

1 Scope of application

These Guidelines shall apply to laboratories in which preparation, analysis or applications engineering work is performed according to chemical, physical or physicochemical methods.

These Guidelines pertain only to protective measures for generally known tasks in laboratories and the attendant hazards. For tasks which can lead to a particular hazard the proprietor must take additional protective steps and give the relevant instructions; see Chapter 5 and Merkblatt M 006 "Besondere Schutzmaßnahmen in Laboratorien".

Laboratories are workrooms in which specialists or instructed persons conduct experiments for the research or application of scientific processes. They include e.g. chemical, physical, medical, microbiological and genetic engineering laboratories.

See also the Merkblatt "Sichere Biotechnologie; Laboratorien - Ausstattung und organisatorische Maßnahmen" (BGI 629 formerly ZH 1/342).

These Guidelines supplement the relevant accident prevention regulations (Unfallverhütungsvorschriften) in particular UVV "Allgemeine Vorschriften" (GUV-V A1, formerly GUV 0.1), UVV "Biotechnologie" (BGV B12 formerly VBG 102), UVV "Gesundheitsdienst" (GUV-V C8 formerly GUV 8.1) and UVV "Umgang mit Gefahrstoffen" (BGV B1 formerly VBG 91).

Furthermore, the relevant legal norms, e.g. the Gefahrstoffverordnung, the Arbeitsstättenverordnung, the Gentechnik-Sicherheitsverordnung, ordinances concerning waste and the Strahlenschutzverordnung are to be observed. Annex 2 contains a list of the relevant legal norms and rules of engineering.

See also GUV-Regel "Umgang mit Gefahrstoffen im Unterricht" (GUV-SR 2003, formerly GUV 19.16) and "Umgang mit Gefahrstoffen im Hochschulbereich" (GUV – SR 2005, formerly GUV 19.17).

Attention is drawn to the employment prohibitions laid down in Art. 22 Jugendarbeitsschutzgesetz, Arts. 3, 4 and 6 para. 3 of the Mutterschutzgesetz and the Gefahrstoffverordnung as well as the relevant accident prevention regulations.

Hazard markings e.g. toxic, inflammable, corrosive are to be used as laid down in Annex I no. 1.1 of the Gefahrstoffverordnung.

2 General requirements

2.1

Laboratories must be designed and operated according to the provisions of these Guidelines and also the generally recognized rules of engineering. Deviations from the generally recognized rules of engineering are permissible if the same degree of safety is ensured by other means.

Generally recognized rules of engineering are e.g. the Technische Regeln für Gefahrstoffe (TRGS), DIN standards and VDE regulations listed in Annex 2 and in the versions as amended.

2.2

The technical solutions contained in these Guidelines do not exclude other solutions which are at least as safe which may also be embodied in the rules of engineering technical of other Member States of the European Union or other states party to the Agreement on the European Economic Area.

2.3

Test reports from test laboratories licensed in other Member States of the European Union or other states party to the Agreement on the European Economic Area are to be regarded in the same way as German test reports if the tests, testing methods and design requirements on which the test reports of the laboratories are based are equivalent to those of the German laboratory. Such laboratories are especially those that fulfil the requirements laid down in the standards series DIN EN 45 000.

3 Building and equipment

3.1 Structural installations

3.1.1 Operating and communication areas

Operating and communication areas must be of adequate dimensions. The minimum width at all places in the laboratory may not be less than 1 m.

DIN 12 926-1 "Laboreinrichtungen; Labortische, Labortische für allgemeinen Gebrauch, Außenmaße, Platzbedarf, Anforderungen und Prüfungen" gives the following as minimum dimensions: for the operating area, i.e. the width of the workplace, e.g. in front of the laboratory bench or fume cupboard, 450 mm and for the communication area, i.e. the width of the communication way e.g. between the operating areas, 550 mm. These are minimum dimensions.

The communication area is to be widened, if e.g.

- the space between two work areas is used not only for the movement of the people working there but also as a communication path for other persons,
- special work conditions exist, e.g. in case of increased fire or explosion hazard,
- in the case of work areas longer than 6 m,
- more than four persons work between the operating areas

or

- if there are two fume cupboards opposite one another.

The operating area is to be widened accordingly if it is restricted e.g. by stools, pull-out writing surfaces, equipment trolleys or substructures on a permanent basis. The operating area must be provided only once if, according to instructions, only one person works between two facing workbenches.

3.1.2 Rescue routes and emergency exits

Taking into account the local conditions, the materials used and the work methods, laboratories must be equipped with an adequate number of rescue routes and exits. Rescue routes (emergency exits) may only lead through an adjacent room if this room can also be abandoned safely without outside help during operation in the event of a hazard.

See Arts. 10 and 19 Arbeitsstättenverordnung and Art. 28 para. 1 and Art. 30 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1)

3.1.3 Doors

Doors of laboratories must open outwards and, for reasons of personal protection, they must be equipped with a window.

See Art. 10 para. 1 and para. 5 of the Arbeitsstättenverordnung with the relevant Arbeitsstätten-Richtlinien ASR 10/1 "Türen, Tore", ASR 10/5 "Glastüren, Türen mit Glaseinsatz" and Art. 28 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1).

The necessary walking width of passing communication ways may not be restricted by open doors.

The window should allow unimpaired vision from the inside to the outside and vice-versa.

3.1.4 Floors

Floors or their coverings and conduits passing through them must be watertight.

See Arbeitsstätten-Richtlinie ASR 8/1 "Fußböden" and Art. 20 para. 1 UVV "Allgemeine Vorschriften" (BGV A1 formerly GUV 0.1) .

3.1.5 Ventilation

3.1.5.1

Laboratories must be equipped with adequate technical ventilation facilities which are always effective. The incoming air must be heated if necessary and must be able to be introduced without causing a draught. The exhaust air may be led entirely or partially via the fume cupboards, provided this does not impair the full efficiency of the fume cupboards. It must be ensured that exhaust air with a hazardous quantity or concentration of hazardous material cannot reenter the work areas.

Ventilation systems which meet the requirements of DIN 1946-7

"Raumlüftungstechnik; Raumluftechnische Anlagen in Laboratorien (VDI -

Lüftungsregeln)" are adequate. The quantity of air introduced is to be so dimensioned that at least 25 m³/(m²h) is achieved; given a room clearance of 3 m, this is equivalent to an eightfold exchange of air.

Fume cupboards, see DIN 12 924-1 "Laboreinrichtungen; Abzüge; Abzüge für allgemeinen Gebrauch, Arten, Hauptmaße, Anforderungen and Prüfungen".

3.1.5.2

Recirculation of air is permissible for room ventilation only if no hazardous concentration of hazardous materials can occur.

See also § 36 Abs. 7 Gefahrstoffverordnung as well as UVV "Umgang mit Gefahrstoffen" (BGV B1 formerly VBG 91).

See also Technische Regeln für Gefahrstoffe TRGS 560 "Luftrückführung beim Umgang mit krebserzeugenden Gefahrstoffen".

3.2 Exhaust equipment

3.2.1 Fume cupboards

3.2.1.1

Fume cupboards must be designed in such a way that, in the operating state, their structure and ductwork

- prevent gases, vapours and dusts in hazardous concentrations or quantities from entering the laboratory room from the interior of the fume cupboard,
- prevent hazardous explosive atmospheres from forming in the interior of the fume cupboard

and

- protect insured persons - by the closed front sliding panel - from splashing hazardous materials or flying broken glass.

Fume cupboards, see DIN 12 924-1 "Laboreinrichtungen; Abzüge; Abzüge für allgemeinen Gebrauch, Arten, Hauptmaße, Anforderungen and Prüfungen".

For fume cupboards for the fuming off of perchloric acid, of sulphuric acid, for work with hydrofluoric acid, see DIN 12 924-2 "Laboreinrichtungen; Abzüge; Abzüge für offene Aufschlüsse bei hohen Temperaturen, Hauptmaße, Anforderungen and Prüfungen".

It must be borne in mind that the retention capacity of fume cupboards may change in an unforeseeable way in the event of large thermal loads.

See also Chapter 5.3.1.

3.2.1.2

Fume cupboards must be made of materials which withstand the mechanical, chemical and thermal load to be expected when used as intended.
See DIN 12 924 Parts 1 and 2.

3.2.1.3

Pipes and ducts of fume cupboards must be designed and arranged in such a way that they cannot contribute to the spread of fire.

3.2.1.4

The windows of fume cupboards must be equipped with safety glass, preferably laminated safety glass or suitable plastic.
See DIN 12 924-1.

3.2.1.5

Fume cupboards must be equipped with devices which enable a relief of pressure. Suitable pressure relief devices are e.g. loosely inserted lightweight plates which are fastened down so that they cannot fly away.

See DIN 12 924-1.

3.2.1.6

Vertically sliding fume cupboard windows, particularly front sliding panels, must be secured to prevent them from falling down. The fume cupboard must be equipped with access openings and must be able to be locked. The front sliding panel must bear a notice saying "Frontschieber geschlossen halten" ["Keep front sliding panel closed"] in a place where it can be easily seen. The notice must comply with the UVV "Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz" (BGV A8 formerly GUV 0.7).

Access openings make it possible for work to take place in the fume cupboard even if the front sliding panel is closed.

For setting up and operating high apparatus arrangements such access openings are also recommended in the upper front windows.

Access openings are not compulsory for front sliding panels of fume cupboards for fuming off. This may restrict their use for other purposes under certain circumstances; see also Chapter 5.3.1.

As regards marking see also DIN 4844 "Sicherheitskennzeichnung" and DIN 30 600 "Graphische Symbole; Registrierung, Bezeichnung".

See also Chapter [5.3.1](#).

3.2.1.7

Even if the front sliding panel is closed, sufficient inflow of air must be maintained. The closing of the front sliding panel may not incur a risk of injury. Such risk of injury occurs e.g. by crushing.

See DIN EN 294 "Sicherheit an Maschinen; Sicherheitsabstände gegen das Erreichen von Gefahrstellen mit den oberen Gliedmaßen".

3.2.1.8

The perfect ventilation function of each fume cupboard must be monitored by an automatic device. In the event of a fault, an optical and acoustic alarm must go off. The optical signal must be clearly assigned to the various fume cupboards and may not be able to be switched off. A signal light for the on-off status of the ventilator motor is not sufficient. The acoustic signal must be able to be heard at all times throughout the entire laboratory room. In the case of centrally controlled fume cupboards it must be ensured that the operating cycle is known to the insured persons.

If there is more than one fume cupboard in the laboratory room, one common acoustic signal device is sufficient.

Editorial remark: A monitoring device is not required for laboratories which have been put into operation before 1.10.1993. See chapter [12.2](#).

3.2.1.9

Permanently installed outlets for liquid or gaseous materials in the fume cupboards must be able to be operated from outside. The assignment of the handles of the fittings must be clearly recognizable.

See DIN 12 920 "Laboreinrichtungen; Farbige Kennzeichnung der Stellteile von Laborarmaturen nach dem Durchflußstoff".

3.2.2 Air circulation exhausters with filters

Air circulation exhausters with filters must be designed in such a way that, in the operating state, their structure and ductwork

- prevent gases, vapours and dusts in hazardous concentrations or quantities from entering the work areas,
- prevent hazardous explosive atmospheres from forming inside them

and

- protect the insured persons - by the closed front sliding panel or the closed flap - from splashing hazardous materials or flying broken glass.

See DIN 12 927 "Laboreinrichtungen; Absaugboxen mit Luftrückführung; Anforderungen, Prüfungen".

3.2.3 Local exhaust devices

Local exhaust devices are recommended in order to reduce emissions.

3.3 Workbenches and their storage spaces

3.3.1 Workbenches

Workbenches must be so constructed as regards their material and design that they withstand the intended workloads. In particular, work surfaces of laboratory benches and fume cupboards are to be equipped with a liquid-proof covering and a raised edge. In the case of work surfaces opposite one another a protection against splashing is necessary up to reaching height (170 - 175 cm).

See DIN 12 926-1.

Editorial remark: This is not required for laboratories which have been put into operation before 1.10.1993. See Chapter 12.2.

3.3.2 Storage spaces for hazardous material wastes

If storage spaces are available for the provision of collection containers for hazardous material wastes they must be connected to an effective ventilation device of adequate dimensions and which remains effective at all times even while the collection container is being filled. The interior of these storage spaces must be lined at least with material which does not burn easily. In the case of liquid hazardous material wastes an adequately dimensioned collection pan must be situated below the collection container.

See also Chapter 4.10.

Editorial remark: This is not required for laboratories which have been put into operation before 1.10.1993. See Chapter 12.2.

3.4 Supply lines, fittings and gas burners

3.4.1 Supply lines

3.4.1.1

Stationary, tightness-tested lines must be available for the continuous supply of liquid and gaseous materials to the laboratory benches and fume cupboards.

For the testing of lines for fuel gas and water see DVGW Arbeitsblatt GW 3 "Technische Regeln für Bau und Prüfung von vorgefertigten Bauteilen mit Gas- und Wasserinstallationen"

For drinking-water lines see DIN 1988 "Trinkwasser-Leitungsanlagen in Grundstücken; Technische Bestimmungen für Bau and Betrieb", and DIN 18 381 "VOB Verdingungsordnung für Bauleistungen; Teil C: Allgemeine Technische

Vertragsbedingungen für Bauleistungen (ATV); Gas-, Wasser- und Abwasser-Installationsanlagen innerhalb von Gebäuden".

3.4.1.2

If hazards can be caused by mix-ups, stationary supply lines must be marked clearly and permanently.

This is achieved if the supply lines are marked by paint, lettering or signs according to DIN 2403 "Kennzeichnung von Rohrleitungen nach dem Durchflußstoff".

See also Art. 49 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1), Chapter 4.1 DVGW Arbeitsblatt G 621 "Gasanlagen in Laboratorien, Naturwissenschaftlich-technischen Unterrichtsräumen; Installation und Betrieb" and DIN 12 924 Part 1.

3.4.2 Shut-off devices

Every fuel gas line which leads to one or more adjacent outlets must be able to be closed separately. The shut-off device must be easy to reach and accessible at all times. Furthermore, a master shut-off device must be available. The control parts of this shut-off device must be outside of the laboratory, close to it and within easy reach, clearly marked and accessible at all times. Only such devices can be used as outlets for fuel gases which are secured from being opened accidentally.

Intermediate shut-off devices, if they can be subject to mix-up, are to be marked, e.g. by paint or lettering.

The control part for the master shut-off device may e.g. be a switch for remote actuation.

See DIN 3537-3 "Gasabsperrrarmaturen bis PN 4; Anforderungen und Anerkennungsprüfung für Laborarmaturen".

See DVGW Arbeitsblatt G 621 "Technische Regeln für die Errichtung von Gasanlagen in Laboratorien und Unterrichtsräumen", DIN 18 381 "VOB Verdingungsordnung für Bauleistungen; Teil C: Allgemeine Technische Vertragsbedingungen für Bauleistungen (ATV); Gas-, Wasser- und Abwasser-Installationsanlagen innerhalb von Gebäuden".

3.4.3 Marking of shut-off devices

Control parts of laboratory devices must be marked according to the material flowing through them.

See E DIN 12 920.

See also Art. 40 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1).

3.4.4 Drainage lines

Drainage lines in laboratories must be equipped with stench traps and easily accessible openings for cleaning.

See DIN 12 924-1, DIN 12 926-1 and DIN 19 541 "Geruchsverschlüsse für Entwässerungsanlagen; Funktionsgrundsätze".

3.4.5 Gas burners

3.4.5.1 Bunsen burners

Bunsen burners may not be equipped with closable adjustment devices (taps, valves) for the fuel gas.

Bunsen burners may not be completely closable, as no gas is to remain under pressure in the gas hose between the shut-off valve and the laboratory burner after the burner has been switched off; see DIN 30 665-1.

Editorial remark: This is not required for laboratories which have been put into operation before 1.10.1993. See Chapter 12.2.

3.4.5.2 Cartridge burners

Storage possibilities must be available for reserve cartridges of cartridge burners so that there can be no increased hazard in case of a fire.

3.5 Emergency showers

3.5.1 Showers

3.5.1.1

A shower supplied with water, if possible of drinking water quality, must be installed at the laboratory exit. It is to be capable of drenching all zones of the body immediately with adequate quantities of water.

At least 30 l/min are needed to drench all zones of the body.

See DIN 12 899-1 "Laboreinrichtungen; Notduschen-Einrichtungen; Körperduschen, Sicherheitstechnische Anforderungen und Prüfungen".

3.5.1.2

In the case of showers, the control part of the rapidly opening valve must be attached in an easily accessible place and must be unable to be mixed up. The direction of opening must be clearly recognizable. Once it has been opened, the valve may not close by itself. Chains for opening the valves are not permissible.

For the functional test of showers see Chapter 11.2.

See also Chapter 4.16.2.

3.5.1.3

The location of showers must be marked by the rescue sign E08 "Notdusche" ["Emergency shower"]. The sign must comply with the UVV "Sicherheits- und

Gesundheitsschutzkennzeichnung am Arbeitsplatz" (BGV A8 formerly VBG 125 bzw. GUV 0.7). Access to the showers is to be kept free at all times.

3.5.2 Eye-wash stands

3.5.2.1

Laboratories must be equipped with an eye-wash stand supplied with drinking water, if at all possible in the vicinity of the shower or slop sink. It is to be capable of rinsing both eyes immediately with adequate quantities of water. The control part of the valve must be easily accessible, fitted so that it cannot be mixed up and easy to operate. Once opened, the valve must not be able to close by itself. See DIN 12 899-2 "Laboreinrichtungen; Notduschen-Einrichtungen; Augenduschen, Sicherheitstechnische Anforderungen, Prüfungen".

Functional tests of the eye-wash stands, see Chapter 11.2.

See also chapter 4.16.2.

3.5.2.2

Notwithstanding Chapter 3.5.2.1 the following are also permissible as eye-wash stands

- mobile eye-wash stands with automatic shut-off valves mounted to the handle,
- eye rinsing bottles with sterile rinsing liquid if no running drinking water is available.

3.5.2.3

The location of eye-wash stands must be marked by the sign E09 "Augenspüleinrichtung" ["Eye-rinsing device"]. The sign must comply with the UVV "Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz" (BGV A8 formerly VBG 125 bzw. GUV 0.7). The access to the eye-wash stands is to be kept free at all times.

3.6 Electrical equipment and appliances

3.6.1 Electrical power supply facilities

Separate electrical circuits must be set up for the lighting, the ventilation and the remaining electrical power supply. Furthermore, laboratory benches and fume cupboards are to be on individual circuits or group circuits.

See DIN VDE 0789 Part 100 "Unterrichtsräume und Laboratorien; Einrichtungsgegenstände, Sicherheitsbestimmungen für energieverborgte Baueinheiten".

For switching off the power it is recommended that a master switch be mounted at an easily accessible location e.g. at the laboratory room exit.

3.6.2 Potential equalization

3.6.2.1

Electrically conductive bench coverings and other conductive structural parts of the laboratory outfittings which can be touched must be connected with one another in such a way that they have good conductive properties. Movable parts need only be included in the potential equalization if they can absorb voltage in the event of a fault. Movable parts are e.g. front sliding panels.

3.6.2.2

Turnkey fume cupboards must be equipped with a connection point enabling an easy connection with the local potential equalizer.
Protective conductor test, see DIN VDE 0789-100.

3.6.3 Switches and sockets

3.6.3.1

Switches and sockets on laboratory benches are to be installed above the working surface or, if mounted underneath the bench top, they are to be recessed so far that they represent no hazard in case of escaping or splashing liquids.

3.6.3.2

Sockets of fume cupboards are to be attached outside of the fume cupboards. If sockets are necessary in the working space of the fume cupboard they must be able to be switched off from outside separately and assigned so as to be recognizable. See DIN 12 924-1.

3.6.3.3

Switches and sockets within spraying range of emergency showers must be protected from spraying water.
See EN 60 529/DIN VDE 0470 Part 1 "Schutzarten durch Gehäuse (IP-Code)".

3.7 Pressure vessels and experimental autoclaves

3.7.1

Pressure vessels (autoclaves for performing known reactions) must be designed in such a way that they safely withstand the mechanical, chemical and thermal loads to be expected owing to the intended mode of operation and can remain tight. In particular, they must be able to safely absorb the permissible operating pressure and the permissible operating temperature.

Acceptance inspection prior to commissioning, see the Druckbehälterverordnung.

3.7.2

Experimental autoclaves for experiments with unknown development of the reaction, pressure or temperature must be set up in special chambers or behind protective walls. These must be designed in such a way that persons are protected should the autoclave fail. The safety and measuring devices must be able to be monitored and operated from a safe place.

See No. 38 "Versuchsautoklaven" of the Technische Regeln für Druckbehälter TRB 801 "Besondere Druckbehälter nach Anhang II zu § 12 DruckbehV"

See also Chapters [5.4.1](#) and [11.4](#).

3.8 Refrigeration appliances

3.8.1 Refrigerators and refrigerator chests

The interior of refrigerators and refrigerator chests in which hazardous explosive atmospheres can develop may contain no ignition sources.

Hazardous explosive atmospheres can e.g. develop from open or untight vessels containing flammable liquids.

In the case of refrigerators and refrigerator chests of normal design, ignition sources can be avoided if lights and light switches are disconnected and temperature controllers are equipped with an electrical circuit with its own fuse. The automatic defrosting system must be switched off.

In refrigerators with automatic defrosting systems the thawed liquid must be diverted into a collection vessel inside. The collection vessel is to be emptied when necessary. If the automatic switch-off device inside works with a heating system, this must be disconnected from the outside. The refrigerator must be defrosted by switching it off and opening the door. Sites where tubes or cables pass through the walls are to be closed with silicone or a similar material.

3.8.2

Converted refrigerators and refrigerator chests must be marked with a sign reading "Nur Innenraum frei von Zündquellen" ["Only interior free from ignition sources"]. The sign must comply with the UVV "Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz" ([BGV A8](#) formerly VBG 125 bzw. [GUV 0.7](#)).

3.9 Dewar vessels (vacuum jacket vessels)

Dewar vessels made of glass and other glass vessels with the same principle of action must be equipped with a protective jacket or must be protected in some other way from the consequences of an implosion. The glass must have a sufficiently small expansion coefficient.

Prevention against the consequences of an implosion can be made for example by coating with plastic.

Types of glass with a sufficiently small expansion coefficient include e.g. borosilicate glass 3.3 according to DIN ISO 3585 "Borosilicatglas 3.3; Eigenschaften, identisch mit ISO 3585 : 1991".

4 Generally valid operating instructions

4.1 General

4.1.1

Insured persons must take care that the laboratories are kept clean and tidy.

4.1.2

Insured persons may only handle hazardous materials and appliances which are necessary for performing their tasks.

See Art. 17 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1).

4.1.3

If an insured person performs a hazardous task alone, the proprietor must ensure their supervision.

See Art. 36 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1).

See also Chapters 4.2 and 5.

4.1.4

The insured persons must eliminate defects of safety engineering facilities and hazardous conditions in laboratories immediately. If this does not belong to their field of tasks or if they do not have the necessary technical knowledge they must report the defects to their superior immediately.

See Art. 16 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1).

4.1.5

Insured persons may only leave their place of work if permanent supervision of their experiments is not necessary or if another insured person who is instructed as to the course of the experiments takes over the supervision.

4.1.6

The proprietor must take care by means of organizational measures that the laboratory workplaces are made safe when work stops.

Making safe takes place e.g. by shutting off the gas, water and steam taps. As far as possible, the main taps are also to be closed, the master switches switched off or the mains plugs pulled out in the case of appliances which can cause a fire.

4.1.7

Experiments which cannot be interrupted at the end of the normal working time may only be conducted without permanent supervision if no other scheduling is possible for the experiment and suitable protective measures safely ensure that no hazardous conditions occur.

See Chapter 4.6.

4.1.8

Work by external personnel is only permissible in laboratories if, according to the laboratory manager's instructions, hazards emanating from the laboratory have been eliminated beforehand or suitable protective measures and rules of conduct have been discussed and have been implemented.

External personnel in laboratories includes e.g. repair and cleaning personnel.

See also Chapter 4.10.5.

4.1.9

The front sliding panels of fume cupboards are to be kept closed during operation. In justified exceptions the front sliding panel may be opened as far as necessary.

When the front sliding panel is open, more noxious substances escape and the person using the fume cupboard is not protected from splashing hazardous materials or flying broken glass.

See also Chapter 3.2.1.6.

4.2 Operating instructions

4.2.1

The proprietor must prepare a set of operating instructions in which the hazards for humans and the environment occurring in the laboratory are described and the generally necessary protective measures and rules of conduct are laid down. The operating instructions are to be formulated in a comprehensible manner and are to be kept available in the laboratory. The operating instructions must also contain instructions for conduct in the event of a hazard and first aid measures.

See also Chapters 4.3, 7, 8 and 10.

4.2.2

The proprietor must prepare separate operating instructions for hazardous work, handling hazardous materials, and the proper disposal of wastes.

See Art. 20 Gefahrstoffverordnung, Technische Regeln für Gefahrstoffe TRGS 555 "Betriebsanweisung und Unterweisung nach § 20 GefStoffV" and Merkblatt A 010 "Betriebsanweisungen".

Hazardous work, see Chapter 5.

Handling wastes, see Chapter 6.

4.3 Instruction

4.3.1

The proprietor must familiarize the insured persons in the laboratories with the contents of these Guidelines and with the operating instructions and must instruct them at least once a year. He must take care that

- these Guidelines are displayed in the laboratory or distributed to the insured persons,
- written information concerning measures for safe work and the protection of the insured persons is distributed to such persons.

The insured persons must observe these documents while performing their work. See Art. 14 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1).

See also Chapter 4.2.

4.3.2

Prior to starting their employment and at suitable intervals thereafter, but at least once a year, the insured persons are to be instructed in detail and suitably, orally and with reference to their workplace, by the laboratory manager or his deputy about general and work-relevant hazards in the laboratory and about the measures to avoid them. New employees are to be instructed accordingly prior to starting work. Female employees of child-bearing age and condition are also to be instructed as to the possible hazards and employment restrictions for expectant mothers. The content and the time of the instruction are to be laid down in writing and to be confirmed by the instructed persons by their signature.

See Art. 20 para. 2 and Art. 26 Gefahrstoffverordnung, Art. 7 para. 2 UVV "Allgemeine Vorschriften" (VBG 1 or GUV 0.1) and Chapter 4.2 of these Guidelines.

These Guidelines and the operating instructions pursuant to Chapter 4.2 serve as the foundation for the instruction.

See also UVV "Umgang mit krebserzeugenden Gefahrstoffen" (VBG 113) which will probably be replaced by the UVV "Umgang mit Gefahrstoffen" on 1 October 1998, and Merkblatt M 006 "Besondere Schutzmaßnahmen in Laboratorien".

4.3.3

The proprietor must take care that the insured persons are instructed on the basis of the manufacturers' operating instructions about the mode of functioning of the

laboratory equipment before using it for the first time and at least once a year thereafter.

4.3.4

Before performing hazardous work the insured persons working in the immediate vicinity are to be instructed as to the particular hazards and protective measures. This applies especially if several insured persons are employed at one fume cupboard at the same time.
See also Chapter 5.

4.4 Special protective measures

The proprietor must take care that suitable protective measures are taken when manufacturing preparations and handling materials whose properties are not known to be non-hazardous. This applies particularly when working according to information given in the literature where it must be expected that the hazards are not made sufficiently clear.
This applies in particular to work with older literature references.

See Chapter 4.3.

4.5 Glass apparatus

4.5.1 Hose connectors, hose connections

The use of glass apparatus with fragile hose connectors (glass olives) and hose connections (hose adapters) made of glass is to be avoided if at all possible. Plug or screw couplings are to be preferred as connecting elements for hoses.
This applies in particular to exsiccators, suction bottles, condensers and gas-washing bottles.

See

DIN 12 475 "Laborgeräte aus Glas; Saugflaschen, zylindrische Form",

DIN 12 476 "Laborgeräte aus Glas; Saugflaschen, konische Form",

DIN 12 491 "Laborgeräte aus Glas; Vakuumsikkatoren",

DIN 12 596 "Laborgeräte aus Glas; Gas-Waschflaschen; Form nach Drechsel".

4.5.2 Handling cylindrical glass parts

Thermometers, glass tubes or rods may not be inserted into or extracted from stoppers and hoses with the bare hands.

To protect the hands e.g. sufficiently resistant gloves or clothes should be used.

To insert cylindrical glass parts into stoppers without hazard, round off any edges beforehand. Cover the parts with a suitable sliding agent, grip them as closely as possible to the stopper and turn, exerting slight pressure, in a straight direction, not placing them on surfaces or even on the body.

Injuries due to cuts can be reduced considerably by using screw caps.

4.5.3 Glassblowing work

Before performing glassblowing work, clean, dry and, if necessary blow out the apparatus carefully.

4.5.4 Work with very fragile vessels

Quantities of more than 5 litres of hazardous materials may not be used in thin-walled glass vessels. Exceptions are only permitted if special protective measures are taken.

Highly inflammable and easily inflammable materials, see Chapter [5.3.2.3](#).

Autoigniting materials, see Chapter [5.3.2.4](#).

Thin-walled glass vessels are e.g. round-bottomed flasks, flat-bottomed flasks, Erlenmeyer flasks.

4.5.5 Permissible glass temperatures

When working with glass apparatus the permissible temperatures and temperature differences are to be observed. When using glass apparatus, temperature differences of more than 140 °C between the vapourized liquid and the cooling liquid are to be avoided.

In the case of apparatus made of borosilicate glass 3.3 according to DIN ISO 3585 temperature differences of up to 200 °C are permissible. This type of glass can be subjected to maximum temperatures of 500 °C if the cooling speeds specified by the manufacturer are observed.

4.6 Heating baths and heating

4.6.1

Only electrical heating devices may be used for heating liquid heating baths and other laboratory apparatus. If it is impossible to avoid heating with gas flames this must take place under supervision.

4.6.2

Only CFC-free heat carriers whose safe maximum operating temperature is known may be used for liquid heating baths and liquid thermostats. In the case of liquid heating baths, the maximum operating temperature must lie at least 20 °C and in the

case of liquid thermostats at least 5 °C below the flashpoint of the heat carrier. For higher temperatures metal baths are to be preferred.
See DIN 12 879-1 "Elektrische Laborgeräte; Flüssigkeitsthermostate, Allgemeine und sicherheitstechnische Anforderungen und Prüfungen".

4.6.3

If experiments cannot be permanently supervised it must be ensured by means of an automatic device that, if the control device of the heating fails, overheating above the maximum operating temperature can be safely prevented.

See DIN 12 879-1, DIN 12 880-1 "Elektrische Laborgeräte; Wärmeschränke, Sicherheitstechnische Anforderungen und Prüfungen, Allgemeine technische Anforderungen" and DIN 12 877 "Elektrische Laborgeräte; Heizbäder; Allgemeine und sicherheitstechnische Anforderungen und Prüfungen".

4.6.4

Liquid heating baths must be set up in such a way that they stand firmly and their height can be adjusted without hazard. Tripod rings are unsuitable for height adjustment.

Laboratory lifting platforms have proved suitable for this purpose.

See DIN 12 897 "Laborgeräte aus Metall; Hebebühnen, Sicherheitstechnische Anforderungen, Prüfung".

See also Chapter [4.9.1](#).

4.6.5

Hazards due to volume increase during heating, by impurities and by dripping water are to be confronted effectively.

4.6.6

Observe the following when using heat carriers:

- Heat carriers which are miscible with water are to be preferred for heating baths.
- Heat carriers which are not miscible with water must be renewed after contamination with water or heated out sufficiently.
- Heat carriers which are miscible with water and those which are not miscible with water may not be mixed with one another.

It is recommended that heat carriers be checked after each case of contamination and, depending on the contamination, renewed.

See also Chapter [5.4](#).

4.6.7

Sand-baths may only be used if the uneven distribution of temperature occurring in them, particularly that caused by reheating, can cause no hazard. The sand used as the heat carrier may not have sharp edges.

4.6.8

Apparatus for the determination of the melting point may not be filled with sulphuric acid.

Silicone oils e.g. are suitable for use as bath liquid.

Metal-block or electrically heated instruments for determining the melting point of liquids e.g. are to be recommended.

4.7 Hoses and fittings

4.7.1

Only such hoses are to be used which withstand the pressures to be expected and other mechanical, thermal and chemical loads.

See also UVV "Verwendung von Flüssiggas" ([BGV D34](#) formerly VBG 21).

4.7.2

Bunsen burners and similar appliances may only be connected with DVGW-tested hoses.

See DIN 30 664-1 "Schläuche für Gasbrenner für Laboratorien, ohne Ummantelung und Armierung, Sicherheitstechnische Anforderungen und Prüfungen" and DIN 30 665-1 "Gasverbrauchseinrichtungen; Gasbrenner für Laboratorien (Laborbrenner); Sicherheitstechnische Anforderungen, Prüfung".

See also Chapter [4.7.3](#).

4.7.3

Hoses must be secured against slippage. They are to be protected from the effects of excessive heat and other forms of destruction.

Securing against slippage of the hoses is possible e.g. by

- using hose clips or hose binders or
- pulling gas hoses according to DIN 30 664-1 onto a hose nozzle according to DIN 12 898 "Laborarmaturen; Schlauchtüllen" with (nominal diameter) $d_2 = 9.5$ mm.

4.7.4

Hoses and fittings on gas lines and gas burners must be checked for visible defects prior to use. Defective hoses or hose ends which have become soft or porous must be removed.

4.8 Closures

4.8.1

When using hazardous materials, conical round joints, spherical ground joints, flanged or screw-cap connections or closures must be used.

See also Chapter 4.12.3.

4.8.2

If, by way of exception, cork or rubber stoppers are needed, cork drilling machines are to be preferred for the drilling. Drilling by hand may only take place on a firm surface. The drills are to be kept sharp.

4.9 Setting up apparatus

4.9.1

Apparatus is to be set up in an uncomplicated arrangement and free from mechanical tension. If stands are required - lattice bar grids are to be preferred - they are to be fastened or weighed down securely.

Apparatus can be set up without mechanical tension e.g. by spherical ground joints, screw-cap connections, PTFE expansion bellows.

See also DIN 12 897.

4.9.2

When setting up apparatus in fume cupboards care is to be taken that the flow conditions are influenced as little as possible.

This can be achieved for example by leaving a free space at least 10 mm high for the flow of air below the apparatus, e.g. in fire protection pans or sand baths.

Furthermore, it is recommended to maintain the largest possible distances to the exhaust air opening.

4.9.3

Heating baths, other external sources of heat, possibly also cooling baths must be able to be removed without hazard and without changing the apparatus.

4.9.4

Hoses and electrical cables are to be laid so that they can lead to no hazard.

4.9.5

If when operating glass apparatus there is the danger of a material or heat explosion or of bursting due to an accidental rise in pressure this apparatus may only be used in the fume cupboard.

An accidental rise in pressure may occur e.g. due to blockage of the absorption capillaries; see also Chapter [4.9.8](#).

Experimental autoclaves made of glass, see Chapters [3.7](#) and [5.4.1](#).

Glass apparatus under vacuum, see Chapter [5.4.4.4](#).

See also Chapters [5.3.1](#) and [5.2](#).

4.9.6

Care is to be taken that absorption vessels containing calcium chloride, phosphoric pentoxide, soda lime or similar materials are not blocked or cannot become blocked during operation. Furthermore, it is to be ensured that no liquid can drip from the absorption vessel into the reaction vessel.

The blockage can for example be prevented by mixing in inert granular or fibrous material. When using calcium chloride as an absorption agent the alcohol vapours are to be condensed or absorbed beforehand.

4.9.7

No easily inflammable materials and no materials containing asbestos may be used for the heat insulation of hot parts on apparatus.

4.9.8

When setting up apparatus, adequately dimensioned barrier vessels are to be installed between vessels with materials which may become hazardous when mixed. Attention is to be paid to the correct direction of flow.

It may prove useful to install an additional non-return valve in front.

The following materials are hazardous when mixed: e.g. concentrated acids with lyes or water, solid alkaline oxides or hydroxides, e.g. in drying jars with water or acids, calcium chloride with alcohols.

See also Chapter [5.4.3.16](#).

4.9.9

The size of distillation apparatus is to be adjusted to the quantity and type of the material to be distilled. The apparatus is to be selected so that there can be no blockage of vapour or condensation. The condenser must be sufficiently effective.

The flow of coolant is to be monitored at the outlet of the condenser. In order to avoid bumping, suitable measures are needed.

The following have proved suitable: e.g. stirrers, boiling stones and boiling capillaries. Boiling stones may not be placed in overheated liquids.

In the case of distillate which solidifies easily there is a hazard of blockage and a dangerous increase in pressure in the apparatus.

4.9.10

Distillation receivers are to be secured firmly and, if necessary, supported.

4.9.11

Ladders or steps are to be used when setting up high apparatus and for working on parts of high apparatus outside of one's reach.

See UVV "Leitern und Tritte" (BGV D36 formerly VBG 74 or GUV 6.4).

4.9.12

Apparatus for procedures in which a power cut may present increased hazard is to be connected to its own power circuit.

Procedures in which a power cut may incur increased hazard are e.g. organometallic reactions.

A separate power circuit is e.g. if a socket is not covered by a the same fuse together with others via a common protection device (e.g. residual current operated device).

4.10 Storage and provision of chemicals

4.10.1

Hazardous materials are to be kept or stored so that they cannot endanger human health and the environment.

See also Art. 24 Gefahrstoffverordnung

4.10.2

Chemicals may only be stored in containers

- consisting of materials which withstand the load to be expected

and

- are marked in accordance with their contents.

E.g. aluminium vessels may not be used for materials containing chlorinated hydrocarbons and glass vessels may not be used for materials containing hydrofluoric acid.

Attention is drawn to the hazard of brittleness, diffusion and deformation when storing chemicals in plastic vessels.

Laboratory storage bottles made of glass with a surface coat of plastic have proved suitable.

4.10.3

In laboratories, laboratory storage bottles containing hazardous materials in quantities needed for daily use must be marked at least with the designation of the material, the preparation and the ingredients of the preparation as well as the hazard symbols and the relevant hazard designations.

See Art. 23 Gefahrstoffverordnung and Chapter 9.2 of the Technische Regeln für Gefahrstoffe TRGS 200 "Einstufung von Stoffen, Zubereitungen und Erzeugnissen".

4.10.4

Containers of hazardous materials may only be stored on shelves, in cabinets and other facilities up to such a height from which they can be safely removed and where they can be safely placed.

As a rule, containers which need to be carried with both hands should not be placed down and removed above reaching height (170 to 175 cm).

See DIN EN 294 "Sicherheit an Maschinen; Sicherheitsabstände gegen das Erreichen von Gefahrstellen mit den oberen Gliedmaßen" und "Kleine ergonomische Datensammlung" of the Bundesanstalt für Arbeitsschutz [Federal Institute for Occupational Safety and Health].

4.10.5

Highly toxic and toxic materials and preparations are to be kept under lock and key or are to be kept or stored in such a way that only qualified or instructed persons have access to them.

Repair and cleaning staff are to be instructed as to the hazards and protective measures prior to working in these areas and are to be adequately supervised.

See also Chapter 4.1.8.

See Art. 24 para. 4 Gefahrstoffverordnung.

4.10.6

The proprietor must take care that materials which are subject to the Betäubungsmittelgesetz [Narcotics Act] are kept under lock and key.

See Betäubungsmittelgesetz [Narcotics Act].

4.10.7

Hazardous materials which emanate vapours which are hazardous to health are to be kept in places with continuous exhaust systems.

Cabinets connected to the ventilation system and with corrosion-resistant pans are recommended; see also Chapter 3.1.5.

4.10.8

Materials which can autoignite at room temperature due to the action of air or moisture are to be kept separately from other explosive, pyrogenic, highly inflammable, easily inflammable and inflammable materials as well as safe from transmission of fire. If they are constantly needed, only limited quantities which are necessary for the immediate continuation of the work may be kept at the workplace during working time.

Materials which can autoignite at room temperature with the action of air or moisture are e.g. metal alkyls, lithium aluminium hydride.

4.10.9

Highly concentrated nitric acid and perchloric acid are to be kept in such a way that no hazardous reactions are possible if a bottle breaks.

This is achieved by placing them in unbreakable and resistant over-vessels.

4.10.10

Flammable liquids of hazard classes A I, A II and B may only be kept in vessels with a nominal volume of not more than 1 litre if kept at the workplace for daily use. The number of vessels is to be restricted to those which are absolutely necessary.

See also Chapter 4.10.2.

See also Technische Regeln für brennbare Flüssigkeiten TRbF 143 "Ortsbewegliche Gefäße".

4.10.11

The number and the capacity of the vessels with flammable liquids is to be restricted to those which are absolutely necessary. For laboratories in which larger quantities of flammable liquids are constantly needed these may be kept available in non-breakproof vessels with a nominal volume of up to 5 l or in other vessels with a nominal volume of up to 10 l in a protected place.

Cabinets according to DIN 12 925-1 "Laboreinrichtungen; Schränke für feuergefährliche flüssige und feste Stoffe; Sicherheitstechnische Anforderungen, Prüfungen" have proved suitable.

Movable plastic vessels with a nominal volume of over 5 l may only be used for flammable liquids with a flashpoint of up to 35 °C if they have sufficient electrostatic derivation ability, i.e. their surface resistance is less than 10^{11} Ohm; see Technische Regeln für brennbare Flüssigkeiten TRbF 143 "Ortsbewegliche Gefäße", Guidelines "Statische Elektrizität" (BGR 132 formerly ZH 1/200 or GUV 19.7) and the collection of examples of the "Explosionsschutz-Richtlinien (EX-RL)" (BGR 104 formerly ZH 1/10 or GUV 19.8) or the Merkblatt T 033 "Beispielsammlung zu den Richtlinien 'Statische Elektrizität'".

Non-breakproof vessels are e.g. glass bottles.

Commercially available safety vessels made of stainless steel with a flashback arrester and pressure relief have proved suitable.

See Art. 24 para. 1 Gefahrstoffverordnung and Art. 46 UVV "Allgemeine Vorschriften" (VBG 1 bzw. GUV 0.1).

4.10.12

The Verordnung über brennbare Flüssigkeiten applies for the storage of flammable liquids.

See in particular Technische Regeln für brennbare Flüssigkeiten TRbF 100 "Allgemeine Sicherheitsanforderungen", TRbF 110 "Läger" and TRbF 143 and Technische Regeln für Gefahrstoffe TRGS 514 "Lagern sehr giftiger und giftiger Stoffe in Verpackungen und ortsbeweglichen Behältern" and TRGS 515 "Lagern brandfördernder Stoffe in Verpackungen und ortsbeweglichen Behältern".

4.10.13

For easily inflammable washing liquids for daily use absolutely no containers made of thin-walled glass may be used.

Suitable containers are spray bottles made of plastic; see also Chapter 4.10.2.

The following are used as washing liquids e.g. acetone, isopropanol.

4.10.14

The proprietor must take care that all chemicals and preparations kept in the laboratory are checked at least once a year that they are in proper condition. Chemicals and preparations which are no longer in proper condition are to be filled into other containers or disposed of.

See also Chapter 6.2.3.

4.10.15

Mechanical devices must be used for pipetting. Pipetting by mouth is prohibited. See also Merkblatt M 651 "Richtig Pipettieren".

4.11 Cleaning

4.11.1

Persons charged with washing tasks may not be exposed to any hazard due to residues, in particular vessels and apparatus must be pre-cleaned by the user before being placed at the washing place.

See also Chapter 6.2.2.

4.11.2

Cleaning agents with a strong reaction may only be used if other cleaning agents have proved unsuitable. Prior to using them, it is to be ensured that any residues in the vessels cannot lead to reactions with the cleaning agent. Such tasks may only be performed by laboratory personnel, in a fume cupboard if necessary.

Cleaning agents with a strong reaction are e.g. concentrated nitric acid, concentrated sulphuric acid, chromium sulphuric acid.

Alkaline permanganate solution has proved suitable for oxidative breakdown. To prepare this add 20 % sodium hydroxide solution to the same quantity of saturated potassium permanganate solution in a vessel to be cleaned.

In many cases, the given cleaning agents with a strong reaction can be replaced, e.g. by special commercially available detergents.

4.12 Handling of stoppers

4.12.1

When using rubber stoppers these are to be so selected that they cannot be sucked in the event of a vacuum.

4.12.2

In the case of strongly alkaline or greasy materials the stoppers are to be secured from sliding out.

4.12.3

Suitable measures are to be used for loosening glass stoppers which have become stuck.

To achieve this e.g. tap the glass stopper with a wooden handle, warm the neck of the bottle carefully but quickly with hot air or with warm water. When doing so, cover the bottle with a cloth; in the case of larger bottles perform this work over a collection pan.

4.13 Food and beverages

4.13.1

In laboratories in which toxic, highly toxic, carcinogenic, embryotoxic or gene-modifying substances, or infectious materials or agents, or materials or agents suspected of being infectious are handled, there may be no eating, drinking or taking of snuff.

See Art. 22 Gefahrstoffverordnung.

4.13.2

Food and beverages may not be brought into laboratories in which highly toxic, carcinogenic, embryotoxic or gene-modifying substances, or infectious materials or agents, or materials or agents suspected of being infectious are handled.

See Merkblatt M 006 "Besondere Schutzmaßnahmen in Laboratorien".

Handling of biological agents, see UVV "Biotechnologie" (BGV B12 formerly VBG 102).

4.13.3

In laboratories in which no materials according to Chapters 4.13.1 and 4.13.2 are handled, the proprietor may designate areas in which the insured persons may place down and consume food and beverages.

4.13.4

Food and beverages may not be kept together with chemicals.

4.13.5

Food and beverages may not be prepared or kept in chemical or laboratory vessels. Food and beverages may only be warmed up with the appliances intended for this purpose. Only refrigerators which have been designated and marked for this purpose may be used for cooling food and beverages.

4.13.6

No vessels may be used for chemicals which are normally intended for food or beverages.

See Art. 48 UVV "Allgemeine Vorschriften" (VBG 1 bzw. GUV 0.1).

4.14 Smoking

There may be no smoking in the laboratory rooms.

4.15 Noise protection

Prior to acquiring new appliances the operator must obtain information concerning the noise emission to be expected from the appliance.

If appliances which produce a noise level of more than 85 dB(A) are operated for longer than only a brief period technical noise protective measures may be necessary.

See also UVV "Lärm" (BGV B3 formerly VBG 121 bzw. GUV 9.20) and the third ordinance to the Gerätesicherheitsgesetz.

4.16 Safety devices

4.16.1

Devices which serve the purpose of safety may not be made ineffective.

See Arts. 14 to 17 UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1).

4.16.2

The proprietor must take care that work on safety devices and their supply and disposal lines is performed only after prior consultation with the laboratory manager and that notices are placed on the safety devices for the duration of the work. He must take care that the insured persons are informed about the work. See also Chapter 3.5.

5 Hazardous work

5.1 Ascertaining the hazard

5.1.1

Before performing hazardous work the proprietor must ascertain and assess the related hazards and determine suitable measures for warding off the hazards. Not only the materials to be used are taken into account but also those materials which occur during the normal course of the reaction or an unexpected course of the reaction.

New materials for which there are neither toxicological data nor comparable compounds with known properties are to be handled with increased care.

See Art. 16 para. 4, Art. 28 and Annex V Gefahrstoffverordnung with the relevant Technischen Regeln für Gefahrstoffe, in particular TRGS 402 "Ermittlung und Beurteilung der Konzentrationen gefährlicher Stoffe in der Luft in Arbeitsbereichen".

Employment restrictions exist e.g. for young persons, expectant mothers, see Art. 15 b Gefahrstoffverordnung and Merkblatt M 039 "Fruchtschädigungen - Schutz am Arbeitsplatz".

5.1.2

The proprietor may charge hazardous work only to specialists or instructed persons who are aware of the related hazards and protective measures.

Specialists are considered to be those persons who on the basis of their specialist training, knowledge and experience as well as knowledge of the relevant regulations can assess the work charged to them and recognize possible hazards. Several years of work in the relevant field of work can also qualify for assessment of the specialist training.

An instructed person is a person who has been instructed, possibly in on-the-job training if necessary, as to the tasks charged to him/her and the possible hazards of improper conduct and has been instructed about the necessary protection devices and protective measures.

Hazardous work may e.g. be :

Work with carius tubes (Bombenrohr) and autoclaves, compressed-gas cylinders, compressed gases, vacuums, flammable liquids and with explosive materials and materials harmful to health.

See Art. 36 UVV "Allgemeine Vorschriften" (VBG 1 or GUV 0.1) and Chapters 4.1.3 and 4.3.4 of these Guidelines.

See also DIN VDE 1000 "Allgemeine Leitsätze für das sicherheitsgerechte Gestalten technischer Erzeugnisse".

5.2 Special protective measures

5.2.1

Hazardous chemical reactions must be conducted with special protective measures. The hazardous chemical reactions include e.g. nitrations, oxidations, polymerizations, diazotizations.

See also

L. Bretherick "Handbook of Chemicals" and "Manual of Hazardous Chemical Reactions" of the National Fire Protection Association,

L. Roth and U. Weller "Gefährliche chemische Reaktionen".

See also Chapters 3.7, 4.4, 4.9.5 and 5.4.1.

5.3 Handling of hazardous materials

5.3.1 Release of gases, vapours or suspended matter

5.3.1.1

Work during which gases, vapours or suspended matter can occur in hazardous concentrations or quantities may only be performed in fume cupboards. The front sliding panel is to be kept closed during such work.

The front sliding panel may be left open during work only in justified exceptions, as more hazardous material escapes while the front sliding panel is open and the person using the fume cupboard is not protected from splashing hazardous materials or flying broken glass.

Fume cupboards are suitable if they comply with Chapter 3.2.1 and DIN 12 924-1 and DIN 12 924-2.

Work in which oxygen concentrations of more than 21 volume percent can occur in the ambient air; see Chapter 6.3.2 of the Merkblatt "Umgang mit Sauerstoff" (BGI 617 vormals ZH 1/307).

See also Chapters 5.3.1.2 and 5.3.1.3.

In order to reduce emissions, noxious substances escaping in the fume cupboard are to be collected and removed at the site of escape or origin if possible.

5.3.1.2

Outside of the fume cupboards, work in which gases, vapours or suspended matter can occur in hazardous concentrations or quantities may only be performed if it is ensured by means of suitable measures or by the type of work that the insured persons are not endangered by these materials.

The suitable measures include e.g. the use of closed apparatuses, downstream cooling traps, gas washers or effective exhaust at source (local suction exhaust).

5.3.1.3

If gases, vapours or suspended matter occur unexpectedly and possibly in a hazardous concentration or quantity, the hazard area is to be evacuated and the surrounding vicinity alerted.

The removal of the hazardous situation may only take place in the presence of suitable protective measures.

See also Chapter [4.3.4](#).

5.3.2 Work with flammable materials

5.3.2.1

If the formation of hazardous explosive atmospheres while working with flammable liquids, gases or dusts cannot be prevented by means of primary protective measures, measures are to be conducted which prevent ignition.

The measures which prevent the formation of explosive atmospheres include e.g. the substitution of flammable by non-flammable solvents or by solvents with a flashpoint which is sufficiently above the room and processing temperature so as to be safe.

The measures which prevent the formation of explosive atmospheres in hazard-threatening quantities include e.g. the exhaust by suction of flammable gases, vapours or dusts at the site of origin or escape, work in fume cupboards according to DIN 12 924-1; see Chapter E 1 of the "Explosionsschutz-Richtlinien (EX-RL)" ([BGR 104](#) formerly ZH 1/10 bzw. GUV 19.8).

The measures which prevent ignition of explosive atmospheres are e.g. the avoidance of open flames, the use of explosion-protected electrical appliances, the avoidance of electrostatic charge; see Chapter E 2 of the "Explosionsschutz-Richtlinien (EX-RL)" ([BGR 104](#) formerly ZH 1/10 bzw. GUV 19.8) and Chapter 5.8.

See also Art. 44 UVV "Allgemeine Vorschriften" ([VBG 1](#) or GUV 0.1).

5.3.2.2

Open evaporation or heating of flammable liquids is to be avoided if possible. If flammable liquids must be evaporated or heated openly this may only take place in a closed fume cupboard.

The avoidance of sources of ignition is recommended as an additional protective measure.

The open evaporation or heating of flammable liquids is permissible e.g. in the case of small quantities in a test-tube, for officially prescribed, standardized or similarly determined examination methods.

5.3.2.3

When working with more than three litres of highly flammable or easily flammable liquids in thin-walled glass vessels a suitable collection pan with a honeycomb grid insert or a suitable special filling is to be used. If possible, additional protective measures are needed.

Additional protective measures may be:

- working in fume cupboards,
- automatic extinguishing systems,
- explosion-protected appliances,
- using thick-walled glass vessels.

See Chapter [4.5.4](#)

Measures against bumping, see Chapters [4.9.9](#) und [5.4.4.5](#).

5.3.2.4

Work with autoigniting materials must be performed in a fume cupboard. All flammable materials which are not needed immediately for continuation of the work are to be removed from the fume cupboard. Suitable extinguishing agents are to be held in readiness.

The autoigniting materials include e.g. metal alkyls, lithium aluminium hydride, silanes, white phosphorous.

Suitable extinguishing agents, see [Annex 1](#).

5.3.2.5

If during the course of a chemical reaction or distillation, signs of a beginning decomposition of the contents of the flask appear in the form of sudden foaming or evolution of gas, the endangered area is to be evacuated and the surrounding vicinity is to be alerted. The heating and the sources of ignition in the vicinity are to be switched off from a safe position.

Master shut-off device for fuel gases, see Chapter [3.4.2](#).

5.3.2.6

Liquids which tend to form organic peroxides must be examined for the presence of peroxides prior to distillation and evaporation, and the peroxides must be removed.

Numerous organic compounds tend to form peroxides e.g. decaline, diethyl ether, dioxane, tetrahydrofuran, also unsaturated hydrocarbons such as Tetralin, diene, cumol and aldehydes, ketones and solutions of these materials.

See also D. Bernabei "Sicherheit - Handbuch für das Labor".

In the distillation and evaporation residues of these liquids and solutions organic peroxides may enrich and decompose in the form of explosions.

5.3.2.7

Liquids which tend to form organic peroxides are to be stored protected from light, particularly from UV radiation.
However, this does not safely impede the formation of peroxides.

5.3.2.8

In the case of work in which ignition hazards exist in the form of electrostatic charges, suitable protective measures are to be taken.

Ignition hazards due to electrostatic charges may exist

- in the case of flammable liquids, during transfer from one container to another, rapid flow in hoses, or spraying,
- In the case of flammable dusts and granulates, e.g. during fluidizing, grinding, mixing, transporting, sieving, (in particular in applications engineering).

Suitable protective measures are e.g.:

- Earthing conductive vessels and appliances (e.g. funnels, siphons, hoses).
- While transferring electrostatically chargeable (non-conductive) liquids (e.g. petrol, toluene, ether, carbon disulphide) appliances and vessels are to be combined which are either only conductive or only non-conductive. No electrostatically chargeable (non-conductive) flammable liquids may be filled into vessels made of electrostatically chargeable (non-conductive) materials, e.g. plastic containers. Plastic containers with a nominal volume of up to five litres are an exception.
- Electrostatically chargeable, (non-conductive) liquids are to be poured out slowly and not in free fall, the funnel is to be held close to the bottom in order to largely avoid splashing of the liquid as it runs into the vessel.

See "Richtlinien für die Vermeidung von Zündgefahren infolge elektrostatischer Aufladungen" (BGR 132 formerly ZH 1/200 bzw. GUV 19.7) and the Merkblätter T 025 "Sicherer Umgang mit Flüssigkeiten, Teil 1: Umfüllen" and T 033 "Beispielsammlung zu den Richtlinien `Statische Elektrizität`".

5.3.3 Handling explosive materials

5.3.3.1

When working with explosive materials and mixtures thereof the relevant regulations are to be observed.

Explosive materials are, inter alia, numerous organic nitroso and nitro compounds, nitric acid ester, diazo compounds, hydrazoic acid, their salts and esters, salts of fulminic acid, of acetylene and its derivatives, heavy metal perchlorates, nitrogen chloride, organic peroxides and peroxy acids.

Mixtures of oxidizing compounds, e.g. nitrates, chromates, chlorates, perchlorates, fuming nitric acid, concentrated perchloric acid and hydrogen peroxide solutions (> 30 %) with flammable or reducing materials may have the properties of explosive materials, e.g. fuming nitric acid reacts explosively with acetone, ether, alcohol and oil of turpentine.

See

- Art. 2 of the first ordinance to the Sprengstoffgesetz,
- Art. 19 Para. 2 UVV "Explosivstoffe - Allgemeine Vorschrift" (BGV B5 formerly VBG 55a),
- UVV "Organische Peroxide" (BGV B4 formerly VBG 58).

5.3.3.2

Explosive materials and mixtures are to be handled in the smallest possible quantities and only in adequately protected workplaces. Overheating, proximity to flames, sparking, impact, friction and hazardous enclosure (damming) are to be avoided.

5.3.3.3

Stores of explosive materials and mixtures are to be kept as small as possible. They are to be kept safe from the influence of flames and heat, closed and removed from the workplaces, if at all possible in a separate room.

5.3.3.4

Ammoniacal solutions containing silver salt must be processed further immediately after preparation.

When working with ammoniacal solutions containing silver salt, it must be borne in mind that a black precipitate forms after some time partly consisting of silver fulminate and may explode violently if touched, stirred or shaken.

5.3.3.5

Acetylene may on no account come into contact with copper or copper alloys consisting of more than 70 % Cu. Parts of apparatus which come into contact with acetylene during chemical reactions may not consist of alloys even with a small copper content.

When working with acetylene it must be borne in mind that acetylene forms acetylides with many heavy metals and that these can explode very easily.

See Technische Regeln für Acetylenanlagen und Calciumcarbidlager TRAC 204 "Acetylenleitungen".

As regards personal protection equipment, see Chapter 8.

5.3.3.6

When handling perchloric acid it must be ensured that explosive perchlorates cannot form in an uncontrolled fashion.

This can take place e.g. with the effect of perchloric acid on wood (laboratory furniture).

For instance the fuming off of perchloric acid may require the use of fume cupboards according to DIN 12 924-2.

5.3.4 Filling and transportation of hazardous materials

5.3.4.1

When transferring hazardous materials out of barrels, carboys, cannisters or other containers, suitable devices are to be used.

This is to avoid the splashing or spillage of hazardous materials.

Suitable devices are e.g. pumps, carboy inclinators, safety siphons and self-closing valves.

See also Chapters [5.3.1.3](#), [5.3.2.1](#) and [5.3.2.8](#).

5.3.4.2

Containers in barrel or carboy inclinators must be secured from sliding out during tipping.

5.3.4.3

When filling into narrow-necked vessels, funnels are to be used and care is to be taken that the air can escape unimpaired during pouring.

See also Chapter [5.3.2.8](#).

5.3.4.4

Barrels and jugs for liquids may be emptied at an overpressure of up to 0.2 bar if

1. the barrel or the jug is suitable for the intended pressure load and the barrel or the jug is in perfect condition,
2. the pressure line in the case of use of overpressure of up to 0.2 bar is equipped with a pressure gauge and a safety valve or other safety device.

5.3.4.5

Only inert gases may be used to produce the overpressure when filling flammable liquids.

The inert gases include e.g. nitrogen and the noble gases.

See also Chapters [4.7.1](#), [4.7.3](#), [5.3.2.1](#) and [5.3.2.8](#).

5.3.4.6

Breakable vessels must be supported at the bottom of the vessel while carrying. Vessels which are removed from cooling appliances or cold rooms may be very smooth or slippery due to condensation.

5.3.4.7

Breakable vessels may only be transported into other rooms using aids which ensure safe holding and carrying.

These are e.g. buckets or carrier boxes.

5.4 Handling apparatuses

5.4.1 Autoclaves for experiments with unknown development

5.4.1.1

If experimental autoclaves made of glass are operated with non-flammable liquids or gases outside of special chambers (autoclave rooms) or not behind protective walls, suitable protection from broken glass is to be used.

In the case of experimental autoclaves made of glass it is to be expected that bursting may occur even due to tension caused by faulty assembly, by mechanical effects from outside or by local temperature peaks.

See also Chapters [3.7.2](#) and [11.4](#).

5.4.1.2

Experimental autoclaves made of glass may only be used with flammable liquids or gases in special chambers (autoclave rooms).

During experiments with flammable liquids or gases the bursting of autoclaves may lead to the violent formation of large quantities of explosive atmosphere.

See also Chapters [3.7.2](#) and [11.4](#).

5.4.2 Carius tubes, carius ovens (furnaces)

5.4.2.1

Carius tubes may only be used if they cannot be substituted by other less hazardous apparatuses.

Less hazardous apparatuses are e.g. exploratory bombs which can be screwed closed.

5.4.2.2

When carius tubes are melted closed, suitable protective measures are to be taken. Protective measures are considered e.g. the cooling of the samples, evacuation or inertization of the carius tube.

5.4.2.3

Carius tubes are to be placed in a steel shell immediately after being melted closed. After the experiment they may not be removed from the carius oven until they have completely cooled and then only in the protective shell.

5.4.2.4

Carius tubes may not be removed from the protective shell until they have been depressurized.

This is performed e.g. by melting open, beating off or pinching off the tip.

5.4.2.5

Carius ovens are to be set up in such a way that there can be no hazard to the insured persons if a carius tube bursts.

5.4.3 Compressed-gas cylinders and fittings

5.4.3.1

In order to avoid hazards, compressed-gas cylinders are to be set up outside of the laboratories, if at all possible, and the gases are to be led to the workplaces by stationary pipelines. If this is not possible, and compressed-gas cylinders have to be operated in laboratories with increased fire hazard, the compressed-gas cylinders are to be protected from excessive heating in the case of fire by means of special protective measures. If such protective measures are not possible or practicable, compressed-gas cylinders must be brought to a safe place after the end of work or after the end of a series of experiments.

Hazards occur e.g. in the case of fires owing to bursting or while transporting the cylinder.

Compressed-gas cylinders are to be protected as befits the possible fire hazard

- keeping them in cabinets according to DIN 12 925-2 "Laboreinrichtungen; Schränke für Druckgasflaschen; Sicherheitstechnische Anforderungen, Prüfung",
- keeping them in permanently ventilated gas cylinder cabinets according to the Technische Regeln Druckgase TRG 280 "Allgemeine Anforderungen an Druckgasbehälter; Betreiben von Druckgasbehältern",

- devices which automatically sprinkle compressed-gas cylinders with water (e.g. according to DIN 14 494 "Sprühwasserlöschanlagen, ortsfest, mit offenen Düsen"),
- installing compressed-gas cylinders behind fire-retardant partitions.

5.4.3.2

Laboratories in which compressed-gas cylinders are installed must be marked with the warning sign W 19 "Warnung vor Gasflaschen" ["Warning: Bottled gas"]. The sign must comply with UVV "Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz" (BGV A8 formerly VBG 125 bzw. GUV 0.7).

See also DIN 12 001-1 "Sicherheitszeichen im Labor; Warnung vor Gasflaschen".

5.4.3.3

Compressed-gas cylinders are to be secured from falling over and are to be protected from intense heating.

Compressed-gas cylinders may e.g. be secured by chains, pipe clamps or adjustment devices.

See also Technische Regeln Druckgase TRG 280 "Allgemeine Anforderungen an Druckgasbehälter; Betreiben von Druckgasbehältern";

See also Chapter 5.4.3.8.

5.4.3.4

Compressed-gas cylinders with highly toxic, toxic and carcinogenic gases must be provided with continuous exhaust if they are installed in the laboratory.

This is achieved e.g. by installing them in fume cupboards or in ventilated gas cylinder cabinets.

See Annex "Giftige Gase" of the UVV "Gase" (VBG 61 bzw. GUV 9.9).

5.4.3.5

For highly toxic, toxic and carcinogenic gases the smallest possible compressed-gas cylinders must be used.

"Lecture bottles" have proved suitable for this purpose.

5.4.3.6

Fittings, pressure gauges, seals and other parts for intensely oxidizing compressed gases must be kept free from oil, grease and glycerin. Nor may they be touched with cleaning cloths containing oil or with greasy fingers. Residues of solvents used for degreasing must be removed by blowing them off with oil-free air.

Intensely oxidizing compressed gases are e.g. oxygen, dinitrogen monoxide.

See Art. 12 UVV "Sauerstoff" (BGV B7 formerly VBG 62 or GUV 9.8).

5.4.3.7

For oxygen only such pressure gauges may be used which are marked in blue and read "Sauerstoff ! Öl- und fettfrei halten" ["Oxygen! Keep free from oil and grease"].

5.4.3.8

Local overheating must be avoided when evaporating liquefied gases by means of external warming. The temperature of the heating medium may not exceed 50 °C.

External heating can take place e.g. by moist, hot cloths, temperature-regulated water-baths, sprinkling with warm water.

5.4.3.9

When transferring gases in the liquid state into smaller compressed-gas cylinders overfilling must be securely avoided. The permissible filling level is to be checked by weighing the smaller compressed-gas cylinders.

Is this not possible, e.g. if a sample is withdrawn, a portion of the liquefied gas is to be released into an exhaust air line after filling.

See Technische Regeln Druckgase TRG 402 "Füllanlagen; Betreiben von Füllanlagen" with Annex 1 "Volumetrisches Füllen von Handwerkerflaschen mit Flüssiggas"

and

Merkblatt "Füllen von Druckbehältern mit Gasen" (BGI 618 formerly ZH 1/308).

5.4.3.10

Hoses for compressed gas are to be fastened securely in place and the hose connectors and hose connections are to be checked for tightness prior to commissioning. Firmly integrated hoses are to be preferred to hoses fastened onto hose nozzles with hose clips or hose binders.

The test of tightness can be conducted e.g. by using a suitable detergent solution.

See

DIN 4815-2 "Schläuche für Flüssiggas; Schlauchleitungen",

DIN 3017-1 "Schlauchschellen; Teil 1: Schellen mit Schneckentrieb; Form A",

DIN 32 620 "Schlauchbinder; Spanner und Band",

DIN EN 560 "Gasschweißgeräte; Schlauchanschlüsse für Geräte und Anlagen für Schweißen und verwandte Verfahren".

5.4.3.11

Valves of compressed-gas cylinders for flammable and combustible (oxidizing) gases are to be opened slowly.

This applies in particular to hydrogen, oxygen and fluoride.

This is to avoid the ignition of these gases and valve fires.

5.4.3.12

No torque-increasing tools may be used for opening the valves of compressed-gas cylinders.

5.4.3.13

Compressed-gas cylinders with valves which cannot be opened by hand are to be taken out of commission, marked accordingly and to be forwarded to the filling company.

5.4.3.14

Valves of compressed-gas cylinders are to be closed after use and also after emptying.

Emptied compressed-gas cylinders contain residual overpressure which is no longer sufficient to remove the gas. This residual overpressure must be maintained by closing the valve until the cylinder is delivered to the filling works. If the valve is left open, changes in temperature or air pressure may cause uncontrolled entry of air into the cylinder.

5.4.3.15

Gases may be fed into apparatuses only when it is ensured that no impermissible overpressure can build up in the apparatus.

Impermissible overpressure may e.g. build up when needle valves are used, as these are only "flow limiters" and not pressure reducers.

Safety immersion has proved useful.

See also Chapters [5.4.3.16](#), [5.3.1.2](#) and [5.3.1.3](#).

5.4.3.16

When feeding gases into liquids, equipment must be used which can safely prevent liquids from climbing back into the line or into the removal vessel.

Liquids can e.g. be prevented from climbing back by means of adequately dimensioned barrier vessels. When installing the barrier vessels, care must be taken that the correct direction of flow is observed.

5.4.3.17

Compressed-gas cylinders must, as far as possible, be operated with suitable pressure reducers.

Pressure reducers (pressure-reducing valves) are not available for all gases.

Needle valves are not pressure reducers; see explanation to Chapter [5.4.3.15](#).

5.4.3.18

Pressure gauges on pressure reducers may only be replaced by specialists. Screw connections of the pressure reducers which are not tight may only be tightened if the cylinder valve is closed.

Specialists are considered to be those persons who on the basis of their specialist training, knowledge and experience as well as knowledge of the relevant regulations can assess the work charged to them and recognize possible hazards. Several years of work in the relevant field of work can also qualify for assessment of the specialist training.

An instructed person is a person who has been instructed, possibly in on-the-job training if necessary, as to the tasks charged to him/her and the possible hazards of improper conduct and has been instructed about the necessary protection devices and protective measures.

See also Druckbehälterverordnung.

5.4.3.19

Before working with hazardous gases the apparatus is to be examined as to whether excess gas can escape only at the site intended for this purpose.

See Chapters [5.3.1.2](#) und [5.3.1.3](#).

5.4.3.20

Compressed-gas cylinders may only be transported with suitable aids and only with a safety cap.

Suitable aids are e.g. cylinder transport trolleys.

5.4.3.21

When working with compressed-gas cylinders attention is to be paid to the date when the next inspection is due.

If the inspection date has passed and the compressed-gas cylinders are in an apparently perfect condition they may continue to be used at the workplace for the purpose of emptying them.

If compressed-gas cylinders containing hazardous gases are not emptied after expiry of the inspection deadline and if they are to be transported e.g. to the filling works a special permit is necessary for their transport.

See also Gefahrgutverordnung Straße (GGVS).

5.4.4 Working with evacuated equipment

5.4.4.1

Thin-walled glass vessels may only be evacuated if they have a suitable shape for this purpose.

Suitable shapes are e.g. round-bottomed flasks, tapered flasks and condensers.

Erlenmeyer and flat-bottomed flasks e.g. are not suitable.

5.4.4.2

Evacuated glass vessels may not be heated on one side.

Glass breakage owing to tension in the glass can be prevented by even heating.

5.4.4.3

Before being evacuated, glass vessels are to be subjected to a visual check for damage which endangers their firmness.

Damage which endangers firmness includes e.g. so-called "asterisks".

5.4.4.4

Suitable measures are to be taken as protection from flying broken glass due to implosion.

The suitable measures include e.g. the use of protective windows, protective curtains - also on the rear side if necessary - and protective hoods or by working in the fume cupboard. Lining with plastic or sticking on adhesive film has proved suitable e.g. for exsiccators and suction bottles.

5.4.4.5

Care must be taken that no bumping takes place in the case of vacuum distillation. Capillaries for the suctioning through of air or inert gases or stirring have proved suitable.

See also Chapter 4.9.9.

5.4.4.6

During vacuum distillation vapours which have not condensed must be condensed out or removed without hazard by some other method.

Use of cooling traps, see Chapter 5.4.6.

5.4.4.7

During vacuum distillation the apparatus is to be evacuated prior to starting heating up and not vented until after it has cooled off. This must be possible without removing the safety devices.

See also Chapter 5.4.4.4.

5.4.4.8

If there is a hazard that the distillation residue will decompose in the presence of oxygen, only inert gas may be introduced to reduce tension.

5.4.5 Drying in heating cabinets

5.4.5.1

If products out of which hazardous explosive atmospheres can develop are dried in heating cabinets, explosion protective measures must be taken.

See Art. 44 UVV "Allgemeine Vorschriften" (VBG 1 bzw. GUV 0.1), Art. 6 UVV "Trockner für Beschichtungsstoffe" (BGV D24 formerly VBG 24) and DIN 12 880-1.

5.4.5.2

Heating cabinets from which gases, vapours or mists can escape in hazardous concentrations or quantities must be connected to a continuously effective venting system.

Special exhaust systems, see DIN 1946-7 "Raumluftechnik; Raumluftechnische Anlagen in Laboratorien (VDI - Lüftungsregeln)".

5.4.5.3

The drying of thermally unstable materials and of materials with easily inflammable components may only take place in heating cabinets with an additional temperature safety device. The set temperature of the temperature safety device must be below the decomposition or ignition temperature.

If the selected set temperature (working temperature), e.g. in case of failure of the temperature regulation device, is exceeded, the temperature safety device must switch off the heating permanently; see DIN 12 880-1.

In the case of thermally unstable materials the set temperature of the temperature safety device must be at least 20 % below the decomposition temperature and, in the case of easily inflammable materials, at least 20 % below the ignition temperature. The percentages given are with reference to the temperatures given in °C.

5.4.6 Deep cooling

5.4.6.1

When using a deep cooling bath of solid carbon dioxide and organic solvents the hazardous reaction with the coolant of the contents of the glass vessels to be cooled is to be avoided should the glass vessels break.

For instance acetone may not be used as a deep-cooling medium if liquids containing hydrogen peroxide are cooled. Upon breakage of the glass vessels explosive acetone peroxide may form and is sensitive to impact.

5.4.6.2

Solid carbon dioxide must be added carefully to the solvents.

Escaping carbon dioxide may cause the solvent to foam over very easily. This may lead to fires in the case of flammable solvents.

5.4.6.3

After use, the deep cooling baths are to be covered up immediately.

5.4.6.4

Dewar vessels may only be filled with liquefied gases in a dry and clean state.

5.4.6.5

If liquid nitrogen is used for the deep-cooling of organic substances the residence time of liquid nitrogen in open Dewar vessels must be limited. If oxygen is condensed into the liquid nitrogen, the Dewar vessel must be emptied out immediately.

A brief residence time prevents oxygen from condensing into the nitrogen after some time. Oxygen which has condensed in can be recognized by the slight blue colouration of the liquid nitrogen.

5.4.6.6

The use of liquid oxygen or liquid air for deep cooling is not permissible. Liquid air or liquid oxygen forms an explosive mixture together with organic substances.

5.4.6.7

For making low-temperature cooling baths only small portions of liquefied gases may stirred into the bath liquid.

Otherwise an explosion-like evaporation of the liquefied gas can occur.

5.4.7 Centrifuging

Operating instructions are to be prepared for the operation of centrifuges. Centrifuges may only be used by instructed persons.

A logbook is to be kept for ultracentrifuges. Insured persons using ultracentrifuges are to be recorded by name.

Attention is to be paid to the special hazards when handling easily and highly inflammable materials (explosion hazard).

See DIN 24 403 "Betriebsanleitungen für Zentrifugen; Hinweise für die Erstellung" and DIN EN 61 010-2-020/VDE 0411-2-020 "Sicherheitsbestimmungen für

elektrische Meß-, Steuer-, Regel- und Laborgeräte; Teil 2-020: Besondere Anforderungen an Laborzentrifugen (IEC 61010-2-020 : 1992, modifiziert)" und UVV "Zentrifugen" (VBG 7z bzw. GUV 3.16).

6 Handling of wastes

6.1 Collection, labelling and transport

6.1.1

The individual types of waste are to be collected separately so that hazardous reactions are ruled out. Containers are to be provided which are suitable in size and design for the collection of the individual types of waste and which can be transported safely by the employees. In particular, the containers must withstand the chemical and mechanical load to be expected from the goods to be filled into them. See Chapter 4.10.11 and Number 1.9 of the Technische Regeln für brennbare Flüssigkeiten TRBF 143 "Ortsbewegliche Gefäße".

6.1.2

Pointed, sharp or fragile objects may only be placed into stab-proof containers which keep their shape. These containers may only be emptied by being tipped out. Suitable protective gloves are to be worn for this purpose.

6.1.3

Collection containers for hazardous material wastes are to be kept in the laboratories in such a way that they do not impair the normal laboratory work.

In the provision and filling of these collection containers it is to be ensured that no gases or vapours containing noxious substances in hazardous concentrations or quantities can enter the laboratory air.

In order to avoid electrostatic charges, both the funnel and the collection container must be connected to a potential equalizer when filling in highly inflammable, easily inflammable or inflammable liquid hazardous material wastes. This does not apply to containers with a nominal volume of up to 5 litres.

In order to enable safe filling, the funnel should be connected firmly with the collection container when filling in the liquid hazardous material waste.

See Chapter 3.3.2.

6.1.4

Waste containers are to be labelled according to the Technische Regeln für Gefahrstoffe Kein SSI !!TRGS 201 "Kennzeichnung von Abfällen beim Umgang".

6.1.5

Waste containers for transport outside of the establishment must comply with the regulations for the transport of hazardous material.

6.2 Disposal of wastes

6.2.1

Wastes which cannot be disposed of by third parties owing to their chemical properties are to be destroyed without hazard in the laboratory or converted into a form which can be disposed of. Special operating instructions are to be prepared for this purpose.

See e.g. D. Bernabei "Sicherheit - Handbuch für das Labor", D. Reichard, W. Ochterbeck "Abfälle aus chemischen Laboratorien und medizinischen Einrichtungen" and L. Roth "Gefahrstoff-Entsorgung".

6.2.2

Emptied containers which contained hazardous materials, in particular flammable liquids, are to be cleaned sufficiently prior to being disposed of or used for some other purpose.

See also Chapter 4.11.1.

6.2.3

The disposal of hazardous wastes is to be performed at such time intervals that the storage, the transport and the destruction of these materials cannot cause a hazard. The workplaces are to be inspected at least once a year for hazardous wastes.

See also Chapter 4.10.14.

7 Clothing and footwear

7.1 Work clothes

7.1.1

When working in laboratories suitable work clothes are to be worn.

Suitable work clothes are e.g. a sufficiently long laboratory coat with long sleeves.

Street clothes are not considered suitable work clothes.

See also "Regeln für den Einsatz von Schutzkleidung" (BGR 189 formerly ZH 1/700) and Merkblatt M 006 "Besondere Schutzmaßnahmen in Laboratorien".

When working with biological agents and in case of infection hazards see UVV "Biotechnologie" (BGV B12 formerly VBG 102), Merkblatt B 002 "Sichere Biotechnologie; Laboratorien - Ausstattung und organisatorische Maßnahmen" (BGI

629 formerly ZH 1/342) and UVV "Gesundheitsdienst" (BGV C8 formerly VBG 103 or GUV 8.1).

When working with embryotoxic working materials see Merkblatt M 039 "Fruchtschädigungen - Schutz am Arbeitsplatz".

7.1.2

Work clothes made of commercially available fibres are permissible, provided no increased hazard for the insured person in case of fire is to be expected due to their burning or melting properties.

It is advisable to wear both clothing and underclothing made of fibres with such properties.

Protective clothing, see Chapter 8.4.

7.2 Footwear

In laboratories, only firm, closed and firmly treading footwear may be worn. See Art. 35 UVV "Allgemeine Vorschriften" (VBG 1 bzw. GUV 0.1).

8 Personal protection equipment

8.1 Eye protection

8.1.1

The proprietor must take care that all persons in the laboratories always wear framed glasses with adequate side protection. When performing work connected with special hazards for the eyes other suitable eye protection equipment must be worn in addition.

Protective glasses with additional covering for the upper eye area have proved useful.

Other suitable eye protection equipment includes e.g. basket glasses, facial protection shields.

See "Regeln für den Einsatz von Augen- und Gesichtsschutz" (BGR 192 formerly ZH 1/703).

8.1.2

If a hazard is to be expected when filling liquids, basket glasses are to be worn. It is recommended that a protective shield be worn as additional protection against splashing.

It is also advisable to wear suitable protective gloves and protective clothing.

See Chapter 8.1.1 and "Regeln für den Einsatz von Augen- und Gesichtsschutz" (BGR 192 formerly ZH 1/703), "Regeln für den Einsatz von Schutzhandschuhen" (BGR 195 formerly ZH 1/706)

and

"Regeln für den Einsatz von Schutzkleidung" (BGR 189 formerly ZH 1/700).

In certain cases respiratory devices may be necessary; see "Regeln für den Einsatz von Atemschutzgeräten" (BGR 190 formerly ZH 1/701) and Merkblatt "Ätzende und reizende Stoffe" (BGI 595 formerly ZH 1/229).

When filling materials for daily use, e.g. from laboratory storage bottles, a hazard is generally not to be expected.

8.1.3

If caustic burns are to be expected when opening drums, face and hand protection is to be worn in addition to the protective glasses.

Danger of caustic burns exists e.g. when opening drums with bulges or closures which are stuck - also of laboratory storage bottles for daily use.

See "Regeln für den Einsatz von Augen- und Gesichtsschutz" (BGR 192 formerly ZH 1/703) and "Regeln für den Einsatz von Schutzhandschuhen" (BGR 195 formerly ZH 1/706).

8.2 Hand protection

When performing work connected with particular hazards for the hands, suitable protective gloves must be worn. These must be selected in accordance with their application and checked for damage each time before they are worn. Damaged gloves or gloves which have otherwise become unusable are to be replaced immediately.

Hazards for the hands can also exist during cleaning work.

Many hazardous materials may diffuse into the glove material. The protective gloves are therefore to be selected according to the manufacturer's information concerning their robustness.

See "Regeln für den Einsatz von Schutzhandschuhen" (BGR 195 formerly ZH 1/706).

See also Art. 14 UVV "Allgemeine Vorschriften" (VBG 1 bzw. GUV 0.1).

8.3 Respiratory devices

If hazardous materials can occur unexpectedly in hazardous concentrations suitable respiratory devices are to be held in readiness. The wearing of respiratory devices must not be a permanent measure.

The unexpected occurrence of hazardous materials in hazardous concentrations is e.g. to be expected when hazardous materials are spilt.

When handling highly toxic gases it may be necessary

- to carry escape equipment (e.g. filter escape equipment)
- to place escape equipment ready in adequate numbers near hazardous locations

or

- to use respiratory devices.

See "Regeln für den Einsatz von Atemschutzgeräten" (BGR !)= formerly ZH 1/701).

8.4 Protective clothing

The proprietor must provide suitable clothing for the respective activity; the insured persons must use this clothing.

Suitable protective clothing for increased fire hazard consists e.g. of poorly inflammable fibres or cotton which has been treated so as to be sufficiently flame-resistant.

It is necessary that the clothing worn beneath the protective clothing consist of textiles which do not melt; see also Chapter 7.1.

Suitable protective clothing for handling larger quantities of caustic liquids consists e.g. of rubberized or PVC-coated fabric.

Suitable protective clothing for medical laboratories, see Art. 7 UVV "Gesundheitsdienst" (BGV C8 formerly VBG 103 or GUV 8.1).

As regards the obligation to wear the protective clothing see Art. 14 UVV "Allgemeine Vorschriften" (VBG 1 or GUV 0.1).

9 Fire protection

9.1 Fire extinguishing facilities

The proprietor must provide equipment in accordance with Annex 1 to extinguish fires in laboratories. The locations at which the fire extinguishing devices are situated are to be marked by the fire-fighting sign F04 "Feuerlöschgerät" [fire extinguisher]. The sign must comply with the UVV "Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz" (BGV A8 formerly VBG 125 or GUV 0.7). The access to the fire extinguishing devices is always to be kept free.

See also Art. 43 UVV "Allgemeine Vorschriften" (VBG 1 or GUV 0.1), und "Regeln für die Ausrüstung von Arbeitsstätten mit Feuerlöschern" (BGR 133 formerly ZH 1/201 or GUV 10.10).

9.2 Conduct in case of fire

9.2.1

The proprietor must set up an alarm plan for the case of fire
See Art. 55 Arbeitsstättenverordnung and Art. 43 para. 6 UVV "Allgemeine Vorschriften" (VBG 1 bzw. GUV 0.1).

9.2.2

The insured persons are to be familiarized with the handling of the available fire extinguishers within the framework of repeated instruction events and practical exercises.

See Art. 43 para. 6 of the UVV "Allgemeine Vorschriften" (BGV A1 formerly VBG 1 or GUV 0.1) and Chapter 4.3.

9.2.3

In case of fire the fire brigade is to be notified immediately. Upon its arrival it is to be guided by persons with a knowledge of the locality and of the incident. Until such time as the fire brigade arrives the fire is to be combatted with the available fire extinguishers, provided this is possible without hazard. All persons not needed for extinguishing work or rescue measures must leave the hazard area.
Extinguishing agents for fires, see Annex 1.

9.2.4

Clothing fires are to be extinguished with suitable fire extinguishers or emergency showers. In the event of a fire the first available fire extinguisher is to be used. For instance powder and carbon dioxide extinguishers have proved suitable.

In case of extinguishing measures it must be borne in mind that persons who have caught fire tend to flee in panic.

10 First aid

10.1

First aid measures must be directed towards the possible injuries and damage to health occurring in laboratories.

These include e.g. measures for caustic burns of the eyes, caustic burns of the skin, cuts, burns, and scalding.

See also UVV "Erste Hilfe" (BGV A5 formerly VBG 109 or GUV 0.3).

10.2

The proprietor must display the first aid guides approved by the Berufsgenossenschaft at suitable locations in accordance with respective hazards. The notices must contain at least information as to the emergency telephone number, first aid facilities and personnel, doctor and hospital. The entries are to be kept up to date.

See Art. 10 para. 2 UVV "Erste Hilfe" (BGV A5 formerly VBG 109 or GUV 0.3),

"Anleitungen zur Ersten Hilfe bei Unfällen" (BGI 510-1 formerly ZH 1/144 or GUV 30.1),

"Merkblatt für die Erste Hilfe bei Einwirken gefährlicher chemischer Stoffe (ZH 1/175),

and

"Erste Hilfe bei erhöhter Einwirkung ionisierender Strahlen" (BGI 668 formerly ZH 1/546 bzw. GUV 20.22).

10.3

The proprietor must take care that sufficient dressing material, the necessary appliances and, for handling highly toxic and toxic materials, antidotes against possible intoxication are held in readiness in the first aid box or first aid cabinets in so far as this may be used for first aid measures without the participation of a doctor. Aids which are only to be used by a doctor are to be kept separately under lock and key.

For the contents of the first aid boxes see implementation instructions Art. 6 UVV "Erste Hilfe" (BGV A5 formerly VBG 109 bzw. GUV 0.3)

and

"Merkblatt für Erste-Hilfe-Material" (BGI 512 formerly ZH 1/146).

See also Merkblätter of the Berufsgenossenschaft der chemischen Industrie concerning hazardous working materials.

10.4

Items of clothing contaminated with hazardous materials, also underclothing, socks, shoes are to be removed immediately. Contaminated items of clothing are to be treated so that they do not endanger any other persons.

If necessary the items of clothing are to be precleaned or disposed of.

10.5

Parts of the body which have come into contact with hazardous materials are to be washed thoroughly immediately.

See Chapter 3.5.

10.6

In the event of the action or suspected action of materials hazardous to health, the affected persons are to be presented to the doctor immediately; the superior staff member is to be notified immediately in any case.

It may be expedient to transport the person concerned in a lying position; after breathing in e.g. ammonia, chloride, nitrous gases, phosgene, transportation in the

lying position is necessary even if the persons are apparently able to walk. The doctor is to be informed about the type of action of the material, e.g. by telephoning, accompanying note or accompanying person who knows about the incident.

See also Art. 13 UVV "Erste Hilfe" (BGV A5 formerly VBG 109 bzw. GUV 0.3).

10.7

In the event of recurrent health disorders and the occurrence of skin irritation and rashes the superior is to be informed, if it is suspected that this may be due to the effect of hazardous materials at the workplace.

11 Inspections

See also Chapter 2.3.

11.1 Gas fittings and lines

The proprietor must have the gas fittings and lines inspected by a qualified person prior to initial commissioning and, after refitting, prior to recommissioning unless type-tested devices are used.

A qualified person is one who, owing to his technical training and experience, possesses sufficient knowledge in the area of gas fittings and lines and is familiar with the relevant official industrial safety regulations, accident prevention regulations, guidelines and generally recognized rules of engineering (e.g. DIN standards, VDE regulations, Technische Regeln of other Member States of the European Union or other states party to the Agreement on the European Economic Area) to such an extent that he can assess the state of the gas fittings and lines from the point of view of industrial safety.

See DVGW Arbeitsblatt G 621 "Gasanlagen in Laboratorien und naturwissenschaftlich-technischen Unterrichtsräumen; Installation und Betrieb".

In case of consumers using liquefied gas see UVV "Verwendung von Flüssiggas" (BGV D34 formerly VBG 21).

11.2 Emergency showers

The proprietor must take care that showers and eye-wash stands are checked for their functioning order at least once a month by a person appointed by him.

See also Art. 39 UVV "Allgemeine Vorschriften" (VBG 1 or GUV 0.1).

11.3 Electrical systems and appliances

The proprietor must take care that electrical appliances in the laboratories are inspected at regular intervals.

See also Art. 5 UVV "Elektrische Anlagen und Betriebsmittel" (BGV A2 formerly VBG 4 or GUV 2.10).

11.4

Pressure vessels and experimental autoclaves (including glass)

Pressure vessels must be inspected in accordance with Art. 31

Druckbehälterverordnung by the expert or in accordance with Art. 32

Druckbehälterverordnung by the qualified person. Attention is to be paid here to the special regulations of the Technische Regeln Druckbehälter TRB 801 "Besondere Druckbehälter nach Anhang II zu Art. 12 DruckbehV", in particular No. 38 "Versuchsautoklaven" and No. 32 "Druckbehälter aus Glas".

According to Art. 32 Druckbehälterverordnung the qualified person must be able to present a certificate of successful participation in a state or state-recognized course.

Inspection of pipes, see Chapter 5 Druckbehälterverordnung.

11.5 Fume cupboards

Fume cupboards must be serviced at regular intervals and their function tested and documented. The inspection must be conducted at least once a year by a qualified person. The annual inspection of the ventilation function may be dispensed with if it ensured by means of continuous monitoring of the individual fume cupboard that any failure to achieve the minimum volume rate is signaled visually and acoustically.

See § 53 para. 2 of the "Arbeitsstättenverordnung" and § 39 para. 3 UVV "Allgemeine Vorschriften" (VBG 1 or GUV 0.1).

A qualified person is one who, owing to his technical training or experience, possesses sufficient knowledge in the area of inspection of fume cupboards and is familiar with the relevant state industrial safety regulations, accident prevention regulations, guidelines and generally recognized rules of engineering (e.g. DIN standards, VDE regulations, Technische Regeln of other Member States of the European Union or other states party to the Agreement on the European Economic Area) to such an extent that he can assess the state of fume cupboards from the point of view of industrial safety.

A technical device used for continuous monitoring signals, e.g. in the case of contamination, corrosion, stress due to chemicals, aging or in case of faults in the electronic system, the non-availability of the monitoring system by means of visual and acoustic error signals.

If appropriate after modification of the ventilation system (e.g. if the volume rates are influenced) a renewed inspection may be necessary.

The regular inspection comprises

- the general visual inspection of the state of the fume cupboard from the point of view of safety,
- the inspection of the sash mechanism for easy running, jamming and noise; if appropriate, cords and weights are also to be inspected for damage depending on the operating conditions,

- the inspection of the ventilation function on the basis of the manufacturer's information; for fume cupboards commissioned before 1 October 1993 the following definitions apply alternatively:
 - bench-top fume cupboards (height of work surface 900 mm) require 400 m³/h air volume rate per metre of front length,
 - low-ceiling fume cupboards (height of work surface 500 mm) require 600 m³/h air volume rate per metre of front length,
 - walk-in fume cupboards (height of work surface 0 mm) require 700 m³/h air volume rate per metre of front length,
 - digestion fume cupboards (height of work surface 900 mm) require 700 m³/h air volume rate per metre of front length.

The regular inspection of the ventilation function may take place in the form of the differential pressure or velocity measurement in the ventilation nozzles above the fume cupboard or at the opening of the sash. The velocity measurement may take place by determining the mean inflow velocity when the sash is opened to a height of 100 mm. Suitable measuring instruments are, for instance, thermal or hydrometric vanes.

The inspection of the ventilation function of fume cupboards installed before 1 October 1993 and manufactured in accordance with DIN 12924-1 of August 1991 or DIN 12924-2 of January 1994 is conducted on the basis of the manufacturer's specifications.

12 Time of application

12.1

These Guidelines are to be applied as of 1 October 1993. They supersede the "Richtlinien für Laboratorien" (ZH 1/119) of 1 April 1982.

12.2

Notwithstanding Chapter 12.1 the regulations of Chapters 3.2.1.3, 3.2.1.8, 3.3.1, 3.3.2 and 3.4.5.1 for laboratories are not to be used for laboratories set up before 1 October 1993.

12.3

Notwithstanding Chapter 12.1 the provisions of Chapters 3.2.2, 3.4.5.2, 3.5.1.1, 3.5.2 and 3.6.3.3 are to be applied as of 1 October 1996.

12.4

Notwithstanding Chapters 12.1 and 12.3 doors of laboratories which have been installed prior to 1 April 1982 are also permissible without a window (see Chapter 3.1.3).

Annex 1

Extinguishing agents for fires in laboratories

In order to effectively combat fires in laboratories the correct choice of the extinguishing agent is of decisive importance. It depends on the type and the properties of the burning materials. The DIN EN 2 "Brandklassen" and DIN EN 3 "Tragbare Feuerlöscher" are to be observed.

1. Portable fire extinguishers must be on hand in laboratories for fighting fires.
2. In addition it may be necessary to provide fire blankets according to DIN 14 155 "Löschdecke", extinguishing sand, special extinguishing agents and objects for covering up the fire. Fire blankets alone are not sufficient for combatting fire involving persons. See also "Regeln für die Ausrüstung von Arbeitsstätten mit Feuerlöschern" (BGR 133 formerly ZH 1/201).
3. In most cases, carbon dioxide extinguishers are sufficient for combatting fires in laboratories. They leave no residues and therefore do not dirty the room, they leave no damage to sensitive equipment, are chemically almost indifferent and can also be used for electrical equipment.
4. Fires of alkaline metals, metal alkyls, lithium aluminum hydride, silanes, and similar substances may on no account be combatted with water or foam extinguishers. A suitable extinguishing agent is for instance for sodium fire extinguishing sand or metal fire powder.
5. Carbon dioxide or extinguishing powder, for electrical equipment under voltage carbonic acid is to be used for flammable liquids.
6. Fires of liquefied or densified gases escaping from compressed-gas cylinders are always to be extinguished by closing the valves of the cylinders (interrupting the supply of gas). If this emergency measure cannot be conducted without hazard (e.g. in the case of fires in the area of the cylinder valves) the fire is to be combatted with powder or carbon dioxide fire extinguishers in order to close the cylinder valves immediately after extinguishing.

Caution: compressed-gas cylinders exposed to the effects of fire are to be taken out of operation, labelled accordingly and forwarded to the filling works. Compressed-gas cylinders warmed by the effect of fire are to be cooled with water from a protected position. In the case of very warm cylinders (recognizable by steaming water!) the vicinity is to be evacuated immediately owing to the possible explosion hazard.

Annex 2

Regulations and Rules

The particularly relevant rules and regulations to be observed are listed below; see also Chapter 2.2:

1.Laws/ordinances

Source: bookshops or Carl Heymanns Verlag KG, Luxemburger Straße 449, 50939 Köln

- Gesetz zum Schutz vor gefährlichen Stoffen (Chemikaliengesetz - ChemG)
 - (Law on Protection from Hazardous Materials (Chemicals Law))
- Gesetz zur Neuordnung des Betäubungsmittelrechts
 - (Law on the Reorganisation of the Law on Narcotics)
- Gesetz über technische Arbeitsmittel (Gerätesicherheitsgesetz)
 - (Law on Technical Work Aids (Appliance Safety Law))
- Gesetz über explosionsgefährliche Stoffe (Sprengstoffgesetz - SprengG)
 - (Law on Explosible Materials (Explosibles Law))
- Gesetz zur Regelung von Fragen der Gentechnik (Gentechnikgesetz - GenTG)
 - (Law for the Regulation of Matters of Genetic Engineering (Genetic Engineering Law))
- Gesetz zum Schutz der arbeitenden Jugend (Jugendarbeitsschutzgesetz - JArbSchG)
 - (Law for the Protection of Working Youth (Youth Industrial Protection Law))
- Gesetz zum Schutze der erwerbstätigen Mutter (Mutterschutzgesetz - MuSchG)
 - (Law for the Protection of the Working Mother (Maternal Protection Law))
- Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf Straßen (Gefahrgutverordnung Straße - GGVS)
 - (Ordinance on the Domestic and International Transport of Hazardous Materials by Road (Hazmat Ordinance Road))
- Erste Verordnung zum Sprengstoffgesetz (1. SprengV)
 - (First Ordinance for the Explosives Law)
- Zweite Verordnung zum Sprengstoffgesetz (2. SprengV)
 - (Second Ordinance for the Explosives Law)
- Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung - StrlSchV)
 - (Ordinance on Protection from Damage Caused by Ionizing Rays (Radiation Protection Ordinance))
- Verordnung über Druckbehälter, Druckgasbehälter und Füllanlagen (Druckbehälterverordnung - DruckbehV)
 - (Ordinance on Pressure Vessels, Pressurized Gas Vessels and Filling Equipment (Pressure Vessels Ordinance))
- with the relevant Technische Regeln Druckbehälter
 - (Technical Rules for Pressure Vessels)
- TRB 801 "Besondere Druckbehälter nach Anhang II zu § 12 DruckbehV"
 - (TRB 801 Special Pressure Vessels Pursuant to Annex II to Sect. 12 of the Pressure Vessels Ordinance)

- Technische Regeln Druckgase (TRG)
 - (Technical Rules for Pressurized Gases (TRG)), especially
 - TRG 280 "Allgemeine Anforderungen an Druckgasbehälter; Betreiben von Druckgasbehältern" (General Requirements for Pressurized Gas Vessels; Operation of Pressurized Gas Vessels)
 - TRG 402 "Füllanlagen; Betreiben von Füllanlagen" (Operation of Filling Equipment) with Annex 1 "Volumetrisches Füllen von Handwerkerflaschen mit Flüssiggas" (Volumetric Filling of Craftsman's Cylinders with Liquefied Gas)
- Verordnung über Anlagen zur Lagerung, Abfüllung und Beförderung brennbarer Flüssigkeiten zu Lande (Verordnung über brennbare Flüssigkeiten - VbF)
 - (Ordinance on Equipment for the Storage, Filling and Transport of Flammable Liquids over Land (Ordinance on Flammable Liquids - VbF))

with the relevant Technische Regeln für brennbare Flüssigkeiten (TRbF) (Technical Rules for Flammable Liquids), especially

- TRbF 100 "Allgemeine Sicherheitsanforderungen" (General Safety Requirements)
 - TRbF 110 "Läger" (Stores)
 - TRbF 143 "Ortsbewegliche Gefäße" (Transportable Vessels)
- Verordnung über Acetylenanlagen und Calciumcarbidlager (Acetylenverordnung - AcetV)
 - (Ordinance on Acetylene Installations and Calcium Carbide Stores (Acetylene Ordinance))

with the relevant Technische Regeln für Acetylen und Calciumcarbidlager (Technical Rules for Acetylene and Calcium Carbide Stores)

- TRAC 204 "Acetylenleitungen" (Acetylene Lines)
- Verordnung über Sicherheitsstufen und Sicherheitsmaßnahmen bei gentechnischen Arbeiten in gentechnischen Anlagen (Gentechnik-Sicherheitsverordnung - GenTSV)
 - (Ordinance on Safety Stages and Safety Measures for Genetic Engineering Work in Genetic Engineering Installations (Genetic Engineering Safety Ordinance))
 - Berufskrankheiten-Verordnung
 - (Industrial Illnesses Ordinance)
 - Dritte Verordnung zum Gerätesicherheitsgesetz (Maschinenlärminformations-Verordnung - 3.GSGV)
 - (Third Ordinance to the Appliance Safety Law (Machine Noise Information Ordinance))
 - Verordnung über Arbeitsstätten (Arbeitsstättenverordnung - ArbStättV)
 - (Ordinance on Places of Work (Workplace Ordinance))

with the relevant Arbeitstätten-Richtlinien (ASR); especially

- ASR 8/1 "Fußböden"
(Floors)
- ASR 10/1 "Türen und Tore"
(Doors and gates)
- ASR 10/5 "Glastüren; Türen mit Glaseinsatz"
(Glass doors; doors with glass panes inserted)

- Verordnung über gefährliche Stoffe (Gefahrstoffverordnung - GefStoffV)
 - (Ordinance on Hazardous Materials)
- with the relevant Technische Regeln für Gefahrstoffe (TRGS)
 - (Technical Rules for Hazardous Materials), especially

TRGS "Auslöseschwelle für gefährliche Stoffe"
100 (Trigger threshold for hazardous materials)

TRGS "Einstufung von Stoffen, Zubereitungen und Erzeugnissen"
200 (Classification of substances, preparations and products)

TRGS "Ermittlung und Beurteilung der Konzentrationen gefährlicher Stoffe
402 in der Luft in Arbeitsbereichen"
(Determination and assessment of concentrations of hazardous materials in the air in work areas)

TRGS "Lagern sehr giftiger und giftiger Stoffe in Verpackungen und
514 ortsbeweglichen Behältern"
(Storage of highly toxic and of toxic materials in packages and movable vessels)

TRGS "Betriebsanweisung und Unterweisung nach § 20 GefStoffV"
555 (Operating instruction and guidance pursuant to § 20 of the Ordinance on Hazardous Materials (GefStoffV))

TRGS "Luftrückführung beim Umgang mit krebserzeugenden
560 Gefahrstoffen"
(Recirculation of air in the handling of carcinogenic hazardous materials)

TRGS "Grenzwerte in der Luft am Arbeitsplatz; Luftgrenzwerte" (ZH
900 1/401)
(Limits in the air at the workplace; limits for the air)

2. Accident prevention regulations

Sources:

- a) for the accident prevention regulations of BG Chemie: Jedermann-Verlag, Postfach 10 31 40, 69021 Heidelberg
- b) for all other VBG regulations: Carl Heymanns Verlag KG, Luxemburger Straße 449, 50939 Köln
- c) GUV regulations: Bundesverband der Unfallkassen e.V., Fockenstraße 1, 81539 München

- Allgemeine Vorschriften (BGV A1 formerly VBG 1 or GUV 0.1)
 - (General regulations)
- Elektrische Anlagen und Betriebsmittel (BGV A2 formerly VBG 4 or GUV 2.10)
 - (Electrical systems and appliances)
- Zentrifugen (VBG 7z or GUV 3.16)
 - (Centrifuges)
- Verwendung von Flüssiggas (BGV D34 formerly VBG 21)
 - (Use of liquefied gas)
- Trockner für Beschichtungsstoffe (BGV D24 formerly VBG 24)
 - (Driers for coating materials)
- Explosivstoffe - Allgemeine Vorschrift (BGV B5 formerly VBG 55a)
 - (Explosive substances - general regulation)
- Organische Peroxide (BGV B4 formerly VBG 58)
 - (Organic peroxides)
- Gase (BGV B6 formerly VBG 61 or GUV 9.9)
 - (Gases)
- Sauerstoff (BGV B7 formerly VBG 62 or GUV 9.8)
 - (Oxygen)
- Leitern und Tritte (BGV D36 formerly VBG 74 or GUV 6.4)
 - (Ladders and step-ladders)
- Biotechnologie (BGV B12 formerly VBG 102)
 - (Biotechnology)
- Gesundheitsdienst (BGV C8 formerly VBG 103 or GUV 8.1)
 - (Health service)
- Erste Hilfe (BGV A5 formerly VBG 109 or GUV 0.3)
 - (First aid)
- Umgang mit krebserzeugenden Gefahrstoffen (VBG 113)
 - (Handling carcinogenic hazardous materials)
- Lärm (BGV B3 formerly VBG 121 or GUV 9.20)
 - (Noise)
- Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz (BGV A8 formerly VBG 125 or GUV 0.7)
 - (Safety and health-protection marking at the workplace)

3. Guidelines, safety rules, principles, "Merkblatts" (instruction sheets) and other publications by the Berufsgenossenschaft

Sources:

a) for the guidelines, instruction sheets etc. of BG Chemie:
Jedermann-Verlag, Postfach 10 31 40, 69021 Heidelberg

b) for all other publications:

Carl Heymanns Verlag KG, Luxemburger Straße 449, 50939 Köln

- Richtlinien für die Vermeidung der Gefahren durch explosionsfähige Atmosphäre mit Beispielsammlung - Explosionsschutz-Richtlinien - (EX-RL) (BGR 104 formerly ZH 1/10 or GUV 19.8)
 - (Guidelines for avoiding hazards due to explosible atmosphere with collection of examples - explosion protection guidelines)

- Richtlinien für die Vermeidung von Zündgefahren infolge elektrostatischer Aufladungen (Richtlinien "Statische Elektrizität") (BGR 132 formerly ZH 1/200 or GUV 19.7)
 - (Guidelines for avoiding ignition hazards due to electrostatic charges)
- Richtlinien für die Verwendung von Flüssiggas (ZH 1/455 or GUV 19.9)
 - (Guidelines for using liquefied gas)
- Regeln für die Ausrüstung von Arbeitsstätten mit Feuerlöschern (BGR 133 formerly ZH 1/201 or GUV 10.10)
 - (Rules for furnishing places of work with fire extinguishers)
- Regeln für den Einsatz von Schutzkleidung (BGR 189 formerly ZH 1/700)
 - (Rules for the use of protective clothing)
- Regeln für den Einsatz von Atemschutzgeräten (BGR 190 formerly ZH 1/701)
 - (Rules for the use of respiratory devices)
- Regeln für den Einsatz von Augen- und Gesichtsschutz (BGR 192 formerly ZH 1/703)
 - (Rules for the use of protection devices for the eyes and face)
- Regeln für den Einsatz von Schutzhandschuhen (BGR 195 formerly ZH 1/706)
 - (Rules for the use of protective gloves)
- Merkblatt: Betriebsanweisungen für den Umgang mit Gefahrstoffen (BGI 566 formerly ZH 1/124)
 - (Instruction sheet: Operating instructions for working with hazardous chemicals)
- Merkblatt: Quecksilber und seine Verbindungen (ZH 1/125)
 - (Instruction sheet: mercury and its compounds)
- Merkblatt: Dimethylsulfat (BGI 568 formerly ZH 1/128)
 - (Instruction sheet: dimethylsulphate)
- Merkblatt: Cyanwasserstoff (Blausäure), Cyanide (BGI 529 formerly ZH 1/129.1)
 - (Instruction sheet: hydrogen cyanide (prussic acid), cyanides)
- Merkblatt: Hautschutz (ZH 1/132)
 - (Instruction sheet: skin protection)
- Anleitung zur Ersten Hilfe bei Unfällen (BGI 510-1 formerly ZH 1/144 or GUV 30.1)
 - (Instructions for first aid in case of accidents)
- Merkblatt: Fluorwasserstoff, Flußsäure und anorganische Fluoride (BGI 576 formerly ZH 1/161)
 - (Instruction sheet: hydrogen fluoride, hydrofluoric acid and inorganic fluorides)
- Merkblatt für die Erste Hilfe bei Einwirken gefährlicher chemischer Stoffe (ZH 1/175)
 - (Instruction sheet for first aid in case of effects of hazardous chemical substances)
- Merkblatt: Salpetersäure, Stickstoffoxide, Nitrose Gase (BGI 591 formerly ZH 1/214)
 - (Instruction sheet: nitric acid, nitrogen oxides, nitrous gases)
- Merkblatt: Reizende Stoffe/Ätzende Stoffe (BGI 595 formerly ZH 1/229)
 - (Instruction sheet: irritant substances/caustic substances)
- Merkblatt: Chlor (BGI 596 formerly ZH 1/230)
 - (Instruction sheet: chlorine)

- Merkblatt: Arsen und seine Verbindungen (ausgenommen Arsenwasserstoff) (ZH 1/236)
 - (Instruction sheet: arsenic and its compounds (except arsane))
- Merkblatt: Phthalsäureanhydrid und Maleinsäureanhydrid (ZH 1/287)
 - (Instruction sheet: phthalic anhydride and malic anhydride)
- Merkblatt: Formaldehyd (BGI 614 formerly ZH 1/296)
 - (Instruction sheet: formaldehyde)
- Merkblatt: Organo-Zinnverbindungen (ZH 1/297)
 - (Instruction sheet: organotin compounds)
- Merkblatt: Phosgen (BGI 615 formerly ZH 1/298)
 - (Instruction sheet: phosgene)
- Merkblatt: Acrylnitril (BGI 616 formerly ZH 1/302)
 - (Instruction sheet: acrylonitrile)
- Merkblatt: Umgang mit Sauerstoff (BGI 617 formerly ZH 1/307)
 - (Instruction sheet: handling of oxygen)
- Merkblatt: Füllen von Druckbehältern mit Gasen (BGI 618 formerly ZH 1/308)
 - (Instruction sheet: filling of pressurized vessels with gases)
- Merkblatt: Phenol, Kresole und Xylenole (ZH 1/314)
 - (Instruction sheet: phenol, cresols and xylenols)
- Merkblatt: Brom (BGI 625 formerly ZH 1/334)
 - (Instruction sheet: bromine)
- Merkblatt: Sichere Biotechnologie; Laboratorien - Ausstattung und organisatorische Maßnahmen (BGI 629 formerly ZH 1/342)
 - (Instruction sheet: safe biotechnology; laboratories - equipment and organisational measures)
- Erste Hilfe bei erhöhter Einwirkung ionisierender Strahlung (BGI 668 formerly ZH 1/546)
 - (First aid in case of the increased effect of ionizing rays)

Source: Berufsgenossenschaft der chemischen Industrie, Kurfürsten-Anlage 62, 69115 Heidelberg

- Merkblatt: Besondere Schutzmaßnahmen in Laboratorien (M 006)
 - (Instruction sheet: special protective measures in laboratories)
- Merkblatt: Betriebsanweisungen (A 010)
 - (Instruction sheet: operating instructions)
- Merkblatt: Sicherer Umgang mit Flüssigkeiten; Teil 1: Umfüllen (T 025)
 - (Instruction sheet: safe handling of liquids; Part 1: Filling)
- Merkblatt: Beispielsammlung zu den Richtlinien "Statische Elektrizität" (T 033)
 - (Instruction sheet: collection of examples on the guidelines "Static Electricity")
- Merkblatt: Fruchtschädigungen - Schutz am Arbeitsplatz (M 039)
 - (Instruction sheet: embryonic damage - protection at the workplace)

Source: Berufsgenossenschaft für Gesundheitsdienst und Wohlfahrtspflege, Pappelallee 35/37, 22089 Hamburg

- Merkblatt: Richtig pipettieren (M 651)
 - (Instruction sheet: correct pipetting)
- Merkblatt zur Verhütung von Erkrankungen durch Schwefelwasserstoff

- (Instruction sheet on the prevention of diseases due to hydrogen sulphide)
- Merkblätter über Gesundheitsschutz
 - (Instruction sheets for health protection)

Source: Bundesverband der Unfallkassen e.V., Fockenstraße 1, 81539 München

- Regeln für Sicherheit und Gesundheitsschutz beim Umgang mit Gefahrstoffen im Unterricht (GUV 19.16).
 - (Rules for safety and health protection on working with hazardous chemicals in schools)

4. DIN standards

Source: Beuth Verlag GmbH, Burggrafenstraße 6, 10787 Berlin

DIN EN	Brandklassen
2	(Classification of fires)
DIN EN	Tragbare Feuerlöscher
3	(Portable fire extinguishers)
DIN EN	Sicherheit von Maschinen; Sicherheitsabstände gegen das Erreichen von
294	Gefahrstellen mit den oberen Gliedmaßen
	(Safety of machinery; safety distances to prevent reaching of hazardous places with the upper limbs)
DIN EN	Gasschweißgeräte; Schlauchanschlüsse für Geräte und Anlagen für
560	Schweißen, Schneiden und verwandte Verfahren
	(Gas welding equipment - hose connections for welding, cutting and allied processes)
DIN	Raumluftechnik; Raumluftechnische Anlagen in Laboratorien (VDI-
1946-7	Lüftungsregeln)
	(Ventilation engineering; ventilation systems in laboratories (VDI ventilation rules))
DIN	Technische Regeln für Trinkwasser-Installationen (TRWI)
1988	(Specifications for drinking-water supply installations)
DIN	Kennzeichnung von Rohrleitungen nach dem Durchflußstoff
2403	(Identification code for pipe lines according to media)
DIN	Schlauschellen; Teil 1: Schellen mit Schneckentrieb; Form A
3017-1	(Hose-clamps; part 1: Clamps with worm gear drive)
DIN	Gasabsperrrmaturen bis PN 4; Anforderungen und Anerkennungsprüfung
3537-3	für Laborarmaturen
	(Gas valves up to PN 4; requirements and tests)
DIN	Schläuche für Flüssiggas; Schlauchleitungen
4815-2	(Hoses for LPG; hose assemblies)
DIN	Sicherheitskennzeichnung
4844	(Safety marking)
DIN	Sicherheitszeichen im Labor; Warnung vor Gasflaschen
12001-1	(Safety markings in the laboratory; glassware warning)
DIN	Laborgeräte aus Glas; Saugflaschen, zylindrische Form

- 12475 (Laboratory glassware; suction flasks, cylindrical shape)
 DIN Laborgeräte aus Glas; Saugflaschen, konische Form
 12476 (Laboratory glassware; suction flasks, conical shape)
 DIN Laborgeräte aus Glas; Vakuum-Exsikkatoren
 12491 (Laboratory glassware; vacuum exsiccators)
 DIN Laborgeräte aus Glas; Gas-Waschflaschen; Form nach Drechsel
 12596 (Laboratory glassware; gas washing flasks; shape according to Drechsel)
 DIN Elektrische Laborgeräte; Heizbäder; Allgemeine und sicherheitstechnische
 12877 Anforderungen und Prüfungen
 (Laboratory electrical appliances; heating baths; safety requirements and tests and general technical requirements)
 DIN Elektrische Laborgeräte; Flüssigkeitsthermostate, Allgemeine und
 12879-1 sicherheitstechnische Anforderungen und Prüfungen
 (Laboratory electrical appliances; constant temperature circulators; safety requirements and tests and general technical requirements)
 DIN Elektrische Laborgeräte; Wärmeschränke; Allgemeine und
 12880-1 sicherheitstechnische Anforderungen und Prüfungen
 (Laboratory electrical appliances; ovens; safety requirements and tests, general technical requirements)
 DIN Laborgeräte aus Metall; Hebebühnen, Sicherheitstechnische
 12897 Anforderungen, Prüfung
 (Metal laboratory ware; supports, scissors jack type, safety requirements and tests)
 DIN Laborarmaturen; Schlauchtüllen
 12898 (Laboratory taps; outlet nozzles)
 DIN Laboreinrichtungen; Notduschen-Einrichtungen; Körperduschen,
 12899-1 Sicherheitstechnische Anforderungen, Prüfungen
 (Laboratory furniture; emergency shower facilities, body showers, safety requirements, tests)
 DIN Laboreinrichtungen; Notduschen-Einrichtungen; Augenduschen,
 12899-2 Sicherheitstechnische Anforderungen, Prüfungen
 (Laboratory furniture; emergency shower facilities, eye-wash stands, safety requirements, tests)
 DIN Laboreinrichtungen; Farbige Kennzeichnung der Stellteile von
 12920 Laborarmaturen nach dem Durchflußstoff
 (Laboratory furniture; colour code for fluids on handlevers and handwheels of laboratory taps)
 DIN Laboreinrichtungen; Abzüge; Abzüge für allgemeinen Gebrauch, Arten,
 12924-1 Hauptmaße, Anforderungen und Prüfungen
 (Laboratory furniture; fume cupboards, requirements for fume cupboards for general use)
 DIN Laboreinrichtungen; Abzüge; Abzüge für offene Aufschlüsse bei hohen
 12924-2 Temperaturen, Hauptmaße, Anforderungen und Prüfungen
 (Laboratory furniture; requirements for fume cupboards, fume cupboards for open reactions at high temperatures, main dimensions, requirements and tests)
 DIN Laboreinrichtungen; Schränke für feuergefährliche flüssige und feste Stoffe;
 12925-1 Sicherheitstechnische Anforderungen, Prüfungen

- (Laboratory furniture; cabinets for inflammable liquid and solid substances; safety requirements, tests)
- DIN 12925-2 Laboreinrichtungen; Schränke für Druckgasflaschen; Sicherheitstechnische Anforderungen, Prüfung
(Laboratory furniture; cabinets for compressed-gas cylinders; safety requirements, tests)
- DIN 12926-1 Laboreinrichtungen; Labortische, Labortische für allgemeinen Gebrauch, Außenmaße, Platzbedarf, Anforderungen und Prüfungen
(Laboratory furniture; laboratory benches, laboratory benches for general use, over-all dimensions, space requirements, requirements and tests)
- DIN 12927 Laboreinrichtungen; Absaugboxen mit Luftrückführung; Anforderungen, Prüfungen
(Laboratory furniture; air circulation exhausters with filters; safety requirements, tests)
- DIN 14494 Sprühwasser-Löschanlagen, ortsfest, mit offenen Düsen
(Water spray systems, fixed, with open nozzles)
- DIN 18381 VOB Verdingungsordnung für Bauleistungen, Teil C: Allgemeine Technische Vertragsbedingungen für Bauleistungen (ATV); Gas-, Wasser- und Abwasser-Installationsanlagen innerhalb von Gebäuden
(Contract procedure for building works, part C: general technical specifications for building works, gas, water and sewage plumbing works inside of buildings)
- DIN 19541 Geruchsverschlüsse für Entwässerungsanlagen; Funktionsgrundsätze
(Traps and accessories; principles for construction and for testing)
- DIN 24403 Betriebsanleitungen für Zentrifugen; Hinweise für die Erstellung
(Centrifuges; directives for arrangement of service instructions)
- DIN 30600 Graphische Symbole; Registrierung, Bezeichnung
(Graphical symbols; registration, designation)
- DIN 30664-1 Schläuche für Gasbrenner für Laboratorien; ohne Ummantelung und Armierung, Sicherheitstechnische Anforderungen und Prüfungen
(Flexible tubes for laboratory gas burners; requirements and tests)
- DIN 30665-1 Gasverbrauchseinrichtungen; Gasbrenner für Laboratorien (Laborbrenner); Sicherheitstechnische Anforderungen, Prüfung
(Gas-appliances; gas-burners for laboratory use (laboratory burners); requirements and tests)
- DIN 32620 Schlauchbinder; Spanner und Band
(Clamps)
- DIN ISO 3585 Borosilicatglas 3.3; Eigenschaften, identisch mit ISO 3585:1991
(Properties of borosilicate glass 3.3), identical to ISO 3585:1991

5. VDE regulations

Source: VDE Verlag GmbH, Bismarckstraße 33, 10625 Berlin

- DIN VDE 0100-200 Errichten von Starkstromanlagen mit Nennspannungen bis 1000 V
(Erection of high-voltage plant with nominal voltages of up to 1000 V)
- DIN EN 61010-2- Sicherheitsbestimmungen für elektrische Meß-, Steuer-, Regel- und Laborgeräte; Teil 2-020: Besondere Anforderungen an Laborzentrifugen

- 020\ (IEC 61010-2-020:1992, modifiziert)
 VDE 0411-2-020 (Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2 - Section 020: Particular requirements for laboratory centrifuges (IEC 61010-2-020:1992, modified)
- DIN VDE 0789-10 Unterrichtsräume und Laboratorien; Einrichtungsgegenstände, Sicherheitsbestimmungen für energieverSORgte Baueinheiten (Instruction rooms and laboratories; furnishings, safety regulations for energy-supplied construction components)
- DIN VDE 1000 Allgemeine Leitsätze für das sicherheitsgerechte Gestalten technischer Erzeugnisse (General directives for the safety-oriented design of technical products)

6. DVGW worksheets

Source: Wirtschafts- und Verlagsgesellschaft Gas und Wasser mbH, Zur Degensmühle 3, 53347 Alfter

- GW 3 Technische Regeln für Bau und Prüfung von vorgefertigten Bauteilen mit Gas- und Wasserinstallationen (Technical rules for the construction and inspection of prefabricated components with gas and water installations)
- G 621 Gasanlagen in Laboratorien und naturwissenschaftlich-technischen Unterrichtsräumen; Installation und Betrieb (Gas facilities in laboratories and rooms for scientific and technical instruction; installation and operation)

7. Other publications

Source: bookshops

- L. Bretherick: "Handbook of Chemicals",
- National Fire Protection Association: "Manual of Hazardous Chemical Reactions".

Source: Ecomed-Verlag, 86899 Landsberg

- L. Roth und U. Weller: "Gefährliche chemische Reaktionen"
 - (Hazardous chemical reactions)
- L. Roth: "Gefahrstoff-Entsorgung"
 - (Disposal of hazardous materials)
- D. Reichard, W. Ochterbeck: "Abfälle aus chemischen Laboratorien und medizinischen Einrichtungen"
 - (Waste from chemical laboratories and medical facilities)

Source: GIT-Verlag, Rößlerstraße 90, 64293 Darmstadt

- D. Bernabei: "Sicherheit - Handbuch für das Labor"
 - (Safety - a laboratory handbook)

Source: Springer-Verlag, Tiergartenstr. 17, 69121 Heidelberg

Th. Brock: "Sicherheit und Gesundheitsschutz im Laboratorium" (Safety and health protection in the laboratory) (ISBN 3-540-61952-6)

Adelmann, Schulze-Halberg: "Arbeitsschutz in Biotechnologie und Gentechnik" (Industrial safety in biotechnology and genetic engineering) (ISBN 3-540-57978-8)