid

The type and amount of harmful gaseous and particulate substances depend on numerous factors: welding process, set process parameters, filler metal, base material, surface finish, etc.

In the case of harmful particulate substances, a distinction is made between the inhalable dust fraction (I dust, particle size < 10 µm) and the alveolar dust fraction (A dust, particle size < 2.5 µm). The majority of particles produced during welding are very fine, alveolar, and have a diameter of less than 1 µm.

Ultrafine particles also pose a hazard (ultrafine is a further gradation of alveolar). Particles with a size of less than 0.1 µm are referred to as ultrafine. Because of their small size, such particles can penetrate into the finest structures of the lungs together with breathable air (01).



01

10.2. Health hazards due to welding fumes

Welding fume causes various health hazards. Its composition is influenced by the materials and processes used.
Although classified as impacting the respiratory tract only, it can impair lung function after entering the lungs. Other substances (e.g., copper oxide and zinc oxide) can have a toxic or carcinogenic effect (e.g., chromium (VI) compounds and nickel oxide).

A distinction is therefore made between the following types of substances, depending on their influence on the human body:

- **Substances damaging to the respiratory tract and lungs**
- **Toxic substances**
- **Carcinogenic, cancerogenic substances**

10.2.1. Substances damaging to the respiratory tract and lungs

This category includes aluminum, iron, and magnesium oxide. When welding with these substances, the welding fume produced can lead to damage to the respiratory tract and lungs if inhaled for extended periods. This results in respiratory diseases such as bronchitis or narrowing of the airways. In the case of iron oxides, dust deposits can occur in the lungs in the form of siderosis (deposition of excess iron). Large amounts of welding fume can even trigger fibrosis (pathological proliferation of connective tissue in the lungs).

10.2.2. Toxic substances

Toxic—poisonous—substances produce a toxic effect in the human body when a certain dose is exceeded. These substances include, for example, gases such as carbon monoxide, nitrogen oxides, ozone, or the oxides of the metals manganese, copper, and zinc. High concentrations can cause life-threatening poisoning, which can even result in death.

10.2.3. Carcinogenic, cancerogenic substances

Carcinogenic substances can cause malignant tumors. These include chromium (VI) compounds, nickel oxides, and cobalt oxide. These substances are mainly found in high-alloy steels.

10.3.
Point at which a risk occurs

10.3.1. Limit values

The concentration of hazardous substances in the air at the workplace is assessed using limit values. In Austria, **so-called MAK and TRK values** are set out in binding form in accordance with the Limit Value Ordinance (GKV).

MAK values (maximum workplace concentration) or TRK values (technical reference concentration) are used for hazardous working materials such as gas, vapor, or suspended solids in the air at the workplace. The relevant protective measures and metrological monitoring are based on these values.

If MAK values are complied with as threshold values, there is generally no risk of adverse health effects. If no such threshold value can be determined for a hazardous working substance, a TRK value can be set. This is based exclusively on technical feasibility and does not permit any statement to be made as to whether health damage will occur or how likely this is—even if the TRK value is complied with. A TRK value is only set for hazardous working materials for which, depending on the state of scientific knowledge, no MAK values can be established based on toxicological occupational medicine, such as for the majority of substances that are clearly carcinogenic.

As already stated, harmful substances occur in a mixture in the field of welding technology. Determining exposure in the workplace is therefore a very complex process.

Austrian Limit Values Ordinance 2021 from 14 August 2024 (German values in brackets)

Hazardous substance	Concentration [mg/m³]	Remarks
Welding fume (all types)	5 A (D: 1.25 A)	MAK
Manganese	0.2 I / 0.05 A (D: 0.02 A)	MAK calculated as Mn
Nickel	0.5 I (D: 0.006 A)	TRK calculated as Ni
Chromium (VI) compounds	0.01 I / 0.05 I* (D: 0.001 A)	TRK *applies until 17 January 2025

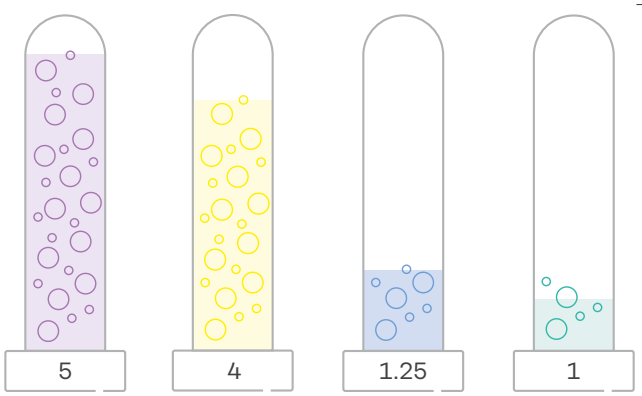
Tab. 10-01
Explanations: **I** = Metrological determination for inhalable dust, **A** = Metrological determination for alveolar dust

02

International comparison of limit values for welding fume particles (A dust) mg/m³

The limit values are set at national level.

- Australia, Austria, Belgium, Canada, France, Ireland, New Zealand, Norway, Singapore, South Korea, Spain, USA
- United Kingdom, Latvia, China
- Germany
- The Netherlands



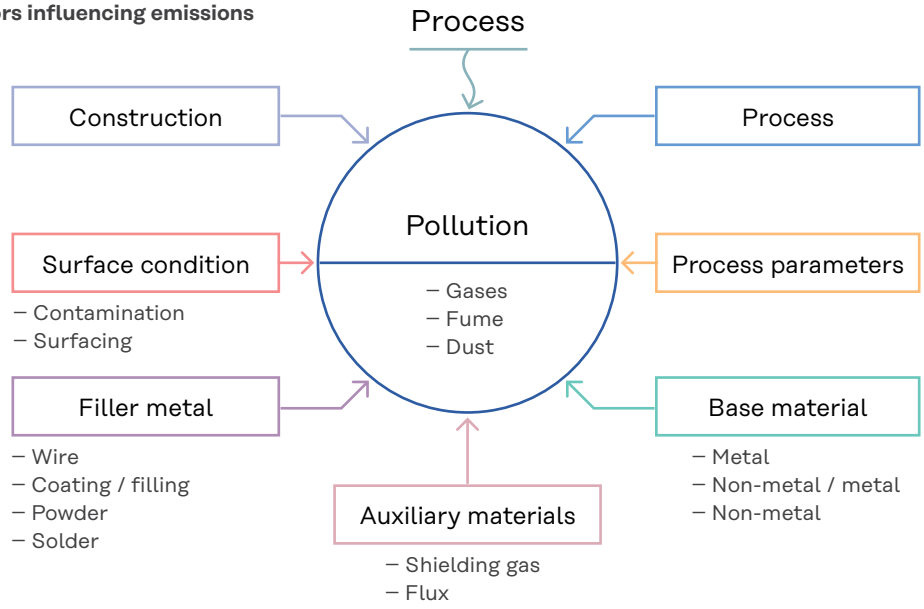
10.3.2. **Process-dependent emission rates**

Welding fume is released in varying amounts (this is referred to as the emission rate = emitted particle mass of a process per time in mg/s) depending on the process, auxiliary materials, additives, and process parameters used.

The emission rate provides information about workers' exposure (actual amount of harmful substances to which the welder is exposed), and subsequently informs protective measures.

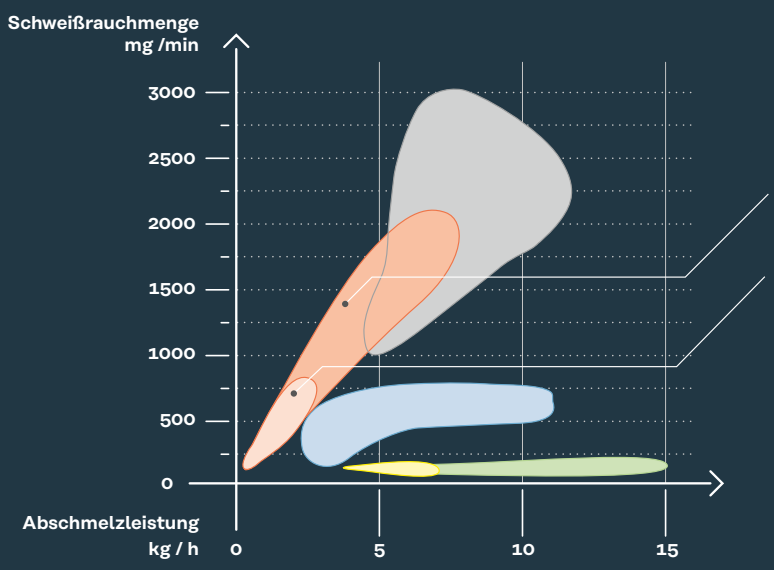
Example of factors influencing emissions

03



04

Emissions as a function of the deposition rate



10.4.
Protective measures according to the STOP principle

S
Substitution

10.4.1. Substitute measures

The following protective measures against welding fume fall under the substitution category (S). There are various possibilities within the scope of the risk assessment: Table 10-02

T
Technik

10.4.2. Technical protective measures

Extracting welding fume (05) where it arises is one of the most effective measures. There are also other ways of doing this (Table 10-03), with the choice of extraction method depending on the welding job.


05

S
Substitution

Type of measure	Examples of ways to reduce welding fume
Choice of welding process	– Select a welding process with lower emissions (e.g., TIG)
Choice of materials or filler metals	– Select a different composition of the weld filler metal (welding wire) (95% of the welding fume consists of parts of the filler metal) – Optimize welding gas
Settings on the welding machine	– Modify process parameters. Modern processes such as PMC (Pulse Multi Control) and LSC (Low Spatter Control) stabilize the arc, reduce spattering, and therefore cause less welding fume.

Tab. 10-02

T
Technik

Type of measure	Examples of ways to reduce welding fume
Closed systems	– Encapsulated welding cells with an extraction system (e.g., robot welding cells)
Extraction system	– Fume extraction torches – Repositionable welding fume extraction hoods – Stationary welding fume extraction system at the welding workstation
Room ventilation system	– Regular ventilation – Building extraction system – Ceiling-mounted air purifier
Structural measures	– Separate spaces—separating work areas

Tab. 10-03

10.4.3. **Organizational protective measures**

O
Organisation

Organizational protective measures (Table 10-04) are necessary if exposure to welding fume cannot be minimized either by substitution or by technical measures. Organizational protective measures also include maintaining the function and effectiveness of the measures already defined (substitution and/or technical measures)—e.g., through maintenance.

10.4.4. **Personal protective measures**

P
Person

If it turns out that the aforementioned protective measures—substitution, technical, and organizational measures—do not sufficiently reduce welding fume or are not feasible from a technical perspective, employees must be provided with suitable breathing apparatuses (06). The apparatuses are also used as supplementary measures in many cases.

O
Organisation

Type of measure	Examples of ways to reduce welding fume
Workplace design	– Clean surfaces before welding – Optimize working position – Limit exposure time – Reduce number of employees exposed – Clean working area correctly at regularly intervals— specify cleaning intervals
System inspections and maintenance	– Regular maintenance and testing of extraction and ventilation equipment – Regular maintenance of welding machines
Briefing employees	– Apply protective measures – Hygiene measures (e.g., ban on eating, drinking, and smoking in the workplace)

Tab. 10-04

06

11. When employing young people

In Austria, adolescents who have reached the age of 15 and are no longer required to attend school are considered adolescents until the age of 18 in the context of the Act on the Employment of Children and Young Persons (KJBG).

They are considered to be particularly vulnerable persons. Young people must be supervised, and a competent person must be present to intervene at any time. Young people who are in training (an apprenticeship) are permitted to weld in Austria from the eighteenth month of training. The employer must first provide a detailed safety briefing. Young people who are not in an apprenticeship may be entrusted with welding work from the age of 17.

Please note: Regulations in other countries may differ from Austrian law.

12. Organizing work

01

General:

Work must be organized in an optimal way to create healthy working conditions in companies. Maintaining order and cleanliness is thus a prerequisite for safe welding at the workplace.

Welding spatter (welding beads) can set flammable materials on fire and/or ignite explosive substances.

For this reason, the following measures must be observed before starting welding activities:

Any highly flammable objects (wood, plastics, textiles, etc.) must be removed from the immediate danger zone.

It should also be noted that the hazardous areas extend up to 7.5 m in the horizontal direction, so hazardous conditions may also carry over to adjacent areas.

Figure 02 shows how sparks and particles of metal and slag are dispersed during welding.

Flammable objects in the danger zone that cannot be removed must be covered and moistened. Sufficient extinguishing agents must be provided so fires can be rapidly dealt with.

Regular cleaning of the workstations and floors is essential, as cleanliness and order create safer working conditions in the welding environment (01).

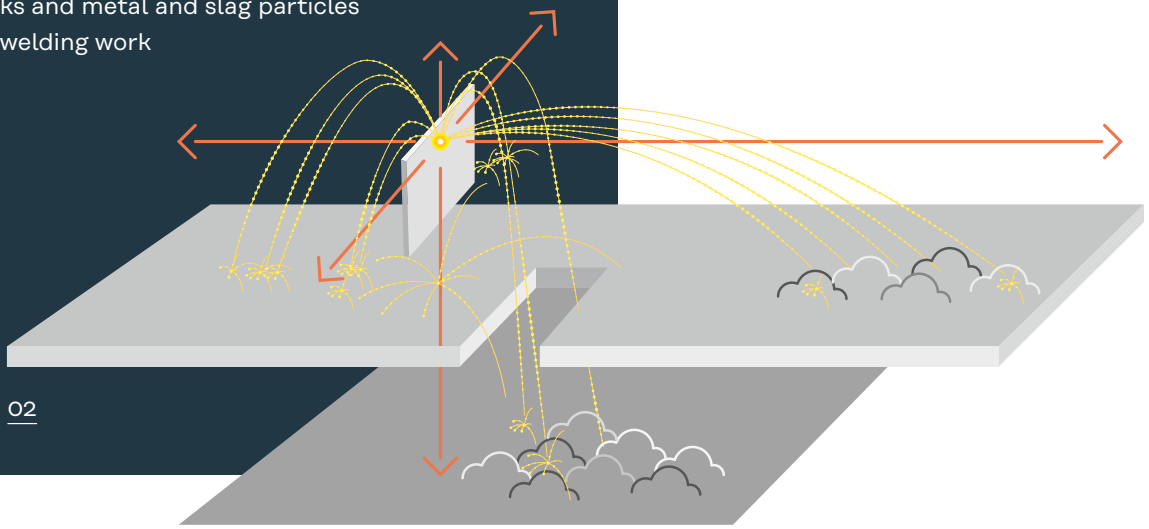
Waste, chips, and/or dust lying on the floor must be removed. Cables must not be left lying around, as they increase the risk of tripping and slipping.

Welding power-leads and other equipment may not be placed near corridors, ladders, or stairs.

Cleaning with compressed air stirs up dust and should therefore be avoided.

Dispersal

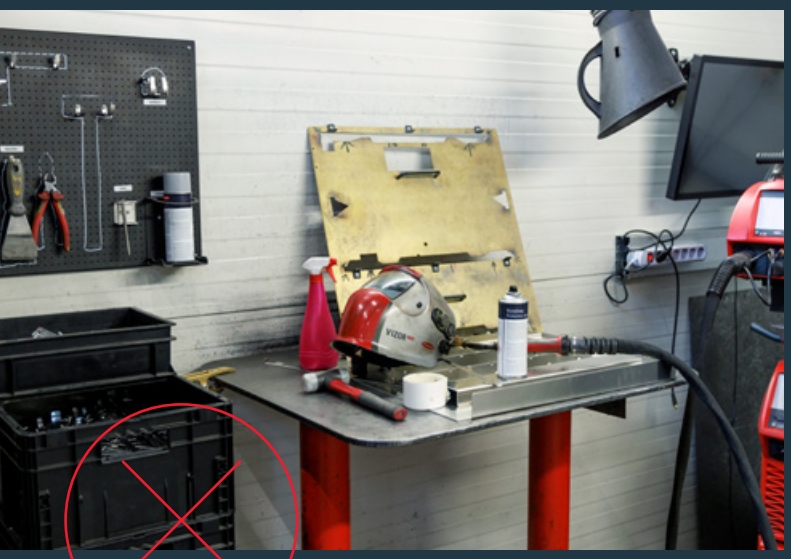
of sparks and metal and slag particles during welding work



02

The work equipment must be arranged to ensure welders can move freely.

Clean and tidy welding workstation 03



Messy welding workstation 04

All necessary parts and tools must be kept close to hand and stored in an organized way in the designated places. Also take into account the space required when moving the workpiece and components.

Transport routes must be kept free of materials and other obstacles.

Welding machines, gas cylinders, and wirefeeders must be set up in a stable position. The manufacturer's operation manuals must be followed accordingly.

Work equipment may not be used if:

- You identify damage that compromises safety
- Protection and safety devices are not working

In general, workplaces must be designed in such a way that employees can work without endangering their health and safety.

Welding workstations must be separated from other workstations to minimize or eliminate potential hazards to other employees.
Also ensure that unauthorized persons are not able enter the danger zone. If a stationary welding workstation cannot be set up for various reasons (extremely large components, etc.), it must be temporarily separated from other areas—e.g., using flame-retardant curtains or partitions.

All working areas must be equipped with artificial lighting that is as uniform and color-neutral as possible.

13. Health monitoring

13.1. Legal basis

If activities can lead to occupational diseases, they may only be carried out by employees if a suitability test consisting of an occupational health examination has been carried out beforehand. The test is thus also relevant in terms of prophylactics. If the work is carried out on an ongoing basis, follow-up examinations must be carried out at regular intervals.

The intervals and scope of the examinations are regulated in Austria in the Regulation on Health Surveillance at Work (VGÜ).

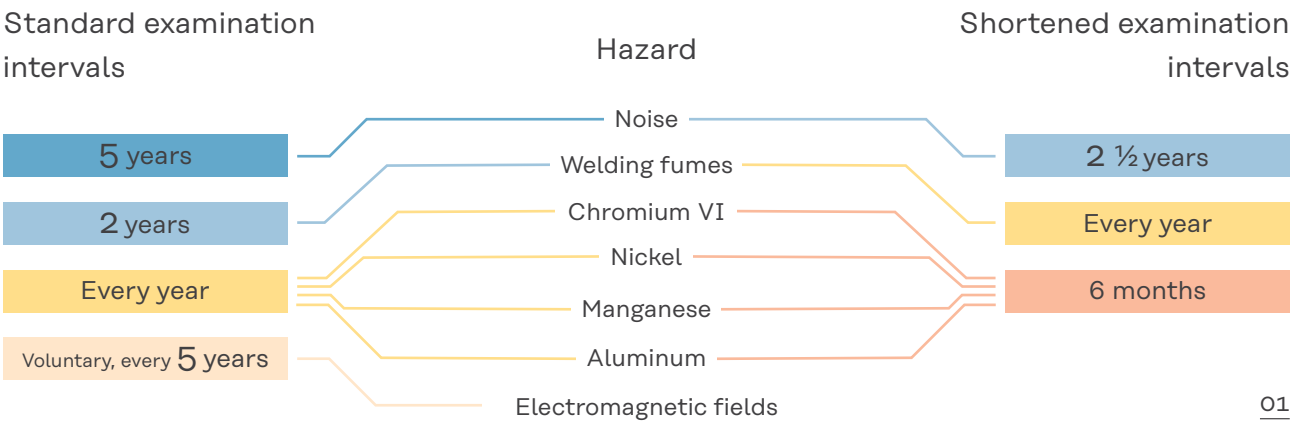
According to Article 177 ASVG (Austrian General Social Security Act), occupational diseases are damage to health caused by the insured activity (exercising a profession). They are listed in full in Appendix 1 to the Austrian General Social Security Act (ASVG).

Occupational diseases can be reported by any person, although it is recommended that experts—attending physicians or company physicians—be given priority.

13.2. Determining whether examinations are required / examination intervals

The question of whether mandatory suitability and follow-up examinations must take place depends on the present working materials that are identified and the outcome of their assessment, as well as on how often and to what extent employees are exposed to hazardous working materials in their job.

Relevant mandatory examination intervals for welding:



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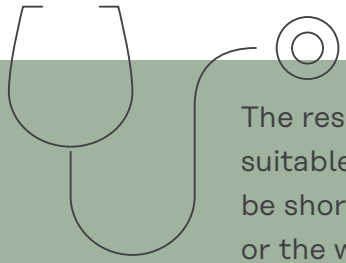
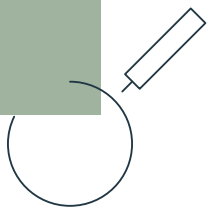
13.3. **Using the results of the examination**

Prior to mandatory health monitoring (as per the VGÜ), hazards are to be minimized to the greatest possible extent by taking appropriate measures. Limit comparison measurements provide information regarding the scope of monitoring (different welding processes also have different emissions).



The results of an examination can be either that a worker is suitable or not suitable, or that the examination period must be shorter. If the examination period needs to be shortened or the worker is deemed unsuitable, the workplace must be re-evaluated:



Identifying and assessing working materials

- What hazardous working materials (compositions, alloy constituents, etc.) are used?
- Which properties hazardous to health (carcinogenic, sensitizing, acutely toxic, capable of penetrating skin, etc.) do the working materials have?
- Which relevant properties (dusty, liquid or gaseous, heavier or lighter than air, water- or fat-soluble, etc.) do the working materials have?
- In what quantities are the working materials processed in the workplace?
- In what concentrations do they occur at the workplace?
- Are there workplace limit values (MAK value, TRK value), are these complied with, and are levels kept as far below these values as possible?
- What possible health hazards does the hazardous substance pose for workers?

Determining exposure

- Type of exposure
- Duration of exposure

What protective measures are in place or can be improved?

Providing employees with information and instructions

14. Occupational hygiene

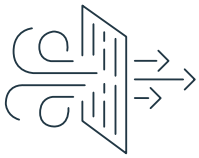
14.1. Basics

Exposure to hazardous substances (contact duration) should be as low as possible. In addition to substitution (different joining methods) and technical measures (welding fume extraction), personal measures such maintaining hygiene at the workplace are also important.

14.2. How do hazardous working materials enter the human body?

Working materials are absorbed in three ways:

- **Inhalation**
- **Swallowing**
- **Skin penetration**



14.3. Protective measures

Observe the following points to ensure good personal hygiene in occupational settings:

- Eating and drinking at workplaces with hazardous working materials is prohibited.
- Hands must be cleaned before consuming food, beverages, and medication, before smoking, and before breaks (absorption via the gastrointestinal tract).
- To keep exposure to a minimum, use an extraction solution located as close as possible to the point of fume origin.
- Private clothing and work clothing must be stored and worn separately.
- Act with an awareness of the dangers (e.g., do not chew nails).
- Follow the skin protection plan (e.g., apply creams before and after work).
- Shower after work so you do not carry dust home with you.
- Hazardous substances such as nickel residues can accumulate on door handles or handrails.
- Correct and regular cleaning (vacuum rather than sweep to avoid stirring up tiny particles).
- Immediately before the examinations (as per the VGÜ), take a good shower and do not attend the examination in work clothes.

15. Welding on and entering containers

General:

Entering containers refers to all activities/work during which workers are inside containers and confined spaces or bend over into them. The official term for this is "confined space entry". Many countries have detailed regulations governing work in containers (referred to in short as CSE for Confined Space Entry).

Containers are considered to be all areas that are largely closed off from their environment and in which only a small amount of air is exchanged. The lack of fresh air here makes work—especially welding—dangerous. This creates pollutants inside these areas, many of which are confined, adversely affecting welders' health. Any flammable or explosive substances still present can ignite or cause explosions. Electrical hazards can also occur in these conductive environments.

15.1.
Factors that can cause hazards in containers

- **Residual hazardous substances in the container**
- **Flammable hazardous substances**
- **Lack of oxygen (inadequate ventilation)**
- **Inadequate separation measures (penetration of hazardous substances)**
- **Penetration of hazardous substances due to different types of work**
- **Access openings that are too narrow**
- **Hazardous areas of machines**
- **Electrical current**
- **Radiation**
- **Hot or cold media**
- **Health hazards due to increased physical strain**
- **Chemical reactions**
- **Inadequate rescue measures (lack of fall protection, etc.)**

15.2.
Hazardous working materials / lack of oxygen

Hazardous working materials and lack of oxygen may either be present in the container before the start of work or only occur during work (e.g., if inert gas is used during welding). These risks must be evaluated beforehand. Gas detectors including sensor equipment and respiratory protection are selected on this basis. Supervisors must constantly monitor both the working materials and compliance with the measures.

15.3.
Risk of fire and explosion in containers

Explosions can occur if a dangerous explosive atmosphere consisting of flammable substances in the form of finely dispersed gases, vapors, mist, or dust occurs in combination with an ignition source (arc, electrical short circuit).

There is a risk of explosion in the range of concentrations between the lower and upper explosion limits (LEL, UEL). If the concentration of flammable substances in the container reaches more than 50% LEL (as indicated by a gas detector), work must be stopped immediately.

15.4.
Leakage of working materials

Unexpected, uncontrolled flows of working materials (liquids, gas, spillages, hot or cold media) from inlets and outlets poses a considerable risk.

These types of hazards are primarily caused by
- **Systems that automatically move into position**
- **Damaged or under-dimensioned shut-off devices**
- **Devices that are inadequately switched off and secured against being switched back on (tagout)**

15.5.
Written entry permit

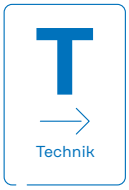
An entry permit must be issued before starting work in containers. This permit covers all protective and rescue measures for entering and working in containers in connection with the respective task—such as welding with shielding gas. The responsible supervisor will issue the entry permit if it can be demonstrated that the specified protective measures have been implemented while preparing for the work. This individual is responsible for compliance with the protective and rescue measures.

15.6.
Actions

Protective measures must be taken when welding work is to be carried out in or on containers. Follow the STOP principle.

Substitute measures
- Check whether welding can also be done outside the container (possibly by disassembling components and welding them from the outside)

Technical protective measures
- Provide gas detectors for monitoring atmospheric conditions
- Use extraction and ventilation systems
- Utilize suitable welding machines
- Ensure the power supply is suitable from an electrotechnical perspective
- Put shut-off measures in place for pipes, engines, hydraulics (switch off and tagout), etc.
- Use correct procedure when restarting systems



Organizational measures
- Determine the fire and explosion protection measures required for the container
- Have the potential risk assessed by an expert (supervisor)
- Issue entry permit
- Name a supervisor who is always present at the job site
- Ensure rescue personnel are available in sufficient numbers
- Test container connections

Personal protective measures
- Brief all employees on the required protective measures shortly before entering the container
- Take correct action when gas detectors trigger an alarm
- Make the necessary personal protective equipment (PPE) available
- Brief employees on how to use the PPE (respiratory protection, fall protection, additional PPE for welding work, etc.)
- Brief employees on how take emergency measures (evacuate and rescue)

16. Regulations and standards

EN ISO 21904 Part 1-4
Health and safety in welding and allied processes – Equipment for capture and separation of welding fume

General:

Austria's Health and Safety at Work Act (ArbeitnehmerInnenschutzgesetz – ASchG) was published on 17 June 1994 as Federal Law Gazette no. 450/1994 and came into force on 1 January 1995. The Health and Safety at Work Act adapted occupational health and safety in Austria to the regulations in the European Union. The scope of the law corresponds to the complexity of the subject matter. The Health and Safety at Work Act is put into action by a series of implementing provisions (ordinances), which are listed below:

- Work Equipment Directive (AM-VO)
- General Workers' Protection Order (AAV)
- Ordinance on Potentially Explosive Atmospheres (VEXAT)
- Adolescents (Employment Prohibitions and Restrictions) Ordinance (KJBG-VO)
- Regulation on Health Surveillance at Work (VGÜ)
- Limit Value Ordinance 2021 (GKV)
- Ordinance on the Protection of Workers from Exposure to Optical Radiation (VOPST)

The Maternity Leave Act (MSchG) also serves to protect the health of expectant and breastfeeding mothers and protect children in the world of work.

16.1. **Eye protection**

- ISO 16321-1:2021 or
  ISO 16321-1:2021/DAM 1:2023
  (Eye and face protection for occupational use - Part 1: General requirements)

16.2. **Breathing apparatuses**

- EN 12941:2023 (Respiratory protective devices – Powered filtering devices incorporating a helmet or a hood – Requirements, testing, marking)
- EN 12942:2023 (Respiratory protective devices – Power assisted filtering devices incorporating full face masks, half masks or quarter masks – Requirements, testing, marking)

16.3. **Protective clothing**

- EN ISO 11611:2022 or ISO 11611:2022 (Protective clothing for use in welding and allied processes)

16.4. **Protective gloves for welders**

- EN 12477:2021 (Protective gloves)
- EN ISO 25980:2023 or ISO 25980:2023 (Health and safety in welding and allied processes - Transparent welding curtains, strips and screens for arc welding processes)

16.5. **Safety shoes**

- EN ISO 20345:2022 or ISO 20345:2021, ÖNORM EN ISO 20345/A1:2024 or EN ISO 20345/A1:2024 or ISO 20345:2021/AMD1:2024 (Personal protective equipment – Safety footwear)

16.6. **Lighting**

- EN 12464-1:2021 (Light and lighting – Lighting of work places – Part 1: Indoor workplaces)

16.7. **Standards for arc welding**

- EN IEC 60974-1:2022, EN IEC 60974-1/A11:2022 or IEC60974-1:2021 (Arc welding equipment – Part 1: Welding power sources)
- EN IEC 60974-2:2019 or IEC 60974-2:2019 (Arc welding equipment – Part 2: Liquid cooling systems)
- EN IEC 60974-3:2019 or IEC 60974-3:2019 (Arc welding equipment – Part 3: Arc striking and stabilizing devices)
- EN 60974-4:2016 or IEC60974-4:2016 (Arc welding equipment – Part 4: Periodic inspection and testing)
- EN IEC 60974-5:2019 or IEC 60974-5:2019 (Arc welding equipment – Part 5: Wire feeders)
- EN 60974-6:2016 or IEC60974-6:2015 (Arc welding equipment – Part 6: Limited duty equipment)
- EN IEC 60974-7:2019 or IEC 60974-7:2019 (Arc welding equipment – Part 7: Torches)
- EN IEC 60974-8:2010 or IEC 60974-8:2021 (Arc welding equipment – Part 8: Gas consoles for welding and plasma cutting systems)
- EN IEC 60974-9:2018 or IEC 60974-9:2018 (Arc welding equipment – Part 9: Installation and use)
- EN IEC 60974-10:2021 or IEC 60974-10:2020 (Arc welding equipment – Part 10: Electromagnetic compatibility (EMC) requirements)
- EN IEC 60974-11:2021 or IEC 60974-11:2021 (Arc welding equipment – Part 11: Electrode holders)
- EN IEC 60974-12:2021 or IEC 60974-12:2022 (Arc welding equipment – Part 12: Coupling devices for welding cables)
- EN IEC 60974-13:2021 or IEC 60974-13:2021 (Arc welding equipment – Part 13: Welding current return clamp)
- EN IEC 60974-14:2018 or IEC 60974-14:2018 (Arc welding equipment – Part 14: Calibration, validation and consistency testing)
- EN IEC 62822-2 (Arc welding equipment – Assessment related to human exposure to electromagnetic fields)

All provisions relate to the legal situation in Europe/Austria in 2024 and may vary from country to country. It should be noted that, despite careful editing, the information contained in this document is provided without warranty and the author as well as Fronius and AUVA will not accept any liability.

This manual was produced through collaboration between Fronius International and the Austrian General Accident Insurance Institution (AUVA).
We hope that this manual is a helpful guide to occupational health and safety in all companies where welding is carried out.

Occupational safety

when welding

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