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DGUV Information 213-013

SF_6-Switchgear and Equipment

October 2021

komm mit mensch
Sicher. Gesund. Miteinander.

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

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Preliminary Remarks

Information from the German Social Accident Insurance (hereinafter referred to as DGUV Information) containing knowledge and recommendations aimed at simplifying the practical application of rulings and regulations related to a specific subject area or subject matter.

This DGUV Information is primarily intended to provide guidance to companies as they implement obligatory state rules and regulations for occupational safety and health, as well as accident prevention regulations for the prevention of work-related accidents, disease and health risks.

In particular, by applying the knowledge and recommendations contained in this DGUV Information, an employer can be assured of having taken the appropriate measures towards the prevention of work-related accidents, disease and health risks. Other solutions are possible if safety and health protection are guaranteed in the same manner. If technical rules have been published to substantiate state occupational protection regulations by the committees established for this purpose, these take priority.

Legally binding information related to national occupational health and safety regulations and reproduced in this DGUV Information is indicated in bold text or listed in the Appendix. Explanations and, in particular, exemplary solutions are depicted with corresponding remarks in italics.

This DGUV Information was compiled by the German Social Accident Insurance Department for Energy, Textiles, Electrical and Media Products (BG ETEM) in collaboration with the working group 'SF₆ in equipment used in the transmission and distribution of electrical power > 1 kV', the German Association of Energy and Water Industries (BDEW), the German Association of the Energy and Power Supply Industry (VIK), the German Electrical and Electronic Manufacturers' Association (ZVEI) and Solvay Fluor GmbH.

Switchgear and electrical equipment are important components in the transmission and distribution of electrical energy. The network's transmission power and the transmission distance determine the respective level of voltage applied.

Switchgear can be designed as an air-insulated and/or gas-insulated configuration. The primary components in a switchgear system are the bus bars, switchgear, current and voltage transformers, power and cable connections, as well as components required for controlling/monitoring, network protection and automation. Cables can also be designed as gas-insulated lines (GIL). When SF_6 is used, a general differentiation is made between insulation and switching (i.e. extinguishing of switching arcs)..

SF_6 switchgear and equipment with a rated voltage greater than 52 kV can be designed for indoor or outdoor usage. As a rule, the switching of high-voltage switchgear at greater than 52 kV is subject to the use of SF_6. Furthermore, SF_6 is used as an insulation medium for interior installations. SF_6 can also be used as an insulation medium for devices, components and/or equipment used in modern outdoor installations.

For SF_6 switchgear and equipment with rated voltages greater than 1 kV up to and including 52 kV, a distinction is made between the primary and secondary distribution levels.

At primary distribution levels, gas-insulated circuit breaker switchgear is commonly used. Circuit breakers in the medium-voltage range are preferably designed using vacuum switching chambers. The vacuum switching chambers are installed together with all other live components in compartments filled with SF_6 insulation medium. At secondary distribution levels, gas-insulated load break switch systems, or ring main units (RMU), are primarily used. The SF_6 load break switch in this switchgear must switch load currents while also serving the activation of electrical equipment and power supplies in conjunction with work being performed. At these secondary distribution levels, the most common gas-insulated switchgear technology uses SF_6 as a combined insulating and switching medium in gas-filled compartments.

SF_6 does not harm the ozone layer but is designated a greenhouse gas under the Kyoto Protocol and has global warming potential (GWP) of 22,800 according to Regulation (EU) No. 517/2014 Annex I Group 3. SF_6 emissions are to be avoided because of their relevance to the climate.

According to Regulation (EU) No. 517/2014 of the European Parliament and Council related to certain fluorinated greenhouse gases dated 16 April 2014, Regulation (EU) 2015/2066 of the Commission dated 17 November 2015 establishing the minimum requirements and conditions

for mutual recognition with a view to the certification of natural persons carrying out installation, servicing, maintenance, repair or decommissioning of electrical switchgear containing fluorinated greenhouse gases or recovery of fluorinated greenhouse gases from stationary electrical switchgear, and the Regulation on climate protection against changes caused by release of certain fluorinated greenhouse gases (German Chemical Climate Protection Ordinance), work with SF_6 on SF_6 plants, systems and equipment (installation, maintenance, servicing, repair or decommissioning) may be carried out only by trained personnel. These personnel must have a proof of requisite qualification or a certificate[1)] for environmentally friendly handling of SF_6. This work includes in particular the recovery, recycling, processing and destruction of SF_6.

This DGUV Information contains instructions and information regarding occupational health and safety as related to work tasks performed in or on SF_6 plants, systems and equipment. Other environmental protection requirements remain unaffected.

The technical solutions contained in this DGUV Information do not exclude other, at least equally as safe solutions, which may be contained in the technical regulations issued by other Member States of European Union or Turkey or other contracting parties to the Agreement on the European Economic Area.

1) Certificate according to Regulation (EU) 2015/2066

1 Scope of Applicability

This DGUV Information is applicable to the manufacture, proper operation, maintenance and servicing, decommissioning and disassembly of SF_6-insulated electrical systems and operating equipment containing SF_6.

For information regarding the safe operation and inspection of SF_6 gas-insulated electrical systems and operating equipment, please also refer to the German Occupational Health and Safety Act (Betriebssicherheitsverordnung, BetrSichV).

The following also apply to mobile gas containers used for the transport of SF_6 in special containers designated for the purpose (not to the aforementioned electrical systems and operating equipment):

- *Latest version of The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR),*
- *Fourteenth Order amending the German Product Safety Act (Pressure Equipment Regulation (Druckgeräteverordnung)),*
- *Transportable Pressure Equipment Directive (TPED / OrtsbeweglicheDruckgeräteVerordnung (ODV) in Germany).*

For sulphur hexafluoride (SF_6), refer also to

- *DIN EN 62271-4/VDE 0671-4:2014-06,*
- *DIN EN 60376/VDE 0373-1:2006-05,*
- *DIN EN 60480/VDE 0373-2:2005-08.*

For the installation of electrical systems and equipment with rated voltages > 1 kV, refer also to DIN EN 619361 (VDE 01011):201412

2 Definition of Terms/ Explanations

In the context of this DGUV Information, the following definitions apply:

1. **SF_6:** Chemical formula and abbreviation for sulphur hexafluoride, an inorganic gas with excellent electrical insulating properties.
2. **SF_6-switchgear:** an SF_6-gas-insulated electrical device enclosed in metal.
3. **SF_6-equipment:** operating equipment filled with SF_6, such as switchgear, transducers, gas-insulated lines (GIL), high-voltage bushings, capacitors and transformers.
4. **SF_6-gas compartment:** part of the SF_6 switchgear or SF_6 equipment filled with SF_6 gas (gas-filled compartment).
5. **Equipment room:** the room in a facility where SF_6 switchgear or SF_6 equipment is situated.
6. **SF_6 gas compartment work:** encompasses the discharging, evacuating or filling of SF_6 gas compartments, the opening of SF_6 gas compartments as well as work on or in opened SF_6 gas compartments.
7. **7. Work in equipment rooms:** any activities performed in the equipment room not associated with SF_6 or its decomposition products.
   Examples of such activities can be the operation of SF_6 switchgear, lighting maintenance, cleaning work, painting work, etc.
8. **SF_6 gas servicing unit:** mobile equipment operating as a closed system used for emptying, evacuating and filling SF_6 gas compartments as well as for cleaning, storing and reprocessing SF_6 gas.
   SF_6 gas servicing units are designated according to their different technical characteristics, such as the SF_6 servicing unit, SF_6 gas maintenance unit or SF_6 gas recovery unit.
9. **Decomposition products:** the decay and reaction products resulting from the decomposition of SF_6 due to the application of energy to SF_6 switchgear.
10. **SF_6 gas container:** a mobile, reusable vessel used to store SF_6 (SF_6 pressurized gas bottle or cylinder)

3 Determination of Information and Risk Assessment

3.1 General

A company involved in the manufacture or operation of SF_6 switchgear and equipment is responsible for determining and assessing the work-related risks to its employees associated with SF_6 gas and its decomposition products as well as for specifying the protective measures required (Art. 5, para. 1 of the German Occupational Safety and Health Act (Arbeitsschutzgesetz, ArbSchG), Art. 7 of the German Ordinance on Hazardous Substances (Gefahrstoffverordnung – GefStoffV)).

According to the CLP Regulation, SF_6 is not classified. According to Art. 2, para. 1, no. 5 of the German Ordinance on Hazardous Substances (GefStoffV), however, SF_6 is defined as a hazardous substance, since it has been assigned an occupational exposure limit value.

Information related to risk assessment can also be found in the German TRGS 'Risk assessment for activities involving hazardous substances' (Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen, TRGS 400).

Relevant examples for documenting risk assessment according to the German GefStoffV can be found in Appendix 1 of this DGUV Information.

It is recommended that the various activities be considered from different perspectives (refer also to DIN EN 622714/VDE 06714:201406).

Information related to the protective measures can also be found in the German TRGS 'Protective measures' (Schutzmaßnahmen, TRGS 500).

Refer also to Appendices 3 and 4 of this DGUV Information for further information regarding protective measures.

When assessing working conditions in accordance with the German Occupational Safety and Health Act, the employer is also responsible for assessing each activity with respect to Art. 10 of the German Maternity Protection Act (Mutterschutzgesetz, MuSchG) to determine whether pregnant or breastfeeding women or their children could be at risk.

The MuSchG stipulates that this requirement must be implemented irrespective of whether women currently perform such activities or whether they may merely perform them in future.

For information regarding risk assessment and planning protective measures, refer to MuSchG and any legal ordinances and technical rules pertaining to maternity protection that may be published in future

3.2 Physical and chemical properties of SF_6

3.2.1

Sulphur hexafluoride (SF_6) is a colourless and odourless gas. It has a density of 6.07 g/l at 20 °C and 1013 hPa. SF_6 is approximately five times denser (heavier) than air and tends to sink and collect at lower levels. Once SF_6 mixes with the ambient air, it can no longer be segregated out. SF_6 liquefies when compressed, making it possible to store and transport it in pressurized gas containers as a liquefied gas.

Pure SF_6 is a chemically stable, inactive (inert) gas, is nearly insoluble in water and is non-flammable.

Due to its high dielectric strength and outstanding arc-extinguishing properties, SF_6 is ideally suited as an insulating and extinguishing agent in electrical switchgear and equipment.

3.2.2

SF_6 tends to decompose when subjected to temperatures associated with electrical discharge or arcing exceeding 500 °C. Subsequent cooling largely effects a recombination process, yet it is also possible for secondary reactions to occur with ambient air and steam as well as with structural elements, such as vaporizing molten material from the switching contacts. This can produce gaseous sulphur fluoride oxides and carbon fluorides, such as thionyl fluoride (SOF_2) and tetrafluoromethane (CF_4), solid metal fluorides, sulphides and oxides as well as harmful hydrogen fluoride (HF) and sulphur dioxide (SO_2) if moisture is present.

Such chemical reactions can, for example, take place inside SF_6 circuit breaker switching chambers under normal switching operations or fault shut-downs, or inside SF_6 gas compartments in conjunction with electric arcing due to an internal fault.

Gaseous SF_6 decomposition products have an unpleasant, pungent odour similar to rotten eggs. Solid SF_6 decomposition products form dust deposits (e.g. metal salts) in SF_6 gas compartments, such as so-called switching dust or caking.

3.3 Health risks

3.3.1 Prior to usage, 'new' pure SF_6 is odourless, tasteless, colourless and non-toxic. It does not contain any contaminants that might be hazardous to health.

For further requirements regarding the purity of SF_6, refer also to section 6.2.1. of DIN EN 60376 / VDE 0373-1.

3.3.2 The occupational exposure limit value (OEL) of SF_6 is 1,000 ml/m^3 (ppm) or 6,100 mg/m^3 as time-weighted average. In addition, there is a short-time value with an exceedance factor of 8 (TRGS 900 'Arbeitsplatzgrenzwerte'; Occupational exposure limit values OEL, English publication not available).

The 'occupational exposure limit value' is the limiting value for a time-weighted average concentration of a chemical substance in the air with respect to a specified reference period at the workplace. OEL represents the concentration of a substance at which acute or chronic adverse effects on general health are not anticipated. This is a time-weighted average within an 8 hour period.

The exceedance factor prescribes the permissible maximum concentration peak levels for a hazardous substance. An exceedance factor of 8 means that the average ambient SF_6 concentration at the workplace must not exceed 8,000 ppm or ml/m^3 or 48,800 mg/m^3 within a 15-minute period. Longer exceedance periods are also permissible as long as the product of the exceedance factor (EF) and the exceedance period is retained (e.g.: EF 4 over 30 minutes is comparable to EF 2 over 60 minutes).

The duration of the increased concentration may not exceed one hour in a single work shift (refer to TRGS 900 'Arbeitsplatzgrenzwerte', Sec. 2.3).

The rationale for determining the OEL for SF_6, can be found in H. Greim (ed.): 'Gesundheitsschädliche Arbeitsstoffe; Toxikologisch-arbeitsmedizinische Begründung von MAK-Werten' ('Harmful substances and materials; toxicological and occupational medical reasons for MAK values'), WILEY-VCH, Weinheim, 1997, P. 1–32 in German.

3.3.3 SF_6 is approximately five times denser than ambient air and tends to sink and collect at lower levels. If allowed to escape into the work environment in large quantities, SF_6 will displace the oxygen required for breathing (risk of suffocation). SF_6 concentrations greater than 19 % vol. will reduce the percentage of oxygen in breathable air to less than 17 % vol., for which special protective measures are required according to Appendix 4.

A risk of suffocation exists in improperly opened, non-vented SF_6 gas compartments, for example, or where relatively large quantities of SF_6 leak from SF_6 gas compartments or SF_6 pressurized gas containers as a result of technical defects. The risk is enhanced where insufficient ventilation is available at the floor levels of small, enclosed equipment rooms, including the rooms located immediately below, such as basement facilities, cable ducts, maintenance shafts, pits, drainage systems, etc.

3.3.4 SF_6 switchgear and equipment in use can contain solid or gaseous decomposition products. SF_6 decomposition products may be toxic and harmful to health when inhaled, ingested or exposed to skin. Furthermore, they may irritate the eyes, respiratory system or skin and possibly cause chemical burns.

Inhalation of large quantities of decomposition products can increase the risk of lung damage (toxic pulmonary oedema). Nevertheless, even small amounts of gaseous decomposition

products will produce certain symptoms within seconds that can serve as a warning – before a risk of poisoning ensues – allowing workers to promptly evacuate to a safe location. These symptoms might include unpleasant or acrid odours as well as irritation of the nose, throat and eyes.

In particular, hazards associated with decomposition products can exist when a gas leakage occurs due to a fault, when opening or working with exposed SF_6 circuit breaker switching chambers, or when a fault arc occurs in an SF_6 gas compartment (refer also to Appendix 4).

Regarding the OEL for SF_6 decomposition products (Sec. 3.2.2), refer to TRGS 900 'Arbeitsplatzgrenzwerte' and DIN EN 622714/VDE 06714:201406 Annex H.1.

3.3.5 Rapidly escaping SF_6 from a gas container can cause ice formation, which creates the risk of frostbite if it comes into contact with persons who are insufficiently protected.

3.4 Equipment room work (fault-free operation)

For all activities in equipment rooms, the possible dangers, in particular in the event of faults, must be pointed out as part of instruction. No special protective measures with regard to SF_6 or decomposition products are required in fault-free operation.

Work activities performed in equipment rooms include the operation of SF_6 switchgear, the maintenance of lights, cleaning work, painting work, etc. There are no activities with SF_6.

Where necessary, warning must be given of the possible risk of suffocation at all access points to hazardous rooms in the form of the W001 warning sign 'general warning sign' and an additional sign with a written warning.

Refer to Annex 1 of German workplace regulation A1.3 'Safety and health protection signage' ('Sicherheits und Gesundheitsschutzkennzeichnung')) (ASR A1.3).

SF_6 switchgear
If SF_6 escapes
immediately leave room!
Risk of death!

Warning signage may be necessary in equipment rooms in which the largest volume of SF_6 able to escape constitutes more than 10 % of the room volume, or in rooms beneath equipment rooms.

3.5 SF_6 gas compartment work

Only persons in possession of a certificate of competence pursuant to Regulation (EU) No. 517/2014 may perform work with SF_6.

SF_6 may not be released during work activities on gas compartment (see ChemKlimaschutzV).

When working with SF_6, tasks or practices which generate significant heat build-up, such as welding or smoking, are strictly prohibited in equipment rooms. This restriction must be clearly indicated using prohibitory sign P003 'No naked flames; fire, open ignition sources and smoking prohibited'.

Refer to Appendix 1 of the German workplace regulation 'Safety and health protection signage' (ASR A1.3).

3.5.1 Initial installation

During a filling procedure, suitable SF_6 maintenance and filling units designed for direct connection to SF_6 gas containers must be used.

During initial installation, new SF_6 gas is usually handled.

When using SF_6 maintenance units, observe the manufacturers' operating manuals for the SF_6 maintenance unit and for the SF_6 equipment.

After connecting an SF_6 maintenance unit to an SF_6 gas compartment and/or an SF_6 gas container, check the connections for leaks.

The leak-tightness of the gas compartments must be checked according to the manufacturer's specifications.

3.5.2 Refilling the SF_6 gas compartments

During the filling procedure, suitable SF_6 maintenance and filling units designed for direct connection to SF_6 gas containers must be used.

When using SF_6 maintenance units, observe the manufacturers' operating manuals for the SF_6 maintenance unit and for the SF_6 equipment.

After connecting an SF_6 maintenance unit to an SF_6 gas compartment and/or an SF_6 gas container, check the connections for leaks.

3.5.3 Maintenance and upgrade work tasks with gas recovery, including decommissioning and disassembly

SF_6 gas compartments must not be opened before they have been completely emptied (recovery of SF_6 gas) and subsequently flooded with air. The pressure must be equalised to match the atmospheric pressure. It is important here to ensure that a closed SF_6 circuit is restored and that the requirements for initial installation and refilling are met.

When opening or working in or on opened SF_6 gas compartments that have not yet been cleaned and are contaminated with SF_6 decomposition products, the employer must provide the necessary personal protective equipment (PPE) and ensure that it is maintained in proper condition. The employees must use the PPE provided and inspect it every working day (according to Art. 30 of the German accident prevention regulations 'Principles of prevention' (DGUV regulation 1) and Art. 7 para. 5 of the German Hazardous Substances Ordinance, GefStoffV).

The following PPE may be required:
- *protective gloves,*
- *protective goggles,*
- *protective suit,*
- *shoe covers,*
- *respiratory protection devices,*
- *skin protection.*

See Appendix 4 for information regarding the selection of personal protective equipment.

Solid decomposition products inside opened SF_6 gas compartments are to be properly removed. An industrial vacuum cleaner designated for dust class H (high) must be used when removing loose dust. This process should be carried out in such a manner that dust is not created or stirred up.

Refer to DIN EN 60335-2-69, Annex AA for information regarding the dust classes associated with industrial vacuum cleaners.

Water-free cleaning fluids and lint-free cleaning cloths should be used when removing firmly caked decomposition products.

When opening or working in or on opened SF_6 gas compartments that have not yet been cleaned, smoking, drinking, eating and storing foodstuffs in the equipment room are strictly prohibited (refer to Art. 8, para. 3 of the German Hazardous Substances Ordinance; GefStoffV). Where necessary, this prohibition must be clearly indicated using prohibitory signs P002 'Smoking prohibited' or P003 'No naked flames; fire, open ignition sources and smoking prohibited' and P022 'Food and beverages prohibited'.

Refer to Appendix 1 of the German workplace regulation 'Safety and health protection signage' (ASR A1.3).

It is essential to thoroughly wash the facial area, neck, arms and hands prior to taking a break or after completing work. Decomposition dust particles (i.e. switching dust) must be removed from the skin immediately. Dust particles must be removed from the eyes immediately by rinsing thoroughly with plenty of water. A doctor must then be consulted.

Solid decomposition products, used cleaning agents and disposable suits as well as used filters from SF_6 switchgear and servicing units, industrial vacuum cleaners or respiratory protection devices must be properly disposed of.

Proper disposal may include collection of the items in dedicated, specially labelled containers for delivery to a specialised waste management company.

Waste code (see AVV):
150202 (e.g. for solid decomposition products, cleaning cloths, etc.)
161001 (e.g. for cleaning liquids))

3.6 Work in equipment rooms following malfunctions with gas leak

3.6.1 In the event of a discharge of decomposition products or if a hazardous quantity of SF_6 is detected or reported, equipment rooms and rooms located immediately beneath and adjacent to equipment rooms, may not be entered or must be evacuated immediately.

These facilities may only be entered or re-entered after they have been thoroughly ventilated or with the aid of self-contained breathing apparatus functioning independently of the ambient atmosphere.

Emission of hazardous quantities of SF_6 can be indicated by:
- *a gas alarm, e.g. activation of luminous or acoustic signals in the equipment room or at its access points,*
- *fault or leakage messages in a control centre,*
- *gas leakage noise,*
- *or activation of a pressure limiting device, e.g. bursting of a rupture disk.*

A discharge of SF_6 together with gaseous decomposition products can be indicated by an unpleasant, pungent odour (like rotten eggs).

The time required for ventilation will depend on, among other considerations, the type and intensity of the gas leak (gas volume, decomposition product content), the room volume, the method of ventilation (natural or technical means) and the ventilator airflow volume as well as the position and size of ventilation openings. Due to the potential risk of suffocation, if in doubt the oxygen content of the air should be measured.

Refer also to DIN VDE 0101 for information regarding the ventilation of equipment rooms and rooms located immediately beneath them.

Refer also to Art. 13 of the German Hazardous Substances Ordinance (GefStoffV) for information regarding operational malfunctions.

3.6.2 Following a gas leak with decomposition product contamination due to a malfunction, the equipment room must be thoroughly cleaned.

Measures must be taken as stipulated in Section 3.5.3 'Maintenance and upgrade work with gas recovery including decommissioning and disassembly'. An industrial vacuum cleaner designated for dust class H (high) must be used when removing loose decomposition dust particles.

3.7 SF_6 gas container work

Work associated with SF_6 gas containers relates to activities on mobile pressurized gas containers used for the transport of SF_6 in special containers designated for the purpose (e.g. gas bottles or cylinders).

Refer also to the German Occupational Health and Safety Act (BetrSichV) for more information regarding SF_6 gas containers.

3.7.1 As long as SF_6 gas containers are under pressure, screws on pressure-bearing components and bolted valve screws may not be loosened. They may only be tightened by specialist personnel using appropriate tools.

Specialist personnel are persons familiar with and trained for use of the equipment.

3.7.2 Full or empty SF_6 gas containers not connected to a SF_6 maintenance or filling unit must be closed and equipped with valve protection caps or valve locking nuts.

3.7.3 Full and empty SF_6 gas containers must be secured against falling while in storage, use or transport. They may not be thrown and should be rolled only on the base of the cylinder.

SF_6 gas cylinders can be secured upright in fixed or movable racks, with clamps or chains, or the like.

3.7.4 Only the SF_6 gas containers necessary for continuation of the work and connected to the SF_6 switchgear filling unit may be present in an equipment room. In addition, an equal number of SF_6 gas containers may be made available in the equipment room. For SF_6 switchgear without SF_6 gas containers that are permanently connected to filling units, only one SF_6 gas container may be located in the equipment room. Additional SF_6 gas containers must be stored in a storage facility or in an outdoor storage area.

3.7.5 SF_6 gas containers must not be stored in work areas, rooms located below ground level, stairwells, landings, corridors or garages. Neither may they be stored in narrow courtyards, passageways and thoroughfares or their immediate vicinity, on stairs serving outdoor facilities nor along specially marked escape routes.

3.7.6 Storage rooms for SF_6 gas containers must be sufficiently aerated and ventilated. They must not be connected to rooms located below ground level. SF_6 gas containers must not be exposed to direct sunlight.

3.8 Documenting the risk assessment pursuant to GefStoffV

The risk assessment must be documented and must contain at least the following information:

1. date and time of the risk assessment and persons performing or involved in it,
2. work area and activities dealing with hazardous substances,
3. risks occurring at the workplace involving inhalation, dermal or physical-chemical exposure,
4. frequency of the activities, duration of exposure as well as additional stress factors relevant to an increased human intake of hazardous substances,
5. the technical, organizational and personnel-related measures required for eliminating or reducing the hazards, including the effectiveness of the technical measures taken,
6. results of an evaluation of the potential for substitution of hazardous substances.

The latest documentation must be retained until the risk assessment is updated.

Refer also to the German 'Risk assessment for activities involving hazardous substances' (Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen, TRGS 400, No. 8).

Appendix 1 contains examples for documenting the risk assessment according to the German Hazardous Substances Ordinance (GefStoffV), including

- *Filling and refilling of SF_6 gas compartments as well as the recovery of non-contaminated SF_6,*
- *Work in SF_6 gas compartments that could possibly contain SF_6 decomposition products,*
- *Clearing up of malfunctions associated with SF_6 switchgear involving a gas leakage.*

3.9 Operating instructions and training pursuant to GefStoffV

3.9.1 Operating instructions must be issued for all activities mentioned. These operating instructions must contain information on the hazardous substances associated with the workplace, potential dangers to humans and the environment, required protective measures and rules of conduct, behaviour in the event of danger, first aid practices and proper waste management procedures. The operating instructions should be posted and made available at suitable locations.

Refer to the German 'Operating guidelines and information for employees' ('Betriebsanweisung und Information der Beschäftigten', TRGS 555).

It is recommended that a copy of the operating guidelines be posted in the equipment room.

Sample operating guidelines can be found in Appendix 2.

3.9.2 Prior to commencing work on active electrical components in SF_6 switchgear or equipment, it must be ensured that the power has been disconnected according the '5 safety rules' and secured for the duration of the work.

Refer also to Art. 6, para. 2 of the German Accident Prevention Regulations (UVV) 'Electrical systems and equipment' (DGUV regulations 3 and 4).

Refer also to DIN VDE 0105-100

3.9.3 Prior to taking up their work assignment and thereafter at least on an annual basis, employees performing work tasks in or on SF_6 gas compartments must receive verbal training based on the company operating guidelines and the risk assessment addressing the potential risks and required protective measures associated with the workplace or the work tasks.

The verbal training provided to employees must be presented in an understandable form and language. The time, date and content of the training must be documented in writing and verified by the trainee's personal signature.

In addition, instructions are required if the conditions of the activity change (e.g. change of process), if other hazardous substances are used or for special reasons (e.g. after damage or accidents) as well as in the event of changes to legal and normative bases. The level of training and experience of the employees shall be taken into account in the instruction. Inexperienced employees must receive particularly comprehensive training and instruction.

Refer also to Art. 14, para. 2 of the German Hazardous Substances Ordinance (GefStoffV) and to No. 5 of the German TRGS 555 'Operating guidelines and information for employees'.

Refer also to Art. 4 of the German Accident Prevention Regulations, 'Principles of prevention' (DGUV regulation 1)

3.9.4 Instruction must include general consultation related to occupational medicine and toxicology for activities involving SF_6. Employees should be provided with the following information in particular:

1. **Possible intake channels of SF_6 and its decomposition products (dermal, inhalative, oral)**
   The main channel of intake of sulphur hexafluoride (SF_6) is through the respiratory tract. The large-scale absorption of SF_6 through the skin is unlikely. Pure SF_6 is not an irritant nor does it have a toxic effect on the human organism. A strong lung-damaging effect is to be assumed if the gas is not present in pure form but contains decomposition products or if such products have been formed by electrical discharges or fires.

2. **Limitation of exposure through protective measures and personal hygiene**
   Inhalation of the gas should be avoided. In exceptional situations (e.g. unintentional release of substances, exceeding of occupational exposure limits) respiratory

protection is required. Sufficient eye protection should be worn. Use leather gloves to prevent injuries when handling pressurized gas cylinders and against frostbite caused by rapidly expanding gas. Wear protective shoes when handling compressed gas cylinders.

3. **Effects and symptoms (acute, chronic)**
   Acute: cold damage on contact with liquefied gas, at very high concentrations suffocation by oxygen displacement from breathable air
   Chronic: no evidence of chronic toxic effects from pure gas.

4. **Occupational medical precautions** must be offered if exposure cannot be excluded during activities involving the substance (precautionary measures). Occupational health precautions must be taken if the occupational exposure limit is not complied with when working with the substance (mandatory precaution).

Refer also to Number 5.2 of the German 'Operating guidelines and information for employees' ('Betriebsanweisung und Information der Beschäftigten', TRGS 555).

Appendix 1

Examples of risk assessment documentation

BG ETEM
Energie Textil Elektro
Medienerzeugnisse

Risk assessment – Documentation

Filling and refilling of SF_6 gas compartments as well as recovery of non-contaminated SF_6

Please note: *Entries in italics are sample texts that you can edit to meet your needs.*

Dokumentation

Prepared by: ..... **Responsible Person:** .....

Status as of: ..... **Expert consultation:** .....

Work area: *Electrical service location*

Work task: *Filling and refilling of SF_6 gas compartments as well as revcovery of non-contaminated SF_6*

Description of work tasks

Connecting SF_6 servicing units and/or SF_6 gas containers to the filling unit in SF_6 gas compartments; checking all connections and lines for secure seating; execution of the filling process; removal of the filling equipment. Recovering the SF_6 gas using the SF_6 gas servicing unit; venting and opening the gas compartments; performing maintenance and upgrade work or work upon conclusion of piece or type testing.

Hazardous substances used/released

Designation	Labelling / H statements	Quantity
SF_6	*Gases under pressure, liquefied gas; H280*	*Quantity used varies according to the filling process Released quantities (only with leaks) in small amounts*

Assessment

Risk due to inhalation
There is no exposure to SF_6 when properly performed.

In the event of leakage, it cannot be ruled out that small amounts of SF_6 will be released. The workplace limit value for SF_6 is reliably maintained. The small quantities involved will not lead to a health risk.

Risk due to contact with the skin
Not applicable

Physical-chemical and other hazards
A displacement of oxygen by SF_6 is not anticipated.

Protective measures/Effectiveness

Protective measures/checkpoints	Responsibility (deadline)	Effectiveness/verification
For technical reasons, another substance cannot be substituted.	*Employer*	
Utilization of the SF_6 gas servicing unit, type _____, manufacturer _____, and/or the SF_6 filling unit, type _____, manufacturer _____, according to the specifications provided by the equipment manufacturer, as well as provided by the SF_6 switchgear and/or the SF_6 operating equipment manufacturer(s).	*Person responsible for work, all employees*	
Compliance with smoking, eating and drinking restrictions	*Employee*	
Compliance with restrictions related to work involving a significant heat build-up	*Person responsible for work, all employees*	
Operating instructions are available	*Employer*	
Instruction and consultation on occupational medicine and toxicological matters	*Employer, annually*	

Applied directives, regulations and information

German Ordinance on Hazardous Substances (Gefahrstoffverordnung, GefStoffV)

TRGS 400 German Technical Rule for Hazardous Substances 'Risk assessment for activities involving hazardous substances' (Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen)
DGUV Information 'SF_6 Switchgear and Equipment' ('SF_6-Anlagen und -Betriebsmittel', DGUV Information 213-013)

Technical Report IEC 62271-303, Annex D

BG ETEM
Energie Textil Elektro
Medienerzeugnisse

Risk assessment – Documentation

Work related to SF_6 gas compartments that may contain SF_6 decomposition products

Please note: *Entries in italics are sample texts that you can edit to meet your needs.*

Dokumentation

Prepared by: ..... **Responsible Person:** .....

Status as of: ..... **Expert consultation:** .....

Work area: *Electrical service location*

Work task: *Work related to SF_6 gas compartments that may contain SF_6 decomposition products*

Description of work tasks

Recovery of SF_6 gas using the SF_6 gas servicing unit

Ventilation and opening of the gas compartments

Removal of solid decomposition products using an industrial vacuum cleaner or manually using water-free cleaning agents or cleaning products

Performance of maintenance and upgrade work

Hazardous substances used/released

Designation	Labelling / H statements	Quantity
SF_6	*Gases under pressure, liquefied gas; H280*	*Quantity utilized varies according to the filling process Released quantities (only with leaks) in small amounts*
Gaseous and solid decomposition products	*Decomposition products can be poisonous, causing a hazard to health, irritation or chemical burns*	*Released quantity varies according to application and damage involved*
Cleaning agent 3 % Na_2CO_3 solution	*Refer to the safety data sheet, section 5.2/10.6*	*Approx. 2 litres*

Assessment

Risk due to inhalation
The inhalation of SF_6 and SF_6 decomposition products cannot be excluded.

A risk ensues when removing solid decomposition products (switching dust), which can lead to lung damage.

A chemical reaction can result in the release of gasses such as hydrogen fluoride (HF) and sulphur dioxide (SO_2) when opening a gas compartment. For this reason, short-term exposure may be greater than the working limit value.

Risk due to contact with the skin
Contact with skin may cause irritation or acid burns. A moderate risk exists from skin contact according to TRGS 401.

Physical-chemical and other hazards
A risk of suffocation may ensue due to a displacement of oxygen if a residual quantity of SF_6 escapes from the switchgear into the working environment.

Protective measures/Effectiveness

Protective measures/checkpoints	Responsibility (deadline)	Effectiveness/verification
For technical reasons, another substance cannot be substituted.	*Employer*	
Utilization of the SF_6 gas servicing unit, type _____, manufacturer _____, according to the specifications provided by the equipment manufacturer, as well as provided by the SF_6 switchgear and/or the SF_6 operating equipment manufacturer(s).	*Person responsible for work*	
Industrial vacuum cleaner, dust class H, will be made available	*Employer*	
Ensure adequate aeration and ventilation.	*Person responsible for work*	
Protective work gear, disposable protective suits with hoods, acid-proof protective gloves, disposable overshoes, safety goggles, protective helmets and respiratory protection (independent of the circulating air) must be provided.	*Employer*	
PPE must be used in accordance with the operating instructions.	*Employees*	
Restricted access zones set up with prohibitory sign D-P006 'Access prohibited for unauthorized persons' visibly mounted.	*Person responsible for work*	
Compliance with smoking, eating and drinking restrictions	*Employees*	
Compliance with restrictions related to work involving a significant heat build-up	*Person responsible for work, all employees*	

A skin protection program is implemented in accordance with the skin protection plan	*Employer / all employees*	
Operating instructions are available	*Employer*	
Instruction and consultation on occupational medicine and toxicological matters	*Employer, annually*	
Occupational medical precautions are organized as a result of the risk assessment and in compliance with the ArbMedVV. *Preventive medical data is being collected and maintained*	*Employer / Company physician*	
Appropriate containers are available for the collection of used PPE as well as contaminated resources, including switching dust, to ensure their proper disposal.	*Employer, Employees*	

Applied directives, regulations and information

German Ordinance on Hazardous Substances (Gefahrstoffverordnung, GefStoffV)

TRGS 400 German Technical Rule for Hazardous Substances 'Risk assessment for activities involving hazardous substances' (Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen).

TRGS 401 German Technical Rule for Hazardous Substances 'Risks resulting from skin contact – identification, assessment, measures' (Gefährdung durch Hautkontakt — Ermittlung. Beurteilung, Maßnahmen)

DGUV Information 'SF_6 Switchgear and Equipment' ('SF_6-Anlagen und -Betriebsmittel', DGUV Information 213-013)

Technical Report IEC 62271-303, Annex D

BG ETEM
Energie Textil Elektro
Medienerzeugnisse

Risk assessment – Documentation

Clarification of faults in SF_6 systems with gas leakage

Please note: *Entries in italics are sample texts that you can edit to meet your needs.*

Dokumentation

Prepared by: ..... **Responsible Person:** .....

Status as of: ..... **Expert consultation:** .....

Work area: *Electrical service location*

Work task: *Clarification of faults in SF_6 systems with gas leakage*

Description of work tasks

In the course of a fault report, the switchgear room must be entered by an employee to clarify the fault. The switchgear must be inspected and the extent of the fault determined.

Hazardous substances used/released

Designation	Labelling / H statements	Quantity
SF_6	*Gases under pressure, liquefied gas; H280*	*The volume released will depend on the malfunction*
Gaseous and solid decomposition products	*Decomposition products can be poisonous, causing a hazard to health, irritation or chemical burns*	*The volume released will depend on the malfunction*

Assessment

Risk due to inhalation
The inhalation of SF_6 and SF_6 decomposition products cannot be excluded. For this reason, the short-term exposure may be greater than the working limit value.

Inhalation can lead to a health risk and result in damage to the lungs.

Risk due to contact with the skin
Contact with skin may cause irritation or chemical burns. There is a moderate risk from skin contact according to TRGS 401.

Physical-chemical and other hazards
A risk of suffocation may ensue due to a displacement of oxygen if a residual quantity of SF_6 escapes from the switchgear into the working environment.

Protective measures/Effectiveness

Protective measures/checkpoints	Responsibility (deadline)	Effectiveness/verification
Determining the criteria for remedying malfunctions in accordance with the extent of the damage	*Employer / Person responsible for work*	
All activities that are not related to fault clearance are prevented.	*Person responsible for work*	
Ensure adequate aeration and ventilation.	*Person responsible for work*	
Protective work gear, disposable protective suits with hoods, acid-proof protective gloves, disposable overshoes, safety goggles, protective helmets and respiratory protection (independent of the circulating air) are be provided.	*Employer*	
PPE appropriate to the fault is used in accordance with instructions from the superior.	*Employees*	
Restricted access zones are set up with prohibitory sign D-P006 'Access prohibited for unauthorized persons' visibly mounted.	*Person responsible for work*	
Compliance with smoking, eating and drinking restrictions	*Employees*	
Operating instructions are available	*Employer*	
Instruction and consultation on occupational medicine and toxicological matters	*Employer, annually*	
Occupational medical precaution is organized as a result of the risk assessment and in compliance with the ArbMedVV. *Preventive medical data is being collected and maintained*	*Employer / Company physician*	

Applied directives, regulations and information

German Ordinance on Hazardous Substances (Gefahrstoffverordnung, GefStoffV)

German Ordinance on occupational health precautions (Verordnung zur arbeitsmeidizinischen Vorsorge, ArbMedVV)

TRGS 400 German Technical Rule for Hazardous Substances 'Risk assessment for activities involving hazardous substances' (Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen).

TRGS 401 German Technical Rule for Hazardous Substances 'Risks resulting from skin contact – identification, assessment, measures' (Gefährdung durch Hautkontakt — Ermittlung. Beurteilung, Maßnahmen)

DGUV Information 'SF_6 Switchgear and Equipment' ('SF6-Anlagen und -Betriebsmittel', DGUV Information 213-013)

Technical Report IEC 62271-303, Annex D

Appendix 2

Sample operating instructions

Company: _____

Sample Operating Instructions

Work area: _____

According to Art. 14 of German GefStoffV

Responsible person: _____
Signature

Workplace: _____

Work task: Working with non-contaminated SF_6

Status as of: _____

B 034 – GHS

Hazardous substance designation

Sulphur hexafluoride (SF_6) without decomposition products

Risks to humans and the environment

warning

Non-contaminated SF_6 is odourless, tasteless, colourless and non-toxic. It does not contain any harmful impurities. There is a risk of frostbite upon coming into contact with liquefied SF_6.
SF_6 is about five times denser than air and tends to accumulate in low-lying rooms. If allowed to escape into the work environment in large quantities, SF_6 will displace the oxygen required for breathing (risk of suffocation).
SF_6 has been designated a greenhouse gas, therefore requiring that SF6 emissions be avoided.

Protective measures and rules of conduct

- SF_6 must not be released into the atmosphere
- Always utilize SF6 gas maintenance units together with filling unit _____
- Inspect connections for leak-tightness _____
- Work which may generate a significant heat build-up, e.g. welding, is prohibited.
- Smoking, eating and drinking, including the storage of foodstuffs, are not permitted in the equipment rooms
- Hand protection:
  Protective gloves _____
  to guard against mechanical hazards and contact with liquefied SF_6

Conduct in the event of danger

Leakage: shut off the gas supply, ensure or restore leak-tightness, ensure good ventilation – fresh air supply.

SF_6 does not burn but decomposition products can be produced by fire. Leave the room in the event of fire. Combat fires only with the fire extinguishers provided and using personal protective equipment. Remove containers/operating materials from the hazardous area and cool them.

First aid

In all situations requiring first aid: Protect yourself and call a doctor immediately.

In the event of inhalation: Seek fresh air immediately; put the affected person an inclined position with their head down; seek medical care in the event of breathing difficulties.

First aider _____ **Emergency contact** _____

Proper disposal

Return SF_6 gas containers to the manufacturer or to an approved disposal service in line with local regulations.

Sample Operating Instructions

Company: _____

Work area: _____

Responsible person: _____
Signature

According to Art. 14 of German GefStoffV

Workplace: _____

Work task: Working with contaminated sulphur hexafluoride (SF_6)

Status as of: _____

B 044 – GHS

Hazardous substance designation

Sulphur hexafluoride (SF6) with decomposition products (contaminated SF_6)

SF_6 in electrical installations may contain decomposition products resulting from electric arcing: gaseous sulphur fluorides and sulphur fluoride oxides, solid (dust particle) metal fluorides, sulphides and oxides, hydrogen fluoride, sulphur dioxide.

Risks to humans and the environment

danger

- Decomposition products can be toxic / harmful to health when inhaled, ingested or brought into contact with the skin or eyes. They can cause respiratory or skin irritations or chemical burns. Inhalation of larger quantities can cause lung damage (pulmonary oedema), which may be noticeable only in the long term.
- Gas leakage increases the risk of suffocation due to oxygen displacement, especially close to the ground and in low-lying spaces.

Protective measures and rules of conduct

Filling, emptying or evacuating of SF_6 switchgear:

- Check SF_6 quality and status (e.g. humidity, air proportion, decomposition products).
- SF_6 must not be discharged into the atmosphere; use an SF_6 servicing unit; inspect connections for leakage after connecting the equipment.
- Contaminated SF_6 should only be filled into designated SF_6 gas containers.
- Work which may generate significant heat build-up and smoking are prohibited in the equipment room.

Opening and working on or in opened SF_6 gas compartments and/or rooms

(additional measures; please complete or delete where applicable)

- Only open SF_6 gas compartments after they have been completely emptied and pressure has been equalized to atmospheric pressure.
- Ensure good ventilation.
- Use personnel protective equipment:
  - Protective gloves, acid resistant _____
  - Disposable protective suit with hood _____
  - Respiratory protection device (filter or self-contained breathing apparatus) _____
  - Safety shoes _____
  - Disposable protective goggles _____
  - Shoe covers _____
  - Skin protection _____
  - Protective helmet _____
- Remove dust with industrial vacuum cleaner _____, caked decomposition products with _____
- Perform the work without interruption where possible
- When removing PPE, ensure that body, clothes or other items are not contaminated.
- Wash the face, neck, arms and hands thoroughly with plenty of water prior to taking a break or after completing the work.
- Do not store food and do not smoke, eat or drink in the equipment rooms.

Conduct in the event of danger

In the event of a gas leakage or if an unpleasant, pungent odour similar to that of a rotten egg is perceived, indicating the presence of SF_6 decomposition products, immediately evacuate or do not enter the equipment room or rooms located immediately beneath and adjacent to it; only enter/re-enter such rooms after they have been thoroughly ventilated or using a respiratory protection device (self-contained breathing apparatus _____).

First aid

- If decomposition products come into contact with skin or eyes, immediately
  - rinse the skin with plenty of water,
  - rinse the eye thoroughly with water while protecting the uninjured eye.
- In the event breathing difficulties, remove the injured person from the danger area into fresh air, ensure they are comfortable and keep them warm, seek medical treatment (risk of toxic pulmonary oedema).

First aider _____ **Emergency contact** _____

Proper disposal

Decomposition products, cleaning agents and materials, disposable protection suits and filters (e.g. from SF_6 switchgear, servicing units, industrial vacuum cleaners or respiratory protection devices) must be disposed of only in appropriate waste containers.

Appendix 3

Information regarding technical, organizational and personal protective measures

	Work in equipment rooms (e.g. SF_6 switchgear operation, cleaning)	Work tasks in SF_6 gas compartments Initial installation, filling, emptying, evacuation of SF_6 gas compartments	Work tasks in SF_6 gas compartments Maintenance and upgrade work Decommissioning and dismantling work Opening SF_6 gas compartments, working on or in open SF_6 gas compartments	Work tasks in equipment rooms following malfunctions with gas leakage
Risk assessment according to GefStoffV		+	+	+
Operating instructions		+	+	+
Instruction	+[1)]	+	+	+
Servicing units		+	+	
Industrial vacuum cleaner			+	+
Personal protective equipment[2)]			+	+
Ban on welding work		+	+	+
Ban on smoking		+	+	+
Ban on eating and drinking		+	+	+
Remarks	[1)] Instruction must at least cover conduct in the event of danger (see Section 3.9.3). [2)] Refer to Appendix 4 for the selection of personal protective equipment.			

Appendix 4

Information regarding the selection of personal protective equipment

SF_6 gas compartment	Degree of decomposition products anticipated	Work on SF_6 gas compartments	Work in SF_6 gas compartments
SF_6 gas compartments without electric arcing, excluding switch	None	Protective gloves	Protective gloves, protective helmet, respiratory protection device (self-contained breathing apparatus) in the event of oxygen deficiency
Isolating switch, load break switch, circuit breaker without significant fault shut-offs	Low	Acid resistant protective gloves	Acid resistant protective gloves, filtering respiratory protection, respiratory protection device (self-contained breathing apparatus) in the event of oxygen deficiency, disposable protective suit with hood, disposable overshoes, protective helmet, possibly safety goggles
Circuit breaker with significant fault shut-offs	High	Acid resistant protective gloves, respiratory protection device (self-contained breathing apparatus), disposable protective suit, possibly protective goggles	Acid resistant protective gloves, respiratory protection device (self-contained breathing apparatus), disposable protective suit with hood, disposable overshoes, protective helmet, possibly safety goggles
SF_6 gas compartments with electric arcing	High		

Protective gloves should be liquid-tight and acid-resistant, as well as solvent-resistant when cleaning with solvents. Always contact the manufacturer for information on this.

The use of skin protection is recommended – draw up a skin protection plan.

The simultaneous use of skin protection products and liquid-tight protective gloves must be coordinated with the company physician.

Protective goggles and/or glasses should conform to application area 5 (protection against gas and fine dust particles) in accordance with DIN EN 166.

Protective suits should be dust-proof.

The use of disposable articles is recommended for protective suits and overshoes.

If respiratory protection is required, filter devices with combination filters (combined gas and particle filters) or respiratory protection devices that work independently of the ambient atmosphere (self-contained breathing apparatus) must be used.

Normally, filter units with combination filters are sufficient. The gas filter section should cover the range of protection found in gas filter types A, B, E and K (e.g. A2B2E2K2). P3 filters should be used for the dust area. Gas filter type B also protects against low SO_2 concentrations. Filter units may only be used if it is ensured that the oxygen content of the air is at least 17% vol. Insulation devices, e.g. compressed air breathing apparatus or regeneration devices, offer universal protection.

Respiratory protection devices with full masks offer the advantage that it is not necessary to wear protective goggles when using them.

If it is necessary to enter a contaminated SF_6 gas compartment, it is recommended to use protective suits with hood and respiratory protection devices (self-contained breathing apparatus) that work independently of the ambient atmosphere.

If protective gloves are worn for longer periods (more than two hours) or if heavy physical work that generates sweat secretion is involved, additional cotton undergloves should be worn or special skin protection preparations should be used to counteract sweat secretion and swelling of the skin (see also TRGS 401 'Hazards due to skin contact – Determination – Assessment – Measures').

Depending on the plant, a safety helmet and safety shoes may be required to protect against mechanical hazards. This must be determined and specified in the risk assessment.

For any occupational health precautions that may be necessary when using respiratory protection devices, refer to the German ArbMedVV and DGUV Information 240-260 'Instruction manual for occupational medical examinations according to the DGUV Principle G 26 "Respiratory protection devices"'.

Keeping in proper condition means that the employer must ensure that personal protective equipment is properly cleaned, maintained, stored and inspected after use or disposed of properly.

Refer also to the DGUV rules in German:

'Use of protective clothing' (DGUV rule 112-189)

'Use of respiratory protection devices' (DGUV rule 112-190)

'Use of eye and facial protection' (DGUV rule 112-192)

'Use of protective gloves' (DGUV rule 112-195)

Appendix 5

Rules and Regulations

The relevant rules and regulations are compiled below.

1. Laws, Directives and Ordinances

Reference source:
Book stores and Internet, e.g. www.gesetzeiminternet.de

- Act on the Implementation of Measures of Occupational Safety and Health to Encourage Improvements in the Safety and Health Protection of Workers at Work (Arbeitsschutzgesetz – ArbSchG)
- Ordinance on Safety and Health Protection in the Provision of Work Equipment and its Use at Work, on Safety in the Operation of Systems Requiring Monitoring and on the Organization of Occupational Safety and Health at Work (Betriebssicherheitsverordnung – BetrSichV)
- Transportable Pressure Equipment Ordinance of 29 November 2011 (Federal Law Gazette I p. 2349), as amended by Article 491 of the Ordinance of 31 August 2015 (Federal Law Gazette I p. 1474) (Ortsbewegliche-Druckgeräte-Verordnung – OrtsDruckV)
- Act on Protection Against Hazardous Substances (Chemikaliengesetz – ChemG)
- Ordinance on Protection Against Hazardous Substances (Gefahrstoffverordnung – GefStoffV) of 29.03.2017 with associated Technical Rules for Hazardous Substances (TRGS), in particular
  - TRGS 400 'Risk assessment for activities involving hazardous substances'
  - TRGS 500 'Protection measures'
  - TRGS 555 'Operating instructions and information for employees'
  - TRGS 900 'Occupational exposure limits'
- Technical Rules for Workplaces (ASR), in particular
  - ASR A1.3 'Safety and Health Protection Signage'
- Fourteenth Ordinance to the Product Safety Act (Druckgeräteverordnung – 14. ProdSV)
- Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006)
- COMMISSION IMPLEMENTING REGULATION (EU) 2015/2066 of 17 November 2015 establishing, pursuant to Regulation (EU) No. 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons who install, maintain, service, repair or decommission electrical switchgear containing fluorinated greenhouse gases or recover fluorinated greenhouse gases from stationary electrical switchgear
- Ordinance on the protection of the climate against changes caused by the input of certain fluorinated greenhouse gases (Chemikalien-Klimaschutzverordnung – ChemKlimaschutzV)
- European agreement on the international carriage of dangerous goods by road (ADR 2017 – German)

2. DGUV regulations, rules and information for occupational safety and health

Reference source:
From your responsible accident insurance carrier and at www.dguv.de/publikationen

DGUV Regulations

- 'Principles of prevention' (DGUV Vorschrift 1)
- 'Electrical installations and equipment' (DGUV Vorschrift 3 and 4)

DGUV Rules

- 'Use of protective clothing' (DGUV Regel 112–189)
- 'Use of respiratory protection equipment' (DGUV Regel 112–190)
- 'Use of eye and face protection' (DGUV Regel 112-192)
- 'Use of protective gloves' (DGUV Regel 112–195)

DGUV Information

- 'Instruction manual for occupational medical examinations according to the DGUV Principle G 26 "Respiratory protection devices"' (DGUV Information 240–260).

3. Standards/VDE regulations

Reference source:
Beuth Verlag GmbH, Burggrafenstraße 6, D-10787 Berlin, Germany and
VDE-Verlag GmbH, Bismarckstraße 33, D-10625 Berlin, Germany

- DIN EN 166:2002-04
  Personal eye protection – Requirements
- DIN EN 61936-1 (VDE 0101-1):2014-12
  Power installations with rated a.c. voltages above 1 kV – Part 1: General rules
- DIN VDE 0105-100 (VDE 0105-100):2015-10
  Operation of electrical installations – Part 100: General requirements
- DIN EN 60376 (VDE 0373-1):2006-05
  Determination for sulphur hexafluoride (SF_6) of technical purity for use in electrical equipment
- DIN EN 60480 (VDE 0373-2):2005-08
  Guidelines for the testing and treatment of sulphur hexafluoride (SF_6) after removal from electrical equipment and specification for its reuse
- DIN EN 62271-4 (VDE 0671-4):2014-06
  High-voltage switchgear and controlgear – Part 4: Methods of handling sulphur hexafluoride (SF_6) and its mixed gases
- DIN EN 60335-2-69 (VDE 0700-69):2015-07
  Household and similar electrical appliances – Safety – Part 2–69: Particular requirements for commercial vacuum cleaners

- DIN EN 60335-2-69 (VDE 0700-69):2015-07
  Sicherheit elektrischer Geräte für den Hausgebrauch und ähnliche Zwecke – Teil 2–69: Besondere Anforderungen für Staub- und Wassersauger für den gewerblichen Gebrauch

4. Miscellaneous

Reference source:
Book stores and/or German Social Accident Insurance Department for Energy, Textiles, Electrical and Media Products, Gustav-Heinemann-Ufer 130, 50968 Cologne, Germany (www.bgetem.de)

Greim, H. (Ed.): Harmful substances; toxicological and occupational medical reasons for MAK values (in German), WILEY-VCH, Weinheim, Germany,

Multimedia instruction 'SF_6 switchgear' (PU 13),

With regard to the previous issue dated May 2008, this DGUV Information was adapted to the current rules and regulations as well as to the current state of safety technology.

Note:
With regard to accident prevention regulations no longer in force, in particular what is known as old machine stock (Maschinenaltbestand), as well as older guidelines, safety rules and instructions that continue to apply under their previous ZH 1 number, refer to online editions of the DGUV 'www.dguv.de/publikationen'.

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