DGUV
Deutsche Gesetzliche Unfallversicherung
Spitzenverband

113-004

DGUV Regel 113-004

Vessels, silos and confined spaces

Part 1: Work in vessels, silos and confined spaces

February 2020

kommmitmensch
Sicher. Gesund. Miteinander.

kommmitmensch is the national campaign of the German Social Accident Insurance (DGUV). Its purpose is to support companies and educational institutions in developing a culture of prevention in which all action is underpinned by safety and health. Further information at **www.kommmitmensch.de**

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DGUV Rules are compilations of content relating to particular areas, work procedures or workplaces. They explain the specific prevention measures that can be taken in order for employers to meet their obligations for the prevention of occupational accidents, occupational diseases and work-related health hazards.

In areas for which no occupational accident regulations issued by the state or the accident insurance institutions exist, DGUV Rules describe how occupational accidents, occupational diseases and work-related health hazards can be avoided. They also provide access to the experience gained by the accident insurance institutions through their prevention work.

Owing to the procedure followed for the creation of DGUV Rules and the focus of their content upon specific in-plant procedures and areas of application (sector/company type/sphere), DGUV Rules constitute recommended good practice for the assurance of safety and health. They are of high practical relevance and value, are regarded by the stakeholders in the main as being necessary, and can therefore be treated as a suitable yardstick for in-plant prevention activity. DGUV Rules do not give rise to a presumption of conformity.

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1 Scope

This DGUV Rule covers work in vessels, silos and confined spaces as defined in Section 2.1 and 2.2.

Surface treatment work in indoor areas and vessels is governed by TRGS 507.

Work performed in vessels and confined spaces of sewerage installations also falls within the scope of DGUV Regulation 21 governing sewerage installations and DGUV Rule 103-003 governing work in enclosed areas of sewerage installations.

Work performed in shafts and pipes of district heating distribution systems also lies within the scope of DGUV Rule 103-002 governing such systems; work performed in thermal power stations and heating plants also falls within the scope of DGUV Rule 103-009 governing these areas.

2 Definitions

The terms below are defined as follows for the purpose of the present DGUV Rule:

2.1 **Vessels and confined spaces** are areas constrained completely or predominantly by rigid walls and in which, owing to their physical confines, inadequate air replacement rates, or the substances, mixtures, contaminants or equipment found within them or introduced into them, particular hazards exist or may arise that substantially exceed the normal prevailing hazard potential of workplaces. Areas only partly surrounded by rigid walls in which however, owing to the design of the areas or to the site conditions, hazardous substances may accumulate or an oxygen deficit may arise, also constitute confined spaces in the sense of this DGUV Rule.

Where the incidence of particular hazards (see below) cannot reliably be ruled out, areas such as the following must also be regarded as confined spaces:

- *Tank pits*
- *Pits in general*
- *Shafts*
- *Sewers*
- *Ships' holds*
- *Weighbridge pits*
- *Cavities in building structures and machines*
- *Box girders of bridges and cranes*
- *Hubs, rotor blades and spinners of wind power installations*

***Particular hazards caused by substances or mixtures** may exist or arise in confined spaces and vessels as a result of:*

- *Work methods such as welding, grinding, cleaning with liquid or solid substances*
- *Surface treatment work*

- *Agitation of residues*
- *Biological processes, such as fermentation, putrefaction*
- *Chemical reactions*
- *Gases used for purging*
- *Substances and mixtures entering through leaky lining or valves*
- *Oxygen deficit; this may be caused by inert gases used for purging, or by substances (including the material from which the vessel is manufactured) that absorb the oxygen, bind it chemically or physically or displace it (see also Annex 5); the consumption of oxygen or unsuitable and inadequate ventilation during work in vessels, silos or confined spaces may also lead to an oxygen deficit.*

Fig. 1 Maintenance work

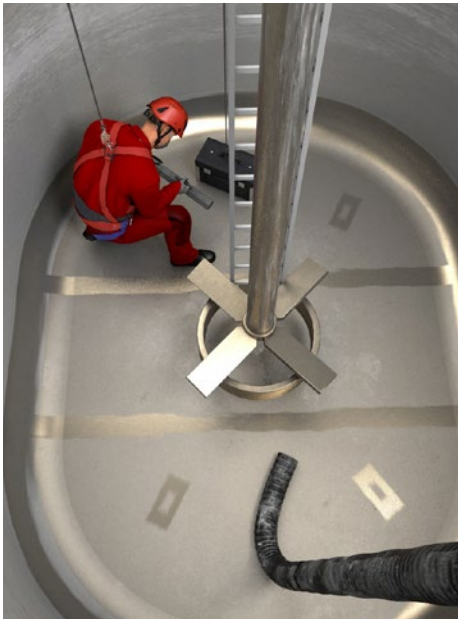


Fig. 2 Repair work

Fig. 3
Inspection tasks (leaning into the vessel or confined space): permissible only with additional protective measures. In this case: a protective mesh in the manhole that prevents persons from falling into it

Fig. 4 Cleaning tasks

- *Enrichment with oxygen, for example owing to operator error or leaks arising during welding work*
- *Hot substances or mixtures, bulk materials, liquids or other fluid substances and mixtures present in or entering vessels or confined spaces*
- *Removal of caked deposits*
- *Gases, vapours, mists or dusts which may arise as a result of fire or explosion*

***Equipment present in vessels, silos and confined spaces** may for example present or give rise to particular hazards such as:*

- *Moving parts or installed equipment such as mixing, crushing, decompaction, conveying or ventilation equipment*
- *Heated or cooled parts of vessels and installed equipment*
- *Closing or opening fittings in pipes, e.g. gate or butterfly valves, explosion decoupling equipment*

Fig. 5 Sewer

Fig. 6 Pit

- *Electrical equipment that is live under operational conditions, such as resistance and HF heaters*
- *Electrical equipment such as hand lamps, electric tools, electric welding equipment*
- *Radiation, caused for example by instruments*
- *Cleaning equipment, e.g. high-pressure cleaners*

***Particular risks of mental stress** may be presented for example by:*

- *Confined spaces*
- *Working at a height, e.g. in silos or shafts*
- *Limited visibility, poor communication with the outside world/with the safety person*

Fig. 7 Vessel during production

Fig. 8 Shell ring below a column

- ***Particular hazards may also be presented*** *for example by:*
- *Fixed installations such as baffle plates, column bases, raised floors*
- *Difficulty of access and rescue owing to the space constraints*
- *Auxiliary equipment such as ladders or scaffolds*

! **The classification of a location as a “confined space” should not be based solely upon its dimensions, but should also always take account of the particular hazards presented by it. In normal use, broom cupboards or bank vaults for example do not constitute confined spaces in the sense of this DGUV Rule.**

2.2 **Silos** are building structures for the storage of bulk materials. They are filled from the top and emptied from the bottom or side.

The term bunker is commonly used in some areas of industry. For particular hazards, refer to the definition of "Vessels and confined spaces".

2.3 **Work** in this context covers tasks performed by persons in vessels, silos and confined spaces.

Such work includes:
- *Maintenance work, such as:*
  - *Repair or replacement*
  - *Servicing, rust-proofing, lubrication or adjustment*
  - *Inspection work*
- *Cleaning work, including the removal of residues*
- *Modification work*
- *Tasks performed during manufacturing processes*
- *Fault clearance*
- *Fireproofing*

Access includes:
- *Non-assisted access*
- *Assisted access*
- *Leaning in*

Fig. 9 Silo

Fig. 10 Sewer access opening

2.4 Access techniques are work methods that permit access to the vessel, silo or confined space (generally with the assistance of work equipment). Examples of such methods are:

- Access simply by climbing in, without the use of equipment (this is generally the case with access points located at the bottom)
- Access by means of ladders (permanently installed or mobile ladders)
- Access by means of suspended access equipment in accordance with DGUV Rule 101-005
- Access by means of a full body harness serving as a lifting and holding device, together with a winch for the transport of persons

Fig. 11 Manhole

2.5 Work positioning techniques in the sense of this DGUV Rule

are work methods in which persons are positioned at a certain point in the vessel, silo or confined space in order to perform work in the sense of No 3. The persons remain in the access equipment for the duration of this work. For the purpose of work positioning, suspended access equipment forming the scope of DGUV Rule 101-005 or rope access and work positioning techniques in accordance with TRBS 2121 Teil 3 and DGUV Informative publication 212-001 governing work performed with the use of such techniques can be used.

2.6 Access openings to vessels and confined spaces include but are not limited to:

- Doors
- Hatches
- Manholes
- Ladders
- Manhole steps

Fig. 12 Manhole (unfavourable position, conditions unfavourable to rescue)

Fig. 13 Permanent ladder

2.7 **Clearance measurement** in the sense used in this rule is the measurement of a possible concentration of a hazardous substance or of the oxygen concentration in order to determine whether the atmosphere in the vessel, silo or confined space can be cleared for safe working.

Clearance measurement is not synonymous with measurement in the sense of the German Ordinance on hazardous substances or TRGS 402, "Identification and assessment of the risks from activities involving hazardous substances: inhalation exposure".

2.8 **Continual monitoring** of the concentrations of oxygen or hazardous substances during work has the purpose of determining that the atmosphere in the vessel, silo or confined space continues to permit safe working after the clearance measurement has been performed.

2.9 **The chief supervisor** is a person tasked by the employer with supervising the preparations for and performance of work in vessels, silos and confined spaces.

Refer to Section 8 (1) of DGUV Regulation 1, "Principles of prevention".

2.10 **The safety person** is a person who maintains continual contact with the persons working in the vessel, silo or confined space and who takes or initiates rescue measures if necessary.

2.11 **An oxygen deficit** is defined in this context as a state in which the oxygen concentration is lower than that of the natural breathing air, i.e. < 20.9%.

2.12 **Excess oxygen** is defined in this context as a state in which the oxygen concentration is greater than that of the natural breathing air, i.e. > 20.9%.

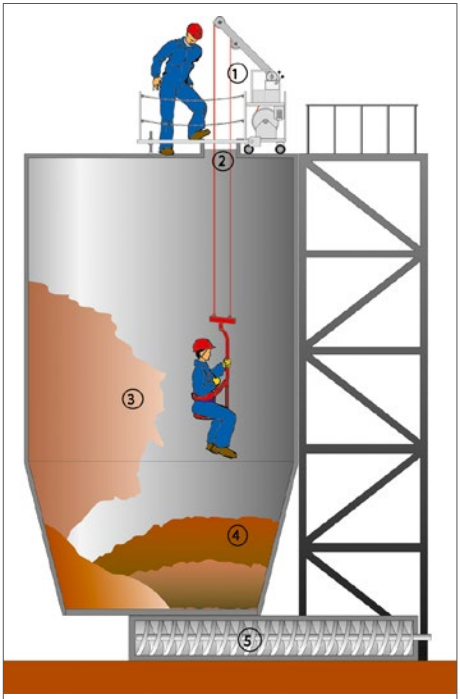
3 Risk assessment

3.1 Prior to commencement of the work, the employer is required to perform a risk assessment.

3.2 Technical or organizational measures in accordance with Sections 4 to 7 must be taken against the hazards and exposures determined in accordance with Section 3.1.

3.3 The measures determined must be set out in a permit or model operating procedure in accordance with Section 4.2.6.

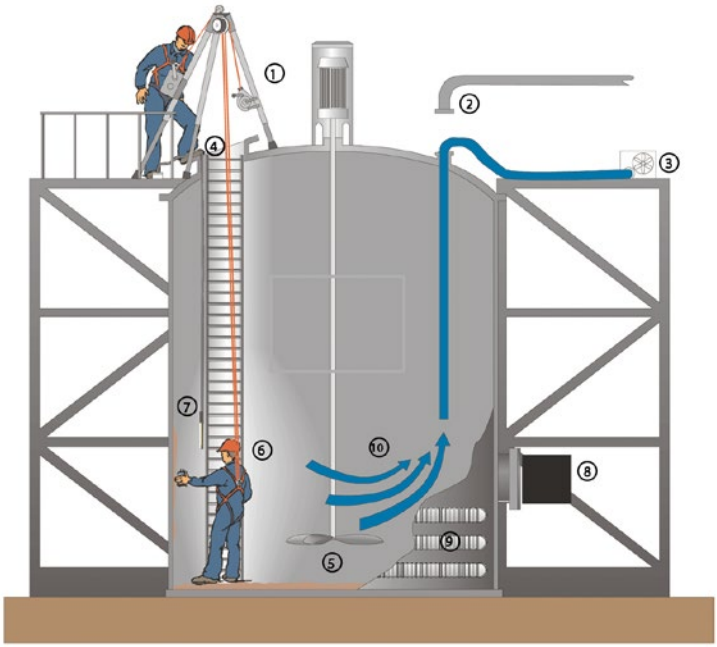
The permit is based upon the model permit found in Annex 1 of the present DGUV Rule and is produced by selection from the general catalogue of hazards for the situations encountered in the company. When produced diligently and comprehensively, the permit serves as the basis for risk assessment in the specific case.



① Inadequate rescue arrangements, inadequate protection against falls from a height
② Insufficient access opening widths, unfavourable rescue routes
③ Risk of engulfment
④ Risk of sinking into bulk materials
⑤ Danger points on machines

Fig. 14 Possible hazards arising during work in a silo (example)

Completion of the permit thus represents the risk assessment for the work in question in the vessel, silo or confined space for a certain task at a certain point in time.



① Inadequate rescue measures; lack of protective equipment against falls from a height
② Inadequate isolation of working areas
③ Inadequate ventilation, oxygen deficit
④ Access openings too narrow
⑤ Danger points on machines
⑥ Health hazards caused by elevated physical stress
⑦ Electric current
⑧ Radiation
⑨ Hot or cold media
⑩ Hazardous substances

Fig. 15 Possible hazards arising during work in vessels and confined spaces (examples)

4 Protective measures

4.1 Principles

Owing to the high potential hazard, consideration must always be given to whether work in vessels, silos and confined spaces can be avoided. This may for example be achieved by:

- The performance of cleaning work from outside (cleaning installation)
- Use of a camera for inspection

4.2 Organizational measures

4.2.1 Planning with regard to work in vessels, silos and confined spaces

The issues associated with the performance of work in vessels, silos and confined spaces must be considered during planning and erection of the installations. This applies in particular to:

- Design of the access points for work and rescue
- Design of the anchor points and facilities for the personal protective equipment
- Facility for disconnection of the supply and waste pipes

Design of the access points should take account not only of the relevant standards, but also and in particular of the planned methods for access and rescue and the personal protective equipment to be used (see Sections 5 and 6 and Annex 4).

4.2.2 Organization of the work schedule

The employer must state in a company work schedule who is to perform the organizational measures and who is to be appointed as:

- Chief supervisor
- Safety person
- Provider of instruction (including practical exercises) to the persons involved
- Performer of the clearance measurement

4.2.3 Provision of instruction to all persons involved in the work

4.2.3.1 Prior to commencement of the work and with reference to the risk assessment, the employer must ensure that instruction has been provided to all persons involved concerning the hazards and the required protective measures as specified in the permit or the operating procedures.

Refer to Section 12 of the German Occupational Health and Safety Act (ArbSchG) and Sections 4 and 31 of DGUV Regulation 1, "Principles of prevention".

4.2.3.2 Where work of the same type is carried out regularly, it is sufficient for the instruction to be repeated at reasonable intervals, but at least once a year.

4.2.3.3 The specified rescue measures must be drilled by the persons assigned to rescue tasks.

Refer to Section 31 of DGUV Regulation 1, "Principles of prevention"

4.2.4 Chief supervisor

4.2.4.1 Prior to the commencement of work in vessels, silos and confined spaces, the employer must appoint a reliable person familiar with the work as chief supervisor of the work and confer upon this person the authority to issue directives.

The chief supervisor is generally appointed by the operator of the vessel, silo or confined space. Should multiple companies be involved in the work, they must agree precisely who is to serve as the chief supervisor.

4.2.4.2 The chief supervisor may issue the permit in accordance with Section 4.2.6.1 on the employer's behalf. He or she must monitor observance of the specified protective measures.

The required checks must be performed by the chief supervisor before commencement of the work and at appropriate intervals during the work. The intervals are dependent upon:

- The potential hazard
- The reliability of the employees
- The form of protective measures taken

The chief supervisor need not remain in the immediate proximity of the work at all times but must be available at short notice.

4.2.5 Safety person

4.2.5.1 Where work is performed in vessels, silos and confined spaces, the employer must appoint at least one safety person. The safety person must be in constant contact with the persons in the vessel, silo or confined space.

The safety person must be reliable and must possess the required mental and physical abilities.

Examples of such abilities include the following, as a function of the protective measures taken:
- *Knowledge of the personal protective equipment to be used*
- *Reliability*
- *Ability to recognize hazards*
- *Adequate hearing and vision*
- *Adequate physical resistance to stress*

Constant contact is generally assured where visual contact exists. If visual contact is not possible, constant contact can be maintained by alternative means, such as a direct speech connection, personal distress signal systems, or lifelines.

A personal distress signal system may be used only as a measure for the assurance of continual contact. It must not be used as a substitute for a safety person.

Refer also to DGUV Rule 112-139 governing the use of personal distress signal systems and DGUV Informative publication 212-139 governing distress call arrangements for persons working alone.

4.2.5.2 The safety person must be able to call for help at any time. He or she must be familiar with the specified emergency and rescue measures in accordance with Section 6 (see also 6.2.2).

4.2.5.3 Safety persons are not required when the following are ensured:
- No hazards are presented by substances or equipment
- The persons present in the vessels, silos or confined spaces are able to leave these without assistance from others and are able to call for help at any time, and an oxygen deficit cannot occur.

Hazards presented by substances or equipment can be ruled out provided protective measures have been taken, particularly those described in Section 4, and experience has already been gained of the work to be performed.

4.2.6 Permit

4.2.6.1 Prior to the commencement of work in vessels, silos and confined spaces, the employer or his delegate must issue a permit setting out the required protective measures. The chief supervisor, the safety person and, where third-party contractors are involved, their responsible representatives, must confirm by signing the permit that they are aware of the measures that have been set out.

Should the permit be issued by a third-party contractor, the contracting party must support the third-party contractor in the performance of risk assessment of the hazards specific to the operations. Where hazards and stresses/exposures are complex, it has proved effective in practice for the permit to be issued by the operator or user of the vessel, silo or confined space.

In special cases, the permit may be issued solely by the employer at the company performing the work.

Examples of such situations are:
- *Non-commercial use of a vessel, silo or confined space, for example an oil tank in a residential building*
- *Work in vessels, silos and confined spaces the ownership of which is not known, for example during redevelopment work in plants that have been decommissioned*
- *Work for which the operator does not possess the necessary expertise*

Following longer interruptions to work, such as resumption of work on the following day or after a change in the persons involved in the work, for example at a shift change, or a change in third-party contractor, the permit must be re-issued or extended.

Suspension of the protective measures at the end of the work must be documented in the permit.

4.2.6.2 The permit can be replaced by operating procedures when the work conditions are always of the same kind and effective protective measures of the same kind are specified (see for example Annex 4).

4.2.7 Commencement of work

4.2.7.1 Work in vessels, silos and confined spaces may not be begun until the employer or chief supervisor has determined that the protective measures set out in writing are suitable and have been taken and that all persons involved have received instruction.

4.2.7.2 Following interruption of work (shift change, resumption of work on the following day), the suitability and efficacy of the measures set out in writing must again be ascertained by the chief supervisor.

4.2.8 Safeguarding of the work site

It must be ensured that persons not involved in the work are kept away from the work site. This applies in particular when work is performed outside closed-off premises, such as on the public highway or on residential premises.

4.2.9 Suspension of the protective measures

The chief supervisor may suspend the protective measures only once the work has been completed and all persons have vacated the vessels, silos and confined spaces.

4.3 Measures for protection against hazardous substances and hazardous media

A hazard is presented by hazardous substances for example when the occupational exposure limits are exceeded or the substances come into contact with the skin.

Hazardous media present hazards caused by effects such as drowning or engulfment in the substance as distinct from direct health hazards.

Other forms of assessment criteria exist (such as exposure-risk relationships, biological monitoring, derived no-effect levels) in addition to the occupational exposure limits.

4.3.1 Emptying of the vessels, silos and confined spaces

4.3.3.1 Vessels, silos and confined spaces must be emptied and cleaned prior to the commencement of work.

Where possible, the vessel, silo or confined space should be emptied of the material without the need for persons to be present in it, for example by draining, vacuuming, pumping or stream-stripping, or by the use of materials handling equipment. Residues should be removed by measures appropriate to the material concerned, for example steaming out, repeated filling of the vessel with water and re-emptying (static conditions permitting), spraying or flushing out with suitable liquids with simultaneous agitation of any residues in the form of sludge, or by purging with suitable gases or air. Attention must be paid to the possible fire, explosion and health hazards presented by organic solvents and cleaning agents.

It must be ensured that substances, mixtures and residues are safely stored, drained or removed during emptying of the vessel, silo or confined space; attention is drawn to the relevant environment protection regulations. If applicable, consideration must also be given to adjacent vessels, confined spaces and other areas. Where high-pressure cleaning methods are used, fully desalinated water or other liquids with a low ion concentration should not be used, in order for electrostatic charging to be avoided.

Emptying and cleaning of the vessels and confined spaces is not necessary when the substances and mixtures do not present a hazard, or when the hazards presented by the content of the vessels and confined spaces cannot be eliminated for operational reasons and other protective measures are therefore taken.

The substances and mixtures in the vessels and confined spaces present no hazard when for example they are neither hazardous to health nor flammable, and no risk exists of drowning, suffocation or sinking into them.

Examples of hazards that cannot be eliminated include:
- *Caked deposits on vessel walls that cannot be removed from the outside and contain hazardous substances, as for example in polymerization vessels*

- *Substances employed for emptying and cleaning, e.g. purging gases or liquids and cleaning agents*
- *Vessels, silos or confined spaces that cannot be emptied or cleaned for operational reasons or as a consequence of operational outages*

Examples of suitable protective measures are:
- *Ventilation*
- *Use of personal protective equipment*
- *Use of silo access equipment*

4.3.2 Isolation of the vessels, silos and confined spaces

4.3.2.1 Prior to the commencement of work in vessels, silos and confined spaces, it must be ensured that all supply and discharge lines to and from the vessels, silos and confined spaces through which hazardous substances or asphyxiant gases may enter the vessels, silos and confined spaces in hazardous concentrations or quantities or at hazardous temperatures or pressures are reliably interrupted.

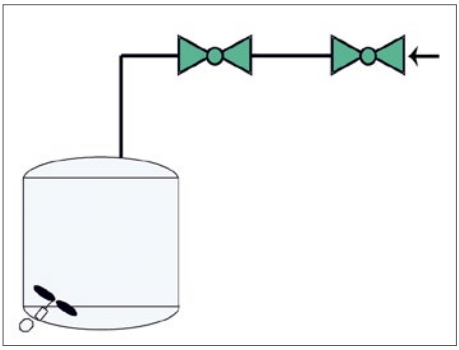


Fig. 16.1 Isolation of the vessel: removal of adapters and fitting of blind flanges. Situation before

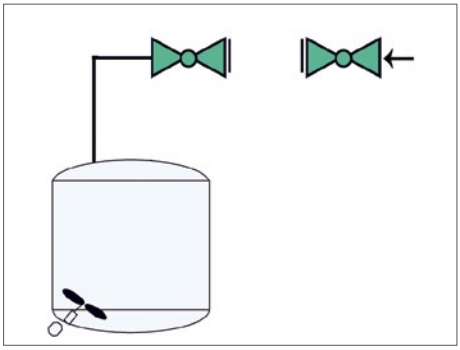


Fig. 16.2 Isolation of the vessel: removal of adapters and fitting of blind flanges. Situation after

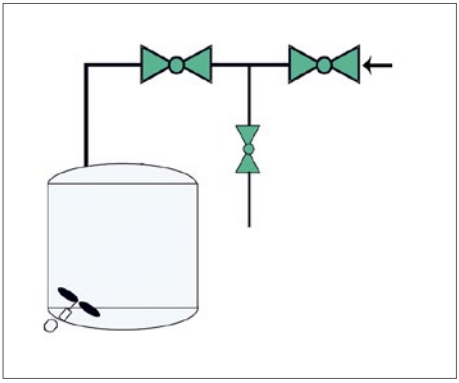


Fig. 17 Two shut-off valves with intermediate bleeder valve

Fig. 18 Isolation by means of a sealing blank

Supply and discharge lines for substances may be interrupted reliably for example by the following measures:

- *Removal of adapters, separation of flanged joints, use of blind flanges on the openings*
- *Two successive shut-off valves, provided the valves are separated by a bleed valve to the outside air (double block and bleed), the actuators are safeguarded against inadvertent, unauthorized or erroneous opening, and the efficacy of the double block and bleed arrangement has been tested*
- *Tightly sealing blanks clearly identifiable as such with dimensions and of materials suitable for the temperatures arising and the substances and pressures to which they are exposed*
- *Two successive shut-off valves without intermediate bleeder valve, provided a pressure build-up upstream of the valves is not possible and the actuators are safeguarded against inadvertent, unauthorized or erroneous opening*

- *One shut-off valve, provided persons cannot be exposed to danger in the event of leaks and the actuator is safeguarded against inadvertent, unauthorized or erroneous opening*
- *An auxiliary shut-off facility, such as gas bags or pipe sealing cushions, provided persons cannot be endangered in the event of leaks*

4.3.2.2 Should reliable isolation not be possible for operational reasons, work may be performed in vessels, silos or confined spaces only when the persons are protected by other means.

Operational reasons preventing reliable isolation apply for example in pipes and shafts.

The persons may be protected by other means, for example by ventilation or the use of personal protective equipment.

4.3.3 Ventilation

4.3.3.1 Prior to and during work in vessels, silos and confined spaces, ventilation measures must be taken to ensure that gases, vapours, mists or dusts in concentrations hazardous to health and explosive mixtures or oxygen deficit are not able to arise.

A distinction is drawn between forced (engineered) and unforced (natural) ventilation.

Unforced ventilation, brought about by differences in pressure or temperature, is adequate only if the occupational exposure limits or other relevant health-based limits are observed and an oxygen deficit is ruled out. This is particularly the case when work is performed on a small scale and the following conditions are met:

- *The quantities are small*
- *The substances concerned present a low potential hazard*
- *The spaces are of large volume*

In addition, no hazardous concentrations of hazardous substances or oxygen deficit have been present in the vessel prior to commencement of the work.

The formation of explosive atmospheres is deemed prevented when it is sustainably ensured that the concentration of the gases, vapours, mists or dusts in the mixture with air is below 50% of the lower explosive limit. Under non-atmospheric conditions, the changes to the safety parameters are to be taken into account in order for the possible formation of explosive mixtures to be assessed.

4.3.3.2 Fresh air must be used for ventilation. The fresh air must have the quality of outdoor air.

The fresh air must be drawn from the open air or, where this is not possible, from indoor areas in which the air is free of contaminants that are flammable or hazardous to health. Such indoor areas must be linked to the open air by large openings. The air supply must be designed such that the air is replenished in the entire space within the vessel and the persons work if at all possible in the fresh air stream.

Where contaminated air is exhausted, it must be ensured that sufficient fresh air is able to flow in to replace it, if necessary by the use of engineered ventilation. Solvent vapours must generally be exhausted at the point at which they arise. The exhaust arrangement must ensure that the solvent vapours do not enter the breathing air of workers.

For information on ventilation, refer to Annex 3.

4.3.3.3 Oxygen or air with an elevated oxygen concentration must not be used for ventilation.

4.3.3.4 Where it can be anticipated that the exhausted air contains hazardous concentrations of substances hazardous to health, it must be drawn away such that it presents no danger to persons.

If the presence of a hazardous explosive atmosphere in the exhausted air cannot be ruled out, additional measures must be taken in order to avoid effective sources of ignition in the exhaust air duct.

4.3.3.5 The efficacy of the ventilation arrangements must be monitored, and safeguarded against manipulation by unauthorized persons.

Monitoring may take the form of (examples):
- *Continual concentration measurements by means of automatic equipment (direct-reading instruments)*
- *Repeat discrete concentration measurements*
- *Monitoring of observance of the specified supply and exhaust flow rate*

Supply and exhaust volumes can be estimated for example by measurement of the airspeed at the exhaust and supply vents by means of a vane anemometer.

The direction of air movement and purging of the space can be determined by means of streamers, wind indicators or airflow smoke tubes.

The instruments used to detect hazardous explosive atmospheres must be deemed suitable by an approved inspection body. (List of gas warning devices the function of which has been tested: www.bgrci.de/exinfode/dokumente/gaswarngeraete/funktionsgepruefte-gaswarngeraete/)

4.3.3.6 Should the ventilation become ineffective, work in the vessel, silo or confined space must be halted immediately. The efficacy of the ventilation must be assured and tested as described in Section 4.3.3.5 before work is resumed.

4.3.4 Respiratory protection

4.3.4.1 Should it not be possible to prevent the incidence of hazardous substances in hazardous concentrations or quantities by means of the measures described in Sections 4.3.1 to 4.3.3, respiratory protective devices must be used during work in vessels, silos and confined spaces. Suitable respiratory protective devices must be selected with consideration for aspects including their protection factor (multiple of the limit). Refer in this context also to Section 3.1.5.2 of DGUV Rule 112-190 governing the use of respiratory protective devices.

4.3.4.2 The use of filtering devices is permissible only if it can be ensured that an oxygen deficit does not present a hazard. Where necessary, the oxygen concentration must be measured continually and an oxygen deficit signalled by visual or acoustic alarms. Refer also to Section 3.1.5.4 of DGUV Rule 112-190.

4.3.4.3 Work may be performed in vessels, silos and confined spaces at an oxygen concentration of below 17 % by volume only if self-contained closed-circuit breathing apparatus is used.

4.3.4.4 Where respiratory protection and personal protective equipment against falls from a height are used simultaneously, the two items of protective equipment must be used in such a way that they do not impair each other.

Mutual impairment can be prevented by the use of matched systems, such as full body harnesses with an integral carrier for compressed air cylinders.

The function of respiratory protective equipment may be impaired by the shock of the fall arrest, which may result in the breathing tube or facepiece being pulled off. In order for this risk to be reduced to a minimum in cases where respiratory protection and personal protective equipment against falls from a height are used simultaneously, the anchor point must be located and the connector adjusted such that the arrest distance is as short as possible.

4.3.5 Clearance measurement of the vessels, silos and confined spaces

4.3.5.1 Risk assessment must include determining what substances and mixtures are present in the vessel, silo or confined space or may arise in the course of the work and if so in what concentration, and whether an oxygen deficit may arise. In the majority of cases, clearance measurement is required for this purpose. Clearance measurements must be performed at a representative location.

For the possible incidence of hazardous substances and oxygen deficit, refer to Section 2.11 and 2.12.

4.3.5.2 Suitable methods must be used for clearance measurement.

Suitable measurement methods are:
- *Continual measurement, e.g. by direct-reading instruments*
- *Repeat individual measurements, e.g. by means of sampling tubes or sample collection followed by laboratory analysis*

Fig. 19 Sampling by means of gas measuring instruments

Fig. 20 Sampling by means of a gas sampling tube

The measurement method must be selected with consideration for the particular characteristics of the substances to be measured, such as cross-sensitivity to other substances, including water vapour.

The conditions in the vessel, silo or confined space are also decisive for selection of the measurement method. A distinction must be drawn between vessels, silos and confined spaces:

- *That are fully emptied, flushed and cleaned and into which the ingress of hazardous substances and asphyxiant gases is ruled out*
- *That exhibit contaminants or residues that may release hazardous substances*
- *That cannot be entirely isolated and into which the ingress of hazardous substances or asphyxiant gases is therefore possible. In these cases, preference is to be given to direct-reading meters*

4.3.5.3 Persons tasked by the employer with performing clearance measurements must possess the necessary expertise.

Expertise relates to:
- *The instruments and measurement methods employed*
- *The hazardous substances to be measured*
- *The circumstances in the plant, such as the design of the vessels, silos and confined spaces and possible equipment installed within them that could influence sampling*

Prior to the commencement of work in tanks and enclosed areas on water-borne vessels and floating installations, the particular provisions of DGUV Regulation 45 governing shipbuilding must be observed, in addition to TRGS 507 governing surface treatment in indoor areas.

The expertise can be acquired for example in accordance with DGUV Principle 313-002 governing the selection, training and appointment of experts for the performance of clearance measurement in accordance with DGUV Rule 113-004.

4.3.5.4 The measurements must be performed at a representative location. The user information provided by the manufacturers of the meters must be observed. The measurements performed and their results must be documented.

4.3.5.5 In many cases, measurement is also performed continually during work following clearance. Expertise in accordance with DGUV Principle 313-002 is not required for such continual monitoring by the safety person, for example by means of gas detectors.

The person performing continual monitoring must first receive instruction in it. This instruction must include at least:

- Basic information on use of the gas detector
- Information on the required response to triggering by the detector of an alarm

Experience has shown that the safe use of sampling tubes requires more comprehensive instruction than for the use of direct-reading gas detectors.

4.4 Measures for protection against hazards arising from an oxygen deficit or excess oxygen

4.4.1 Avoidance of hazards caused by an oxygen deficit

4.4.1.1 Hazards caused by an oxygen deficit may arise when the oxygen concentration is lower than that of the natural breathing air, namely 20.9% by volume. Should the oxygen concentration be below this level, the cause must be determined and it must be assessed whether foreign gases or hazardous substances present a hazard.

A hazard exists for example when the difference between the actual oxygen concentration and the 20.9% by volume is accounted for by hazardous substances and the occupational exposure limits or short-term exposure values of these hazardous substances are exceeded. This also applies for example to carbon dioxide.

A hazard does not exist for example when the difference between the actual oxygen concentration and the 20.9% by volume consists of nitrogen or noble gases and the oxygen concentration is at least 17%.

Substances and stored items that are not hazardous substances may also deplete the oxygen concentration in vessels, silos and confined spaces with potentially fatal effects (see Annex 5).

4.4.1.2 The measures described in Section 4.3 must be taken in order to provide protection against an oxygen deficit.

4.4.2 Avoidance of hazards caused by excess oxygen

Excess oxygen may present a hazard when the oxygen concentration exceeds 20.9 % by volume and the risk of substances igniting is thereby increased.

In order for excess oxygen to be prevented:

- Persons must not bring oxygen cylinders with them when entering a vessel
- Supply lines must be kept as short as possible and checked regularly
- Where work is interrupted for longer periods, equipment and hoses must be removed from the vessel, or disconnected from the supply point
- The vessel must be ventilated
- Where applicable, clearance measurements must be performed before the commencement of work or before resumption following longer interruptions

Even a minor increase in the oxygen concentration causes fiercer combustion, i.e. a considerable increase in the rate of combustion. Should the oxygen concentration in the atmosphere be elevated, a smouldering fire for example may develop into a lively flame.

Oxygen may cause spontaneous ignition of oil and grease and of textiles contaminated with oil and grease.

Elevated oxygen concentrations may also modify safety parameters, such as: upper explosion limits, dust explosion classes, rates of pressure rise, ignition and glow temperatures, explosion pressures, flame temperatures.

Excess oxygen may arise through enrichment with oxygen, owing for example to incorrect operation, or to leaks during welding work or in containers previously filled with oxygen and not thoroughly emptied and purged.

Where work is performed with self-contained breathing apparatus in inertized vessels containing substances capable of spontaneous ignition, the exhaled air may be sufficient to negate the inertization effect in the immediate proximity.

4.5 Measures for protection against explosion

4.5.1 Avoidance of the incidence of explosive atmospheres or explosive mixtures

The primary measure for explosion protection is avoidance of the incidence of hazardous explosive atmospheres by the measures described in Section 4.3 (refer also to TRGS 720 ff).

During work in vessels, silos and confined spaces, non-atmospheric conditions may prevail, for example as a result of elevated oxygen concentrations or the presence of other oxidants. The explosion protection measures specified must take account of differences in the safety parameters under non-atmospheric conditions.

In many cases, the incidence of an explosive atmosphere or explosive mixture is difficult to estimate. Such atmospheres/mixtures may occur:

- *As a result of residues released during cleaning work*
- *As a result of work processes, such as welding gases, cleaning agents*
- *As a result of continued evaporation from flammable liquids in caked deposits or contaminants in a poorly cleaned vessel*

- *When flammable substances cannot be removed from vessels, silos or confined spaces for operational reasons*
- *As a result of the raising of dust deposits with a flammable component*

The formation of explosive atmospheres is deemed prevented when it is sustainably ensured that the concentration of the gases, vapours, mists or dusts in the mixture with air is below 50% of the lower explosive limit.

Vapours from a flammable liquid are unable to form an explosive atmosphere when the processing temperature of the liquid lies below its lower explosive limit (LEL). The following must be considered in this context:

- *The ambient temperature may rise above the LEL (e.g. under the influence of sunlight)*
- *The flammable liquid may be heated to a temperature above the LEL (for example by tank heating equipment)*

For fluids consisting of only a single component, this is the case when the maximum processing temperature is at least 5 K below the flash point, and for liquid mixtures, when the maximum processing temperature is at least 15 K below the flash point.

When a flammable liquid is sprayed (e.g. paint spraying), aerosols are produced in the spray area. Irrespective of the above requirements, the aerosols form a hazardous explosive atmosphere.

The formation of a hazardous explosive atmosphere by aerosols need not be anticipated when only non-flammable liquids, such as water-thinnable coatings/cleaning liquids in the required composition, are sprayed. UV-cured coatings may be flammable when finely distributed, despite not containing organic solvents.

The formation of explosive atmospheres can also be prevented by inertization (for example by the introduction of nitrogen). Inertization must be monitored.

4.5.2 Avoidance of sources of ignition

4.5.2.1 When, for operational reasons, the presence of hazardous explosive atmospheres or hazardous explosive mixtures cannot be avoided, the incidence of effective sources of ignition must be thoroughly prevented in accordance with TRBS 2152 Teil 3. Surface treatments in indoor areas and vessels are governed by TRGS 507. This technical rule contains instructions regarding explosion protection measures. Its descriptions of the measures required to prevent ignition are also useful for assessments of scenarios of a similar nature.

During temporary work in vessels, silos and confined spaces, zoning as described in DGUV Rule 113-001 governing explosion protection is of no benefit.

Examples of measures for the avoidance of sources of ignition include:

- Avoidance of sparks caused by friction and impact
- Avoidance of parts containing aluminium (such as ladders, PPE) in rusty environments
- Avoidance of electrostatic charging of persons, work equipment, PPE (e.g. protective overalls), equipment installed in the vessels. The measures for this purpose are in particular those described in the TRGS 727 technical rules concerning the avoidance of ignition hazards presented by electrostatic charging

Note: When PPE against falls from a height is used correctly, hazardous electrostatic charging need not be anticipated (refer also in this respect to the publication concerning the use of PPE against falls from a height in areas posing an explosion hazard, issued by the Subcommittee PPE/ rescue equipment: http://www.dguv.de/fb-psa/sachgebiete/sachgebiet-psa-gegen-absturz-rettungsausruestungen/veroeffentlichungen-zum-download/index.jsp)

- Selection of electrical and non-electrical equipment suitable for safe operation in the potentially explosive area in which the work concerned is being carried out. This also applies to fan impellers including housings and bearings that are operated outside potentially explosive areas but that transport exhausted air that may contain explosive atmospheres

4.5.2.2 Sources of ignition in the immediate vicinity of vessels, silos and confined spaces must also be considered.

Besides sources of ignition caused by equipment serving operational purposes, work involving an ignition hazard must also be considered, such as:

- Welding, grinding and cutting work:
  - Within vessels and confined spaces
  - At the entrances to vessels and confined spaces
  - Above and below the openings on vessels and confined spaces
  - On the outside of the perimeter walls of the vessel or confined space
  - Within a horizontal safety distance which is to be determined
- Work involving open flames

4.6 Protective measures against hazards presented by biological substances in the sense of the German Ordinance on biological substances (BioStoffV)

4.6.1 In order for protection to be assured against biological hazards, vessels, silos and confined spaces must be emptied, cleaned and isolated as described in Sections 4.3.1 and 4.3.2 prior to the commencement of work.

Selection of appropriate work equipment is important in this context. A high-pressure cleaner for example may remove biofilms, but at the same time give rise to bioaerosols that may contain biological substances such as Legionella.

Refer also to Section 9 of the BioStoffV in this context.

4.6.2 Effective disinfection and inactivation methods for the vessels, silos and confined spaces must be specified in consideration of the potential hazards presented by biological substances.

A risk of infection for workers must be assumed when biological substances of Risk Group 2 or higher are present. Information on biological substances, the associated risk group and potential exposure, and on risk assessment, disinfection and preventive medical check-ups, can be obtained from the DGUV's online database of biological substances (GESTIS, www.dguv.de/ifa/gestis/gestis-stoffdatenbank/index-2.jsp).

Disinfection is the specific physical or chemical treatment of materials, objects or surfaces in order to eliminate any further risk of infection.

Effective agents and methods must be employed for disinfection measures. Details can be found in:

- *The list of disinfection agents and methods tested and recognized by the Robert Koch Institute (RKI) in accordance with Section 18 of the German Infection Protection Act (IfSG)*
- *The list issued by the Association for Applied Hygiene (VAH)*
- *The lists of suitable disinfection agents and methods issued by the disinfection agents committee of the German Veterinary Medical Society for the various areas of veterinary medicine*

4.6.3 Where tasks are performed that are not limited to contact with Risk Group 1 biological substances without sensitizing and toxic effects, more far-reaching protective measures must be taken as a function of the results of the risk assessment. Such measures particularly include:

1. Substitution of tasks and work methods, including cleaning methods, involving the generation of dust or aerosols with tasks and work methods involving lower or no dust or aerosol generation, where permitted by the state of the art; should substitution not be possible, suitable methods must be taken for reducing exposure to a minimum
2. Taking of the measures required for disinfection, inactivation or decontamination and for proper and safe disposal of biological substances, contaminated objects, materials and work equipment
3. Cleaning, maintenance, repair and proper disposal of the personal protective equipment made available, including protective clothing. Workers must use the personal protective equipment provided as long as a hazard exists
4. Taking of measures to ensure that personal protective equipment including protective clothing can be removed safely upon vacation of the workplace and stored separately from other items of clothing
5. Ensuring that workers do not eat, drink or smoke in working areas in which biological substances may be present; separate areas that cannot be accessed with personal protective equipment including protective clothing are to be set up for these purposes before work is begun

Refer in this context to Section 9 (3) of the German Ordinance on biological substances (BioStoffV).

Vaccinations form a part of preventive occupational medical care and are to be offered to workers exposed through their tasks to a higher risk of infection than that of the wider population.

Refer in this context to Section 6 (2) of the German Ordinance on occupational medical care (ArbMedVV).

4.7 Measures for protection against radiation

Before work is carried out in vessels, silos and confined spaces, sources of radiation must be removed, reliably screened, or deactivated and safeguarded against activation.

Examples of sources of radiation include X-ray equipment, radioactive preparations, laser equipment, sources of UV radiation, sources of microwaves, and equipment generating electromagnetic fields.

Special protective measures may be required for persons with active or passive implants (for example on transformer stations etc.).

Depending upon the nature of the radiation sources, options include their removal, adequate lead shielding, or reliable isolation from the power supply.

Refer here also to the German Ordinances on X-rays (RöV) and radiation protection (StrlSchV), the German OSH Ordinance on artificial optical radiation (OstrV), and DGUV Regulation 15 governing electromagnetic fields.

4.8 Protective measures against high and low temperatures

4.8.1 Prior to the performance of work in vessels, silos and confined spaces, heating, cooling and refrigeration equipment must be put out of operation and safeguarded against reactivation should the surface and room temperatures present a potential hazard to persons. Work may be begun in vessels and confined spaces only when potential hazards are no longer presented by excessively high or low temperatures.

During risk assessment, consideration must be given to the surface and room temperatures (refer also to DGUV Informative publication 215-510 governing assessment of the room climate).

4.8.2 Should, for operational reasons, derogation from the requirements of Section 4.8.1 be necessary, work may be performed in vessels, silos and confined spaces only when the persons concerned are protected by other means.

Other suitable means of protection include the use of personal protective equipment, or limitation of the time spent in the spaces concerned. Occupational medical experts are to be consulted for risk assessment.

4.9 Measures for protection against mechanical hazards

4.9.1 Work in vessels, silos and confined spaces may commence only once hazardous movements have been halted and unauthorized, erroneous or unanticipated restarting is reliably prevented. For this to be achieved, all drives of moving parts and machinery must be isolated reliably and continually from each individual source of energy and safeguarded against reconnection.

"Lock out tag out" (LOTO) systems have proved particularly effective for continued reliable isolation of the work equipment from the sources of energy.

4.9.2 In addition to the requirements of Section 4.9.1, the starting of movements presenting a hazard owing to stored energy must also be reliably prevented.

The starting of movements presenting a hazard owing to stored energy is reliably prevented for example when:

- *On pressure accumulators or other systems with a comparable pressure storage action, such as hydraulic and pneumatic drives, the energy transmission lines and the storage vessels are isolated*
- *Parts able to change their position are locked by means of stays, locking bars or similar locking arrangements*
- *Systems with potential or kinetic energy are lowered or braked to a standstill*

Multiple measures may have to be taken simultaneously in some cases.

Fig. 21
Safety pulley

4.9.3 Where a risk exists of insured individuals being injured by falling objects during work in vessels, silos and confined spaces, protective measures must be taken.

Hazards presented by falling objects may for example arise as a result of:
- *Work being performed on different levels*
- *The transport of materials, such as the raising or lowering of work equipment*
- *The use of unsuitable helmets not secured to the head*

Measures for protection against falling objects include:
- *Keeping persons clear of the area beneath loads*
- *Safety pulleys that prevent the rope from passing through the pulley (see Figure 21)*
- *Use of a load winch*
- *Use of safety nets*

4.9.4 Blasting and spraying work must be performed in such a way that persons do not place themselves or others in danger.

4.10 Measures for protection against electrical hazards

Owing to the characteristics of vessels, silos and confined spaces (in particular the access situation, materials used in their construction, and freedom of movement within them), an increased electrical hazard must generally be assumed (=> protective measures under circumstances of constrained freedom of movement in a conductive environment).

4.10.1 Operation of stationary electrical equipment

One of the following measures must be taken when stationary electrical equipment is used:

- Safety extra-low voltage (SELV). Only Class III equipment may be used; irrespective of its rated voltage, such equipment must feature ingress protection of at least IP2X, i.e. be isolated or shrouded to be fingerproof.
- Protective separation. Only one item of current-consuming equipment may be connected per secondary winding of an isolating transformer or motor generator (refer to DGUV Informative publication 203-032 concerning the selection and operation of power generators on construction and installation sites). The windings must be galvanically isolated from each other.
- Protection by automatic disconnection of the power supply. Where Class I items of equipment are used, their enclosures must be fitted with supplementary local potential equalization. Residual current devices with $I\Delta n \leq 30$ mA must be used for automatic disconnection.

4.10.2 Operation of mobile electrical equipment

One of the following measures must be taken when mobile electrical equipment is used:

- Safety extra-low voltage (SELV). Only Class III equipment may be used; irrespective of its rated voltage, such equipment must feature ingress protection of at least IP2X, i.e. be isolated or shrouded to be fingerproof.
- Protective separation. Only one item of current-consuming equipment may be connected per secondary winding of an isolating transformer or motor generator. The windings must be galvanically isolated from each other.
- Hand-held lamps may be operated only with safety extra-low voltage (SELV).

4.10.3 Mobile sources of electrical power must be situated outside the area presenting an increased electrical hazard.

Should this not be possible for technical reasons (e.g. in the case of very long pipelines, sewers, box girders, etc.), the electrical power source (i.e. the isolating transformer) may be situated on a case-by-case basis within the area presenting an elevated electrical hazard provided the supply line meets the following requirements:

- The manner of its routing protects it against damage, and it is of type H07RN-F or H07BQ-F
- It is operated through an RCD with $I\Delta n \leq 30$ mA

4.10.4 Mobile electrical equipment should ideally be of Class II only. Mobile isolating and safety transformers must satisfy Class II.

The provisions of this section do not apply to mobile items of equipment with their own electrical power source.

Examples of such equipment are cordless screwdrivers and battery-powered lamps.

If an increased electrical hazard can reliably be prevented from arising, measures in accordance with good practice on construction and installation sites (see DGUV Informative publication 203-006 governing the selection and operation of electrical installations and equipment on construction and installation sites) are sufficient in derogation from the provisions of Section 4.2.

The actual work situation, i.e. the tasks to be performed in consideration of the conditions of the working environment, must be taken into account by the assessment.

4.11 Measures for protection against falls from a height

4.11.1 Should a risk of falling be presented during work in vessels, silos and confined spaces, the employer must take suitable protective measures against it.

Owing to the particular hazards arising during work in vessels, silos and confined spaces, protective measures against falls from a height may be necessary even at low heights. Firstly, the risk of a fall may be exacerbated (for example by soiling of vertical ladders); secondly, the consequences of injury may be exacerbated by constrained facility of rescue.

Personal protective equipment against falls from a height must always be used where rope ladders are used.

Fig. 22 Rescue winch, being used in this case for protection against falling

Fig. 23 Retractable type fall arrester with rescue lifting device

4.11.2 Preference should be given to technical measures to prevent falls from a height. Examples of technical measures are guard rails, covers, silo access equipment, and rope access and work positioning systems.

4.11.3 Where the use of technical measures is not possible, e.g. due to space constraints, personal protective equipment against falls from a height must be used. The required anchor points and the personal protective equipment to be used must be specified by the chief supervisor.

The use of personal protective equipment against falls from a height is described in DGUV Rule 112-198.

4.12 Measures for protection against sinking or engulfment

4.12.1 Before the commencement of work it must be ensured that the vessel charging and discharging equipment is deactivated and safeguarded against inadvertent and unauthorized activation.

Fig. 24 Silo access equipment

Persons may not walk on bulk materials without safeguards unless hazards presented by a risk of sinking into the bulk material or by the discharge equipment can be ruled out.

4.12.2 Should a risk exist of insured persons sinking into the bulk materials when standing on them, the bulk materials must be safeguarded by one of the following methods:

- Use of a rigid work platform from which the work is performed
- Use of silo access equipment in accordance with DGUV Rule 101-005 governing suspended access equipment

The most reliable means of rescuing a person who has partly sunk into bulk material is by the use of silo access equipment. Personal protective equipment intended for rescue purposes is therefore wholly unsuitable for work on bulk materials: such equipment is neither designed for the forces arising, nor can it be used to free persons who have sunk into the bulk material.

The hazard of sinking into the bulk material exists for example:
- *Owing to the possible formation of a void above the discharge equipment (bridge formation)*
- *Owing to the properties of the bulk material*
- *Owing to the pull of the outflowing bulk material*

4.12.3 The use of personal protective equipment against falls from a height on bulk materials is prohibited. Refer also to Section 5.3.4.

For example, fall arresting devices and guided type fall arresters on a flexible anchor line lock only at certain drop speeds, which are not reached when the wearer sinks into bulk material.

4.12.4 Persons must keep clear of areas beneath clogging or adhering bulk material. Clogging or adhering bulk materials may be cleared only from above. Suitable tools or equipment must be made available and used for loosening and clearing clogging and adhering bulk material.

Suitable tools for the clearing of jams or for loosening clogging bulk material include rods, long-handled tools and lances. Suitable automated equipment includes vibrating and rodding equipment, whips, rotating chains scrapers, and equipment for forcing in compressed air.

4.12.5 The use of rope ladders during work on or above bulk material is not permissible. Free rope ends of equipment used above bulk material, for example parts of the personal protective equipment against falls from a height or equipment used for rope access and work positioning techniques, must not dip into the bulk material or be able to be caught by mechanical equipment (agitators, dischargers).

4.13 Measures for protection against health hazards arising from increased physical stresses

4.13.1 Work conducted in confined spaces constitutes high physical stress by definition. Additional stresses, arising for example from the use of personal protective equipment, difficulties of access, high or low temperatures or heavy transport work, should be avoided if possible.

The use of respiratory protection during work in vessels, silos and confined spaces should be the exception. It should be used only when the alternatives stated in Sections 4.3.1 to 4.3.3 to assure adequate quality of the breathing air, thereby making respiratory protective equipment unnecessary, have all been exhausted.

Wherever possible, the access points and where applicable the arrangements for descent into the vessels, silos and confined spaces should be such that the points at which work is to be performed can be reached without major physical exertion.

4.13.2 The possible physical stresses must be considered in the risk assessment.

Additional breaks should be allowed for if necessary.

4.14 Mental stresses

The performance of work in vessels, silos and confined spaces may give rise to mental stresses over and above the normal levels. Such stresses must be considered in the risk assessment.

In the checklist of aspects contained in the GDA guidance document on psychological issues, Point 4.3 covers the aspect of workplace and information design. Unfavourable working areas and confined spaces are explicitly stated as being in this category. Work in confined spaces in particular is to be regarded as a mental stress factor with an inherent risk of having negative effects. "Angst", the German word for fear, is linguistically related to "Enge", the German word for confinement or narrowness. Work performed in confined spaces is to be considered mentally stressful and addressed accordingly in the risk assessment, even if workers do not report consciously experiencing fear. The requirements are similar to those associated with other stressful forms of work. They begin with the selection of workers suited to such tasks; observance of the safety measures already stated is mandatory; the duration of work performed in confined spaces should be substantially limited. A number of suitable workers should be able to alternate at reasonably short intervals. Finally, the involvement of the affected persons in drawing up arrangements is important. The workers should be asked (for example in moderated workshops) which aspects of their work function well, which aspects are associated with problems or difficulties, and what measures they can suggest for addressing these difficulties. A proven procedure for moderated discussions of this kind can be found for example in DGUV Informative publication 206-007 concerning the organization of brainstorming meetings.

5 Access techniques

5.1 Access openings

5.1.1 Access openings for vessels, silos and confined spaces in which work is to be performed must be adequately dimensioned and arranged such that persons are able to enter and leave through them and to be rescued at any time. In the interests of swift and stress-free rescue, the access openings must be as large as permitted by the conditions of operation.

5.1.2 *The minimum dimensions of access openings are dependent upon factors including:*

- *The location of the access opening (top, bottom, side)*
- *Its accessibility*
- *The clearance above, in front of or below the opening*
- *The use of personal protective equipment, such as respiratory protection or PPE against falls from a height*
- *The rescue equipment used*
- *The use of access equipment (work platforms, suspended chairs, silo access equipment)*
- *The wall thickness or nozzle length*
- *The frequency with which work is performed*

Examples of suitable dimensions for access openings are shown in Annex 4.

Access openings to sewerage installations are governed by DGUV Regulation 21.

The dimensions recommended in Annex 4 should be observed during purchase even where standards make provision for lower opening widths.

5.1.3 Failure to observe the required minimum dimensions of the access openings leads to aggravated access and rescue conditions. Should the dimensions be smaller, the vessels or silos should be adapted to the recommended dimensions. Special rescue measures are otherwise required.

Examples of such measures are:
- *Provision of suitable rescue stretchers*
- *Provision of rescue slings*
- *Provision of equipment with which the vessel wall can be cut open quickly*
- *Selection of suitable persons for the work and for rescue (e.g. with body dimensions suitable for the narrow openings)*
- *Keeping of additional personnel on hand (a single safety person is not generally sufficient in such cases)*

5.1.4 Work may be performed in vessels, silos and confined spaces only when the access openings are designed such that rescue with the use of rescue equipment is not obstructed or rendered impossible. Suitable anchor points for the personal protective equipment must be provided at the access opening (see also Section 6.1).

Rescue is rendered more difficult for example by the presence of safety cages on fixed ladders. In order to facilitate rescue, fixed ladders in vessels, silos and confined spaces such as pits should not be fitted with safety cages. Personal protective equipment against falls from a height is to be used if necessary.

5.1.5 Sufficient clearance must be available at the access openings for anchoring of the rescue equipment and stress-free transport of persons requiring rescue.

Clearance is sufficient for example when the anchor points for rescue lifting devices are located at least 1.5 m above the access opening.

5.1.6 Access openings to vessels, silos and confined spaces must be kept clear during work, or it must be possible for them to be cleared immediately for rescue purposes.

5.1.7 Upon completion of the work, access openings must be safeguarded against unauthorized use.

Examples of measures for safeguarding against unauthorized use are:
- *Closing of the manhole cover*
- *Fitting of a safety crossbar*
- *Additional posting of the sign prohibiting access for unauthorized persons (refer to the ASR A 1.3 technical rules for workplaces governing safety and health signage, Sign P 006).*

5.2 Access techniques

5.2.1 Suitable access techniques must be selected for work in vessels, silos and confined spaces. Examples of such techniques are:
- Access without the use of equipment (e.g. access to a horizontal tank from the side)
- Access by means of ladders (permanently installed or mobile ladders)
- Access by means of suspended access equipment in accordance with DGUV Rule 101-005
- Access by means of a winch for the transport of persons and suitable full body harness
- Rope access and work positioning techniques in accordance with DGUV Informative publication 212-001

The access techniques selected are dependent upon:

- *The nature of the access openings (dimensions, location, accessibility)*
- *The possible means of rescue (obstruction by installed equipment)*
- *The design of the vessels, silos or confined spaces (height, depth, geometry)*

For a number of reasons, preference should be given to the use of suspended access equipment, full body harnesses, or rope access and work positioning systems (e.g. no risk of falling, ergonomics, fast rescue)

Where a full body harness and a lifting device are used for access, careful consideration should be given to the advantages and disadvantages of use of a second rope. At greater lifting heights, the drawbacks may in fact be greater (risk of entwining).

Fig. 25
Access technique involving full body harness and rescue winch

5.2.2 The access techniques selected must permit both safe access and swift rescue.

Ladders for example may make rescue difficult, since in many cases they reduce the clear cross-section of the access opening, and also obstruct rescue by means of rescue lifting devices. Preference should be given in such cases to access techniques involving suspended access equipment or a lifting device.

5.2.3 A person may be transported into a vessel, silo or confined space with a full body harness only if it is ensured that the duration of the upward lifting process does not exceed 5 minutes.

The duration of the lifting process is dependent upon:
- *The height of the vessel, silo or confined space*
- *The lifting device used*
- *The number of assistants*

If the duration of five minutes is exceeded, suitable access equipment should be used.

Examples of suitable access equipment are suspended access equipment such as:
- *Silo access equipment*
- *Work seats*
- *Working platforms*

5.3 Work positioning techniques

5.3.1 Only suitable work positioning techniques may be used for work positioning in vessels, silos or confined spaces. Preference should be given to silo access equipment for work positioning in silos.

5.3.2 Rope access and work positioning systems may be used only by persons who are at least 18 years of age, are trained as first aiders, are physically fit and suitably skilled, and have demonstrated their relevant skills by passing an examination (for details, see TRBS 2121 Teil 3 and DGUV Informative publication 212-001 governing work with the use of rope access and work positioning systems).

5.3.3 It must be ensured that free rope ends are not able to dip into the bulk material or be caught by mechanical equipment (agitators, dischargers).

5.3.4 Only silo access equipment may be used for work positioning on bulk materials; see also Section 4.12.

The operation of silo access equipment is governed by DGUV Rule 101-005.

5.3.5 Persons may leave the access equipment for the performance of operational tasks in silos only if a hazard presented by the bulk material is ruled out and permission has been granted by the chief supervisor.

6 Emergency and rescue measures

6.1 Measures for rescue from vessels, silos and confined spaces

6.1.1 The employer must keep suitable rescue and transport equipment ready for rescue from vessels, silos and confined spaces.

The employer whose personnel are working in the vessel, silo or confined space is responsible for rescue. In many cases, personnel and equipment for rescue are made available by the operator of the vessel, silo or confined space.

Where personnel from multiple companies work simultaneously or at staggered intervals in a vessel, silo or confined space, the parties responsible must coordinate and document (for example on the permit) who is to perform rescue should it be necessary.

Refer also to Section 25 of DGUV Regulation 1, "Principles of prevention" and DGUV Informative publication 213-055 governing rescue from vessels, silos and confined spaces.

Section 11 (2) 2 of the German Ordinance on industrial safety and health (BetrSichV) requires the necessary anchoring facilities for rescue equipment to be provided on and in work equipment.

Since rescue must usually be performed swiftly, the equipment must be kept ready at all times where it will be needed. Maintaining rescue equipment ready at a central point in the company, for example at the works fire service, is advantageous only when effects of hazardous substances or an oxygen deficit during work in the vessels, silos and confined spaces can be ruled out.

Rescue personnel may enter vessels, silos or confined spaces without breathing apparatus only if it is ensured that hazardous concentrations of hazardous substances or an oxygen deficit are not present.

The use of rescue equipment is subject to DGUV Rule 112-199 governing rescue from above and below.

The following equipment may be suitable for rescue in a horizontal direction:

- *Rescue basket*

> **!** **Should a risk of falling exist, personal protective equipment against falls from a height must be used in addition, or equipment must be used that combines protection against falls from a height with the rescue function (such as fall arresting devices with rescue lift function, see Section 4.10).**

Where the personal protective equipment is used for rescue, the person to be rescued is drawn out of the vessel, silo or confined space by means of a rescue harness.

Fig. 26
Access from the side by means of a special fixture on the rescue lifting device

Swift rescue is generally assured only if this person has already donned the rescue harness before the commencement of work. Should pressing reasons exist for the worker not to don the rescue harness before entering the vessel, silo or confined space, other measures must be planned that permit swift rescue. Possible measures in this context are:

- *Provision of suitable respiratory protection equipment by means of which rescue crews are able to reach and rescue the insured persons in distress without delay*
- *Provision of equipment that enables the interior of the vessel to be accessed quickly, such as equipment for cutting open the vessel wall*

Work in vessels, silos and confined spaces without a permanent connection between the rescue equipment and the rescue harness should be the exception. Pressing reasons for the harness not to be connected permanently to the rescue equipment include:

- *The performance of work simultaneously by several persons in the vessel, silo or confined space (which may quickly lead to mutual obstruction when several ropes are used)*
- *Equipment installed within the vessels, silos or confined spaces that may entrap the rope*
- *The circumstances in the case at hand, for example frequent changes of direction*

6.1.2 The parties involved, particularly the safety persons, must be instructed in the use of the rescue equipment. The measures required for rescue of persons in distress must be drilled in a practical manner at regular intervals and at least once a year.

6.1.3 Complex situations require the production of a written rescue plan.

6.1.4 Where the rescue plan provides for the involvement of rescue personnel from outside the plant in rescue measures, these personnel must take part in the drills referred to in Section 6.1.2.

6.2 Fire extinguishing equipment

6.2.1 Should a risk of fire exist, suitable fire extinguishing equipment must be made available on an appropriate scale and where it is easily accessible during work in vessels, silos and confined spaces.

6.2.2 The employer must familiarize an adequate number of persons, particularly the safety persons, with use of the fire extinguishing equipment for combating incipient fires. Familiarization is to take the form of instruction and drills.

6.2.3 Depending upon the substances to be extinguished, foam extinguishers or water are suitable for the extinguishing of fires in vessels, silos and confined spaces.

CO_2 and powder extinguishing agents are not suitable for work in vessels, silos and confined spaces.

Fig. 27
Rescue by means of a fall arresting device with rescue lift function

Fig. 28
Rescue sling (particularly suitable for fast rescue, for example where the person to be rescued is not wearing a full body harness, and risk to life is presented by an oxygen deficit or hazardous substances)

7 Special protective measures

7.1 Compressed gas cylinders

7.1.1 Compressed gas cylinders must not be taken into vessels, silos and confined spaces.

7.1.2 Section 7.1.1 does not apply to the use of fire extinguishers or compressed gas cylinders for respiratory protective devices.

Where long supply lines may present increased hazards, compressed gas cylinders may be taken into the vessel, silo or confined space provided additional protective measures are taken.

Welding work in vessels, silos and confined spaces is subject to Chapter 2.26 (concerning welding, cutting and related methods) of DGUV Rule 100-500 governing the operation of work equipment, particularly Section 3.7.

Supply lines are generally considered long when the dimensions of vessels, silos and confined spaces, such as tunnels, drifts or sewers, require supply line lengths in excess of 100 m. Increased hazards may arise for example during transport work around the hoses.

Supplementary safety measures can be found in DGUV Regulation 79 governing the use of liquefied petroleum gas.

7.2 Fire extinguishing and explosion suppression systems

Fire extinguishing and explosion suppression systems must be deactivated and safeguarded against inadvertent or unauthorized activation before the commencement of work in vessels, silos and confined spaces.

Annex 1

Model permit

Note: *This model permit can be expanded or abridged according to the conditions and hazards arising on the site.*

Company

.....

Vessel/confined space .....
Planned work .....
Chief supervisor .....
Safety person .....

Measures against hazards arising as a result of the planned work methods must be agreed between the chief supervisor and the company/department carrying out the work (for example for surface treatment or welding work).

1 **Preparatory measures**
1.1 Information for other companies ☐ No ☐ Yes.....
1.2 Vessel contained/contains.....
1.3 Empty the vessel ☐ No ☐ Yes.....
1.4 Purge/clean vessel ☐ No ☐ Yes.....
1.5 Isolate vessel ☐ No ☐ Yes.....
By removal of ..... adaptors
By fitting of ..... blind flanges
By other measures.....
1.6 Ventilate vessel ☐ No ☐ Yes.....
Ventilation arrangement.....
1.7 Clearance measurement ☐ No ☐ Yes
Type of instrument .....
Substances to be measured ..... and oxygen; result.....
1.8 Disinfect/sterilize vessel ☐ No ☐ Yes.....
1.9 Vaccinate personnel ☐ No ☐ Yes.....
1.10 Remove/screen source of radiation ☐ No ☐ Yes.....
1.11 Provisions concerning electromagnetic fields ☐ No ☐ Yes .....

1.12 Deactivate heating/cooling installations ☐ No ☐ Yes by:
- Electrical safeguarding measures ☐ No ☐ Yes
  Remove fuses, electrician's signature: .....
- Disconnect pipes ☐ No ☐ Yes .....

1.13 Secure mechanical drives ☐ No ☐ Yes by: .....
- Remove fuses ☐ No ☐ Yes Electrician's signature .....
- Secure repair switch ☐ No ☐ Yes Signature .....

1.14 Secure system against unintended movements ☐ No ☐ Yes .....

1.15 Secure stationary electrical equipment ☐ No ☐ Yes
Electrician's signature .....

1.16 Check working environment
Means of access .....
Risk of falls from a height on the vessel .....

1.17 Measures against falls from a height ☐ No ☐ Yes
- Specify anchor devices .....
- Specify fall arrest system .....

1.18 Specify measures against sinking/engulfment ☐ No ☐ Yes
- Silo access equipment ☐ No ☐ Yes Type .....
- Other suitable access techniques ☐ No ☐ Yes .....

1.19 Select access technique .....

1.20 Specify measures for rescue ☐ No ☐ Yes
- Specify anchor devices .....
- Specify rescue system .....

1.21 Fire precautions ☐ No ☐ Yes .....

1.22 Welding work ☐ No ☐ Yes .....
If yes, produce a separate welding permit.

1.23 Other measures ☐ No ☐ Yes

2 Measures prior to commencement of work

2.1 Checking by the chief supervisor of the measures specified in Section 1 .....

2.2 Instruction of the safety person and if applicable of the delegate of the company/trade involved .....

2.3 Visual and functional test of the PPE and the work equipment
PPE against falls from a height ☐ No ☐ Yes
Respiratory protection ☐ No ☐ Yes
Air supply ☐ No ☐ Yes (cylinders, fan)
Rescue equipment ☐ No ☐ Yes
PPE against low temperatures ☐ No ☐ Yes .....
Chemical protective suit/gloves ☐ No ☐ Yes .....
Mobile electrical equipment ☐ No ☐ Yes .....
Ventilation ☐ No ☐ Yes .....
Other equipment ☐ No ☐ Yes .....

3 Measures during work

3.1 Continually monitor air quality ☐ No ☐ Yes
Equipment .....

3.2 Perform ventilation measures in accordance with Section 1 ☐ No ☐ Yes
Ventilation arrangement .....

3.3 Use PPE against hazardous substances ☐ No ☐ Yes
Respiratory protection ☐ No ☐ Yes System .....
Protective gloves ☐ No ☐ Yes Type .....
Chemical suits ☐ No ☐ Yes Type .....
Other measures .....

3.4 Measures against excess oxygen ☐ No ☐ Yes
.....

3.5 Measures for protection against explosion ☐ No ☐ Yes
Use of a portable gas detector ☐ No ☐ Yes
Avoidance of sources of ignition ☐ No ☐ Yes .....
Equipment/lighting to be used, Category 1 ☐ 2 ☐ 3 ☐
IP 54 Vapours/mists (G) Dusts (D)

☐ Temperature class: ..... Explosion class: .....
Measures against electrostatic charge as a source of ignition:

.....

Specify and mark safety clearances ☐ No ☐ Yes

.....

Additional measures during coating work: ☐ No ☐ Yes

.....

Material properties
Lowest ignition point/LEL ..... °C
Flammable ☐ No ☐ Yes
Highest room temperature during work..... °C
Quantity consumed:..... l/h
Of which..... litres of solvent, equal to..... kg/h
Existing ventilation adequate ☐ No ☐ Yes
Supply fan: ..... each with a delivery of..... m³/h
Air-conditioning equipment: ..... each with a delivery of..... m³/h
Exhaust fan: ..... each with a delivery of..... m³/h

3.6 Particular hygiene measures ☐ No ☐ Yes .....

.....

3.7 Safeguard sources of radiation ☐ No ☐ Yes .....

.....

3.8 Provisions concerning electromagnetic fields ☐ No ☐ Yes .....

.....

3.9 Provisions concerning excessively high or low temperatures ☐ No ☐ Yes

.....

3.10 Provisions concerning material transport ☐ No ☐ Yes

.....

3.11 Provisions concerning the use of electrical equipment ☐ No ☐ Yes

.....

In rooms with limited freedom of movement, use of the following safety systems ☐ No ☐ Yes .....

.....

In other rooms, use of the following safety systems ☐ No ☐ Yes

.....

3.12 Use of the silo access equipment or other measures to prevent sinking in/ engulfment by the bulk material ☐ No ☐ Yes

.....

3.13 Provisions concerning PPE for rescue specified in Section 1: ☐ No ☐ Yes
Permanent connection between harness and rescue lifting device ☐ No ☐ Yes

.....

If no: equivalent measures .....

.....

3.14 Other measures ☐ No ☐ Yes

.....

4 Authorization

All measures performed, authorization issued for work
Date: ..... Time: .....

.....

Signature of chief supervisor

Specified measures read and understood
Date: ..... Time: .....

.....

Signature of safety person

.....

Signature of employer/delegate of companies/trades involved

Extension of authorization

Extension granted until	**Repeat clearance measurement** after…….hours	**Result**	**Signature** Safety person	**Signature** Companies/ trades involved

Relief of the safety back-up person

Handover Safety person	**Date/time**	**Relief of the safety person**	**Remarks**

Termination of work/suspension of approval

All measures suspended, work ended
Date: ..... Time: .....

..... Signature of chief supervisor

..... Signature of safety person

Information on the model permit

This model permit is intended to support the companies in producing an access permit for the specific hazards and conditions arising in the company. It covers all hazards conceivably arising during work in vessels, silos and confined spaces. Consideration is also given to the sequence of the protective measures.

Section 1, "Preparatory measures", lists the measures that require greater preparation and must be taken in advance of the work proper.

These include selection of the personal protective equipment (PPE) for rescue and PPE against falls from a height, since these generally require preparatory work (creation of the anchor points, assembly of equipment).

In Section 2, "Measures prior to commencement of work", the protective measures specified in Section 1 of the permit are checked. The equipment that is to be subjected to a visual and functional inspection, such as welding equipment, electrical equipment and the PPE, is also listed.

Section 3, "Measures during work", sets out all the measures that must be taken in the course of the work rather than being regarded as preparatory work. Examples are the use of certain items of personal protective equipment (e.g. gloves, respiratory protective devices) and the performance of certain explosion protection measures (such as the use of equipment with suitable explosion protection) and ventilation measures. This section also sets out all measures intended to provide protection against hazards caused by the work itself (e.g. particular ventilation measures during coating work).

The model permit can be downloaded as an editable MS Word document (in German) in the download centre of the German Social Accident Insurance Institution for the raw materials and chemical industry (BG RCI)(http://downloadcenter.bgrci.de/resource/downloadcenter/downloads/BGR117-1_Annex1.2011-11-17.doc). This enables it to be adapted easily to the operational conditions in particular cases.

Annex 2

Model operating procedure for access (pit containing substances harmful to health)

Operating procedure
for regularly repeated accessing of the vessel:
Styrene pump pit, centre

Work to be performed

Checking of the pumps

Possible hazards

- Oxygen deficit
- Harm to health caused by styrene (owing to leaking pumps or pipes)
- Injuries caused by impact against pipes/tanks

Protective measures

- Before the pit is accessed, report to the control centre, agree a report-back time
- Carry a multi-substance detector providing warnings against oxygen deficit and styrene
- Should the detector trigger an alarm, leave the pit immediately
- Keep access points clear
- If the report-back time elapses without contact, have the pit checked via the control centre

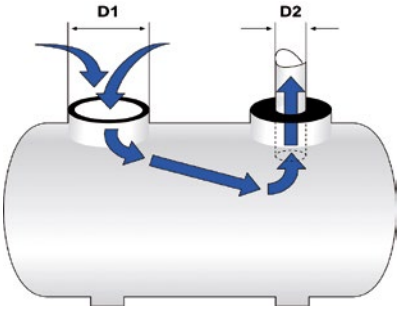
Application

This operating procedure applies only to brief access to the pit for the purpose of checks. For work in the pit, an access permit must be issued.

Date, Signature: .....

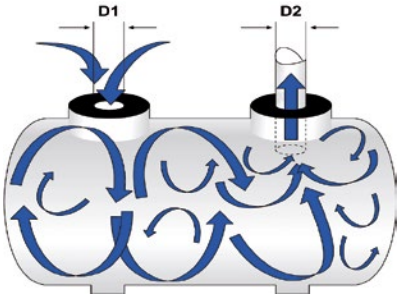
Annex 3

Information on ventilation arrangements

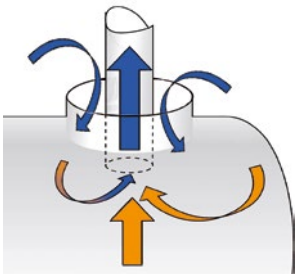


Engineered air exhaust

In vessels with several openings, the diameter of the fresh air vent must be equal to that of the exhaust vent. If the fresh air vent is larger, a virtually laminar airflow with relatively low flow velocity arises which fails to reach the peripheral areas of the vessel.

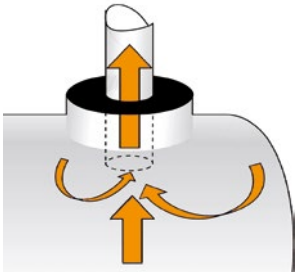


If the inlet and exhaust vent diameters are the same, the air ingress velocity is greater and is combined with a turbulent airflow that also reaches the peripheral areas of the vessel.



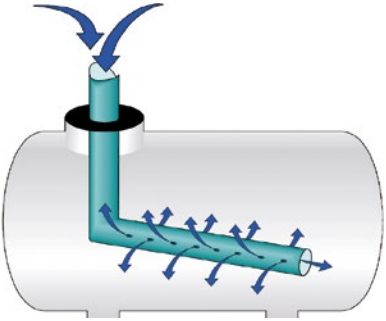
The suction hose also draws fresh air.

On tanks with two or more openings, the clear cross-section around the suction hose should be covered, for example with a tarpaulin, sack, etc. This measure, which is easy to implement, prevents fresh air from also being drawn in. The air contaminated with hazardous substances will then be replaced by the fresh air flowing in. This substantially improves the air discharge rate.



The cover prevents fresh air from being drawn.

Covering the opening as described also ensures that persons are able to exit the tank swiftly in the event of an emergency, particularly since the hose and the cover can easily be pushed away or to the side from inside the tank.

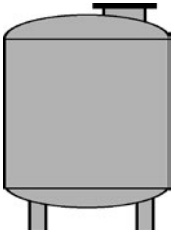


Engineered air supply

When fresh air is forced in, it has been found effective to provide small holes in the air hose over the entire length of the hose within the vessel.

Annex 4

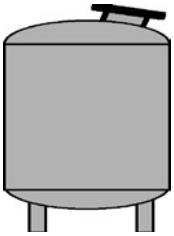
Recommended minimum dimensions for vessel openings



1. Access from above

Examples: tanks (vertical, horizontal), reactors

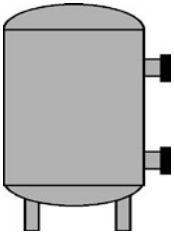
Access with PPE against falls from a height/ rescue equipment:
Manhole diameter: 600 mm; 500 mm if the nozzle length does not exceed 250 mm
Access with respiratory protection in addition:
Manhole diameter: 800 mm
Access by means of a mobile ladder:
Manhole diameter: 800 mm



2. Access from above through inclined manhole

Examples: tanks (vertical, horizontal), reactors

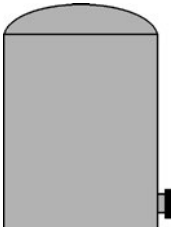
Access with PPE against falls from a height/ PPE for rescue purposes:
Manhole diameter: 800 mm; 600 mm when the nozzle length does not exceed 250 mm



3. Access through manholes from the side (potential risk of falling)

Examples: distillation columns, silos

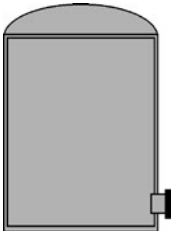
Access with PPE against falls from a height/ PPE for rescue purposes:
Manhole diameter: 600 mm
Access with respiratory protection in addition:
Manhole diameter: 800 mm



4. Access from the side, ground level

Examples: tanks, water basins

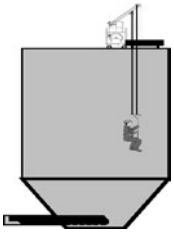
Normal access:
Manhole diameter: 600 mm; 500 mm when the nozzle length does not exceed 250 mm
Rectangular openings:
At least 0.25 m², minimum length of the shortest side: 500 mm
With breathing protection in addition:
Manhole diameter: 800 mm
Rectangular openings:
At least 0.4 m², minimum length of the shortest side: 600 mm



5. Access from the side, ground level

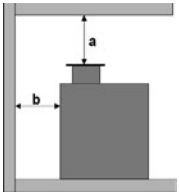
Examples: double-walled vessels, concrete water basins

Double-walled vessels/vessels with wall thicknesses > 500 mm:
Manhole diameter: 800 mm
Rectangular openings:
At least 0.4 m², minimum length of the shortest side: 600 mm



6. Silos

Openings for access with the use of silo access equipment:
Manhole diameter: 800 mm
Rectangular openings:
At least 0.4 m²; minimum length of the shortest side: 600 mm (dimensions are also determined by the silo access equipment to be used)



7. Tank welded in situ

Manhole diameter: 500 mm;
a min. 600 mm;
Manhole diameter: 600 mm,
a min. 500 mm
b in both cases min. 400 mm

Annex 5

Oxygen-depleting cargoes and materials

(excerpt from the Resolution A.1050(27) of the International Maritime Organisation, "Revised recommendations for entering enclosed spaces aboard ships")

"A prominent risk with such cargoes is oxygen depletion due to the inherent form of the cargo, for example, self-heating, oxidation of metals and ores or decomposition of vegetable oils, fish oils, animal fats, grain and other organic materials or their residues. The materials listed below are known to be capable of causing oxygen depletion. However, the list is not exhaustive. Oxygen depletion may also be caused by other materials of vegetable or animal origin, by flammable or spontaneously combustible materials and by materials with a high metal content, including, but not limited to:

1. grain, grain products and residues from grain processing (such as bran, crushed grain, crushed malt or meal), hops, malt husks and spent malt;
2. oilseeds as well as products and residues from oilseeds (such as seed expellers, seed cake, oil cake and meal);
3. copra;
4. wood in such forms as packaged timber, round wood, logs, pulpwood, props (pit props and other propwood), woodchips, woodshavings, wood pellets and sawdust;
5. jute, hemp, flax, sisal, kapok, cotton and other vegetable fibres (such as esparto grass/Spanish grass, hay, straw, bhusa), empty bags, cotton waste, animal fibres, animal and vegetable fabric, wool waste and rags;
6. fish, fishmeal and fishscrap;
7. guano;
8. sulphidic ores and ore concentrates;
9. charcoal, coal, lignite and coal products;
10. direct reduced iron (DRI);
11. dry ice;
12. metal wastes and chips, iron swarf, steel and other turnings, borings, drillings, shavings, filings and cuttings; and
13. scrap metal."

Annex 6

Bibliography

The relevant regulations, rules and informative documents that in particular must be observed are listed below.

1 Acts, ordinances, technical rules

Sources:
Book trade and Internet, e.g. www.gesetze-im-internet.de and www.baua.de

- Occupational Safety and Health Act (ArbSchG)
- Prevention Against Infection Act (InfSchuG)
- Ordinance on industrial safety and health (BetrSichV) with supporting technical rules for industrial safety (TRBS)
- TRBS 2121 "Gefährdung von Personen durch Absturz" (technical rules governing hazards to persons caused by falls from a height)
- TRBS 2121 Teil 3 "Gefährdung von Personen durch Absturz – Bereitstellung und Benutzung von Zugangs- und Positionierungsverfahren unter Zuhilfenahme von Seilen" (technical rules governing hazards to persons caused by falls from a height: provision and use of rope access and work positioning systems)
- Ordinance on hazardous substances (GefStoffV) with supporting technical rules on hazardous substances (TRGS)
- TRGS 507 "Oberflächenbehandlungen in Räumen und Behältern" (technical rules governing surface treatments in indoor areas and vessels)
- TRGS 727 "Vermeidung von Zündgefahren infolge elektrostatischer Aufladungen" (technical rules governing the avoidance of ignition hazards caused by electrostatic charging)
- Ordinance on biological substances (BioStoffV) with supporting technical rules for biological substances (TRGS)
- Ordinance on workplaces (ArbStättV) with supporting technical rules for workplaces (ASR)
- ASR A1.3 "Sicherheits- und Gesundheitsschutzkennzeichnung" (technical rules governing safety and health marking)

- OSH Ordinance on artificial optical radiation (OstrV) with supporting technical rules governing artificial optical radiation (TROS)
- Ordinance on radiation protection (StrSchV)
- Ordinance on X-rays (RöV)
- Ordinance on preventive occupational medical care (ArbMedVV)

2 Rules, regulations and informative documents concerning occupational safety and health

Sources:
Available from your accident insurance institution and at www.dguv.de/publikationen

Accident prevention regulations

- DGUV Vorschrift 1, “Principles of prevention”
- DGUV Vorschrift 11 “Laserstrahlung” (DGUV Regulation governing laser radiation)
- DGUV Vorschrift 15 “Elektromagnetische Felder” (DGUV Regulation governing electromagnetic fields)
- DGUV Vorschrift 21 “Abwassertechnische Anlagen” (DGUV Regulation governing sewerage installations)
- DGUV Vorschrift 38 “Bauarbeiten” (DGUV Regulation governing construction work)
- DGUV Vorschrift 45 “Schiffbau” (DGUV Regulation governing shipbuilding)
- DGUV Vorschrift 79 “Verwendung von Flüssiggas” (DGUV Regulation governing the use of liquefied petroleum gas)

DGUV Rules

- DGUV Regel 100-500 und 100-501 „Betreiben von Arbeitsmitteln“ (DGUV Rules governing the operation of work equipment)

- DGUV Regel 101-005 „Hochziehbare Personenaufnahmemittel“ (DGUV Rule governing suspended access equipment)
- DGUV Regel 103-002 „Fernwärmeverteilungsanlagen“ (DGUV Rule governing district heating distribution systems)
- DGUV Regel 109-009 „Fahrzeug-Instandhaltung“ (DGUV Rule governing vehicle maintenance)
- DGUV Regel 112-139 „Einsatz von Personen-Notsignal-Anlagen“ (DGUV Rule governing the use of personal distress alarm systems)
- DGUV Regel 112-190 „Benutzung von Atemschutzgeräten“ (DGUV Rule governing the use of respiratory protective equipment)
- DGUV Regel 112-198 „Benutzung von persönlichen Schutzausrüstungen gegen Absturz“ (DGUV Rule governing the use of personal protective equipment against falls from a height)
- DGUV Regel 112-199 „Retten aus Höhen und Tiefen mit persönlichen Absturzschutzausrüstungen“ (DGUV Rule governing rescue from above and below involving personal protective equipment against falls from a height)
- DGUV Regel 113-001 „Explosionsschutz-Regeln (Ex-RL)“ (DGUV Rule governing explosion protection)

DGUV Informative publications

- DGUV Information 201-055 „Feuerfest-, Turm- und Schornsteinbau“ (DGUV Informative publication governing work on fireproof structures, towers and chimneys)
- DGUV Information 203-004 „Einsatz von elektrischen Betriebsmitteln bei erhöhter elektrischer Gefährdung“ (DGUV Informative publication governing the use of electrical equipment with an elevated electrical hazard)
- DGUV Information 206-007 „So geht’s mit Ideen-Treffen“ (DGUV Informative publication concerning brainstorming meetings)
- DGUV Information 209-045 „Absauganlagen und Silos für Holzstaub und -späne“ (DGUV Informative publication governing exhaust systems and silos for wood dust and chips)

- DGUV Information 212-139 „Notrufmöglichkeiten für allein arbeitende Personen“ (DGUV Informative publication governing distress call arrangements for persons working alone)
- DGUV Information 213-002 „Hitzearbeit“ (DGUV Informative publication governing work in hot environments)
- DGUV Information 213-055 „Retten aus Behältern, Silos und engen Räumen“ (DGUV Informative publication governing rescue from vessels, silos and confined spaces)
- DGUV Information 215-510 „Beurteilung des Raumklimas“ (DGUV Informative publication governing evaluation of the room climate)

DGUV Principles

- DGUV Grundsatz 312-001 „Anforderungen an Ausbildende und Ausbildungsstätten zur Durchführung von Unterweisungen mit praktischen Übungen bei Benutzung von persönlichen Schutzausrüstungen gegen Absturz und Rettungsausrüstungen“ (DGUV Principle governing the requirements to be met by trainers and training establishments for the provision of instruction involving practical exercises in the use of personal protective equipment against falls from a height and rescue equipment)
- DGUV Grundsatz 313-002 „Auswahl, Ausbildung und Beauftragung von Fachkundigen zum Freimessen nach DGUV Regel 113-004“ (DGUV Principle governing the selection, training and appointment of experts for clearance measurements in accordance with DGUV Rule 113-004 Part 1)

3 Standards/VDE specifications

Sources:
Beuth-Verlag GmbH, Burggrafenstrasse 6, 10787 Berlin, Germany
VDE-Verlag, Bismarckstrasse 33, 10625 Berlin, Germany

- DIN 4420-1:2004-03 Service and working scaffolds, Part 1: Service scaffolds – Performance requirements, general design, structural design
- DIN 33403-2:2000-08 Climate at the workplace and in its environments, Part 2: Effect of the climate on the heat balance of human beings
- DIN 33403-3:2011-07 Climate at the workplace and its environments, Part 3: Assessment of the climate in the warm and hot working areas based on selected climate indices
- EN 50110-1:2013-03 Operation of electrical installations – Part 1: General requirements
- DIN 4124:2012-01 Excavations and trenches; Slopes, planking and strutting breadths of working spaces
- EN 617:2010-12 Continuous handling equipment and systems; Safety and EMC requirements for the equipment for the storage of bulk materials in silos, bunkers, bins and hoppers
- EN 547:2008-09 Safety of machinery; Human body measurements

Illustrations

Illustrations for this DGUV Rule were kindly provided by:

Figures 1, 14, 15, 18:
Jedermann-Verlag, Mittelgewannweg 15, 69123 Heidelberg, Germany

Figure 5:
BG BAU, An der Festeburg 27–29, 60389 Frankfurt, Germany

Figures 4, 7:
BGHM, Seligmannallee 4, 30173 Hannover, Germany

Figure 21:
BORNACK GmbH & Co. KG, Bustadt 39, 74360 Ilsfeld, Germany

Figures 23 and 27:
Stadtwerke Münster, Hafenplatz 1, 48155 Münster, Germany

Figure 28:
Expert committee Personal protective equipment, Sub-committee Personal protective equipment against falls from a height, Zwengenberger Strasse 68, 42781 Haan, Germany

All other illustrations were taken from documents of the BG RCI.

Notes

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