DGUV
Fachbereich Holz und Metall
Berufsgenossenschaft
Holz und Metall

Fachbereich AKTUELL

FBHM-139

Blasting work - cleaning and decoating with laser radiation

- Translation, in any case the German original shall prevail –

Subcommittee Surface technology
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Translation of German version

Laser radiation can be used to clean or remove coatings from surfaces of various material, such as metals or plastics. Laser processes are applied to remove absorbent corrosion and passivation layers, paint and coating materials or process residues. A focussed, powerful laser beam is used for this purpose (laser class 4). With suitable process parameterisation, cleaning or decoating is carried out gently and damage-free.
In special cases, surface structures such as roughness can also be adjusted using the laser process.

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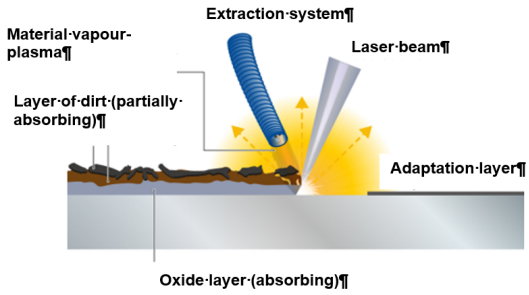

Figure 1 - Principle of surface cleaning with laser radiation

1 Scope

This Fachbereich AKTUELL covers the treatment of surfaces with laser radiation using hand-held laser equipment. This applies in particular to works carried out at different locations, such as on construction sites, in external companies, etc.

Hand-held laser systems are used for cleaning and decoating components or workpieces:

- before further processing
- during cleaning work for maintenance, testing and inspection tasks
- for maintenance work
- for special tasks

This Fachbereich AKTUELL is intended as a guide when preparing a risk assessment for such kind of work. The contents of this

document relate exclusively to hand-held class 4 lasers for cleaning and decoating and ***not*** to the use of other laser equipment such as laser measuring systems or laser cutting systems.

The hazards considered in this document mainly arise from the laser radiation and the hazardous substances emitted during processing.
A functional, efficient extraction system is to be provided. Discharge products should be collected as close as possible to the point of origin, for example by means of an extraction system attached to the device.

Work on the laser devices themselves, for example during manufacture or maintenance and adjustment, is ***not*** covered in this document.

2 Definition

Absorption

... is the absorption of electromagnetic radiation in a medium: the energy of the penetrating radiation is partially transferred into the medium and converted into heat. This reduces the proportion of transmission and reflection. [1]

Adaptation layer

... is the surface layer generated by laser treatment.

Aerosol

... is a mixture of liquid and solid particles in a gaseous medium (in this case air).

Work area

... is the maximum range in which the operator, certain parts of the body such as the hands, the laser processing head, a handheld laser device or the workpiece can be located.

Eye safety distance (NOHD)

(E)NOHD - (Enhanced) Nominal Ocular Hazard Distance = (extended) eye safety distance

According to the TROS Laserstrahlung, the eye safety distance describes the distance at which the irradiance or the irradiation is equal to the corresponding exposure limit value according to the TROS Laserstrahlung of the eye for a duration specified in the risk assessment. Should the eye safety distance also allow for the possibility of viewing with optical aids, this is referred to as the extended eye safety distance (ENOHD). [2, 3]

Irradiance (power density)

... describes the radiant power dP falling on a surface element dA
Symbol: E; E = dP / dA
SI unit: Watt per square metre, W/m^2 [1]

Directional reflection (reflective surfaces)

... describes a reflection from a surface in which the ratio between the incident and reflected beam is maintained, comparable to the reflection from a mirror. [1]

Diffuse reflection (matt surfaces)

... describes the change in the spatial distribution of a radiation beam after scattering by a surface or a substance in many directions. A completely diffusely scattering material destroys any ratio between the directions of the incident and reflected radiation. [1]

Note:
As a rule, diffuse and directionally reflected radiation occur simultaneously. The lower the surface roughness and the greater the angle of incidence, the higher the proportion of directional, reflected radiation - depending on the wavelength.

Energy density (radiant exposure)

... is the radiant energy dQ falling on a surface element dA. It is represented mathematically

by the temporal integral of the power density.
Symbol: H; H = dQ / dA = ∫ E dt
SI unit: Joule per square metre, J/m² [1, 2]

Exposure limit value(s) (ELV)

... in accordance with section 6 (2) OStrV [2] are maximum permissible values for exposure of the eyes or skin to laser radiation without acute damage to health to be expected - in accordance with Table A3.1 of Annex 3 of the TROS Laserstrahlung Part "Allgemeines" [1]. To protect against long-term damage caused by the carcinogenic (cancer-causing) effect of UV radiation, special attention should be paid to the minimisation requirement in accordance with section 7 OStrV [1]. [2]

ELV are listed in the TROS Laserstrahlung in Annex 4, section A4.1, part 2, „Messungen und Berechnungen von Expositionen gegenüber Laserstrahlung“. In this context, the duration of the exposure is always taken into account.

Pulsed laser radiation (pulsed laser)

... emits energy in the form of a single pulse or a pulse train (pulse). The duration of a pulse is less than 0.25 s. [3]

Laser, laser radiation

... is an artificially generated optical radiation with special properties which is very easy to focus. It can be used to transmit power in the form of radiation over long distances or to achieve very high power densities over small areas. [4]

Laser range

... is the range in which the exposure limit values can be exceeded.
Note: The laser range does not have to coincide with the working range, but can be larger (see TROS Laserstrahlung).

In the applications considered herein, the laser area is generally accessible (DGUV Information 203-093) [6].

Laser Safety Officers

… have acquired specialised knowledge by successfully participating in a training course with specified training content and have passed an examination. The employer has to appoint a laser safety officer for the handling of class 3R, 3B or 4 lasers (section 5 OStrV). [2, 5]

Light wave guidance system / beam delivery system (fibre optic cable)

... is a transport medium for the low-loss transmission of laser radiation which can be used for certain laser devices.

Reflectance

... is the proportion of reflected radiant power in relation to the incident radiant power.
Symbol: ρ
SI unit: "1", given in [%] [2, 3]

Radiant energy

... is a time integral of the radiant power over a certain period of time dt.
symbol: Q; Q = ∫ Pdt
SI unit: Joule (J) [2]

Radiant power

... is a power emitted, transmitted or received in the form of radiation.
Symbol: P; P = dQ / dt
SI unit: Watt (W) [2]

Transmittance

... describes the proportion of transmitted radiant power in relation to the incident radiant power.
Symbol: τ
SI unit: 1 [2, 3]

[1] [(BfS - Introduction - Cancer diseases)

3 Laser radiation

Laser radiation may cause damage to eyes and skin.

Laser radiation can be focussed using optical systems such as lenses. A high irradiance can be achieved by focussing the radiation.

Powerful class 4 lasers are used for cleaning or surface processing. Pilot or auxiliary lasers support positioning and indicate the working position. They emit visible laser radiation (red, green) and typically correspond to laser class 2.

Unclassified laser equipment - without a recognisable laser class - must not be used for surface processing.

4 Hazards and measures

Due to the biological effects of laser radiation, hazards cannot be ruled out, and therefore protective measures are **always** necessary. These depend on the power and energy density of the laser as well as the application. The specification of the laser class contains information on the hazards posed by the respective device. The hierarchy of measures in accordance with the Labour Protection Act must be taken into account when determining the protective measures. Technical safety measures have priority over purely organisational measures. To improve the effectiveness of these measures, it may be necessary to supplement them with the use of personal protective equipment (PPE). Basic requirements, such as to the behaviour of employees, should always be defined.

4.1 General protective measures for the use of class 4 lasers

DGUV Information 203-093 [6] provides a detailed guide for creating a risk assessment for the operation of open laser devices for material processing with manual guidance or manual positioning (hand-held laser devices).

If no separately determinable laser area can be defined, at least lockable main/key switches must be available. The manually guided laser should preferably be operated using a two-hand control device (see DIN EN ISO 11553-2 No. 5.4.8.3).

Anyone who uses laser equipment is also responsible for its safe operation.

The employer must appoint a laser safety officer for the handling of class 3R, 3B or 4 lasers (section 5 OStrV).

Expertise for carrying out the risk assessment for laser applications

Specialists must have sufficient knowledge of the hazards posed by laser radiation based on their professional training or experience. They are authorised to define, evaluate and check protective measures. The scope and depth of the necessary knowledge depend on the activity to be assessed. The requirements for further training are described in DGUV Grundsatz 303-005 „Ausbildung und Fortbildung von Laserschutzbeauftragten sowie Fortbildung von fachkundigen Personen zur Durchführung der Gefährdungsbeurteilung nach OStrV bei Laseranwendungen“. [5]

Hazardous substances, fire and explosion protection and other hazards have to be considered in the risk assessment as well.

All employees who perform work with laser equipment or those who work nearby the laser area must be instructed accordingly. This includes instructions on **basic behaviour**:

- Wear suitable laser safety goggles.
- Do not operate laser equipment at eye level.
- Never look directly into the laser beam.
- Do not reach into the beam path.
- Never point the laser at people.

- Do not point the laser beam at reflective surfaces.
- Delimit work areas.
  This can be achieved, for example, by means of a complete partitioning (separate room/separate cabin) or suitable laser safety barriers.
- The switch-on status of the laser device must be indicated by e. g. a warning light, flashing light, rotating beacon or horn.
- Protect employees and uninvolved third parties from impairment and glare.
- Operating instructions, which must be adapted to specific working conditions and the existing laser equipment, must be observed.
- If the spatial separation or shielding of the laser area is insufficient, laser work must be temporally separated from other work.
- Do not carry out any repairs to laser equipment.

In addition, persons operating a laser device must be trained, for example by the manufacturer.

The specific protective measures are determined as part of the risk assessment. The laser safety officer should recommend the measures required from a technical point of view.

In addition to the general protective measures, further safety measures may be required in accordance with the risk assessment:

- Define device access and key authorisations.
- Prohibition of optical instruments that can lead to an increase in the power density of the eye.
- Reliable and behaviour-independent access restrictions to the laser area and operating indicators (warning lights) at the entrances and to laser areas.

4.2 Hazards to the eyes

When a laser beam hits the eye, the highly focussed beam can also be focused further on the retina by the cornea and lens. Due to the high irradiance/energy density, all parts of the eye can be damaged or destroyed.

Never look directly into the laser beam.

Wear suitable laser safety goggles. Further information can be found in DGUV Information 203-042 [3].

Figure 2 - Laser safety goggles with labelling on the lens and with labelling on the goggle frame

4.3 Glare

Glare can always occur when working with laser radiation. This applies to work with lasers of all laser classes - including pilot or positioning lasers. As a result of glare, a lack of visibility can lead to secondary accidents (tripping, falling and crashing accidents) or incorrect operation of equipment, which in turn can endanger third persons.

4.4 Skin hazards

All lasers for cleaning or surface processing can damage both the eyes and the skin.

Avoid direct radiant exposure of the skin by all means.

Do not work with uncovered skin parts, unless you can ensure that the exposure limit values for radiation for the affected areas of skin are not exceeded or the manufacturer of

the laser device has issued a corresponding approval. [6, 2]

Wear suitable protective clothing if the ELVs for laser radiation or incoherent optical radiation (secondary radiation) are or may be exceeded.

If other persons are working in the laser area, suitable additional behavioural and protective measures must be taken.

4.5 Hazardous substances from coatings

Many different coatings are available which in turn consist of different components or can be applied in several layers. While processing coatings or surfaces with laser radiation, hazardous substances can be generated. These can be absorbed via the respiratory tract and are respirable.

Fumes and vapours should be captured and extracted at source. If the risk assessment in accordance with the hazardous substance ordinance (German: Gefahrstoffverordnung / GefStoffV) [7] shows that "assessment criteria for inhalation exposure" to hazardous substances cannot be complied with, the employer must utilise all technical and organisational protective measures. If the respective assessment standards for inhalation exposure cannot be met as a result, personal protective equipment (PPE), in particular respiratory protection, must be provided (compare chapter 5), and must be worn by the employees. The use of detrimental PPE must be temporally limited.

It must be checked whether employees should be provided with washrooms and separate storage facilities for work clothes and street clothes to prevent the spread of harmful dusts, e. g. lead[2], asbestos fibres[3] into the domestic area.

Occupational preventive care and mandatory preventive care must be checked based on the risk assessment and the measures derived from it (especially PPE). See chapter 5.3.

Expertise in carrying out risk assessments for activities involving hazardous substances

Expertise for risk assessment “essentially includes” the following aspects:

1. suitable vocational training or relevant professional experience or a relevant professional activity carried out in the recent past and
2. competence in occupational health and safety, which includes knowledge and skills. This knowledge can be acquired through participation in specific training programmes. (TRGS 400, chapter 4.1, paragraph 3) [8]

For further information, see DGUV Grundsatz 313-003 [9].

Examples of common hazardous substances

Hazardous substances released from coatings can include

- Red lead
- Chromates
- Zinc
- Pyrolysis products (e. g. from plastics or synthetic resins)
- fillers containing asbestos

Before materials with unknown coatings are processed, they should be analysed to obtain information about the hazardous substances to be expected and to be able to take suitable protective measures.
If knowledge of the release of hazardous substances is not available, the highest level of possible protective measures in

[2] Observe TRGS 505

[3] Observe TRGS 519

accordance with section 6 GefStoffV paragraph 14 must be applied.

If the coating materials are known, information on hazards can be determined using the product data sheets.

Extraction of hazardous substances

Risks caused by hazardous substances generated during the process must be prevented by effective extraction. Discharged products must be collected as close as possible at source, e. g. by means of extraction elements attached to the device.

Figure 3 - Laser device with integrated extraction unit

Suitable separator systems and filters must be used.

4.6 Hazard due to ignition (explosion and fire protection)

The energy of the laser radiation applied is sufficient to ignite an explosive mixture or flammable substances. Therefore the presence of or the formation of an explosive atmosphere must be safely prevented during work. Laser radiation involves hot work or open flame operations. It must be checked whether an authorisation procedure is to be applied, which must be observed in particular when working in areas at risk of explosion and in confined spaces (e. g. tanks, silos).

Measures must be determined individually for each location and - in the relevant case - with the commissioning party. As a rule, the container or the danger zone in general are subjected to a clearance measurement in this context and the work is authorised by means of a "permit".
The work area must be kept clear of all combustible materials that are not required for processing.

4.7 Noise

The noise level of the processes frequently used in practice is generally below 80 dB(A). Higher noise levels may occur during the treatment/machining of workpieces with complex geometry or during work in confined or highly sound reflective spaces. In these cases, the daily noise exposure level must be determined. For daily noise exposure levels > 80 dB(A), hearing protection must be provided, employees must be instructed and "noise" precautions must be offered (see chapter 5.4).

4.8 Ergonomics

Depending on the body posture to be adopted and weight of the hand-held laser device, increased loads may occur. Design ergonomic working heights and reduce the forces required to hold the device. In order to assess the use of exoskeletons for cleaning and decoating work accordingly, the Fachbereich AKTUELL FBHM-020 [10] should be consulted.

4.9 Hazards due to the surface properties of the workpieces

The composition of the layer to be removed and the properties of the material surface can give rise to further hazards that must be taken into account when planning the work. This concerns hazardous substances that can be released from the coating materials through thermal decomposition and the reflective properties of the surface, which influence both intensity and spread of the reflected and scattered radiation. This is also influenced by

the geometry of the workpiece. Angles, pipes, weld seams etc. lead to a change in the propagation of the radiation.

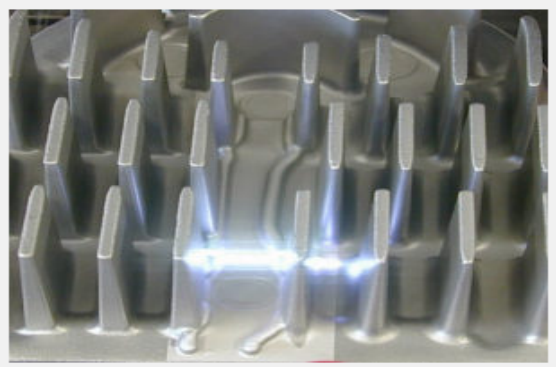

Figure 4 - Laser cleaning on a highly structured component with visible, reflected radiation

4.10 Organisational measures

Before using work equipment for the first time, employees must be provided with appropriate information based on the risk assessment in an understandable form and language (instructions for use or operating instructions (section 12 BetrSichV)). A sample operating instruction for customisation is shown in Annex 3.

If there is a possibility of hazardous substances being released, the preparation of operating instructions in accordance with section 14 GefStoffV is mandatory.

Instructions should be given based on this information.

The following measures, for example, may be necessary to **safeguard the work or the work site**: Lay and mark fibre optic cables in such a way that they are protected against being driven over and destroyed by being driven under.

Safety attendants observe the person working with the laser from outside the danger zone or remain in contact with them by other means (radio communication). They must be able to call for help without leaving their position.

Preparation of a rescue concept

When working on construction sites or in confined spaces, it is necessary to draw up a rescue concept before starting work and to inform employees accordingly.

Before starting work on external company premises, employees must be informed about the specified escape and rescue routes and the relevant contact persons at the external company must be named.

4.11 Working on external company premises

Additional hazards may arise during work on external company premises. These include, for example: unknown integration of the work into other work processes, necessary barriers and safety measures, escape routes and numbers or the coordination of work with the external company's operations.

> If the risk assessment cannot cover all conditions given at external companies, they must be recorded and assessed by means of a supplementary risk assessment before starting work at the respective workplace (e. g. glare, risk to other persons, cordoning off the work space, determining sufficient safety distance, where possible: spatial separation).
>
> If mutual hazards can occur, a joint risk assessment should be drawn up (see section 13 of the German Ordinance on Industrial Safety and Health [11] and section 6 of DGUV Regulation 1 [12], in accordance with section 8 of the ArbSchG (German Occupational Health and Safety Act).

4.12 Additional hazards on construction sites

Besides the need to adapt to constantly changing conditions on construction sites, the

mutual obstruction caused by different trades must also be taken into account.

> Coordinate the work of the various trades before starting work (coordination in accordance with the Construction Site Ordinance, section 6 DGUV Regulation 1, section 8 ArbSchG) [13].

Dangers exist when working at height on scaffolding or when using aerial work platforms.

> Take special protective measures for glare protection and pay attention to glare downwards or upwards. Personal fall protection must also be provided and used.

Frequent assembly and disassembly of the devices and the fibre optic cables lead to increased wear.

> Check the equipment before each use and carry out regular inspections at appropriate short intervals and document the condition of the equipment.

4.13 Working in confined spaces

If cleaning and decoating work with lasers has to be carried out in confined spaces, TRGS 507 "Oberflächenbehandlung in Räumen und Behältern" [14] must be applied. Confined spaces are, for example, containers, tanks or closed rooms aboard vessels.

The following hazards must always be checked:

- Hazardous substances in dangerous concentrations
- Fire and explosion hazards
- Oxygen deficiency
- Hazards due to restricted movement, escape and rescue possibilities
- Increased electrical hazards in the event of restricted mobility and conductive surfaces (environment), see DGUV Information 203-004 [24].

Laser equipment is always an effective ignition source. Therefore, the presence or formation of a hazardous explosive mixture during work in confined spaces must be safely prevented by the measures described in TRGS 507.

The areas (confined spaces) in which work is carried out in accordance with number 1 paragraph 1 of TRGS 507 must be safeguarded against unauthorised entry and clearly marked as a hazardous area.

Safety signs in accordance with Annex I No. 1.6 (5) GefStoffV [7], DGUV Information 211-041 "Sicherheits- und Gesundheitsschutzkennzeichnung" [15] and Technische Regeln für Arbeitsstätten ASR A 1.3 [16] must be affixed at the entries/accesses relating to the existing hazard. Further information can also be found in DGUV Regel 113-004, DGUV Information 213-055 and DGUV Grundsatz 313-002.

4.14 Working alone

If no other person is within call or sight, this is considered working alone. Depending on the hazard, the likelihood of an accident and the expected duration until first aid can be provided, the risk of working alone must be determined. Measures to safeguard the rescue chain must be defined based on the results of the risk assessment. If the risk is too high - for example if there exists a life threatening risk by unconsciousness as a result of a laser accident - working alone is not permitted without a reliable and independent emergency system.

To assess the hazards, the task and the workplace must always be evaluated, e. g:

- Have there already been accidents during these or comparable activities?
- Is there a risk of falling?

The work process must also be assessed. What kind of hazards exist when handling laser

radiation in the intended work situation?
Examples:

- Ignition source due to working temperature? (fire, explosion hazard)
- Creation of hazardous substances? (adequate extraction and ventilation)
- Damage to eyes, skin, etc.?
- Risk of crushing when assembling and dismantling the equipment?

4.15 Pregnant and nursing women

According to section 11 of the Mutterschutzgesetz [17], pregnant and nursing women may not be employed in work spaces that could pose an irresponsible risk to the health of the mother or child (foetus).[4] This has to be taken into account in particular when assessing possible exposure to hazardous substances.

4.16 Malfunctions, Maintenance

In the event of defects and malfunctions, the laser system must be safely shut down immediately.

Maintenance work on the device, the extraction system and peripheral components may only be carried out when the laser system is switched off.

Maintenance work may only be carried out by specialised personnel, e. g. from manufacturing companies, or by persons trained for this purpose. During maintenance and servicing work, the specialised personnel may be exposed to further significant electrical hazards even after the appliance has been switched off.

The intended use specified in the operating instructions must be observed.

Prevent tampering with the system, especially with safety equipment.

5 Personal protective equipment, suitability and precautions

Personal protective equipment (PPE)
Before starting any activities, the required PPE must be determined by the employer and provided in working order.

Personal protective equipment is subject to the PSA Benutzungsverordnung [18].

For category 3 PPE, such as respiratory protection devices, PPE against falls from a height (...), a practical exercise on correct use is prescribed for instructions in accordance with this regulation.

Laser safety eyewear is put on the market in accordance with the PPE Regulation and labelled in accordance with DIN EN 207 or E DIN EN ISO 19818-1. According to DIN EN 207, the resistance to laser radiation under standard conditions must be 5 seconds or 50 pulses.

When working with open laser equipment, suitable laser safety goggles/eyewear - derived from the maximum power/energy density in the respective wavelength range - must always be worn (TROS [2], DGUV Information 203-042 [3] and Annex II of 2006/25/EC [19]). This also applies to persons who do not actively carry out work with laser equipment but who are present in the danger zone (laser area).

Respiratory protective devices are categorised as category 3 in accordance with PPE Regulation (EU) 2016/425 [18].[5]

[4] BG RCI leaflet A027 "Mutterschutz im Betrieb" and BG RCI leaflet M039 "Gefahrstoffe – Fruchtschädigende Stoffe"

[5] This can be recognised by the CE mark with a four-digit code indicating the identification number of the monitoring body.

Whether and which **respiratory protection** is required depends on the surface coatings to be removed and must be determined before starting work, for example by analysing the coatings. If necessary, adjustments must also be made during the work.

Personal protective equipment against falls from height (PPE) is also categorised as category 3 in accordance with the PPE Ordinance.

Combination of personal protective equipment
If several sets of personal protective equipment are required due to different hazards, their interaction must be taken into account. It is necessary to coordinate the different PPE with each other and in relation to the work task and environment.

5.1 Aptitude assessments

Aptitude tests serve to answer the question of whether the existing physical and mental abilities of the employees indicate that they are capable of carrying out the tasks to be performed during their employment.

The current version of DGUV Information 250-010 "Eignungsbeurteilungen in der betrieblichen Praxis" [20] provides assistance on the subject of aptitude assessments. It also includes the legal basis and the requirements for the legality of aptitude assessments.

The "DGUV Empfehlungen für arbeitsmedizinische Beratungen und Untersuchungen" [21] provide practical information on the implementation of aptitude assessments by occupational physicians. Examples include the DGUV Empfehlungen "Fahr- Steuer- und Überwachungstätigkeiten" and "Arbeiten mit Absturzgefahr" in the aptitude section of the publication.

5.2 Occupational health care

Employers must ensure appropriate preventive occupational health care based on the risk assessment. In accordance with the Annex to the Ordinance on Occupational Health Care (ArbMedVV) [22], mandatory preventive care must be arranged and optional preventive care must be offered. Optional preventive care in accordance with ArbMedVV must be made possible at the request of the insured person, unless the assessment of the working conditions and the measures taken indicate that no damage to health is to be expected.

The "DGUV Empfehlungen für arbeitsmedizinische Beratungen und Untersuchungen" provide practical information for the implementation of occupational medical precautions by occupational physicians. Examples include the DGUV Empfehlungen "Atemschutzgeräte", "Blei und anorganische Bleiverbindungen", "Chrom(VI) Verbindungen", "Asbest", "Polycyclische aromatische Kohlenwasserstoffe", "Schweißen und Trennen von Metallen", "Lärm", "Belastungen des Muskel-Skelett Systems einschließlich Vibrationen“ and "Künstliche optische Strahlung".

6 Preventive maintenance and review

To ensure safe use, the information provided by the manufacturer in the operating instructions must be observed. This applies in particular to the maintenance intervals, such as changing and cleaning filters, cleaning optical equipment and checking electrical safety.

Before changing the filters of extraction systems, it must be checked whether further protective measures must be taken against filter dust and for fire and explosion protection.

7 Summary and limits of application

This "Fachbereich AKTUELL" is based on the experience gained by the expert committee Woodworking and Metalworking (FBHM), sub-committee Surface Technology (SG OT) of German Social Accident Insurance DGUV in handling laser equipment used for cleaning and decoating work.

The contents of this document ***do not*** refer to the general handling of lasers and laser equipment and ***not* to their** use for special applications in art and monument preservation.

The provisions of individual laws and regulations remain unaffected by this "Fachbereich AKTUELL". The requirements of the statutory regulations apply without restriction.

To obtain complete information, it is necessary to consult the relevant regulatory texts.

The expert committee Woodworking and Metalworking is composed of representatives of the accident insurance institutions, government agencies, social partners and manufacturing and operating companies.

The present Fachbereich AKTUELL is the translation of the German edition. No liability is accepted for translation errors.

Further "Fachbereich AKTUELL" or information sheets from the expert committee Woodworking and Metalworking (FBHM) are available for free download on the Internet.

Further sources of information

- BG ETEM Fachkompetenzcenter „Strahlenschutz“
- Fachinformationen des IFA der DGUV
- BG ETEM: Plakat "Vorschriften und Maßnahmen zur Lasersicherheit"
- Laserprodukte als Maschinen im Sinn der Maschinenrichtlinie (www.baua.de)
- Expositionsgrenzwerte für gepulste Laserstrahlung an Beispielen (Artikel aus Zeitschrift "sicher ist sicher")
- AUVA M 080 (2023-05) „Grundlagen der Lasersicherheit - Sicherheitsinformation für Arbeitnehmer:innen“
- AUVA M*plus 087 (2023-04) „Sicherheit in der Lasermaterialbearbeitung – Sicherheitsinformation für Führungskräfte
- DIN EN 207 "Personal eye protection - Filters and eye protection devices against laser radiation (laser safety spectacles)" (05/2017)
- E DIN EN ISO 19818-1 Eye and face protection - Protection against laser radiation - Part 1: "Requirements and test methods" (05/2020)
- DIN EN ISO 11553-2 Safety of machinery - Laser processing machines - Part 2: Safety requirements for hand-held laser processing machines (ISO 11553-2:2007); German version EN ISO 11553-(02/2008)

Note: Standards can be obtained from DIN Media.

German Bibliography

[1] Technische Regeln zur Arbeitsschutzverordnung zu künstlicher optischer Strahlung - TROS Laserstrahlung, Teil: Allgemeines.

[2] Verordnung zum Schutz der Beschäftigten vor Gefährdungen durch künstliche optische Strahlung (OStrV) vom 27.07.2010, zuletzt geändert durch Art. 5 Abs. vom 18.10.2017.

[3] DGUV Information 203-042 " Auswahl und Benutzung von Laser-Schutz- und Justierbrillen" (05/2018).

[4] www.bghm.de, webcode: 474.

[5] DGUV Grundsatz 303-005 "Ausbildung und Fortbildung von Laserschutzbeauftragten sowie Fortbildung von fachkundigen Personen zur Durchführung der Gefährdungsbeurteilung nach OStrV bei Laseranwendungen" (12/2018).

[6] DGUV Information 203-093 "Handlungshilfe für die Gefährdungsbeurteilung beim Betrieb von offenen Laser-Einrichtungen zur Materialbearbeitung mit Handführung oder Handpositionierung (HLG)" (04/2019).

[7] Verordnung zum Schutz vor Gefahrstoffen (Gefahrstoffverordnung) in der Fassung vom 27.07.2021.

[8] TRGS 400 „Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen“ (GMBl 2017 Nr. 36 S. 638).

[9] DGUV Grundsatz 313-003 "Grundanforderungen an spezifische Fortbildungsmaßnahmen als Bestandteil der Fachkunde zur Durchführung der Gefährdungsbeurteilung bei Tätigkeiten mit Gefahrstoffen" (11/2018).

[10] Fachbereich AKTUELL FBHL-020 "Checkliste für den betrieblichen Einsatz von Exoskeletten" (07/2020).

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[13] Gesetz über die Durchführund und von Maßnahmen des Arbeitsschutzes zur Verbesserung der Sicherheit und des Gesundheitsschutzes der Beschäftigeten bei der Arbeit (Arbeitsschutzgesetz) in der Fassung vom 31.05.2023.

[14] Technische Regeln Gefahrstoffe (TRGS) 507 "Oberflächenbehandlung in Räumen und Behältern - GMBl Nr. 18/19 2009.

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[17] Gesetz zum Schutz von Müttern bei der Arbeit, in der Ausbildung und im Studium (Mutterschutzgesetz) in der Fassung vom 01.01.2020.

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persönlicher Schutzausrüstungen bei der Arbeit (PSA-Benutzungsverordnung) vom 04.12.1996.

[19] Directive 2006/25/EC of the European Parliament and of the Council of 5 April 2006 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (artificial optical radiation) (19th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) Official Journal of the EU L 114, 27.04.2006, p. 38-59

[20] DGUV Information 250-010 Eignungsbeurteilungen in der betrieblichen Praxis.

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[22] Verordnung zur arbeitsmedizinischen Vorsorge (ArbMedVV), Ausgabe 07/2019.

[23] DGUV Information 203-004 Einsatz von elektrischen Betriebsmitteln bei erhöhter elektrischer Gefährdung 04/2018

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The DGUV expert committees are led by the German Social Accident Insurance Institutions for the Public Sector, the industry-related German Social Accident Insurance Institutions and the umbrella organisation DGUV.
The German Social Accident Insurance Institution for the Woodworking and Metalworking Industries (BGHM) is the institution in charge for the expert committee Woodworking and Metalworking and thus the first point of contact at federal level for questions regarding the health and safety at work in this field.

The following parties were involved in the development of this Fachbereich AKTUELL:

- DGUV expert committee Energy, Textile, Electrical and Media Products, subcommittee Non-ionising Radiation
- DGUV expert committee Construction Industry, subcommittee Building Cleaning
- DGUV expert committee "Raw Materials and Chemical Industry" subcommittee Hazardous Substances
- DGUV expert committee Personal Protective Equipment subcommittee Skin Protection and subcommittee Eye Protection
- Deutscher Industrie-Reinigungs Verband e. V. (DIRV)
- Institut für Arbeitsschutz (IFA) der DGUV
- VDMA
- Clean-Lasersysteme GmbH
- 4JET Technologies GmbH

- Glatt Laser Process Technology GmbH

Annex 1: Assistance for process selection

Before introducing a new work process, all parties involved should clarify important basic questions. The following table can help you to correctly assess the planning and effort involved.

Procedure for the selection of devices and techniques for hand-held cleaning and decoating work on workpieces with laser radiation (laser beam surface treatment)

Planning phase

a) Define applications.

b) Check ways to achieve the desired result
(decoating of workpieces using laser radiation or other processes such as mechanical cleaning, chemical processes, other blasting processes).

c) Define process limits.

d) Specify workrooms/work areas/time schedules.

Tests and selection of suitable processing systems

e) Clarify and test which laser beam cleaning system is suitable, if necessary in co-operation with the manufacturer. (Knowledge of the laser characteristics is necessary for the selection of suitable protective measures).

f) Determine the specific boundary conditions of the intended application and location, including the material properties.

Determination of necessary protective measures, preparation of required documents, provision of specialised knowledge and analytics

g) Specify safety technology, e.g. laser safety, extraction technology, fire protection, explosion protection, personal protective equipment, ergonomics.

h) Analyse coatings - as a basis for risk assessment.

i) Evaluate application in terms of safety, prepare risk assessment, operating instructions and instruction documents.

Introduction of the technology

j) Implementation of the specified measures according to the TOP principle (technical before organisational before personal protective measures)

k) Monitoring and, if necessary, adapting procedures and measures

Annex 2: Checklist

Work with laser systems always exposes workers and uninvolved third parties to hazards. Both groups of people must be protected.
The checklist helps you to plan and check measures to ensure safe working with laser systems for cleaning and decoating workpieces.

General measures - necessary for all work	yes	no	**not relevant**
Measures before, during and after the work			
Carry out a risk assessment.	☐	☐	
Prepare operating instructions.	☐	☐	
Carry out instructions.	☐	☐	
Appoint a laser protection officer.	☐	☐	
Ensure effective collection and extraction of hazardous substances, do not operate lasers without extraction. Keep exposure times as short as possible.	☐	☐	☐
Always use laser safety goggles.	☐	☐	☐
Set up a skin protection plan and provide skin protection.	☐	☐	☐
Provide and use additional personal protective equipment (PPE) in accordance with the risk assessment (protective gloves, respiratory protection, protective suits, ...).	☐	☐	☐
If PPE is required, check whether a combination of different PPE is possible or authorised.			
Check interactions between different PPE.	☐	☐	☐
Avoid glare. Observe the protection of other persons in the work area and in the vicinity.	☐	☐	☐
Lay fibre optic cables in such a way that they are protected against being driven over or under.	☐	☐	☐
Do not lay or pull fibre optic cables over sharp edges.	☐	☐	☐
It must be checked whether work involving exposure to toxic hazardous substances that are hazardous to health requires one-piece, dust-tight, fully ventilated type 3 protective suits in accordance with DIN EN ISO14877 and self-contained breathing apparatus to be worn.	☐	☐	☐
Check equipment for damage before each use, replace damaged or worn equipment before starting work.	☐	☐	☐
Cordon off, shield and label the work area (warning lamp).	☐	☐	☐
Ensure that access is secured and, if necessary, appoint safety attendants.	☐	☐	☐
Note the special features of fire alarm systems. Inform the relevant authorities about the work.	☐	☐	☐
Secure workpieces against falling over and down.	☐	☐	☐
Do not eat, drink or smoke at the workplace.	☐	☐	☐
...	☐	☐	☐
Emergency measures			
Plan emergency measures (rescue chain, emergency call and emergency telephone numbers, ...).	☐	☐	☐
Switch off the laser device in an emergency, de-energise it if possible.	☐	☐	☐
Remove the injured person from the danger zone.	☐	☐	☐
If the eye has been hit by laser radiation, the injured person must immediately consult an ophthalmologist or contact an eye clinic.	☐	☐	☐
In the event of exposure to hazardous substances, proceed in accordance with the product data sheet and risk assessment.	☐	☐	☐
If fire loads are present, a fire watch and control must be organised.	☐	☐	☐
...	☐	☐	☐

Construction site/ object:
Date:

Responsible:

Signature

Special measures for special areas of application or working environments	yes	no	not relevant
Working in rooms and containers - special additional measures			
Empty rooms and containers before starting work and clean them of hazardous substances.	☐	☐	☐
For work in rooms and containers that contain or have contained hazardous substances, employers must have a competent person carry out a **clearance measurement** and assess possible fire, explosion and health hazards before starting work.	☐	☐	☐
Access openings to rooms and containers must be designed in such a way as to ensure that the room can be exited quickly and that people can be rescued at any time (TRGS 507).	☐	☐	☐
For work in confined spaces (tanks, shipbuilding, silos, boxes, bridge structures, ...) assign supervisors and safety attendants in accordance with TRGS 507.	☐	☐	☐
Provide aids for rescue from confined spaces and containers.	☐	☐	☐
....	☐	☐	☐
Working in areas where there is a risk of fire or explosion - special additional measures			
When working with laser equipment, ensure that the presence or formation of an explosive mixture is prevented.	☐	☐	☐
Remove all flammable materials from the work area.	☐	☐	☐
...	☐	☐	☐
Working on construction sites - special additional measures			
Take additional organisational measures: safety attendants, communication equipment	☐	☐	☐
Use coordinated PPE.	☐	☐	☐
Exclude hazards from other trades/through other trades Make arrangements, appoint a coordinator if necessary.	☐	☐	☐
If necessary, appoint a coordinator.	☐	☐	☐
...	☐	☐	☐
Working at heights			
Provide defences, railings as technical fall protection.	☐	☐	☐
Do not carry out any work with laser equipment from the ladder.	☐	☐	☐
Use work platforms or scaffolding.	☐	☐	☐
Use slings and personal fall protection equipment (PPE).	☐	☐	☐
...	☐	☐	☐
Working alone			
Ensure communication.	☐	☐	☐
Prepare a rescue concept.	☐	☐	☐
...	☐	☐	☐
Other measures			
Are additional protective measures required?	☐	☐	☐
Coordinate measures.	☐	☐	☐

Construction site/ object:

Responsible:

Date:

Signature

Annex 3: Example of operating instructions

Operating instructions for working with hand-held class 4 laser devices

Company: (Firmenbezeichnung) **Number:**
Person responsible: (Name)

1. Scope

Cleaning and decoating of workpiece surfaces with laser beam systems
Work area: (Betriebsort angeben oder: Wechselnde Einsatzorte bei Kunden)
Laser: (Anlagentyp, Laserklasse und Hersteller eintragen, ggf. mehrere Einträge vornehmen)
Technical data: (Wellenlänge: …, Leistung: …, Impulsdauer: …, Spotgröße: …, Arbeitsabstand (Fokus): …)

2. Hazards to people and the environment

Laser devices of laser class 4:
The accessible laser radiation is very dangerous to the eye and dangerous to the skin.
Diffuse scattered radiation can also be dangerous. Laser radiation can also cause fire or explosion hazards.
The live parts on or inside the laser housing pose a risk of electric shock or electric shock to the body.

There is a danger to life.

3. Protective measures and rules of behaviour

Only use the laser system for applications that have been authorised by the manufacturer.
The laser area must be clearly recognisable and permanently marked. Unauthorised persons are not permitted to enter (only under supervision). Operation must be indicated by warning lights or warning signs at the entries to laser work areas.
Irradiation above the maximum permissible irradiation, including reflected or scattered laser radiation, must be prevented. If this is not possible, suitable personal protective equipment (eye protection, protective clothing or protective gloves) must be worn. Before using the personal protective equipment, check that it is suitable for the application and that it has no obvious defects. In case of doubt, the person in charge of laser protection must be consulted.
Eye protection: Wear laser safety goggles with at least protection class according to DIN EN 207:
D specification / IR protection class.
Skin protection: If the irradiation exceeds specify J/m² or the irradiance exceeds specify W/m², the necessary skin protection must be ensured.
If the laser systems are not in use, they must be secured against unauthorised use by removing the key from the key switch.
There is a risk of fire if the laser power exceeds specify W. Protective measures specified in the risk assessment must be observed.

4. Behaviour in the event of faults and danger

Emergency call:
otruf:

Switch off the laser equipment in the event of special operating conditions.
Inform the laser safety officer and supervisor.
In the event of fire: only use CO_2 fire extinguishers if this is possible without risk. Make an emergency call.

5. Behaviour in the event of accidents – First aid

Emergency call:

If the eye has been hit by laser radiation, the injured person must immediately consult an ophthalmologist or an eye clinic.
De-energise the device.
Rescue the injured person from the danger zone and provide first aid.
Ensure emergency medical care.

6. Maintenance, disposal

The irradiation of persons must be prevented.
If laser areas can occur that cannot be clearly defined in advance (e.g. breakage of optical fibres), the employees carrying out maintenance must be equipped in such a way that they are protected against the maximum possible laser radiation.
If the protection class changes during maintenance, the safety regulations of the new class must be complied with.

Date: **Signature:**