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Guidelines for Fire Loss Restoration

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Publication on Restoration of Property Damage

Guidelines for Fire Loss Restoration

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Insert:

- Guidance for identification of hazards by pollution due to fire
  Explanations as to evaluation criteria for hazard identification

- Flow chart of responsibilities
  Tasks of coordinator according to BaustellV and BGR 128

- Personal protective equipment (PPE matrix)
  Fractionation of fire residues according to waste code

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1 Scope and fundamentals of VdS 2357

1.1 Scope

The present guidelines apply to all measures and activities of fire loss restoration. For this application, they detail German requirements of occupational safety and health (OSH) and waste law as well as statutory accident insurance institutions. Relating to OSH, they are mainly based on the German Construction Site Regulations, German Hazardous Material Regulations, and German Biomaterial Regulations, the appurtenant technical rules and regulations, especially the TRGS 524 dealing with protection measures for activities in contaminated areas as well as the BGR 128 dealing with contaminated areas (refer to Fig. 1).

VdS 2357 is to be considered as generally accepted code of practice to be applied to fire loss restoration. It is based on experience regarding losses and restoration gained by insurers as well as experience gained by consulting and assessing experts and restoration companies. Since it is based on TRGS 524 and BGR 128, its application provides for legal security and project planning reliability regarding the OSH to be applied to the loss area. Regular harmonisation of VdS 2357 with legal requirements and technical rules and regulations is effected especially in conjunction and cooperation with representatives of authorities, employers' liability insurances, restoration companies, experts, and the insurance industry.

Further hazards, such as by affected statics, ground with insufficient load-bearing capacity, resulting openings and areas with risk of falling, as well as electricity, are not explicitly dealt with in these guidelines.

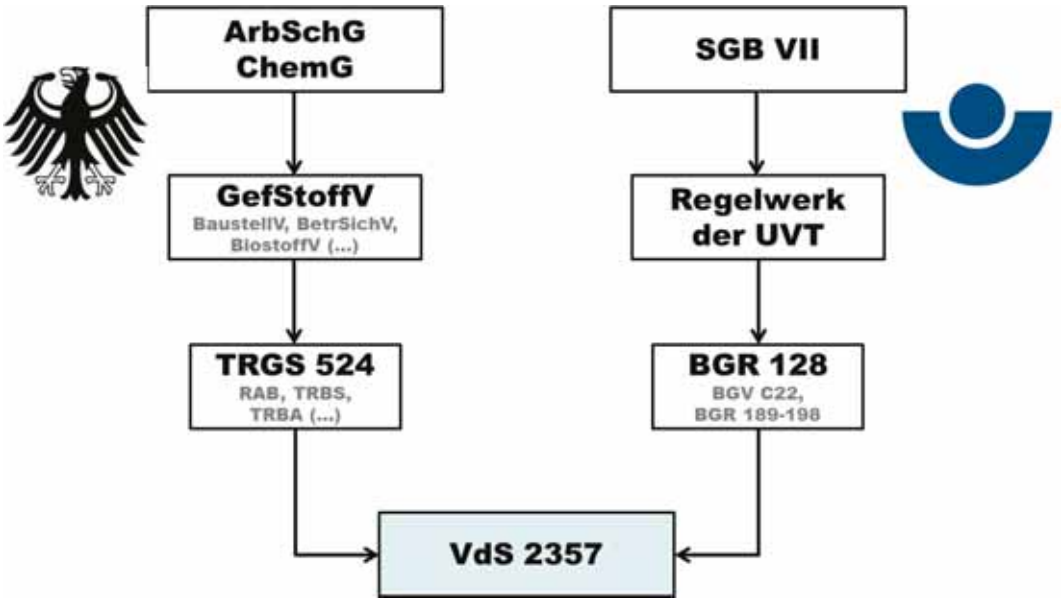

Fig. 1: Importance and integration of VdS 2357 in the system of legal regulations and regulations of employers' liability insurances regarding Occupational Safety and Health (OSH), in particular of TRGS 524 and BGR 128.

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1.2 Fundamentals

Under fire conditions, harmless substances, goods, equipment, or components may generate or release various substances (combustion residues = products of combustion, residues, etc.) with a risk potential which is difficult to assess. All parties involved have to face the challenges resulting therefrom regarding environmental protection, safety, and health protection of those who perform restoration works on the cold fire ground on behalf of the party having suffered the loss:

- Who is responsible for what?
- Who performs what in case of damage?
- Who bears the responsibility?

Among others, the parties involved comprise of insured party, insurer, representatives of authorities, planners, experts, and restoration companies. The respective duties and responsibilities are described in Cl. 3.1.

In order to support all persons and organisations involved and to prepare an integral restoration concept, the Guidelines for Fire Loss Restoration (VdS 2357) describe a systematic procedure for planning and prompt execution of the required works (see Fig. 2):

- They consider the procedures and protection concepts of the German Hazardous Materials Regulations and Biomaterial Regulations as well as the related technical rules and regulations for risk assessment and definition of protection measures (refer to Annex A4).
- They define the tasks and responsibilities for all parties involved which in particular result from the German Construction Site Regulations, TRGS 524, and BGR 128 for works in connection with fire loss restoration (refer to Annex A5).

The term "fire loss restoration" covers all measures and activities on cold fire grounds. In terms of the present guidelines, hazardous substances, biomaterials, and other substances such as those with corrosive effect are referred to hereinafter collectively as hazardous substances.

Other technical terms are explained in the glossary (Annex A9).

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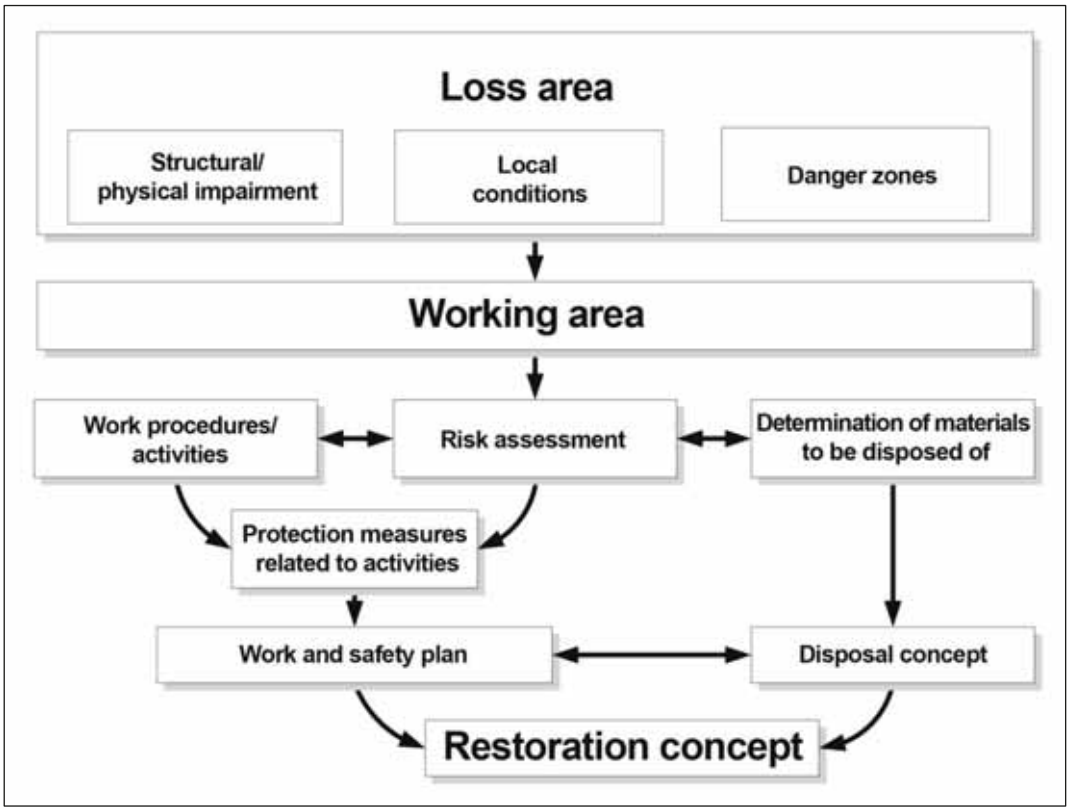

Fig. 2: Planning of fire loss restoration according to VdS 2357

In accordance with BGR 128 and TRGS 524, activities for fire loss restoration shall always be deemed activities in contaminated areas. However, this classification does not entail any specifications being made regarding protection measures but decisions on whether and to what extent protection measures shall be taken or shall be made on the basis of the risk assessment:

Starting from the loss area, i.e.

- existing spatial and structural conditions,
- physical impairment of building fabric, in particular statics, as well as
- type and concentration of combustion residues and their spatial distribution (refer to danger zones),

the risk shall be assessed for any activity and the corresponding measures shall be defined. For this purpose, a connection shall be established between the materials ("combustion residues") to be encountered in the different working areas and the working procedures to be applied there and their potential to activate hazardous substances, e.g. as dust. The corresponding method is described in the present guidelines on the basis of BGR 128 and TRGS 524.

Examinations and decision steps of the risk assessment as well as definitions regarding measures to be taken are documented in the so-called "work and safety plan" (refer to Annex A6).

For proper disposal of the debris and other material affected by the fire, a disposal concept shall be prepared which includes the general requirements of the German Waste Avoidance, Recycling and Disposal Act (KrWG) but also the local conditions and requirements which may vary from town to town (refer to Cl. 6).

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The restoration and disposal concept includes the planning steps and definitions:

- restoration or dismantling of equipment and buildings affected by the fire;
- disposal of corresponding waste;
- OSH measures documented in work and safety plan.

2 Formation, composition, and distribution of combustion residues

2.1 Course of fire

A combustion process is the reaction of a combustible material with oxygen (oxidation) accompanied by strong heat release and light. The combustion products formed under ideal combustion conditions mainly comprise of water and carbon dioxide.

The actual combustion process in case of a hostile fire cannot be considered as being ideal (incomplete combustion) regarding temperature profile and oxygen supply and results in a vast number of conversion products which are known to a limited extent, only. Among other substances, these may include toxic (in particular carcinogenic) and corrosive substances as well as substances which are hazardous to the environment and water.

Apart from a complete combustion in terms of the above reaction (oxidation), an incomplete combustion also results in thermal decomposition processes (pyrolysis and cracking) in which the burning materials are decomposed in low-molecular fragments. New compounds are also formed to a minor extent (de novo synthesis). Moreover, an evaporation of liquids and solid materials with subsequent deposition is possible.

2.2 Hot stage

2.2.1 Formation of hazardous substances and distribution

The substances formed during the combustion process are discharged by way of smoke in the hot stage. The entire load of substances is thus mobile first. The high concentrations of toxic and irritant gases and vapours formed during this phase, such as carbon monoxide (CO), carbon dioxide (CO_2), hydrogen chloride (HCl, condensed: hydrochloric acid), acrolein, and hydrogen cyanide (HCN, condensed: hydrocyanic acid) present a potential risk for rescue service and fire fighters. The corresponding regulations of these institutions refer to these special hazards.

In terms of the present guidelines, hazardous substances, biomaterials, and other substances such as those with corrosive effect are referred to hereinafter collectively as hazardous substances.

2.2.2 Distribution through the air

The main distribution path of substances during the combustion process is the air while the combustion products are discharged from the fire ground in gaseous, liquid, or solid form. When the smoke cools down, hazardous substances precipitate. Gaseous products condense on colder surfaces. When the gas cloud cools down, water and acids form drops which entrain gaseous compounds and solid materials. Soot particles and ash residues come down as rain due to lack of thermals. Moreover, precipitation occurs on surfaces and objects in the air flow (impaction). Normally, the individual processes are closely interconnected and superimpose one another in a way that the precipitating soot serves as a carrier for the gaseous and liquid pollutants. A major part of the smoke is left

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in the loss area as soot or smoke gas condensate and precipitates on the building structure, operating equipment, and stock.

In case of major fires, the smoke mass with the load of substances may be distributed at large distances in the environment due to the uplift caused by the fire (thermals) and the wind. This does not only affect combustion residues but also parts of building material may be distributed in the environment, such as fragments of asbestos cement roofs, insulation comprising of asbestos, or biopersistent mineral wool. This fact shall be taken into account when preparing the restoration concept.

The meteorological conditions at the time of loss may have a decisive effect on the contamination of the environment of the loss area.

2.2.3 Distribution through soil and water

The residues left over in the loss area still comprise of a great number of combustion products and ash residues. The substances can be carried away by extinguishing or rain water so that the existing substances enter the sewerage system or soluble components simply penetrate the soil.

Supplies, fuels, or chemical agents leaking from tanks or pipes damaged by the fire present a particular risk not only for ground and groundwater but in particular for anyone involved in fire loss restoration.

2.3 Cold fire ground

The term "cold fire ground" describes the situation after the hostile fire has been extinguished and the fire load has reached ambient temperature.

On the cold fire ground, in particular low-volatile organic hazardous substances adsorb to surfaces and soot particles in particular. The strong adsorption causes a clear reduction in mobility. The assessment of mobility of combustion residues is a material parameter of the risk assessment for fire loss restoration (refer to Cl. 4.4).

2.4 Combustion residues

The term "combustion residues" covers substances, which

- had already existed before the fire and were released by the fire or firefighting works and
- were formed by the fire, contact with extinguishing water or other extinguishing agents, and other effects.

In this respect, in particular the following aspects shall be considered regarding risk assessment in terms of OSH as well as loss minimisation and saving of real value:

- Hazardous substances, such as stocks, consumables, and supplies as well as other materials which already existed before the fire;
- biomaterials which were available already before the fire (e.g. in hospitals, genetic engineering installations, waste bunkers, butcher's shops) or which may be formed as a consequence of the damage (e.g. bacteria in defective cooling systems, mould fungus);
- combustion and pyrolysis products;
- extinguishing agents;
- hazardous substances released by the building material due to the fire (e.g. asbestos, biopersistent mineral wool);
- substances with corrosive effect.

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Composition of fire load and course of fire are decisive for type and quantity of **combustion and pyrolysis products**.

On the cold fire ground, in particular medium-volatile to low-volatile organic substances and released heavy metals shall be expected; e.g. resulting from short-circuits, damaged fluorescent tubes, or energy-saving bulbs.

Annex A1 deals with some of the most toxic substance groups which are representative for a great number of combustion residues, such as

- polycyclic aromatic hydrocarbons (PAH),
- polychlorinated biphenyls (PCB),
- polyhalogenated dibenzo-p-dioxins (PHDD) and dibenzo furans (PHDF),
- asbestos and persistent mineral wool

as well as resulting substances which are aggressive to metals and building materials,

- such as hydrogen chloride (HCl), hydrogen bromide (HBr),

with their formation, effect, and evaluation criteria.

Mould fungus attack may occur in rare fire loss cases especially if drying measures were not taken immediately after the fire (for further information in this respect refer to BGI 858 and VdS 3151).

2.5 Wastes

In case of a fire loss, various types of waste are generated which are composed of the fire residues themselves, furnishings, stock, and building materials which are useless due to the fire as well as the operating and work equipment contaminated in the course of restoration measures.

The occurring wastes shall be classified and disposed of according to the applicable waste law (refer to Cl. 6 and Annex A8).

3 Measures after the fire

According to the flow chart (Fig. 3), this chapter describes the necessary steps for safe and quick handling of a loss. First, a short overview of the responsibilities for the measures to be taken is given.

3.1 Responsibilities

The allocation of responsibilities in OSH is in compliance with the decision-making authority. Accordingly, the employer is always responsible for the required OSH measures in a company (§ 3 Par. 2 German Occupational Safety and Health Act (ArbSchG): *The employer undertakes to take the necessary OSH measures taking into account the circumstances which affect safety and health of the employees at the workplace*).

If the works are performed by several companies, their employers shall cooperate in the execution of safety and health regulations (§ 8 ArbSchG).

For activities involving hazardous substances, this basic requirement is substantiated in § 15 German Hazardous Material Regulations (GefStoffV): If in case of activities of employees of one employer, hazards resulting from the hazardous substances for the employees of other employers cannot be excluded, all affected employers shall cooperate in the execution of their risk assessments and coordinate the protection

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measures. The responsible coordinator shall be provided with any necessary, safety-relevant information as well as information on defined protection measures by all employers involved. The appointment of a coordinator does not exempt employers from their responsibility.

Regarding performance of construction works, however, the material decisions on the activities to be performed and the work conditions are not taken by the individual employer but by the owner. This is why the German Construction Site Regulations allocates special OSH duties to the owner, in particular:

- considering the general OSH principles (§ 4 ArbSchG) already in the planning stage of the execution of the building project;
- appointment of a coordinator for safety and health matters (SiGeKo);
- preparation of a safety and health plan.

TRGS 524 and BGR 128 follow this principle by requiring the appointment of a coordinator with expert knowledge or expertise having authority to issue instructions if more than one company is involved in the building project or if the restoration works are performed while operations are continued. The equivalent of the safety and health plan of the BaustellV is the work and safety plan specified in TRGS 524 and BGR 128.

In case of restoration after fire losses, the party having suffered the loss is usually the owner and / or client in terms of the above mentioned regulations and thus has the obligation to implement. However, the BGR 128 goes even one step further and includes those natural and legal persons who as an owner or a proprietor of a contaminated area or as another person responsible for the restoration of the contaminated area have the works required for restoration effected by a third party and pay for these works.

Accordingly, the insurer may also take over the function of the party responsible for safe and healthy execution of the restoration works, in particular if due to the personal skills and the circumstances of the party having suffered the loss it cannot be assumed that the latter is able to grasp and implement the OSH duties incumbent on it as an "owner" or a "client". In this respect, the insurer has a special duty towards its customer. In particular, a lump sum payment for the incurred loss as from danger zone 1 up without giving any information on OSH duties possibly incurred by the party having suffered the loss when charging companies with cleaning and restoration works presents an issue under this aspect.

Other duties (duties of notification):

On the basis of GefStoffV and BGR 128, different authorities shall be notified of the works, extensive documentation shall be prepared, and certain proofs shall be provided prior to and during the works.

The following notifications are required from the executing companies:

- according to Par. 11.2 of BGR 128, notification of the statutory accident insurance institution responsible for the company;
- according to § 18 GefStoffV, notification of the public OSH authorities under the terms mentioned therein.

The deadline of 4 weeks before starting the works mentioned in BGR 128 cannot be met due to the eventful character of a fire. It is therefore recommended that the executing companies comply with their duty of notification immediately on the earliest possible date, e.g. immediately after contract awarding.

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3.2 Expertise and expert knowledge

Before starting restoration works, the affected party shall perform several assessments and take decisions which require competent assistance by, e.g. the insurer, experts, or restoration companies. These assessments shall be effected by persons who are able to assess potential risks in the loss area due to their training and experience.

The special expert knowledge required for appropriate planning and control of works in contaminated areas is designated "expertise" in TRGS 524 and "expert knowledge" in BGR 128. The expert knowledge about safety and health protection for works in contaminated areas gained according to BGR 128 complies with the expertise requirements according to TRGS 524. This is why only the term "expertise" is used in the following.

According to TRGS 524, the respective knowledge can be acquired in the scope of occupational training or further education and training and can be considered as being available if proven by corresponding certificates.

In order to ensure an objective and reliable determination and assessment of the dangers due to substances, the person to be assigned shall also have sufficient practical experience in the evaluation of fire grounds (e.g. regarding sampling, evaluation of analysis results).

In case of fire in the commercial / industrial sector or public institutions, it is generally appropriate to ask for claims adjusters from all insurance classes (building, contents / equipment / stocks, technical insurance, etc.).

3.3 Notice of claim to insurer

One of the most important steps of the party having suffered the loss is to immediately notify the insurer according to the individual obligations agreed in the insurance contract. In general, the insurer is able to react in a timely and appropriate fashion only if notified of the damage immediately. Among other things, this ensures a quick and qualified assessment of the loss situation on the spot to be initiated by the insurer. The entire loss adjustment, in particular in case of fires with higher risk potential, is affected thereby materially. Any duties to notify authorities shall be complied with.

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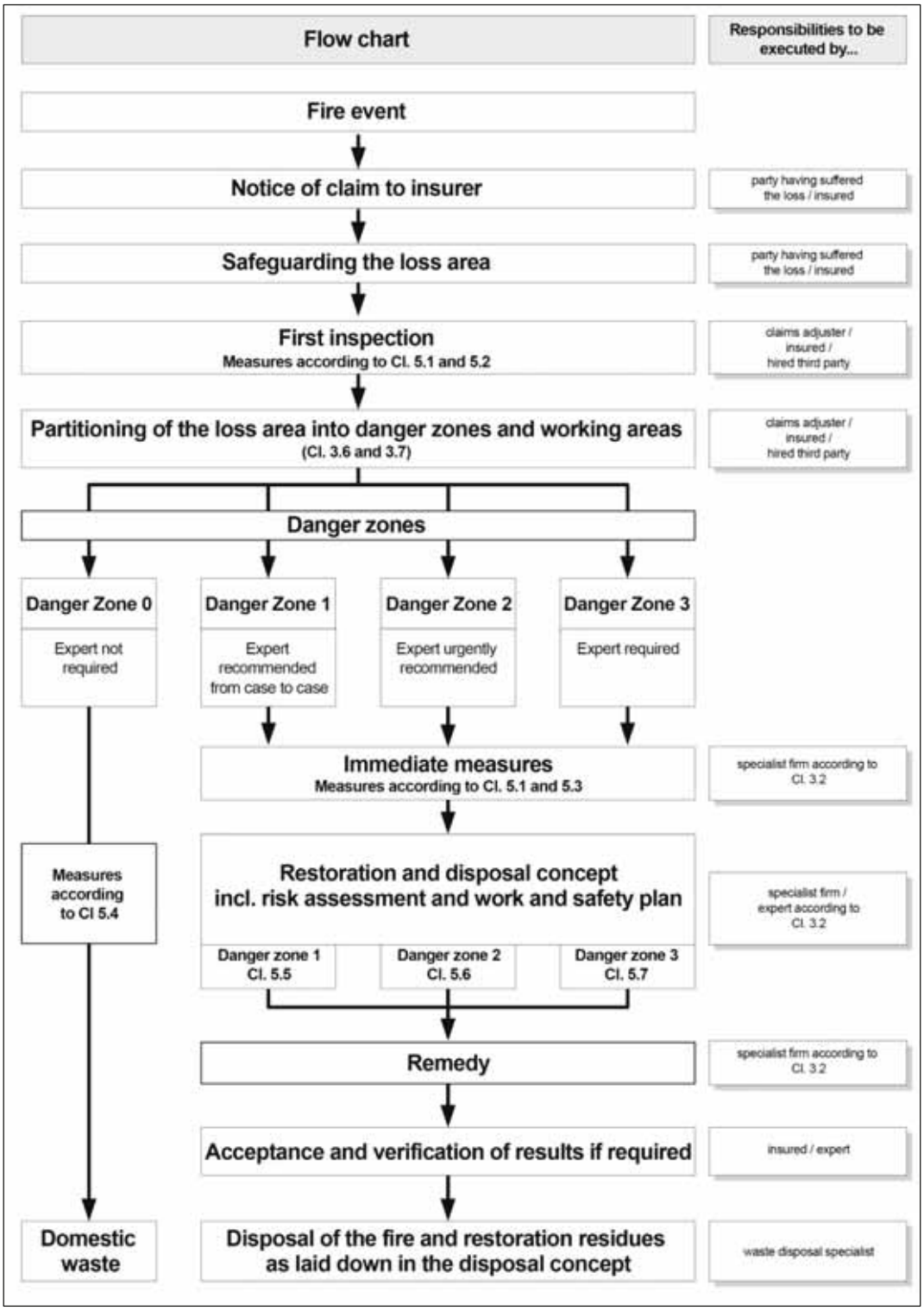

Fig. 3: Flow chart of responsibilities

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3.4 Safeguarding the loss area

Due to the general duty to implement safety precautions of the owner or party having suffered the loss to avoid hazards for third parties (e.g. hazards such as hazardous substances, collapse, etc.), the cold fire ground shall be protected from being accessed by unauthorised third parties and shall be marked clearly and permanently. Consultation in this respect or, in case of more extensive measures, organisational support of the party having suffered the loss shall be effected by the insurer, e.g. in the scope of response to the notice of claim and the subsequent claims management (refer to Cl. 5.1).

3.5 First inspection

The first inspection aims at:

- estimating the extent of damage,
- estimating the hazards resulting from the loss area in a preliminary way,
- effecting a preliminary classification into danger zones and working areas on the above basis (refer to Cl. 3.6 and 3.7) as well as
- determining the required emergency measures.

Accordingly, the results of the first inspection present a material part of the hazard identification to be effected in another step.

Before accessing the loss area, any information required for a preliminary classification into danger zones (see Cl. 4) shall be collected to protect the persons involved. In case of fires in the commercial / industrial sector, they include information on products, raw materials, consumables, or supplies, in particular hazardous substances and biomaterial which were available in the area of the building or system. Moreover, a report of the scene of fire prepared by the police department or fire brigade may contain further important information.

The protection measures to be taken in the first inspection shall be defined by means of a hazard identification based on the above information (refer to Cl. 5.2).

3.6 Classification of loss area into danger zones

As one result of the first inspection, the loss area is classified into danger zones 0 to 3 according to the criteria described in Cl. 3 and 4. The classification into danger zones describes the substances to be expected in the fire residues as well as the extent and spatial distribution of contamination through smoke condensates and is dependant upon the division of space of the damaged object.

The extension of a danger zone can be equal to individual spatial areas of the loss area. It is also possible that different spatial areas shall be assigned to one danger zone. In other cases, it may be reasonable that a spatial area is divided into different danger zones, e.g. a staircase with greater pollution upstairs due to fire or a large manufacturing shop where several works are carried out in parallel; where required the danger zones shall be partitioned off by walls or ceilings made of plastic film.

In danger zones 1 to 3 it can be "possible" up to "imperative" to involve experts who are able to evaluate type and scope of risks of material more extensively in order to verify, for example, the preliminary classification effected by the claims adjuster (refer to Cl. 4.7).

As long as a classification into danger zones has not yet been effected, the works shall be effected according to the requirements of danger zone 3.

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3.7 Classification of loss area into working areas

A working area is an area of the loss area with spatial or organisational limits where activities of fire loss restoration are performed.

The division into working areas is a material part of the risk assessment and serves to clearly describe where which activities shall be performed. It is mainly based on the division of space of the loss area.

In case of housing fires, the division of space is, for example, "kitchen", "staircase", and "attic space"; in the commercial / industrial sector, we rather have a process-based division, such as "paint shop", "solvent storage room", or "cold storage house". During planning and work preparation, the divisions resulting from the restoration works shall be considered, too, such as areas for debris (belong to contaminated area) or equipment provided to clean system parts and the like.

3.8 Emergency measures

Regarding limitation of loss, so-called "emergency measures" shall be effected in many cases as quickly as possible while taking into account possible access restrictions, e.g. due to investigation of the root cause, preservation of evidence, or danger of collapse:

- protection of loss area from access by unauthorised persons (refer to Cl. 3.8);
- corrosion protection of machines and systems;
- safeguarding the statics of the building fabric;
- sealing measures (including emergency roofing);
- drying measures;
- measures to avoid environmental hazards (e.g. in case of liquids which are hazardous to water);
- safeguarding of equipment and goods.

Before taking the emergency measures, a risk assessment shall be prepared for the activities scheduled in this respect.

If the emergency measures are taken by companies, employees shall be charged who have the expert knowledge required according to BGR 128 or the expertise according to TRGS 524 or are accompanied by a third person having the required expert knowledge or expertise.

3.9 Restoration and disposal concept

Fire loss restoration means all measures and activities required to eliminate the contaminations due to the fire in the contaminated area. Among other things, they comprise of:

- emergency measures (refer to Cl. 3.8 and 5.3),
- decontamination, cleaning,
- clean-up work,
- removal of debris from the loss area,
- disposal of debris as well as other restoration waste.

A **restoration and disposal concept** shall be prepared for the execution of these works which specifies the extent and procedure of decontamination of the structure damaged by the fire and how to dispose of or recycle the waste fractions occurring due to the fire. The

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restoration and disposal concept also includes the **work and safety plan** to be prepared according to TRGS 524 or BGR 128 (refer to Cl. 3.10; for requirements on contents and structure, refer to Annex A6). Accordingly, the restoration and disposal concept documents all planning steps including investigations and assessments required in this respect (refer to Fig. 1 and 2).

3.10 Work and safety plan

The work and safety plan intends to understandably document the investigations regarding hazardous substances, classification into danger zones (refer to Cl. 3.6 in connection with Fig. 4), exposure assessment and risk assessment and to determine protection measures on the basis of the most common working procedures for the situation of loss (for protection measures refer to Annex A7).

On the basis of the division into working areas, the working procedures and activities of fire loss restoration to be effected there shall be defined. On the basis of the definition and evaluation of the hazards connected with the scheduled works by an expert, activity-related OSH measures shall be defined.

In this respect it shall be taken into account that requirements resulting from the disposal concept (e.g. reception criteria of the disposal company) could affect the OSH measures.

Especially in case of fires in commercial or industrial companies it shall be taken into account that special OSH regulations apply to the areas affected by the fire already during normal operation which shall be considered in fire loss restoration too.

The work and safety plan forms the basis for the restoration company being able to comply with its duties according to various OSH regulations. This is why it is to be implemented in the contract awarding conditions as a material part by way of a performance description or bidding procedure when awarding the contract. Irrespective of the type of awarding procedure, the conditions of the German construction contract procedures (VOB) Part C, DIN 18299, Par. 4.2.5 shall be complied with:

Special protection measures to be taken for works in contaminated areas do not present ancillary services but special services. They should be identified as such in qualified invitations to tender, quotations, and invoices.

If applicable, the restoration and disposal works shall be effected under the supervision of an expert (refer to Cl. 4.7 in connection with Annex A3) on the basis of these planning documents.

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4 Danger Zones

On the basis of the results of the first inspection, the working areas are classified into the danger zones 0 to 3 (refer to Fig. 4) according to the criteria described in Cl. 3.6 and 4. The classification into danger zones assesses only the substances to be expected in the fire residues as well as the extent and the spatial distribution of the contamination by smoke condensates and is generally independent from the division into working areas (refer to Cl. 3.7).

A danger zone is an area which can be separated spatially and is contaminated with pollutants due to the fire. The areas affected by the fire and its residues (refer to Cl. 2.4) are classified into danger zones 0 to 3 with increasing pollution. In this respect, the risks resulting from the fire form the basis. They result from the fire residues, the extent and spatial distribution of the pollution by smoke condensates and are based on the following investigations:

- extension of the contaminated area ("polluted by the fire");
- type and quantity of materials involved, in particular hazardous substances (e.g. effect of the fire load);
- fire conditions;
- pollution due to fire in the loss area (degree of pollution, consistency, ability of mobilisation).

In addition to the above, further aspects shall be considered. Among other things, they include information of the fire brigade (What has burned how and where?) or of the operator (What was stored / manufactured where?).

The classification into danger zones 0 to 3 includes the hazard identification (refer to Fig. 4). In danger zone 3, highly critical combustion residues (for definition refer to Cl. 2.4; e.g. stocks, asbestos) exist or health hazards by biomaterials shall be considered.

Other hazards such as impairment of the building statics by corrosive combustion residues, electric hazards (in particular in case of photovoltaic plants) are taken into account upon classification into danger zones. The risks resulting therefrom shall be established and assessed separately. They shall be considered in the preparation of the work and safety plan and the safety and health plan.

There may be different danger zones in one loss area. The extension of a danger zone may correspond to an individual working area. It is also possible that different working areas shall be assigned to one danger zone. In other cases, it may be reasonable that a working area is divided into different danger zones, e.g.

- a staircase with greater pollution upstairs due to fire or
- a large manufacturing shop where several works are carried out in parallel; where required the danger zones shall be partitioned off by walls or ceilings made of plastic film.

The classification into danger zones can also be changed due to new findings, e.g. accompanying investigations, or as a function of the restoration progress.

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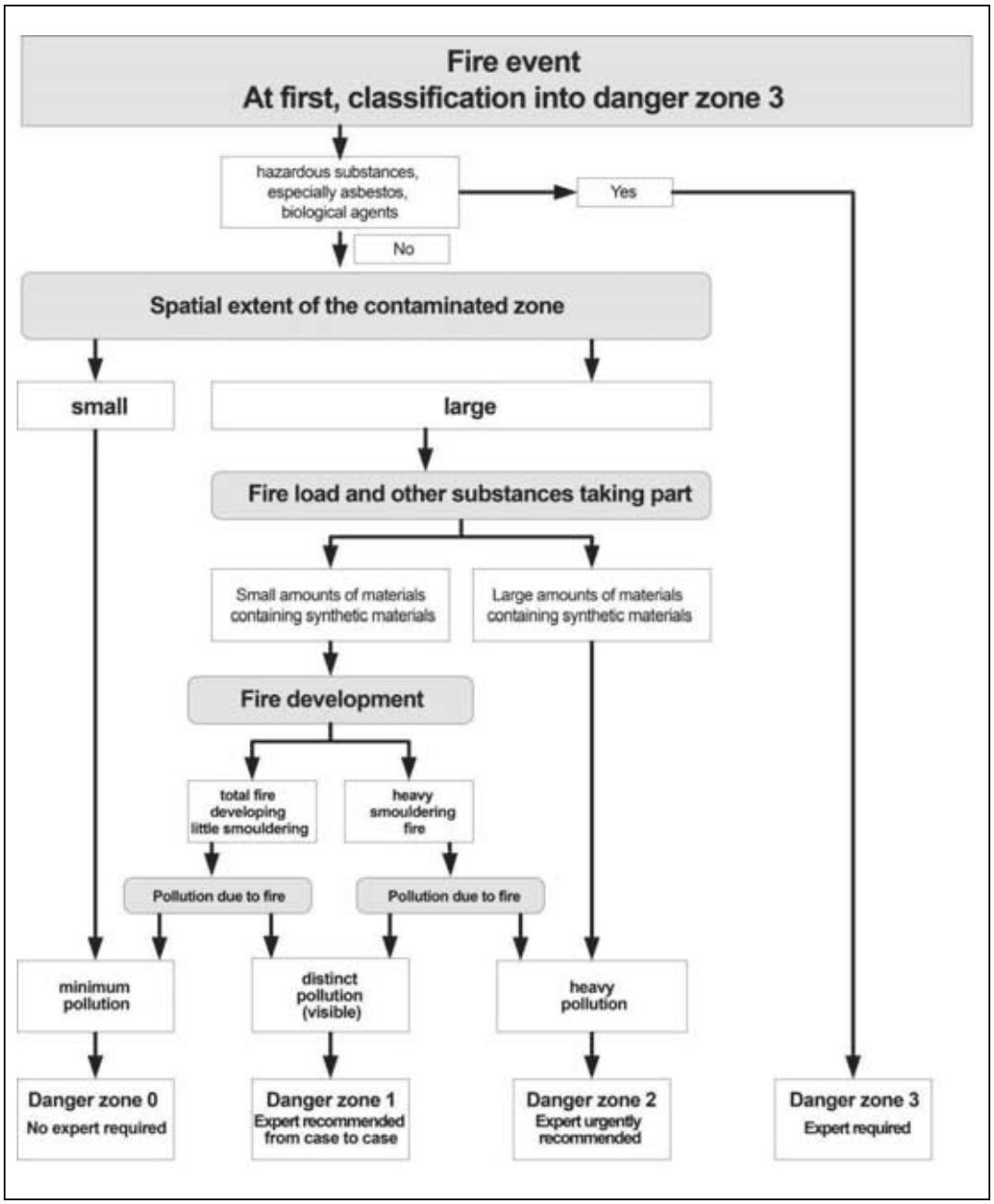

Fig. 4: Guidance for identification of hazards by pollution due to fire (for selection of a qualified expert, refer to Cl. 3.2)

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4.1 Extension of the area polluted by fire

Classification of the loss area into danger zones starts with examination of the spatial distribution of the hazardous substances caused or released by the fire first without assessing their corresponding concentration. The spatial distribution can be seen from the visible pollution due to fire.

Spatial extension of the area polluted by fire

Small:
Restricted spatial extension (approx. 1 m²) of the area polluted due to fire (e.g. fire in a waste-paper basket, of an arrangement with candles, or of a cooking place).

Large:
The area polluted due to fire extends to, for example, industrial, production, or storage halls or several rooms / floors in residential or office buildings.

4.2 Effect of fire load

The effect of the fire load presents a main criterion for evaluating the existing release of hazardous substances. Especially in case of large quantities of materials containing plastics, incomplete combustion and thus increased concentrations of pollutants (in particular PAH) shall be expected. Particular attention shall be paid to materials which contain plastics such as polyvinyl chloride (PVC), polyurethane (PU), polystyrene (PS), or melamine and phenolic resins. E.g., they may exist in insulating material, floorings, packaging, electric and electronic devices, window frames, ceiling cladding, and / or composite wood panels (chipboards).

"Small amounts of materials containing plastics" shall be assumed if, for example, in the residential sector the above mentioned materials are available in quantities which are usual for households and affected by the fire. This also applies to office and administrative areas with usual office equipment.

"Large amounts of materials containing plastics" shall be assumed if, for example, production and storage areas, longer cable trays, data centres, computer centres, control rooms, larger roof surfaces insulated with the respective materials and the like are affected by the fire.

If halogen-containing plastics are involved, the formation of more toxic combustion residues, in particular halogenated aromatic compounds such as penta-/ hexachlorobenzene as well as polyhalogenated dibenzo furans (PXDD/PXDF) shall be assumed. Typical materials are, in particular, PVC, plastics containing polyvinylidene, chloroprene, chlorinated / brominated flame retardants, which are also included in plastics with flame retardant properties, PCB from paints, jointing compounds as well as wood treated with wood preservers containing pentachlorobenzene.

Moreover, other substances such as hazardous substances and biomaterials shall be considered, which

- had already been available as raw material, consumables, supplies, or building material (among other things asbestos, biopersistent mineral wool) before the fire and were involved in the fire or released as a consequence of the fire. Considerable hazards may already result from the unburned product if the container is damaged (e.g. pesticides, solvents, synthetic resins).

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- developed as an indirect consequence of the fire, only, e.g. germs or hazardous reaction products caused by failure of systems.

The following is of fundamental importance for the classification into danger zones:

- investigations, measuring and examination reports about possible or existing hazardous substances on the part of the fire brigade, supervising authority, and/or a qualified expert,
- information of the client about what burned and which materials or even hazardous substances / biomaterials may still be available in unburned, perhaps thermally changed state.

In general, this information shall be provided by the mentioned organizations and / or client.

4.3 Evaluation of fire conditions

The fire conditions are of vital importance for the formation of pollutants. With decreasing levels of oxygen during a fire (smouldering fire), the more incomplete the combustion and thus the release of soot and substances, in particular PAH. Accordingly, a considerable release of pollutants shall be expected under unfavourable fire conditions even in case of wooden material classified as "uncritical".

Signs of a stronger smouldering fire situation are closed premises as well as building areas with increased pollution due to fire on all surfaces.

By contrast, bright flames during the fire or destruction and thus opening of building parts such as roofs, walls, windows with quick exhaust of the smoke indicate a largely complete combustion at high temperatures and thus low contamination with pollutants.

Fire development

Full fire situation with little smouldering:
- open fire with bright flames and smoke exhaust through building openings;
- unimpaired distribution of combustion residues.

Heavy smouldering fire:
Fire situation in case of lack of oxygen, e.g.:
- room partitioned off;
- minimum outward exhaust;
- pressure build-up inside.

4.4 Pollution due to fire

In addition to the type and mobility of the combustion residues, the intensity of pollution due to fire is to be considered for separation of areas which are affected to different extents. Experience has shown that in areas with decreasing pollution due to fire a decreasing substance load and thus a lower risk shall be expected.

The mobility and bioavailability of the existing pollutants also present a material criterion for the classification into danger zones. Experience has shown that on cold fire grounds hazardous substances with low vapour pressure are highly bound to soot so that the risk of absorption of vaporous substances by airways or skin by possible soiling can be considered as being low. In order to evaluate the possible absorption through the airways as a particle, the consistency and ability of mobilisation of the soot (flaky or sticky soot)

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and regarding absorption through the skin the existence of skin-absorptive and skin-irritant fire residues shall be taken into account.

Pollution due to fire

Minimum pollution:
- a few soot particles (not on all surfaces);
- thin film of smoke condensate, hardly visible on the affected surfaces but may be visible as dark soiling when wiping the surface with a white cloth.

Distinct pollution
- soot particles deposited on all surfaces;
- smoke condensate film on all surfaces with clearly visible discolouration of the affected surfaces.

Heavy pollution
- thick layer of soot particles on all surfaces;
- thick layer of smoke condensate film on surfaces with intensive blackening of the surfaces.

4.5 Definition of danger zones

Danger zone 0:

- restricted spatial extension (approx. 1 m²) of clearly visible up to highly polluted area due to fire, e.g. fire of a waste-paper basket, arrangement with candles, or cooking plate

or

- larger extension but with minimum pollution due to fire.

Danger zone 1:

Fires with clearly visible pollution due to fire and when compared with danger zone 0 larger extension of contaminated area, during which materials (quantity usual for households) containing plastics burned and for which a serious pollutant contamination of the fire ground shall not be expected due to fire conditions and aspect of the fire.

Danger zone 2:

Fires with stronger extension of the contaminated area and very strong pollution due to fire, which involved greater quantities of materials containing plastics, in particular organochlorinated and bromated substances such as PVC (e.g. highly occupied cable trays, stocks) or in case of which a serious pollutant contamination of the fire ground exists due to the fire aspect and course of fire. Smouldering fire situations in which the outer building structure is largely preserved but all surfaces are polluted due to the fire are typical for danger zone 2.

Danger zone 3:

Fires in case of which in addition to the existence of combustion residues larger quantities of biomaterials or hazardous substances or products containing hazardous substances shall be expected. They may be available as raw materials, consumables, or supplies or in the area of the building and system. In this respect, special attention shall be paid to the existence of asbestos and biopersistent mineral wool. Moreover, critical biomaterials can either be released directly (e.g. biological laboratories of protection class 3) or be formed by subsequent processes (e.g. decaying animals).

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As long as a classification into danger zones has not yet been effected, the loss area shall be handled in compliance with danger zone 3.

4.6 Additional information on classification into danger zones

It is recommended to classify the loss area into different danger zones if the following criteria are met:

- Clearly varying degrees of soiling are available.
- Spatial separation of individual danger zones is possible.

If further findings exist, the allocation to a danger zone can be changed to the higher or lower level if, for example,

- in the course of first inspection or during restoration works fire loads and thus also possible combustion residues with a higher risk potential are found which had not been known or detected before;
- in the course of time or in case of delay of required clearing-up and restoration works, biological and/or chemical pollutants develop from the fire load in an uncontrolled way;
- an analytic evidence of the pollutant situation requires a new evaluation;
- in the course of restoration works, the hazardous situation is reduced by elimination of hazardous aspects which are decisive for the classification.

4.7 Hiring of experts

Irrespective of the economic evaluation of the loss, it may be necessary to seek expert advice to evaluate the hazards in the loss area due to the fire. The selection of the corresponding experts differs from case to case depending on the available hazards, e.g. collapse, chemical or biological contaminations by the fire or building materials (asbestos, wood preservers), pollution of ground or ground water.

In order to evaluate the hazards due to the substances and determine the danger zones from case to case, it may be necessary to consult an expert specialising in the evaluation and restoration of fire losses. Due to his / her training and experience, the expert shall be able to evaluate the risk potential caused by pollutants as a basis for restoration planning and work and safety plan. E.g. this task can be performed by a chemist but also by another expert depending on his / her training and expert knowledge. In general, the evaluation of the substances is documented in an expert opinion about pollutants (refer to Annex A3).

In case of allocation to danger zone 0, hiring of an expert is not necessary; in general this also applies to danger zone 1.

If the fire occurred at a "sensitive" site, such as kindergarten, schools, museums, and the like, consulting of an expert is recommended also in case of classification into danger zone 1.

If, however, the criteria according to Cl. 4 result in a classification into danger zone 2, hiring of an expert is strongly recommended.

In case of classification into danger zone 3, hiring of an expert is required (refer to Fig. 4).

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5 Measures of occupational safety and health (OSH)

Any planning of occupational safety and health protection is based on the principle given in § 4 ArbSchG (German Occupational Safety and Health Act), which urges to prevent or minimise any risk. Here, the selection of an "appropriate" working procedure has got highest priority. To activities involving hazardous or biomaterial applies that the working procedures shall be emission or exposition reducing. If such working procedures are not available or are insufficient to minimise exposition, technical and organisational measures get priority over the wearing of personal protective equipment (PPE).

Experience has shown that fire loss restoration work even despite of all technical and organisational measures taken always involves a residual risk, which shall be reduced by using personal protective equipment. Selection of the personal protective equipment depends on the danger zone and the corresponding exposure of workers to such substances, which depends on their activities.

The procedures and working methods usually used in fire loss restoration had been assessed exemplarily as to their risks and classified into danger zones 0 to 3. The result was taken as a basis to work out the requirements for measures to provide for OSH when handling certain substances. These are the minimum requirements and shall be met above all by those who work in corresponding areas. They can be replaced anytime with superior equipment proving equivalent or higher protection. Annex A7 presents a proposal of the personal protective equipment to be selected in consideration of the danger zones and of the activities required during the usual working procedures.

In the course of restoration it shall be permanently verified whether the selected measures still come up to the actual danger situation.

Regarding occupational safety and health some facts shall be documented. Annex A5 gives information on the obligations to document.

5.1 Measures to be taken irrespective of the classification in danger zones

The loss area shall be protected against any unauthorised access and marked so as to meet the requirements for work in contaminated zones (also see the Employers' Liability Association regulations BGV A8 dealing with safety and health protection markings at workplaces). On the occasion of a first inspection of the loss area (see Cl. 3.5), type and extent of protection shall be specified, e.g. whether barrier tape is sufficient to "mark" the danger zone or whether this shall be fenced out or the like.

Danger zones shall be marked correspondingly. If several danger zones exist within one working area, they ought to be partitioned at least visually.

Any company working in the loss area shall prepare operating instructions for the particular activity and instruct the employees correspondingly; all in compliance with § 14 GefStoffV [German Hazardous Material Regulations] (in case of any risk due to biomaterial according to § 12 BiostoffV [German Biomaterial regulation]).

Only employees shall be assigned, the physical aptitude of whom has been proven in corresponding preventive medical check-ups. In addition to the danger due to hazardous substances, the use of breathing protection and protective clothing presents a particular physical stress, for which the employee shall be fit. To point out the necessity of special

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preventive medical check-ups regarding all dangers due to substances and activities, especially regarding carcinogenic substances we refer to the German Regulations on Occupational Health Care (ArbMedVV), the DGUV guidelines (DGUV: German statutory accident insurance) presenting a guidance for works' doctors on occupational medical examinations of workers working in contaminated areas, and the BGR 128 (Employers' Liability Insurance Association regulation).

5.2 Measures to be taken for first inspection

A risk assessment shall be made for the first inspection too. In addition to dangers due to substances, in particular any danger due to impaired statics, instable foundations, as well as resulting openings and areas with risk of falling in the affected building shall be taken into consideration. Moreover, electricity can involve danger, e.g. in photovoltaic plants. Only, after having clarified the above it will be decided whether or not to inspect the corresponding area.

Regarding any dangers due to substances, you should always treat the substance as if it were classified into danger zone 3 (see Cl. 4.5) until knowledge will be gained allowing to classify the substance into another danger zone. Critical hazardous situations as given in danger zone 3 may exist if, e.g. receptacles with hazardous substances (e.g. biocides such as plant production products and wood preservers, solvents, acids) have been destructed, if material containing asbestos or biopersistent mineral wool, i.e. "old mineral wool", according to the technical rules for hazardous substances TRGS 521 (former designation MMMF – man-made mineral fibre) exists or has been liberated by fire. The same applies to areas where biomaterial is probable, e.g. highly infectious disease agents in corresponding laboratories or hospital departments, in butcher's shops or facilities for disposal of animal remains, in waste bunkers holding municipal waste or the like.

As experience has shown so far, short inspection of a cold fire ground classified into danger zone 0 to 2 normally does not involve any risk to health by combustion residues. However, we do recommend to hold available or wear a minimum of personal protective equipment during the first inspection or other investigations (e.g. investigation of the root cause of fire) (see Annex A7 on this topic):

- protective helmet, DIN EN 397;
- safety shoes, min. S3 (steel toe cap, penetration resistant);
- safety gloves, min. EC category II (protects against physical danger, liquid-tight);
- breathing protection, min. half-face mask featuring a variety of filters for the substances expected;
- chemical protective clothing, EC category III, type 6 (particle-tight).

The above assessment and specifications of corresponding measures to be taken does not release from the obligation to carry out a risk assessment (see Annex A4.1). If higher danger due to substances is to be expected during the first inspection, the measures shall be selected on the basis of the requirements specified in Annex A7.

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5.3 Measures when taking loss-related emergency measures

The results originating from the first inspection are the OSH basis for taking loss-related emergency measures (see Annex A7).

As long as no other classification is known, you should always take it as if classified into danger zone 3 to the best of anyone involved. In addition to the danger due to substances, any danger due to impaired statics, instable foundations, as well as resulting openings and areas with risk of falling in the affected building shall be taken into consideration in particular for the time when taking the emergency measures. Moreover, electricity can involve danger, e.g. in photovoltaic plants.

5.4 Measures in danger zone 0

As experience has shown so far, this danger zone does not present any significant risk provided that normal hygienic standards are complied with. Thus, the required work can be done with commercial-quality cleaning agents (e.g. washing agent solution) by laymen because the pollutant load is to be neglected. We do recommend using adequate elementary protective equipment:

- disposable coverall, EC category III, type 6;
- watertight safety gloves against physical danger (min. EC category II); as well as
- breathing mask P2 with filter if required.

5.5 Measures in danger zone 1

From danger zone 1 up the loss area shall be considered contaminated as defined in BGR 128 or TRGS 524. Cleaning and restoration should be done by expert companies; however, in particular cases victims of fire can do this themselves. The following requirements shall always be met to ensure proper execution of the work:

- deployment of appropriate personnel, in particular occupational health checkups;
- use of appropriate procedures and work equipment;
- skilled knowledge by experts (expert knowledge as defined in BGR 128 or expertise as defined in TRGS 524);
- protection and if required sealing of the restoration area from any area not affected (partitioning into black and white areas);
- entry prohibited for unauthorised persons;
- personal protective equipment for activities in danger zone 1 (see Annex A7);
- black/white areas (definition see Annex A9).

Safety gloves and disposable coveralls remain in the loss area. After leaving the loss area thorough cleaning of the body is obligatory.

5.6 Measures in danger zone 2

As there is an increased pollutants potential in danger zone 2, expert companies for fire loss restoration shall be entrusted with tasks in such zones. They shall be familiar with the handling of pollutants, have appropriate personnel at their disposal, provide for expert knowledge in this field, and have adequate equipment. In addition to the measures in danger zone 1 the measures below shall be taken:

- use of dustless devices;
- personal protective equipment for activities in danger zone 2 (see Annex A7);

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- black/white areas featuring a decontamination installation and a washing installation for boots;
- construction equipment shall be equipped with systems to supply breathing air to the driver according to BGI 581. If filtering installations are used, the filters to be used shall be defined on the basis of the potential of hazardous substances and the rules how to use an breathing apparatus (BGR 190).

Depending on the damage situation and the assessment by a skilled coordinator or an expert, special measures may be required and defined.

5.7 Measures in danger zone 3

Depending on the damage situation and the assessment by an expert, special measures to provide for OSH may be required in addition to the measures for danger zone 2 and higher demands may be made on the personnel carrying out the work. Here, the higher dangers in danger zone 3 shall be taken into consideration, e.g. expertise as defined in TRGS 519 for existing asbestos.

6 Waste disposal

6.1 Legal rules

According to the principles and general obligations laid down in the German Closed Substance Cycle and Waste Management Act (KrWG) wastes are substances and objects the owner wants or shall get rid of. We distinguish between wastes to be recycled and wastes to be disposed of. To foster conservation of resources the sequence below (waste hierarchy) shall be followed in waste management:

1. Avoidance
2. Preparing for reuse (use to the same purpose)
3. Recycling (material recovery, no energetic recovery)
4. Other recovery, in particular energetic recovery and backfilling
5. Disposal

Based on the waste hierarchy, any procedure which ensures protection of man and the environment shall be selected first. Wastes which are not recovered shall be disposed of. Wastes shall be pretreated to reduce quantity and harmfulness. Energy or wastes produced during waste recovery and disposal shall be used to the highest-possible result.

Hazardous waste is defined in the German List of Wastes Regulations (AVV § 3) to be any waste the composition of which shows a risk potential as described in the criteria H1 through H15 in Annex III of the directive 2008/98/EC or which have been qualified as hazardous waste by any regulations issued by a German Land or the Federal Government. Any other waste is non-hazardous according to the KrWG.

Wastes for recovery shall be classified for registration and treatment to a degree that waste disposal becomes proper and safe as well as economically reasonable. Apart from special exceptions, mixing of hazardous wastes is not permitted.

The German List of Wastes Regulations (AVV) specifies a six-digit waste code for all wastes – branch-specifically, following the waste type and the composition of waste. Hazardous waste is identified by the waste code and an asterisk (*). As laid down in the KrWG, special requirements shall apply to the disposal and monitoring of hazardous waste. Some of these requirements are subject to regulations by the German Länder and require a special verification management (verification procedure).

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The disposal route shall be specified according to the waste classification as laid down in the AVV and the waste characteristics so that the waste can be delivered to recovery or disposal. For non-hazardous waste from private households any municipal duty to surrender shall be taken into consideration.

We strongly recommend early coordination with the competent authorities already when preparing the waste disposal concept.

6.2 Execution

Fire residues often are charred material or material subject to strong thermal load, such as scorched or charred wood and plastic material. Often they are mixed with stocks, furnishings, and building material soiled by the fire, as well as hazardous substances to be recovered, which have been used as raw materials, consumables, and supplies, as well as in building materials. In the course of restoration, e.g. contaminated consumables and working means are used, such as washing liquids, abrasives, protective clothing.

By an early separation of the resulting wastes, a high portion can be supplied into recovery procedures and, moreover, the disposal procedure becomes smoother and more economic and the quantity of hazardous waste can be reduced.

Annex A8 lists typical groups of substances occurring as a result of damage due to fire. To provide an example, some waste codes complying with the German List of Wastes Regulations (AVV) are assigned to these groups. Such codes are required to declare waste to operators of waste disposal plants and waste management authorities.

In the course of clearing-up and dismantling, generally all resulting wastes should be separated into mineral and organic material. The expenditure required for waste separation mainly depends on the composition of wastes and the quantities of the different fractions.

In case of smaller fire events, such as housing fires, it may often not be reasonable to separate down to the last detail so that all the waste there is classified higher. However, single waste components of an increased pollutants potential should be separated nevertheless and delivered to the municipal collecting points.

In case of fires in trade and industry, as a rule the particular case shall be considered. Here – the same as in case of problems with pollutants – a waste disposal concept shall be prepared already before starting with restoration work. Any restoration activities in the danger zones 2 and 3 should be carried out in cooperation with an appropriate expert who even supervises them where required.

Depending on the composition of resulting wastes, the separated wastes may show high pollutant content. To determine the disposal route, an expert shall take samples of the different waste fractions (sampling protocol). The examination programme is determined in coordination with the competent waste authorities and the operator of the waste-disposal plant. The results of examination, in particular the declaration analysis is part of the compulsory verification procedure.

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7 Literature

The Guidelines for Fire Loss Restoration (VdS 2357) deliver comprehensive instructions for anyone and any group taking part in planning and execution of the required work. The risk potential, which is very high in parts and could be difficult to assess, calls for knowledge of many statutory provisions and regulations. Those are the basis of VdS 2357 (see Annex A4 on this) and are listed in Annex A10 together with further reading.

You will find there:

- Acts and regulations governed by the law of wastes, OSH law, and environmental law;
- technical rules for workplaces, operational safety, hazardous substances and biomaterial, as well as for the occupational safety and health on construction sites;
- regulations, rules, and information of the statutory accident insurance institutions;
- publications of GDV [German Insurance Association];
- other standards, regulations, and recommendations.

The statements made in the VdS 2357 take into account the statutory provisions and regulations as amended on the date of publication of the corresponding edition.

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Annexes

A1 Typical combustion residues (as defined in Cl. 2.4)

Note: The mass-related specifications of concentration in proportion/kg relate to solid material, the volume-related specifications in proportion/m^3 relate to the air, the surface-related specifications in proportion/m^2 relate to the surfaces exposed.

A1.1 Hydrogen chloride (HCl), hydrogen bromide (HBr)

Formation

Pyrolysis or burning combustion of halogenated organic compounds (e.g. PVC, plastics with halogen-containing and flame retardant additives, halogenated hydrocarbons).

Consequences

Hydrogen halides and their precipitates could cause progressive corrosion of metallic surfaces depending on the material and relative air humidity.

With an increasing air humidity above approx. 45 % the reaction speeds up more and more.

Cement-bonded and lime-bonded building materials react on halogen acid to become the corresponding calcium salt (contamination phase). Consequential damage to the building is possible only if halides reach the steel reinforcement (distribution phase) in case of humidity there (e.g. air humidity), in case of a reduced alkali strength of the concrete, and in case of exceeded limit values (listed below).

Health hazards

Hydrogen chloride and hydrogen bromide are gaseous compounds of the hydrochloric or hydrobromic acid, respectively. They are highly caustic.

HCl and HBr gases cause inflammatory response or reaction of the eye and the mucous membranes of the respiratory tract. Precipitates of hydrogen halide involve only a minor dermal risk potential (irritation of skin).

The typical surface load or concentrations caused by fire (danger zones 1 and 2) have no relevance to health. If such substances are involved, corresponding hazards shall be taken into account (danger zone 3).

Guidance values

Corrosively critical surface load	
for metal (depending on material)	approx. 5-10 µg halide/cm²
Restoration target:	<< 5 µg/cm^2
Corrosively critical reference value, reinforced concrete:	
for unstressed reinforced concrete:	≤ 0.06 % Cl, related to concrete (according to Richartz, with a cement factor of 1:7)
corresponds to:	≤ 0.40 % Cl, related to cement
Restoration target:	To fall short of these limits.

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A1.2 Polynuclear aromatic hydrocarbons (PAH)

Polynuclear aromatic hydrocarbons (PAH) are a group of substances of multi-cyclic aromatic compounds.

Formation / release

Typically, PAH result from incomplete combustion and pyrolysis (lack of oxygen) of any organic material. They also exist in bituminous materials and tar oils used in the past for insulation inside buildings.

Consequences

Deposition as / in condensate on the surfaces of buildings and equipment / furnishings with the PAH generally being highly bound to the soot or fire residues. Volatility of the compounds is minor.

Health hazards

Many PAH rank among carcinogenic compounds with benzo(a)pyrene as lead compound. Benzo(a)pyrene is a carcinogenic, mutagenic, embryotoxic substance that impairs fertility and is classified into category 2 of the German Hazardous Materials Regulations (TRGS 905).

Assessment shall take into account that biologic availability is low due to the high adsorption in soot. Volatility of most PAH is minor.

Note: The average absorption per day of benzo(a)pyrene of non-smokers is 7.6 ng/kg BW and day, 90 % of which through food. A smoker absorbs about twice as much.

Guidance values

Typical / often existing background values	
industrial environment	< 100 µg/m^2
living space and offices	< 10 µg/m^2
Restoration target:	≤ background value

Examination

16 compounds are typically registered to analyse them in accordance to EPA 610 (standard).

A1.3 Polychlorinated biphenyls (PCB)

The polychlorinated biphenyls are a group of substances with 209 individual substances (congeners) of different chlorinating degrees and different positions of the chlorine atoms in the molecule.

As required by the German Chemicals Ban Regulations (ChemVerbotsV or Regulation (EC) No. 1907/2006 (REACH regulation) tri and higher chlorinated biphenyls as well as any compound holding more than 50 mg/kg of these substances shall not be put into circulation.

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Until about 1975, products containing PCB had been used in open applications. Since 1983, PCBs have not been produced in the Federal Republic of Germany. In case of damage it cannot be excluded that especially building materials contain PCB.

Formation / release

Released by plasticisers in permanently elastic sealing compounds, coatings (paintings), and ceiling panels. As a result of the PCB ban it is released or evaporated from insulating liquids of leaking capacitors, transformers, and hydraulic oils in exceptional cases only.

PCBs can evaporate as a result of the heat impact, when the fire is hot, and condensate together with the precipitating flue gas. PCB formation due to fire materials containing chlorine can be neglected.

Consequences

Deposition as condensate on the surfaces of buildings and equipment / furnishings or as a highly viscous liquid. Despite of low vapour pressure there is minor volatilisation (degasification) into the ambient air.

Health hazards

PCBs are classified to be carcinogenic (K3) and hazardous to the environment. PCBs should be considered to be embryotoxic (R_E2) and to impair fertility (R_F2).

Acute toxicity (toxic effect upon single or short absorption) of pure PCB is low.

The chronic load (permanent absorption of low doses over a longer period of time) with PCB shall be considered critical as it affects the liver. The reason is the high capacity of accumulation in liver and fat, the strong chemical stability, and the connected low biological degradability of PCBs. The average absorption per day of PCBs of adults is 60 ng/kg BW and day, 95 % of which through food.

The fabrication and operations relating load of PCB products with polychlorinated dibenzo furans (PCDF) as well as fires of transformers containing PCB leading to formation of a relatively high amount of PCDF can increase the hazard (also see Annex A2.4).

Guidance values

Air load		
Indoor air limit value:	< 300 ng/m^3	tolerable
(PCB guideline NRW, approval controlled by the German Länder)	300 -3000 ng/m^3 medium term	to be removed in the
	> 3000 ng/m^3	intervention required
Restoration guide value: (PCB guideline):	< 300 ng/m^3	
Surface load		
Restoration target:	<< 100 µg/m²	

Examination:

6 congeners according to LAGA waste code (work group of German Länder on waste), PCB 28, 52, 101, 138, 153, 180; nomenclature according to Ballschmiter; if possible with occlusion of penta and hexachlorobenzene.

A1

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A1.4 Polyhalogenated dibenzo-p-dioxins (PHDD) and dibenzofurans (PHDF)

Polyhalogenated dibenzo-p-dioxins comprise of 75 and polyhalogenated dibenzofurans comprise of 135 individual substances (congeners). The group of substances shortly called "dioxins" is almost ever a mix of congeners in varying combinations. From the toxicological point of view only the 17 dibenzo-p-dioxins and dibenzo furans are important and are analysed to assess their toxicity; they have halogen atoms (chlorine or bromine) bound (substituted) at the four positions 2, 3, 7, 8. Only the polychlorinated (PCDD / PCDF) and to a considerably less degree the polybrominated (PBDD / PBDF) ones are important. In the combustion process brominated flame retardants can cause mixtures of chlorinated / brominated "dioxins" with theoretically 5020 congeners. However, this group of substances is of very little importance.

Formation

During incomplete combustion and pyrolysis of organochlorinated and brominated substances or inorganic chlorides or bromides in combination with organic material (de novo synthesis in combustion processes), e.g. by burning combustion of PVC.

Consequences

Deposition as a condensate on the surfaces of buildings and equipment / furnishings. The PHDD/F are generally highly bound to the soot or fire residues.

Health hazards

When accumulating in adipose (fat), PHDD/F can cause hyperpigmentation, damage to hepatocytes, dysfunction of the fat metabolism, or cancer.

The high capacity of accumulation in liver and fat, the strong chemical stability and the connected low biological degradability of PCDD / PCDF, and the carcinogenicity are the reasons for a high health hazard in case of chronic exposure (permanent absorption of low doses over a longer period of time). The average absorption per day of PCDD / PCDF of adults is 0.7 pg/kg BW and day, 95 % of which through food.

In case of fire losses you shall take into account that the availability for absorption is low due to the high adsorption of the PHDD/F in soot and, consequently, resorption should be very low. Pathological symptoms typical for the profession are not known, neither in the field of fire service nor in the field of fire loss restoration. The German Land committee for immission control (LAI) estimated the carcinogenic potential of PCDD / PCDF compared to that of PAH benzo(a)pyrene to be 20:1. However, the quantitative relation of PCDD / PCDF to benzo(a)pyrenes in fire residues is in the range of >1:100-1000. The total of all carcinogenic PAH is certainly about 10-100 times above the total of benzo(a)pyrenes. Thus, the carcinogenic health hazard of fire residues is definitely caused by PAH and the risk due to dioxins shall be considered to be very low.

The toxicity of brominated dioxins is very similar to that of chlorinated dioxins, only a bit less.

Guidance values

Acute and chronic toxicity of a multitude of single compounds combined in the groups of "dioxins" is very different and can vary up to a factor of 10,000. Toxicity equivalence factors (TEF) have been introduced to determine the toxicity of congener mixtures of polychlorinated dibenzo dioxins and dibenzo furans; here, the 2,3,7,8-TCDD as a representative of highest toxicity has got TEF 1. For the toxicologically most important

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congeners with chlorine substitution at least at positions 2,3,7,8, the relative intensity of impact compared to the 2,3,7,8-TCDD has been determined and the corresponding TEF has been specified. Therefore, the toxicity of a mixture can be roughly estimated by multiplying the concentration of the individual congener with the corresponding TEF and using the total value as toxicity equivalent. The resulting toxicity equivalent is approximately the potential risk.

New knowledge on the effects of dioxins urged the WHO to publish a revised WHO-TEF list in 2005. Today's assessments on human toxicology are based on this list and the EC has used it to derive reference and limit values. Former I-TEFs are still valid in Germany within the scope of some regulations (BImSchV, KlärSV, BBodSchV); however, we act on the assumption that they will be replaced sooner or later with WHO-TEFs to support European harmonisation because the assessment of the health hazards made with the WHO-TEFs is closer to reality.

2,3,7,8-TCDD is classified to be carcinogenic (K1) according to TRGS 905.

TRGS 557 (dioxins) is not applicable to restoration and demolishing work as well as accidental incidents.

The orientation values below have been adjusted to the 2,3,7,8-TCDD and the 2,3,7,8-chlorinated congeners.

Indoor threshold value, Hessen / Germany Official Gazette of Hessen (a German Land), No. 51, 2549 (1989)	10 ng ITE/m^2
Restoration target for contaminated surfaces:	< 50 ng ITE/m²
In rooms for occasional use:	< 100 ng ITE/m²

A1.5 Asbestos

Asbestos (Greek meaning "everlasting") covers a group of fibrous silicate-based minerals found in nature.

Occurrence and properties

Asbestos can be found in large deposits in Russia, South Africa, and North America. Due to its non-combustibility, its high electrical and thermal insulating properties, and its chemical resistance, asbestos was used in a large variety of products.

Formation / release

A fire can uncover or liberate asbestos when thermal / mechanical loads apply. A decisive point for the classification into a danger zone is the occurrence in the loss area and the risk that fibres are liberated during and due to the fire.

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Especially to be taken into consideration are:

- exposed fire-protecting materials (sprayed asbestos), sealing cords at firing installations, etc.;
- destroyed / cracked asbestos-cement sheets; as well as
- products containing asbestos which have to be removed during dismantling.

Classification of asbestos products

Based on the TRGS 519 and the asbestos guideline we classify asbestos products as follows:

- weakly-bound asbestos products (apparent density under 1,000 kg m^{-3}, asbestos content about 60 wt%);
- asbestos-cement products (apparent density min. 1,400 kg m^{-3}, asbestos content less than 15 wt%);
- other asbestos products (products to be assessed by analysis).

Sheets manufactured in the GDR which contain asbestos and are named "Baufatherm", "Sokalit", and "Neptunit" are classified to be weakly-bound asbestos products irrespective of their apparent density.

Production ban and prohibition of use

1979 Prohibition of sprayed asbestos in the FRG;

1982 Prohibition of weakly-bound asbestos products;

1984 Prohibition of asbestos in storage heaters;

1995 General production ban and prohibition of use of asbestos itself and any material containing asbestos. Excepted from such prohibition have been only demolition, restoration, and repair work.

2005 European-wide ban of asbestos products.

Health hazards

Asbestos fibres are chemically inert and do not show any acute toxicity; however, the human body does not cope well with degrading.

Due to the critical geometry of the fibres contained in asbestos dust (fibre length of min 5 µm and a diameter of max. 3 µm) they can penetrate down to the alveoli in the lungs. The health hazards known are asbestosis, mesothelioma (tumours in the peritoneum and the pleura), as well as lung cancer.

Examination

An analysis of asbestos fibres in the air of working areas, which can be absorbed by the lung, complies with BGI 505-46. This allows determination of the fibre concentration and specification of the chemical composition of the particles. Material samples are examined following VDI 3866.

A1

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Legal framework

The legal framework for asbestos repair consists of the German Chemicals Ban Regulations, the German technical rules and regulations for hazardous substances TRGS 519 based on the GefStoffV [German Hazardous Material Regulations], and the asbestos guideline (only applicable to weakly-bound asbestos products). Disposal of wastes containing asbestos shall be based on the notification No. 23 of the work group of the German Länder and the federal government on waste (LAGA).

A1.6 Old mineral wool / man-made mineral fibres

Man-made mineral fibres are inorganic synthetic fibres produced by melting mineral material, i.e. raw material for glass production, volcanic rock, and limestone, through a variety of nozzles and centrifugal procedures.

Man-made mineral fibres are used mainly for heat and sound insulation and for fire protection. In most cases they are used in the form of grey or yellowish rock wool or glass wool, in some cases in the form of slag wool.

Old mineral wool means man-made mineral fibres produced until the production ban and prohibition of use 06/2000 (see below). The man-made mineral fibres produced in a transition period starting in 1996, which do not meet the exemption clause requirements of the then German Hazardous Materials Regulations, are called new mineral wool.

Old mineral wool is subject to an increased incidence of suspicion regarding the liberation of inhalable fibres of carcinogenic potential.

Occurrence

"Old mineral wool" is primarily liberated from destructed or damaged components, which – depending on the installation location – can be exposed by the fire itself, by firefighting operations, or in the course of possible restoration and dismantling.

Man-made mineral fibre are in most cases soft woollen quilts or pressed fibreboards as well as an aggregate of fire-protection plaster. Typical areas of application are e.g.:

- heat insulation in roofs and roof coverings;
- lightweight building walls or behind the casing;
- suspended ceilings;
- heat and impact sound insulation under the flooring / screed topping;
- door and window reveals;
- heat insulation of pipes and air ducts (mostly under aluminium or PVC film).

Consequences

An increased concentration of fibres in the air involves a health hazard. This results when "old mineral wool" is damaged or exposed in the course of fire losses or the restoration measures required then. Heat impact and destruction of binding agents can also increase considerably liberation of fibres.

Health hazards

In a similar manner to with asbestos, the hazard comes from the fine inhalable fibres (so-called WHO fibres), which are chemically inert to a great extent. Due to their biological stability, degrading of fibre dust in the lungs is very slow. Compared to asbestos, man-

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made mineral fibres generate less fine dust and contain less inhalable fibres while showing in most cases a bit less biological stability.

Consequently, old mineral wool is classified to be carcinogenic of category K2 or K3. Classification in Germany is based on the existence of critical fibres (WHO fibres) as well as the carcinogenicity index (KI).

Acute toxicity is not given.

Definition and classification:

WHO fibres: Fibre dust of the following dimensions: length >5 µm, diameter <3 µm, and a length-to-diameter-ratio of >3:1.

Carcinogenicity index KI (applicable in Germany only):

Difference of the total mass content percentage (%) of the oxides of sodium, potassium, boron, calcium, magnesium, barium, and the double mass content (%) of aluminium oxide.

Based on these definitions "old mineral wool" is classified as follows:

a) Vitreous WHO fibres of a carcinogenicity index KI ≤30 are classified into category 2 for carcinogenic substances (enough indications that the substance can cause cancer in humans).
b) Vitreous WHO fibres of a carcinogenicity index KI >30 and K <40 are classified into category 3 (suspicion that the substance is carcinogenic but not proven sufficiently to classify it into category 2).
c) No classification to be carcinogenic results for vitreous WHO fibres if their carcinogenicity index is KI ≥40.

A1

Other adverse health effects of old mineral wool

In addition to the potential carcinogenicity of old mineral wool, the fibre structure and additives (binding agents) can cause a variety of other adverse health effects resulting from the handling of man-made mineral fibres (even new mineral wool). These are in particular skin and mucous membrane irritations but also irritations of the upper airways and the eyes.

Production ban and prohibition of use

In 1997, the EC directive 97/69 EC for classification of man-made mineral fibres on the basis of biosolubility was adopted.

Since 01 June 2000 it has been prohibited in Germany to produce, put into circulation, and use insulating material containing mineral wool which do not meet the exemption clause requirements of Annex IV Item 22 of the German Hazardous Materials Regulations.

The RAL quality mark is granted for bio-soluble mineral fibre products. Those products meet the provisions of the German Hazardous Material Regulations.



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Mineral fibre insulating material manufactured and used until 1995 shall be considered to contain potentially critical fibres. In the transition period from 1996 - 2000 both types of mineral wool were used, the old and the new one.

There is no obligation for rehabilitation if "old mineral wool" is found as far as the material has been installed properly and fibres have not been liberated to an increased extent.

Examination methods:

- BGI 505-31 – Analysis procedure approved by the Employers' Liability Insurance Associations to determine the concentrations of carcinogenic agents in the air of working areas – procedure to determine inhalable fibres – light-microscopy procedure.
- BGI 505-46 – Procedure for separate determination of concentrations of inorganic fibres in working areas – scanning electron microscopy procedure
- WHO fibres: Scanning electron microscope (SEM) coupled with energy-dispersive X-ray micro-analysis (EDXA) to identify fibres; according to VDI 3492.
- Carcinogenicity index: X-ray fluorescence analysis according to BIA 7488

Legal framework

The legal framework for restoration consists of the German Hazardous Material Regulations [GefStoffV], the German Chemicals Ban Regulations, and the German technical rules and regulations for hazardous substances TRGS 521 and TRGS 905 based on the GefStoffV.

A1

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A2 Sampling and pollutant analysis

Sampling may be reasonable and required in danger zones 2 and 3 to prove that a real value is at risk as well as to identify the hazard. The samples taken serve the hazard identification as well as the limitation of damage regarding its extent and intensity. This analysis shall consider both, the combustion residues and the perhaps still existing hazardous substances, which could be subject to changes due to thermal impact, in the stock or the production areas.

Regarding the combustion residues, the sampling effected for equipment and furnishings typically is in relation to the surface and takes place by wiping, whereas the sampling effected in the field of the substance of the building is in relation to the mass where samples are taken.

Typical parameters to find pollutants caused by fire are:

- pH value (e.g. test with stick);
- surface load of chloride / bromide;
- polynuclear aromatic hydrocarbons (PAH, total of 16 proven congeners according to EPA);
- penta- and hexachlorobenzene;
- polychlorinated biphenyls (PCB, 6 congeners according to LAGA waste code);
- lipophilic pyrolysis substances or pure pyrolysis hydrocarbons.

The range of examinations shall be adapted to the damage (e.g. heavy metals, other hazardous substances, biomaterial).

The load of hydrogen halides is most important as it adversely affects the real value of the technical equipment due to corrosion.

In many cases the surface load with PAH marks the path of distribution of pollutants.

A secondary distribution process takes place on surfaces of building elements contaminated by fire, especially in case of lime and cement bound building materials. Particularly for hydrogen chloride this can bring in pyrolysis substances. Therefore, three-dimensional sampling is required at reinforced building members to be effected by mechanical removal in layers. The examination for precipitated halides can be made titrimetrically, potentiometrically, or by means of ion-sensitive electrodes.

Normally, an examination for PHDD / PHDF shall be made only if the materials affected by fire or any test results increase the incidence of suspicion (e.g. suspicious load of hexa, pentachlorobenzene, PCB).

For a chemical examination in view of the waste disposal concept, it shall be agreed in advance with the authorities upon the method of sampling, e.g. in compliance with LAGA-PN98.

An expert shall evaluate the result of examinations and document this together with the sampling plan. This is the basis for specification of the restoration and waste disposal concept, including the corresponding occupational safety and health. It is recommended to entrust the expert with a declarative statement that restoration has been successful.

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A3 Minimum requirements for the pollutant expert analysis and opinion report

A pollutant expert opinion and analysis shall give the client certainty to planning of the measures required after a fire. The pollutant expert opinion and analysis shall meet the following requirements:

- The task (e.g. preparing a restoration concept) as well as the corresponding objects under examination (building, technical equipment, commercial equipment or other furnishings / household effects or stocks) shall be clearly defined.
- The examination methods as well as sampling shall be presented exactly:
- The pollutant load on the corresponding test sample shall be described as to its extent and height and shall be compared to perhaps existing operations relating loads and/or unloaded areas. The determined pollutant load normally gives the reason for restoration measures.
- The pollutant expert opinion and analysis shall name the restoration procedures appropriate for the particular case and this shall include the measures required to provide for OSH.
- The pollutant expert opinion and analysis includes – if the task requires so – proposals for disposal of the waste resulting on the fire scene. If required, adequate environmental protection measures shall be formulated.
- The pollutant expert opinion and analysis shall be transparent, plausible, and so that anyone involved understands it.
- The pollutant expert opinion and analysis shall be court proof; however, it shall not present legal valuation.

These objectives serve the creation of

- a uniform appearance and
- plausible quality criteria.

The pollutant expert opinion and analysis shall be structured as follows:

- **Title page**
  Shows the main details of client and loss event
- **Task**
- **Description of the object**
- **Loss experience**
- **Assessment of danger on site according to VdS 2357**
  Contains preliminary subdivision of the loss area into danger zones.
- **Loss specifications**
  Contains detailed descriptions of damage stated in the different areas affected, separately for the building, the commercial and technical equipment, household effects, etc.
- **Assessment**
  Evaluation of inspection results and assessment of the damage situation regarding the hazards by substances.
- **Emergency measures and restoration proposals**
- **Occupational safety and health**
- **Waste disposal**

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- **Summary**
- **Annex**
  Presents descriptions of sampling, the measuring procedures, the examination results, the site plans with marked sampling locations and demarcation of the danger zones, a table with all results.

If this structure is observed when drawing up the expert opinion, the latter can also be used as a basis for the invitation to tender for the required restoration work and damage remediation.

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A4 Implementation of the requirements specified in the standard of occupational safety and health in VdS 2357

Protection from the dangers (due to substances) during fire loss restoration requires compliance with primarily the GefStoffV [German Hazardous Material Regulations], the BiostoffV [German Biological Agents Regulations], the BaustellV [German Construction Site Regulations] and the appurtenant technical rules and regulations, especially the TRGS 524, as well as the legal framework of the accident insurance providers, especially the BGR 128. Please find below how the requirements of this body of rules and regulations are implemented in the present VdS 2357.

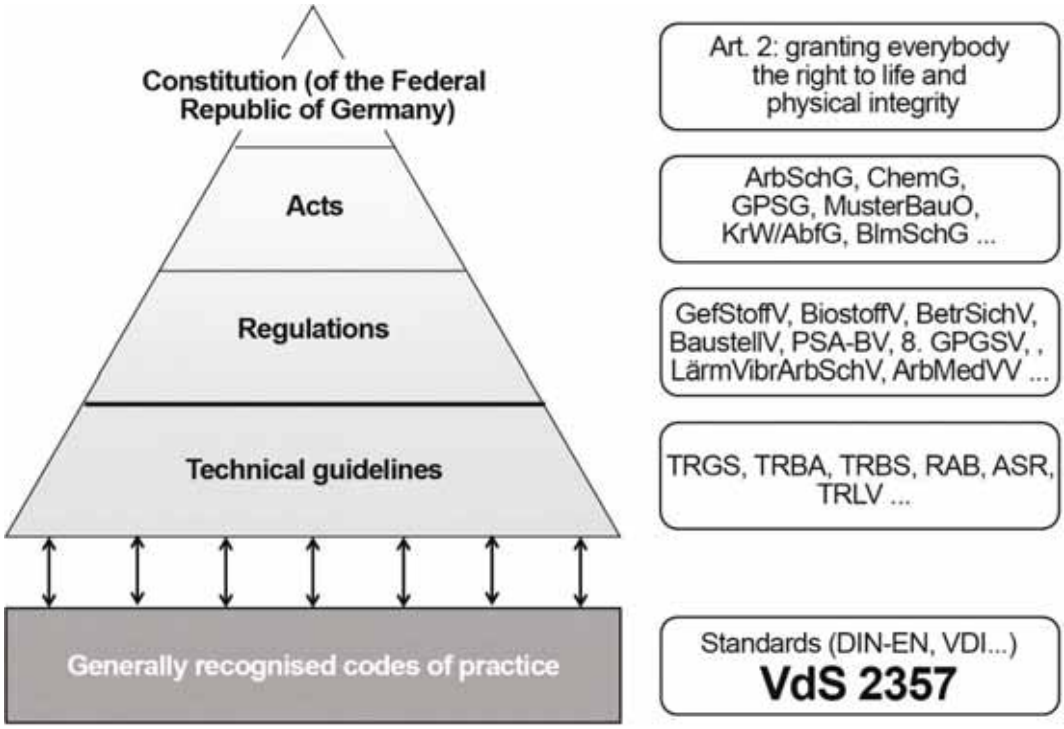

Fig. 5: Legal framework

A4.1 Requirements of the GefStoffV [German Hazardous Material Regulations] and the TRGS 524

Risk assessment for any "work with hazardous substances" is generally based on the determination of hazardous substances ("Which hazardous substances do exist?") and their "hazardous" properties, the assessment of type and height of the physical or chemical risks to be expected and/or the exposure to toxic substances. Important part of the risk assessment is the assessment of the working procedures with regard to the "exposed" activities required. Classifications and limit values of the substances, findings in the field of occupational health, as well as verification of the effectiveness of the measures taken shall also be included (see § 6 GefStoffV).

Risk assessment methods to be applied to works in contaminated areas, thus also to any fire loss restoration work, are described in the TRGS 524 dealing with protection measures to be taken for activities in contaminated areas. It includes requirements for an investigation into the hazardous substances as required (type and properties), the activities to be carried out, the marginal conditions to be expected in the working areas, and it defines minimum standards regarding the protection measures as well as the requirements to be met by the personnel (expertise).

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To comply with the objective of the BaustellV, the TRGS 524 with its requirement to prepare a work and safety plan and to appoint a skilled coordinator also assigns responsibility to the client regarding planning and supervision of the occupational safety and health.

In the case of fire loss restoration these obligations are mostly incumbent on the party having suffered the loss as this is the client. Should – due to a personal incompetence or adverse living conditions of the person who suffered the loss – it be unrealistic that this person as the "owner" or "client" has things under control in view of the OSH obligations and their implementation, the insurer gets a special duty to give assistance to its customer. The insurer shall see to it that a corresponding expert renders advice to the person who suffered the loss. This can be done by the claims adjuster, provided this has expertise as specified in TRGS 524, or by any other skilled person.

Investigations into hazardous substances

After a fire there is a mixture of substances composed of the following:

- the combustion products (very different substances presenting very different risk potentials depending on the mix of materials burnt and the conditions prevailing during the fire),
- components of the building material (wallpaper, insulating materials, such as old mineral wool, perhaps asbestos products), and
- the used extinguishing medium (water, foam, powder, etc.).

Mainly in trade and industry, there could also be hazardous substances (raw material, consumables, and supplies in the production area or the stock) liberated by the fire and perhaps even subject to thermal changes (see Cl. 2.4 as well as Annex A1 for combustion residues and the conditions of their formation).

Based on the many experiences gained in fire losses and on the hazardous substances to be expected, VdS 2357 introduces the concept of the so-called danger zones for corresponding examinations: Using the analysis of the mix of materials, the distribution of the combustion residues, as well as the degree of exposure to and surface load of smoke condensate, the danger zone concept allows both, an assessment of the hazards due to substances and at the same time partitioning of the loss area.

This concept meets the requirements of the GefStoffV and the TRGS 524 for the purpose of a description of the materials to be expected, on the one hand as a basis of a first hazard identification and on the other hand as a basis of the risk assessment together with the type of activities to be carried out (see above).

In this context, the term "presumption of conformity" is important. For an explanation see below:

The GefStoffV 2005 has introduced the so-called "presumption of conformity" (§ 8 Par. 1 GefStoffV) – the same have done other new regulations complying with the German Occupational Safety and Health Act. This means that the entrepreneur in complying with the measures and procedures laid down in the technical rules and regulations (especially the TRGS 524) meets the requirements of the GefStoffV. In this case, even the supervising authority and other parties involved generally act on the assumption that the requirements laid down in the regulations are met. Concurrence of VdS 2357 and TRGS 524 is documented in Chapter 4.2.3 of the latter where direct reference to VdS 2357 is made.

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In connection with the TRGS 524 the application of VdS 2357 as generally accepted rules of technology thus provides for legal security for all parties involved and particularly for the restoration companies but also for the building owner and/or the client (see above).

As to the implementation of the requirements laid down in § 15 GefStoffV for cooperation of different companies and the resulting duties to coordinate and cooperate for clients and contractors, also refer to the Annex A4.7 *"Requirements of the rules by the Employers' Liability Insurance Association on "contaminated areas" – BGR 128"*.

A4.2 Requirements of the BiostoffV [German Biological Agents Regulations]

The BiostoffV shall be applied when working with biological agents ("biomaterial"), i.e. microorganisms (especially bacteria, viruses, protozoa, and fungi), endoparasites (e.g. roundworms), which could put the human at the risk of infections, contagious diseases, toxin production, sensitising or other hazardous effects. This includes ectoparasites if those cause independent human diseases or if they cause the aforementioned effects (e.g. ticks). Infectious biomaterials are classified in risk groups ranging from "harmless" (risk group 1, e.g. yeast fungus) to "highest risk" (risk group 4, e.g. Ebola viruses). Most infectious materials are classified into risk group 2, e.g. the tetanus bacterium. As to the toxic and sensitising effects there is no classification into risk groups; however, they shall be taken into consideration in the risk assessment (e.g. the sensitising effect of mould fungi).

As to the risk assessment, the BiostoffV distinguishes between purposeful activities and unpurposeful activities: the fire loss restoration work is always unpurposeful.

During fire loss restoration, risks due to biomaterial can occur e.g. in a food product market where a fire destroyed the deep freezing system, in a slaughterhouse or an abattoir by-products plant, in bunkers of municipal waste incineration plants, in areas loaded with mould fungi or pigeon's dung, etc.

In compliance with the BiostoffV the protection measures in question for any of the above jobs shall be determined and selected on the basis of the risk assessment. The sensitising / toxic potential of any such biomaterial shall additionally be taken into account.

A4.3 Requirements of the BaustellV [German Construction Site Regulations]

The fundamental decisions making construction safe are taken when planning the execution. These are for instance requirements for the tender, the construction project development, and even the selection of the executing companies. Consequently, the building owner and the experts rendering advice get particular responsibility – also for the security and health protection of the persons working later in the building project.

This is regulated by law in the regulations governing the security and health protection on construction sites (BaustellV [German Construction Site Regulations]). This assumes that any construction work shall be planned and carried out in consideration of the provisions of § 4 German Occupational Safety and Health Act saying that *risks shall be avoided and where impossible minimised as far as possible*. Therefore, it shall be verified when planning execution of the fire loss restoration work whether the activities are subject to the BaustellV.

If so, the party ordering the construction work (the client) or the building owner shall appoint a coordinator for safety and health protection and draw up or develop a safety and health plan; all this depending on the extent of construction works, the number of companies involved (more than 1), and the execution of especially dangerous works in

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compliance with Annex 2 of the BaustellV. Moreover, the competent authority shall be notified of those construction sites where more than 30 work days are estimated and where more than 20 persons will be working at the same time or where the extent of work will presumably exceed 500 man-days, and this two weeks prior to the site mobilisation at the latest.

Companies involved can be either several restoration companies, or sub-contractors of those, or the restoration company together with employees of the party having suffered the loss who e.g. resume production while the smoke condensate is being removed from the ceiling of a production shop.

To implement the requirements of the German Occupational Safety and Health Act laid down in the BaustellV (see above) a risk assessment is required to draw up a safety and health plan according to the objectives of the BaustellV regarding mutual endangering of the companies involved.

A4.4 Requirements of the ArbStättV [German Workplace Regulations]

The ArbStättV is targeted to security and health protection of the employees when workplaces are being set up and operated and defines minimum requirements for the security and health protection of employees when workplaces are being set up and operated.

The notion 'workplace' is defined broadly and includes all places in buildings or outdoors, located on the site of a company or a construction site and which are intended for use as workstations and other places in buildings or outdoors which are located on the site of a company or a construction site and to which workers have access within the framework of their work.

The ArbStättV comprises of nine sections and one annex subdivided into five paragraphs presenting the requirements for workplaces. The regulations contains general protection objectives and, therefore, grants more room for employers' decisions how to set up and operate the workplace.

The annex puts the general requirements in concrete terms by defining more detailed:

- the general requirements (e.g. design and stability of buildings, dimensions of rooms, air space, safety and health signs, floors, walls, ceilings, roofs, traffic routes);
- safeguards to protect from special dangers (e.g. safeguard against workers falling off and against falling objects, entry to danger zones, measures to prevent fire, escape routes and emergency exits);
- working conditions (e.g. movement area, arrangement of workstations, lighting);
- sanitary rooms, rest and stand-by rooms, first-aid rooms, accommodations;
- additional requirements for special workplaces (e.g. for workplaces not enclosed on all sides and located outdoors and for construction sites).

The technical rules for workplaces put these requirements in concrete terms.

A4.5 Requirements of the BetrSichV [German Regulations on Industrial Safety and Health]

The BetrSichV (German regulations on safety and health in the provision of equipment and its use at work, on safety when operating installations subject to monitoring, and on the organization of industrial safety and health at work) presents minimum requirements for occupational safety and health of the employees when using work equipment and installations subject to monitoring.

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The BetrSichV presents the basis for a comprehensive protection concept to avert any danger originating from work equipment. Once again the crucial point is the risk assessment for work equipment or the safety assessment for an operation of installations subject to monitoring. But the BetrSichV also relates to the state of the art as a safety level criterion (and equally to the state of knowledge in the field of occupational medicine and hygiene as well as in the field of work sciences); it defines the framework for operational protection measures and tests of work equipment as well as for the minimum requirements as to their nature.

The first requirement of the BetrSichV is *[quotation from the official translation of this regulations]*:

"The employer shall perform the activities called for by the general principles laid down in section 4 of the Protection at Work Act in order to ensure that the employees shall be provided with work equipment only which is suitable for the conditions given at the workplace, and which guarantees that safety and health at work are ensured if it is used under its intended operating conditions. Where it is not possible fully so to ensure that work equipment can be used by workers without risk to their safety or health, the employer shall take appropriate measures to minimize the risks."

This is based on a risk assessment also used to determine type, extent, and delays of the required inspections of work equipment. Only especially skilled persons are allowed to carry out such inspections. Training and instruction or briefing of the employees by the employer shall be adequate; this especially applies to the corresponding risks presented by the work equipment in their work environment (explicitly if they use such work equipment). As far as required, operating instructions shall be given for the work equipment in use.

A4.6 Requirements of the LärmVibrationsArbSchV [German Noise and Vibration OSH Regulations]

This regulations shall apply in order to protect the employees against actual or potential dangers to their health and safety by noise or vibrations at the workplace. It contains basic requirements to protect employees against exposure to noise and vibrations at work.

The regulations aims at prevention of health damage to employees and improving safety at work. Here again the assessment of working conditions according to § 5 of the German Occupational Safety and Health Act is the focus of attention. First, the employer shall find out whether the employees are or could be exposed to noise or vibrations. If so, the employer shall judge every danger to health and safety of the employees arising therefrom. To this end the employer shall determine and evaluate the exposition at workplace. If it cannot be definitely established that the release and exposition values remain within limit, the employer shall take readings to prove the extent of exposition. The employer shall take the results of the risk assessment to define protection measures using best available technology.

A4.7 Requirements of the rules by the Employers' Liability Insurance Association on "contaminated areas" – BGR 128

The rule by the Employers' Liability Insurance Association on "contaminated areas" (BGR 128) aims at establishing a reasonable protection level for any work in contaminated areas involving particular risks compared to "standard" construction sites, and at notification of anyone involved, the client, the planner, and the companies performing the work, of their duties and respective responsibilities.

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The client's duties and/or the planner's duties for any work in contaminated areas, thus for fire loss restoration as well, mainly are:

- transmitting information on the substances assumed to exist or proven by analyses to exist and on their hazard;
- defining the protection measures to be taken against existing hazardous substances and/or biomaterial by assessing the risks related to the working procedure in view of fair prices which are open to everyone;
- documenting their/its planning results in a work and safety plan according to BGR 128; as well as
- appointing a skilled coordinator according to BGR 128 in matters of supervision and coordination of works to avoid any hazard arising from the coordinator's sphere of responsibility (general duty to implement safety precautions).

To this effect, the requirements of TRGS 524 and BGR 128 are identical. However, the BGR 128 shows three major differences compared to the TRGS 524:

- It shall be applied in case of biomaterial contamination too.
- It considers anyone as the client who pays for the work to be carried out.
- It obliges every company involved in fire loss restoration to notify its responsible accident insurance provider of such work.

See the Annexes A5 and A6 for the contents of a work and safety plan according to BGR 128 and for the integration and differentiation of the coordination duties resulting from the different legal bases.

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A5 Client's duties to coordinate and protect

Using the German Occupational Safety and Health Act and the Employers' Liability Association regulations BGV A 1 on the principles of prevention as a basis, the German Hazardous Material Regulations, the TRGS 524, the German Construction Site Regulations, and the BGR 128 dealing with contaminated areas, they all lay down duties and obligations of the ordering party subject to particular conditions. Duties to protect on the side of the client result from the legal principle of the duty to implement safety precautions. The party that provides for hazard sources or is responsible for the condition of a thing involving risks shall take measures to protect third parties (cf. Palandt, Kommentar zu BGB § 823 "Schadenersatzpflicht" – a comment on the § 823 of the German Civil Code).

Normally, the party ordering fire loss restoration (the client) is the party having suffered the loss due to fire. But this party very rarely is skilled enough to provide the services (see below) required in the different legal bases. Therefore, it becomes the insurer's duty to render corresponding advice to the party having suffered the loss, i.e. the insured, and to coordinate the measures to be taken within the scope of settlement of the damage.

A5.1 German Hazardous Material Regulations (GefStoffV)

If an employer entrusts a second company to carry out activities where hazardous substances are involved **in the employer's company**, § 15 GefStoffV requires of the employer as well as of the ordering party that

1) only expert companies proving corresponding expert knowledge and experience (expertise) shall be entrusted with such work.
2) the client shall fulfil its duties to protect by
   - transmission of information about operational hazards to the second company,
   - integrating the second company in its occupational safety and health system,
   - assisting in the risk assessment of the second company ending up with the definition of protection measures, as well as
   - appointing a coordinator should mutual hazards exist.

A5.2 German Construction Site Regulations (BaustellV)

The application criterion of the German Construction Site Regulations (BaustellV) is the definition of a construction site as the location where the construction project takes place. A construction project is the plan to build, change, or demolish one or several structures. Change of a structure means significant redevelopment, such as:

- change of the structure itself;
- exchange of important members (e.g. roof, façade, new exterior plaster, gutting).

These are works which could also be required during fire loss restoration. In such cases the building owner shall comply with the BaustellV.

- **Compliance with the principles of § 4 ArbSchG** (avoid and/or minimise risks) in the planning stage already; applies without reservation to all construction sites.
- **Announcement** of the construction project to the competent authority for occupational safety and health (if the extent of work will exceed 500 man-days).
- Appointment of an appropriate **coordinator for safety and health protection (so-called SiGeKo)** as required in the RAB 30 if more than one company take part in the construction project (at the same time or in turn).

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- Drawing up a **safety and health plan (so-called S & H plan)** if more than one company take part in the construction project (at the same time or in turn) and if the extent of work will exceed 500 man-days or if particularly dangerous work as defined in Annex II of BaustellV (e.g. handling of carcinogenic or very toxic substances, danger of falling from a height of more than seven metres) is required.
- Preparing a **document** informing on the security and health protection to be ensured for any later work at the structure if more than one company take part in the construction project.

A5.3 TRGS 524 and BGR 128

Both, TRGS 524 and BGR 128, impose on the client

- to appoint a skilled expert as the coordinator if more than one company take part in the construction project or if "hot" restoration work is planned, i.e. production etc. in an industrial company is running;
- to draw up a work and safety plan (see Annex A6 for its content).

In case of application on the occasion of fire loss restorations these requirements shall be met for any danger zones 1, 2, and 3.

The duty of the coordinator is to draw up the work and safety plan prior to starting any restoration work and to supervise that the measures defined therein will be taken.

Therefore, the functions of the coordinator are exclusively within the range of occupational safety and health. The coordinator is no loss handling manager. This is the duty of another person to be appointed by the insurer and the party having suffered the loss by mutual agreement.

A5.4 Overlapping scopes of GefStoffV, BaustellV, TRGS 524, and BGR 128

Since these Guidelines require that any fire loss restoration work in the danger zones 1 through 3 shall only be commissioned to those companies that dispose of skilled employees as laid down in BGR 128, the requirement according to § 15 GefStoffV is met anyway. The other duties to inform and to participate laid down there can be fulfilled by the party ordering fire loss restoration (the client) mainly by having a work and safety plan developed and appointing a skilled coordinator.

The scopes overlapping with the BaustellV are as follows:

1) The **safety and health plan** according to the BaustellV differs from the **work and safety plan** in the fact that the first shall consider every risk involved with the respective building project (e.g. falling hazard, hazard due to falling objects, collapse, etc.), including the risks due to existing or assumed hazardous substances / biomaterial. Consequently, the work and safety plan with its focus on the OSH regarding hazards by substances according to the BaustellV shall be considered as part of the safety and health plan (S & H plan) and cannot replace the latter.
2) The coordinator function (SiGeKo) as required by the BaustellV, GefStoffV, TRGS 524, and BGR 128 can be fulfilled by one person if this person is the "right" person for this according to RAB 30 and can also prove the expertise. This person may come from the client / the building owner, from the executing company, or even from a third party.

   The coordinator and the coordinator's substitute shall be designated in the safety and health plan and/or the work and safety plan. It is recommended to stipulate the

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coordinator's responsibilities and rights to intervene regarding the executing companies and draw a clear dividing line between them.

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A6 Work and safety plan

The client uses the work and safety plan to plan safe execution of works and to prepare the performance description. The executing companies / contractors use the work and safety plan to make their own safety plan and to prepare the operating instructions and/or carry out oral instruction as defined in § 14 GefStoffV. Should biomaterial be detected, we recommend to complement the work and safety plan accordingly.

Thus, the work and safety plan is in the broadest sense a "risk assessment supplied" by the client, which the contractor can adopt after verification for coherence regarding the working procedures used by the contractor.

Therefore, preparation of the work and safety plan shall allow for the general principles of OSH according to § 4 ArbSchG (German Occupational Safety and Health Act).

- Work is to be shaped so as to avoid as far as possible putting health and life at risk and to minimise the residual hazard.
- Any hazard shall be fought at its source.
- The measures shall take into account the state of the art, occupational medicine and hygiene, as well as other well-founded industrial science data.
- Individual protection measures shall be subordinate to other measures.
- Appropriate instructions shall be given to the employees.

The methodology of TRGS 524 says that the risk assessment is based on the following steps, which, therefore, shall be seen as the primary contents of the work and safety plan.

1. **Determination of pollutants** (type, concentration, and properties of the hazardous substances and/or biomaterial)
2. **Work plan**, i.e. on the determination of
   a) the working areas where activities according to Item 2.1. shall take place;
   b) the working procedures available and the work processes, working steps, and activities resulting therefrom; as well as
   c) the risk factors dependant on working areas and activities.
3. **Assessment of the exposure and hazard to be expected** due to
   a) inhalation, ingestion, or skin absorption of hazardous substances;
   b) fire and explosion hazard for the working procedures available and in consideration of the respective factors related to the working areas and activities.
4. **Selection of the working procedure involving the least risk**
5. **Selection and arrangement of measures**
6. **Check and assessment of the measures regarding their effectiveness**

Therefore, the work and safety plan is mainly the documentation of different steps to come to a decision regarding risk assessment and definition of protection measures.

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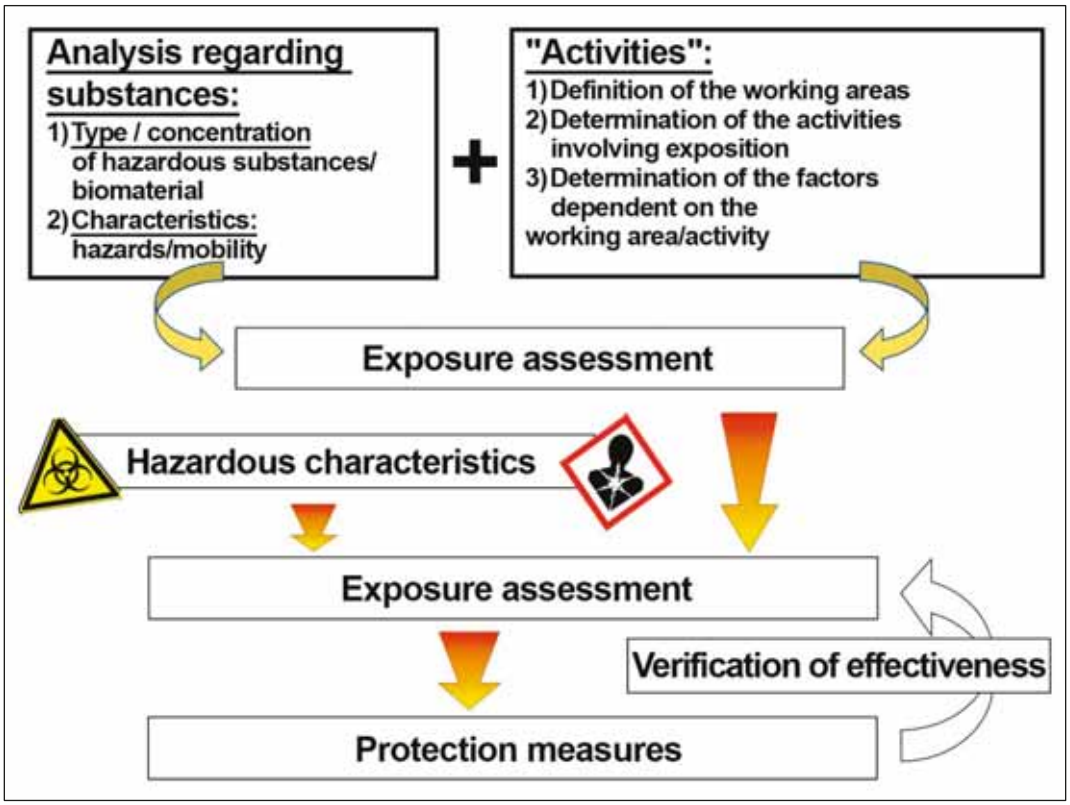

Fig. 6: Methodology of risk assessment and the definition of protection measures for activities in contaminated areas according to TRGS 524

A6.1 Determination of pollutants

The **determination of pollutants** (hazardous substances / biomaterial) during fire loss restoration aims at the identification

- of the materials that have burned (the "fire load"),
- the combustion residues resulting from the fire (PAH, HCl, dioxins, cyanides, aromatics, etc.), as well as
- of any other hazardous substances or biomaterial having existed in the form of raw materials, consumables, or supplies before the fire, and liberated by the fire, or which could develop from the fire load after longer storage, and which are involved and to be taken into consideration for the assessment of danger.

Should this not be clear, a chemical-analytic assessment is required.

In the following step, the data of substances important as to OSH and environmental protection shall be compiled for the risk assessment (see TRGS 524, Enclosure 5).

A6.2 Work plan

The work plan as a compilation of operations and procedures in chronological order always includes the steps below:

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a) Determination of the working areas and classification in danger zones 0 - 3

Regarding a clear indication of the location where to find substances and the corresponding protection measures to be taken, the site of the incident shall first be divided into several working areas (see Fig. 7) This division of the areas affected by the fire or the restoration work is based on the one hand on the given structure, e.g. "kitchen", "staircase", and "attic space" for housing fires, or "paint shop", "solvent storage room", or "cold storage house" in the commercial-industrial sector. On the other hand, it shall be considered to follow the procedures for division; e.g. areas for debris (belong to the contaminated area) or equipment provided to clean system parts, and the like.

Extension of a danger zone may correspond to an individual working area. It is also possible that different working areas shall be assigned to one danger zone. In other cases, it may be reasonable that a working area is divided into different danger zones, e.g. a staircase with greater pollution upstairs due to the fire or a large manufacturing shop where several works are carried out in parallel; where required the danger zones shall be partitioned off by walls or ceilings made of plastic film.

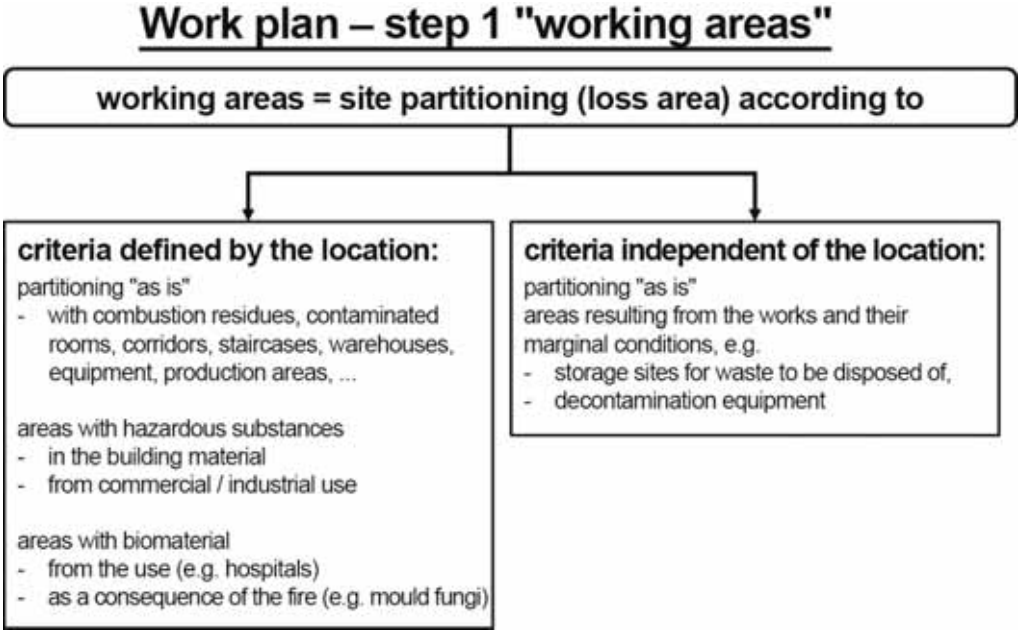

Fig. 7: Local division of the location subject to fire loss restoration required to determine the working areas of potential exposition

b) Determination of the activities required in the corresponding working areas and danger zones

The operations required during restoration or the required working procedures are based on the specific damage pattern and the restoration target defined and differ from case to case. These are e.g.:

- extent of first measures, such as rough clearing, corrosion stop;
- specification of the clearance work required on cold fire grounds;
- definition of the measures to be taken for decontamination and cleaning;
- specification of advanced working procedures for neutralisation, decorrosion, passivation, and conservation;
- specification of disassembly and reconstruction procedures;

A6

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- measures to be taken for removal / reconditioning of damaged building parts and of equipment;
- coordination / handling of disposal measures.

As required by the GefStoffV and TRGS 524, any working procedure and equipment shall satisfy low-emission requirements (also see www.gisbau.de on low-dust equipment). The activities required for execution shall be determined for the selected working procedures (see Fig. 8).

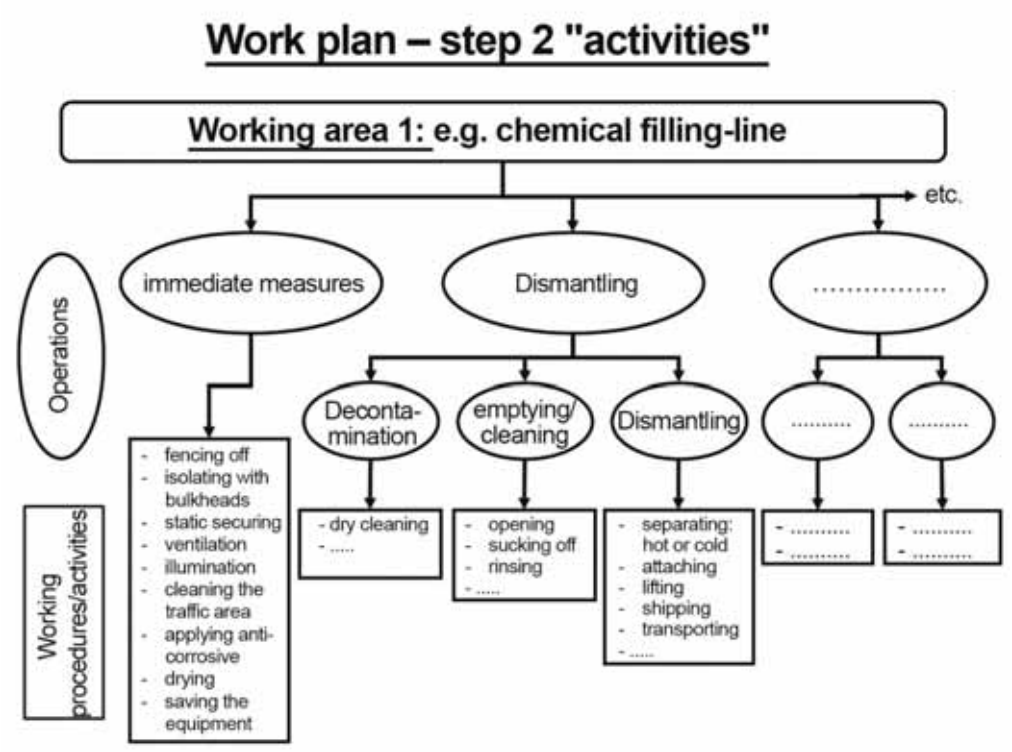

Fig. 8: Determination of the steps, procedures, and activities required in the different working areas aiming at determination of the activities involving exposition

A6.3 Exposure assessment, risk assessment, and definition of protection measures

Each single activity shall be evaluated using the criteria below as a basis:

- potential contact with hazardous substances;
- type, extent, and duration of contact subject to the type and properties of the substances found;
- frequency, duration of contact.

This results for each activity in an exposure assessment, which again can be used to derive a risk assessment in connection with the "hazardous" properties of the hazardous substances and the biomaterial. This is the basis to be used to define the protection measures following the usual ranking.

1) Technical protection measures, especially
   - selection of low-emission working procedures and equipment;
   - ventilation or vacuum.

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2) Organisational measures, especially
   - site mobilisation incl. black/white areas, firestop seals, etc.;
   - occupational health checkup;
   - operating instructions / briefing.
3) Personal protective equipment.

Further details see the Annexes A6.4 and A7.

For a clear representation of the work plan, the exposure assessment, the risk assessment, and the most important protection measures, see Enclosure 10 enclosed with the TRGS 524.

A6.4 Example of the outline and the contents of the work and safety plan for fire loss restoration

1 General data

1.1 Address of the affected working area / sites

1.2 Name and phone number of the client

1.3 Name, address, and phone number of the authorities involved, the OSH departments, the expert, the coordinator according to BaustellV / its substitute, the coordinator according to TRGS 524 or BGR 128 / its substitute including a specification of their rights to instruct

1.4 Description of the group affected by the work and safety plan

2 Work plan

2.1 Specification of the working areas, the chronological sequence of steps, and the individual activities

2.2 Selection of low-emission working procedures and equipment

2.3 Determination and specification of disposal processes

3 Ascertaining the hazard

3.1 Determination of the fire load, the combustion residues, and other hazardous substances and biomaterial involved in the damage

3.2 List of analysis results including a site plan of the sampling points (if an analysis is required, e.g. danger zone 3)

3.3 List of the properties, mobility, and action patterns of the substances

3.4 Definition of the danger zones with reasons

3.5 Determination of activities involving exposition by means of the work plan;

3.6 Exposure and risk assessment related to activity

4 Safety and health protection measures

4.1 Technical and organisational protection measures

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- Planning and execution of the site mobilisation incl. the required site logistics:
  - Site partitioning into black/white areas
  - Description of the access situation, the escape and rescue routes, the traffic areas, sanitary facilities, and break rooms and the like
  - Establishing perhaps required firestop seals with / without vacuum
- General rules of conduct
- Special rules of conduct in case of danger
- Description of the monitoring measurements regarding health protection (hazardous substances, temperature in the working area)
- Requirements on machines and technical work equipment (e.g. vacuum cleaner dust class H, equipment for breathable air supply, transport devices, scaffolds, technical ventilating equipment)

4.2 Personal protective equipment
- Specification of the PPE
- Specification of the wearing times

4.3 Occupational health checkup

4.4 Emergency measures, first aid, emergency ID

5 Documentation, proofs

5.1 Specifications of the documentation to be made by the client or its coordinator:
- Work plan / safety plan
- Coordinator / authority to instruct
- Iff required measurements for emission control
- Announcement of the construction project according to BaustellV

5.2 Specification of the documentation each contractor shall deliver as well as the proofs to be established:
- Notifying the statutory accident insurance institutions responsible for the executing company of the work – as laid down in BGR 128
- Operating instructions / briefing
- Special preventive medical check-ups
- Rescue and first aid measures
- Emergency ID
- Usage history of respiratory protective filters (filter log)
- Fire Precaution Regulation with alarm plan / fire drill
- Daily construction records
- Proofs of disposal, handover certificates, transportation license
- Results of monitoring measurements regarding the hazardous substances in the air ambient to the workplace (danger zone 3).

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A7 Special protection measures related to activities (PPE)

Special OSH measures following the danger zones / personal protective equipment (PPE)

All information exclusively refer to activities to be carried out on the cold fire ground. Inspection and working on a fire ground, which is not cold, could require further measures. If chemicals are used for remediation, the PPE shall comply with the requirements of the corresponding safety data sheets and with the manufacturer's specifications given there. The situation may even require a higher level of protection.

1 work clothes [1] **2 protective clothing cat. III, type 5+6** **3 protective clothing cat. III, type 4** **4 splash apron** **5 breathing protection, min. half-face mask particle filter class 3** [2][3] **6 breathing protection, full-face mask min. particle filter class 3** [2][3]	**7 safety gloves cat. I** **8 safety gloves cat. II** **9 safety gloves cat. III** **10 eye / face shields** **11 foot protection S3** [4] **12 foot protection S5d** **13 protective equipment for jet-spraying work** **14 helmet (DIN EN 337)**	**Danger zone 0**	**Danger zone 1**	**Danger zone 2**	**Danger zone 3**
Inspections	first inspection (PPE at least available for all danger zones	**no special protection / hygiene measures**	2,12,(5,8)[5]		2,5/6,8,11,14
	Sampling				
Preparation / first measures	removal of extinguishing water / building barriers for the liquid		3,5,8,11/12	3,5,8,11/12	3,5/6,8,11/12
	propping up in zones in danger of collapse		1,5,9,11,14	2,5,8,12,14	3,5/6,7,11,14
	building emergency roofs		1,5,8,11,14	2,5,8,11,14	2,5/6,8,11,14
	anticorrosive measures		2,5,8,11	2,5,8,11	2,5/6,8,11
	closing wall apertures providing for movement areas drying in areas where nothing has been undertaken so far removing fire residues, sucking off loose soot particles		2,5,8,11	2,5,8,11	2,5/6,8,11
Surface treatment	dry sandblasting		13	13	13
	wet blasting low pressure vortex system		3,5,8,10,11/12	3,5,8,10,11/12	3,5/6,8,10,11/12
	Abnadeln / dabbing / händischer Oberflächenabtrag		2,6,8,11	2,6,8,11	2,6,8,11
	dry ice blasting (CO_2)		2,5,8,11	2,6,9,11	2,6,9,11
	manual wiping		2,5,9,11	2,5,9,11	2,5/6,9,11
	high-pressure washing high-temperature steaming		3,5,,9,11/12	3,5/6,9,11/12	3,5/6,9,11/12
	pulse extraction high-pressure extraction		2,5,8,11	2,5,8,11	2,5/6,8,11
	shot-blasting standard floor cleaning spray extraction, rotary brushing, shampooing electric diffusion		2,5,8,11	2,5,8,11	2,5/6,8,11
Taking building members apart	removing wallpapers removing old mineral wool (formerly MMMF) suspended ceiling, luminous elements, ventilating pipes, cable trays		2,5,8,11	2,5,8,11	2,5/6,8,11
In-situ remediation of stocks, tools, equipment	manual wiping		2,5,9,11	2,5,9,11	2,5/6,9,11
	dipping bath		2,4,5,9,11	2,4,5,9,11	2,4,5/6,9,11
	ultrasonic cleaning		1,4,5,9	1,4,5,9	1,4,5/6,9
electronic rehabilitation	dry restoration		1,5	1,5	1,5/6
	wet restoration		1,4,5,9,10,11	1,4,5,9,10,11	1,4,5/6,9,10,11
	selective wet restoration		1,4,5,9	1,4,5,9	1,4,5/6,9

[1] For the cases where a lot of dust is produced, we do recommend for specific activities wearing protective clothing EC cat. I on top of the work clothes.
[2] For hard or moderate labour power-assisted breathable air systems shall be used.
[3] If gases or vapours are on site, select the gas filter type / class acc. to BGR 190.
[4] Safety shoes, calf-length / optionally provide for cleaning facility.
[5] Hold available breathing protection and safety gloves; use them where required.
[6] Hold available eye / face shield; use them where required

A8 Separation of fire residues according to waste code

According to the Regulations on the European waste catalogue (AVV)[1], all wastes shall be assigned to waste categories identified by a six-digit waste code. Classification into the waste categories takes place following the chapters in the waste catalogue (two-digit title) and the group of substances (four-digit title). Within one group, the more special waste category gets priority over the more general waste category. Hazardous waste is identified by an asterisk (*). Any other waste is non-hazardous according to this Regulations. In case of a damage due to fire, classification as non-hazardous waste shall be proven for the particular case. If the pollutant load is not clear, the waste shall be considered to be hazardous. The disposal route is not inevitably defined by the waste classification.

The German Landfill Regulations (DepV) restricts the portion of organic waste (defined as ignition loss) for deposited wastes to 3, 5, or 10 weight percent depending on the applicable landfill class (I, II, III). For wastes originating from damage, the DepV 2009 allows exceptions if the separation expenditure is unreasonable. The manner of proceeding shall be agreed upon with the local authorities.

In most cases of damage due to fire the occurring fractions of waste can be classified in one of the following groups of substances. To provide an example, some waste codes complying with the German List of Wastes Regulations (AVV) are assigned to these groups. These are waste codes, which are often used to declare debris to operators of waste disposal plants and waste management authorities. This is not exhaustive.

Waste separation for groups of substances

Group of substance	Type of waste	Waste code
Wastes resulting from cleaning and restoration (e.g. washing liquids, chemicals, phosphatizers, etc.)		
	Wastes resulting from chemical surface finishing of metals and other materials	**11 01**
	aqueous rinsing liquids containing dangerous substances	11 01 11*
	aqueous rinsing liquids other than those mentioned in 11 01 11	11 01 12

Group of substance	Type of waste	Waste code
Stock, such as packaging (e.g. empty packages, cardboard, paper, plastic films, etc.)		
	Packaging (incl. separately collected municipal packaging waste)	**15 01**
	mixed packaging	15 01 06
	packaging containing residues of or contaminated by dangerous substances	15 01 10*
	plastic packaging	15 01 02
	paper and cardboard packaging	15 01 01

[1] AVV = German Waste Catalogue Regulations – Regulations on the European waste catalogue

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Group of substance	Type of waste	Waste code
Residues resulting from cleaning measures (e.g. protective clothing, wiping cloths)		
	absorbents, filter materials, wiping cloths, and protective clothing	**15 02**
	absorbents, filter materials (incl. oil filters not otherwise specified), wiping cloths, and protective clothing contaminated by dangerous substances	15 02 02*
	absorbents, filter materials, wiping cloths, and protective clothing other than those mentioned in 15 02 02	15 02 03

Group of substance	Type of waste	Waste code
Extinguishing water loaded with pollutants resulting from a fire damage and from production		
	aqueous liquid wasted destined for off-site treatment	**16 10**
	aqueous liquid wastes containing dangerous substances	16 10 01*
	aqueous liquid wastes other than those mentioned in 16 10 01	16 10 02

Group of substance	Type of waste	Waste code
Construction and demolition wastes		
	concrete, bricks, tiles, and ceramics	**17 01**
	mixtures of, or separate elements of concrete, bricks, tiles, and ceramics containing dangerous substances	17 01 06*
	mixtures of concrete, bricks, tiles, and ceramics other than those mentioned in 17 01 06	17 01 07

Group of substance	Type of waste	Waste code
Various materials from building construction and furnishings (e.g. laminated glue girders, solid wood panels, windows, furniture)		
	wood, glass, and plastic	**17 02**
	glass, plastic, and wood containing or contaminated with dangerous substances	17 02 04*
	wood	17 02 01
	glass	17 02 02
	plastic	17 02 03
	bulky waste	20 03 07

Group of substance	Type of waste	Waste code
Bituminous / tar felts, black coatings or glue, etc.		
	bituminous mixtures, coal tar, and tarred products	**17 03**
	bituminous mixtures containing coal tar	17 03 01*
	bituminous mixtures other than those mentioned in 17 03 01	17 03 02

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Group of substance	Type of waste	Waste code
Metals from structures, equipment, stocks		
	metals (incl. their alloys)	**17 04**
	metal waste contaminated with dangerous substances	17 04 09*
	mixed metals	17 04 07
	iron and steel	17 04 05

Group of substance	Type of waste	Waste code
Soil (excavated soil from contaminated sites)		
	soil (incl. excavated soil from contaminated sites), stones, and dredging spoil	**17 05**
	soil and stones containing dangerous substances	17 05 03*
	soil and stones other than those mentioned in 17 05 03	17 05 04

Group of substance	Type of waste	Waste code
Insulating materials *(old mineral wool),* ***construction materials containing asbestos*** *(fibrated cement boards)*		
	insulation materials and asbestos-containing construction materials	**17 06**
	insulation materials containing asbestos	17 06 01*
	other insulation materials consisting of or containing dangerous substances	17 06 03*
	insulation materials other then those mentioned in 17 06 01 and 17 06 03	17 06 04
	construction materials containing asbestos	17 06 05*

Group of substance	Type of waste	Waste code
Plasterboard panels, gypsum plasters, anhydrite floors		
	gypsum-based construction materials	**17 08**
	gypsum-based construction materials contaminated with dangerous substances	17 08 01*
	gypsum-based construction materials other than those mentioned in 17 08 01	17 08 02

Group of substance	Type of waste	Waste code
Fire residues, various mixed and charred wastes		
	other construction and demolition wastes	**17 09**
	other construction and demolition wastes (incl. mixed wastes) containing dangerous substances	17 09 03*
	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02, and 17 09 03	17 09 04

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A9 Glossary: Abbreviations and definitions

Acute and chronic toxicity: We distinguish between acute toxicity (toxic effect of a substance upon single or short absorption) and chronic toxicity (toxic effect of a substance upon repeated absorption for quite a while); on cold fire grounds chronic toxicity is more important.

Adsorption / adsorptive: Accumulation of a substance on the surface of a solid body due to molecular forces (adhesion). Finely divided and porous substances show a relatively high adsorption effect; these are e.g. soot and fine dust as they provide a large inner surface (e.g. activated carbon up to 500 m^2/g).

Aromatics: This is the class of aromatic compounds the most common one is benzene and all its derivatives and condensation products. The common molecule structure is a planar ring system with non-localised double bonds.

BGA: former Federal Ministry of Health in Germany (in 1994 distributed into successor institutions and also integrated into the German Federal Environmental Agency).

Biological availability (bioavailability): This is the availability of pollutants to the human organism through blood circulation. To develop their effect, the pollutants have to be absorbed in an available form or be liberated correspondingly in the body.

To the pollutants resulting from fire losses applies that their biologic availability is generally low due to the high adsorption in soot.

Biomaterial (former biological agents – cf. pollutants): These are in the broadest sense microorganisms which can cause infections, sensitising, or toxic effects. The term 'biological agents' is finally defined in the BiostoffV [German Biological Agents Regulations].

BiostoffV – German Biological Agents Regulations – regulations on safety and health protection when working with biological agents (German Biological Agents Regulations – BiostoffV).

The BiostoffV applies to all activities involving biomaterial including activities in their danger zone. The BiostoffV aims at protection of the employees from safety and health hazards during their work.

Black/white areas: Black/white areas serve prevention of entrainment of pollutants from loaded ("black") into unloaded ("white") areas. Normally, they are composed of three interconnected elements:

The part directed toward the unloaded area is the so-called white area to put off, deposit, and later put on again everyday wear, which may serve as a recreation room, too. The connected centre part contains sanitary facilities, e.g. wash-basins, showers, toilets. Toward the loaded area and connected to the sanitary area there is the so-called black area to put on and later put off again the PPE.

Design of the BW areas follows function, i.e. the BW areas shall be adjusted to the requirements of the risk assessment taking the space conditions into account.

Breathing apparatuses and filters: We distinguish between breathing protection working independent of ambient air (e.g. compressed air breathing apparatus) and dependant equipment (e.g. filter equipment). For fire loss restoration, we recommend mainly the filter equipment. Those provide face masks and, consequently, prevent any contact of the respiratory organs or any part of the face with the ambient atmosphere and

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are also used to connect the filter. Face masks are available as full-face and half-face shields and as half-face filter shields; filters are available as gas, particle, and combined filters. The filter class identifies the filtration efficiency (1 = small, 2 = average, 3 = high).

Gas filters are required to protect from gases and vapours removed from the ambient air either by physical accumulation (adsorption) or by chemical change in the filter material. The gas filters are classified as to their type (e.g. gas filter type A, identification colour: brown, appropriate for organic gases and vapours) as well as into classes (see above).

Particle filters serve protection from unwanted particulate matters (dusts, smoke). Based on their retention power they are identified as particle filter class P1 to P3.

Combined filters are appropriate to protect from gases, vapours, and particles. They are composed of a gas filter part and a particle filter in front of. E.g. A2-P3 identifies a combined filter of type A (organic vapours) and gas filter class 2 (corresponds to a maximum pollutant concentration of 0.5 volume percentage) featuring an integrated particle filter of particle filter class P3 (high retention power).

Combustion residues: The term 'combustion residues' designates both:

- substances already existing before the fire and liberated by the fire or the fire-fighting operations and
- substances resulting from the fire, the contact with extinguishing water and extinguishing mediums, and other reactions.

Congeners: Congeners consist of a multitude of single substances of a body substituted differently regarding number and positions, e.g. p-dibenzo-dioxin or dibenzo furan. If the number of substituents is identical but their positions differ, we speak of isomers.

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Contamination: Contaminated areas are sites, structural works, objects, floors, water, air, and the like polluted with hazardous substances or biomaterial to a degree beyond a limit being recognised as safe.

De novo synthesis: Reactions of the radicals generated in the heat of fire resulting in new compounds of mainly aromatic structures.

Dioxins: See PHDD / PHDF and/or TCDD.

EOX: Elutable organic halogen

EPA: Environmental **P**rotection **A**gency (American environmental authority).

Expert knowledge according to BGR 128: see expertise according to TRGS 524.

Extraction: Dissolving a substance out of a mix of substances by means of a solvent (extractive agent).

Expertise according to TRGS 524 and/or expert knowledge according to BGR 128: Requirement for special knowledge on the occupational health and safety during any work in contaminated zones as defined in the TRGS 524, Enclosures 2a and 2b and as defined in BGR 128, Annexes 6A and 6B.

The expert knowledge as to safety and health protection when working in contaminated areas gained according to the BGR 128 dealing with contaminated areas fulfils the expertise requirement of the TRGS 524.

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Fire smoke: Fire smoke is composed of gases, aerosols / vapours, and particles. High-volatile substances at the source of fire still emitting hot smoke are present as a gas but as they mix heavily with the ambient air during further transmission they cool down rapidly and condensate to aerosols / vapours and in parts adsorb to particles, whereas low-volatile substances condensate faster or largely adsorb to particles. Deposition of particles and aerosols depends on size and volume and deposition on surfaces depends on the type of surface. When the fire is still hot any contact with surfaces already results in deposition; this increases when the fire smoke cools down. The deposited substances are condensates and particles (mainly soot).

GefStoffV: Regulations on protection against hazardous materials (German Hazardous Materials Regulations)

This regulations applies when putting substances, preparations, and products into circulation and aims at protection of the employees and other persons against any health and safety risk by hazardous substances and at protection of the environment against any damage due to substances.

Halogenated / halogenated organic compounds: Halogens include the chemical elements fluorine, chlorine, bromine, iodine, and astatine. Consequently, halogenated organic compounds are carbon compounds containing halogens, such as chlorine and bromine, in addition to the functional groups, such as the alcohol, aldehyde, or ketone groups (e.g. chlorinated hydrocarbons, pentachlorophenol (PCP), bromobenzene).

Hazardous substances (also see pollutants):
Hazardous substances are pursuant to § 3, Paragraph 1 GefStoffV [German Hazardous Material Regulations] the following substances, preparations, and products:

- hazardous substances and preparations pursuant to § 3a ChemG [German Chemical Act] as well as substances and preparations of other chronically deleterious properties,
- potentially explosive substances, preparations, and products,
- substances, preparations, and products that during production or use can develop into or liberate substances or preparations as defined under 1 and 2,

other hazardous chemical agents as defined in the directive 98/24/EC.

KrWG – German Closed Substance Cycle and Waste Management Act: According to the principles and general obligations laid down in the German Closed Substance Cycle and Waste Management Act, wastes are substances and objects the owner wants or shall get rid of. We distinguish between wastes to be recycled and wastes to be disposed of (see Cl. 6.1 and Annex A8).

Limit values at workplaces: According to the GefStoffV [German Hazardous Material Regulations] the limit value at workplaces is the limit value of the time-weighted average concentration of a substances in the air ambient to the workplace against a given reference period. It specifies the concentration of a substance at which normally acute or chronic, harmful effects on health shall be expected (§ 3 Par. 6 GefStoffV).

Limit values at workplaces are shift averages for an exposure of normally eight hours/day at five days/week during the working life (corresponds to reference period).

MMMF – man-made mineral fibres: see old mineral wool.

NATO/CCMS: North **A**tlantic **T**reaty **O**rganization / **C**ommittee of the **C**hallenges of **M**odern **S**ociety

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Old mineral wool: According to TRGS 521 (formerly designated MMMF – man-made mineral fibre)

Old mineral wool is a large group of fibres produced synthetically. Often they were used as insulating material but also for textile purposes, to reinforce plastics, or for optical purposes (optical fibres).

The technical characteristics of old mineral wool are similar to those of asbestos. The same as the latter old mineral wool liberates the fibres. Depending on their composition, those fibres may be carcinogenic, or very carcinogenic, or not carcinogenic at all.

PAH – polynuclear aromatic hydrocarbons: They result from incomplete combustion of organic material. Some substances belonging to this group are considered to be carcinogenic pollutants with benzo(a)pyrene being the lead compound.

PCB – polychlorinated biphenyls: PCBs were widely used in the past as they show properties like non-combustibility, thermal stability, and chemical resistance; they were used e.g. as insulant and coolant or hydraulic liquids. Since PCBs had contained varying quantities of PCDD / PCDF, their production was stopped (regulation regarding the prohibition and restriction of putting hazardous substances, preparations, and products into circulation according to the German Chemical Act, German Chemicals Ban Regulations (ChemVerbotsV). During a thermal load of PCB in the temperature range of 600 through 900 °C – such as in a fire event – there is the possibility that additional dioxins and furans result.

PCP – pentachlorophenol: For a long time, PCB was used as an effective wood preserver. However, production, sale, and use have been prohibited since 1989 (regulation regarding the prohibition and restriction of putting hazardous substances, preparations, and products into circulation according to the German Chemical Act, German Chemicals Ban Regulations (ChemVerbotsV).

PHDD / PHDF – polyhalogenated dibenzo-p-dioxins and dibenzo furans: The term "dioxins" is the synonym for 75 chlorinated p-dibenzo-dioxins (PCDD) and in the broader sense even of 135 dibenzo furans (PCDF); an identical number of congeners of analogue bromine compounds (PBDD / PBDF) is possible. Taking all mixed halogenated dioxins and furans (PHDD / PHDF = PHDD/F) into account, we talk about more than 5,000 single compounds. The acute and chronic toxicity of a multitude of single compounds combined in the groups of "dioxins" is very different and can vary up to a factor of 10,000.

Pollutants: In addition to hazardous substances and biomaterial, pollutants as defined in these Guidelines are substances or substance mixtures (pure substance, product, residual substance, residue, waste) that can cause adverse changes when entering the ecosystems, or when being absorbed by living organisms, or to physical assets (e.g. corrosive substances).

Pyrolysis (and cracking): Pyrolysis is the thermal decomposition / destruction of molecular compounds in organic substances in lack of oxygen. If pyrolysis is effected deliberately in a technical process (e.g. production of fuel), we normally speak of cracking.

SGB VII – German code of social law, book VII – statutory accident insurance: This is the legal basis how the statutory accident insurance institution shall act.

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Specifications of concentration: In principle, there are three possibilities how to specify concentrations in fire losses. The quantity of pollutants contained in a sample can be related to either

- the weight of the assay, or
- the surface from which it is taken, or
- the air volume sucked in.

Standard weight- or mass-related concentration units:

1 ppm (parts per million)	= 1 mg/kg	= 10^{-3} g/kg (m=milli)
1 ppb (parts per billion)	= 1 µg/kg	= 10^{-6} g/kg (µ=micro)
1 ppt (parts per trillion)	= 1 ng/kg	= 10^{-9} g/kg (n=nano)
1 ppq (parts per quadrillion)	= 1 pg/kg	= 10^{-12} g/kg (p=pico)

Standard surface-related specification of concentration: ng/m²

Standard volume-related specification of concentration: pg/m³ or ng/m³

TCDD: 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) is the most known and most toxic substance of the group of PHDD / PHDF.

TDI: The TDI value (**t**olerable **d**aily **i**ntake) specifies the peak dose per day for substances liberated into the environment unintentionally with no health effect even if this is taken in for life, whereas the ADI value (**a**cceptable **d**aily **i**ntake) is applicable only to the substances intentionally released into the environment, e.g. pesticides.

TRBA: Technical regulations, biological agents inform on the state of the art, occupational medicine and hygiene, as well as other well-founded industrial science data. They are developed and amended by the committee for biological agents (ABAS). The BMAS (German Federal Ministry for Labour and Social Affairs) announces the TRBA in its Ministerial Gazette.

TRGS: Technical rules for hazardous substances inform on the state of the art, occupational medicine and hygiene, as well as other well-founded science data for activities involving hazardous substances, incl. their classification and marking. They are developed and amended by the committee for hazardous substances (AGS). The BMAS (German Federal Ministry for Labour and Social Affairs) announces the TRGS in its Ministerial Gazette.

VCHC: Volatile **c**hlorinated **h**ydro**c**arbons

WHO: World Health Organization.

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A10 Laws, regulations, technical rules and regulations, and literature

A10.1 Laws and regulations

Note: To the list below applies that laws and regulations can only define a framework whereas the realisation often requires rules and regulations by the German Länder.

Waste laws

- **KrWG – German Waste Avoidance, Recycling and Disposal Act –** Act on recycling economy and maintenance of ecologically benign waste management
- **AVV – German Waste Catalogue Regulations –** Regulations on the European waste catalogue
- **AltholzV – German Waste Wood Regulations –** Regulations on the recycling and disposal requirements applicable to waste wood.
- **German Landfill Regulations (DepV) –** Regulations on landfills and long-time storage areas
- **German Regulations Pertaining to the Recovery of Waste at Surface Landfills (DepVerwV) –** Regulations on recycling of wastes on landfills above ground
- **NachwV –** German regulations on waste disposal and recovery records
- **Requirements on substance recycling of mineral residues / wastes –** Technical rules and regulations of the work group of the German Länder on waste (LAGA)

Occupational safety law / environmental law

- **ArbSchG – German Occupational Safety and Health Act –** Act on the introduction of measures to encourage improvements in the safety and health of workers at work
- **BBodschG – German Federal Soil Protection Act –** Act on protection against harmful changes to soil and on rehabilitation of contaminated sites
- **ChemG – German Chemical Act –** Act on protection against hazardous substances
- **WHG – German Federal Water Act –** Act on managing water resources
- **ArbStättV – German Workplace Regulations –** Regulations on workplaces
- **German Construction Site Regulations (BaustellV) –** Regulations on the security and health protection on construction sites
- **BetrSichV – German Regulations on Industrial Safety and Health –** Regulations on safety and health in the provision of equipment and its use at work, concerning safety when operating installations subject to monitoring and concerning the organisation of industrial safety and health at work
- **BiostoffV – German Biological Agents Regulations –** Regulations on safety and health protection when working with biological agents
- **BBodSchV – German Federal Soil Protection and Old Hazardous Site Regulations**
- **GefStoffV – German Hazardous Materials Regulations –** Regulations on protection against hazardous materials
- **German Noise and Vibration OSH Regulations (LärmVibrations ArbSchV) –** Regulations on protection of employees against any harm due to noise or vibrations
- **AwSV – German regulations on installations handling materials hazardous to waste**
- **German Regulations on Occupational Health Care (ArbMedVV)**

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Bundesanzeiger Verlagsgesellschaft m.b.H.,
P.O.Box 13 20,
D-53003 Bonn
Internet: www.bundesanzeiger.de

A10.2 Technical rules and regulations

Guidelines for workplaces

- **ASR A1.3 –** Safety and health protection markings
- **ASR A1.8 –** Traffic routes
- **ASR A2.1 –** Protection of areas with risk of falling and against falling objects, entry to danger zones
- **ASR A2.2 –** Measures against fire
- **ASR A4.2 –** Rest and stand-by rooms
- **ASR A4.3 –** First-aid rooms, first-aid means and equipment
- **ASR A4.4 –** Accommodations

Internet: www.baua.de

Rules and regulations for OSH on construction sites

- **RAB 01 –** Subject, Origin, Structure, Application and Coming into Effect of RABs
- **RAB 10 –** Definitions (Specification of Terms in the German Construction Sites Regulations BaustellV)
- **RAB 25 –** Working in Compressed Air (Specification of the Compressed Air Regulations)
- **RAB 30 –** Suitable Co-ordinator (Specification of Section 3 BaustellV)
- **RAB 31 –** Safety and Health Plan – S & H Plan
- **RAB 32 –** Document for Subsequent Work (specification under Section 3 (2) No. 3 BaustellV)
- **RAB 33 –** General Principles according to Section 4 of the Occupational Safety and Health Act during application of the Construction Sites Regulations

Internet: www.baua.de

Technical regulations for operational safety (TRBS)

- **TRBS 1111 –** Risk assessment and safety assessment
- **TRBS 115 –** Hazards at the interface 'man/work equipment'; ergonomic and human factors
- **TRBS 1201 –** Check of work equipment and equipment subject to monitoring
- **TRBS 1203 –** Skilled persons
- **TRBS 2111 –** Mechanical danger – general requirements
- **BekBS 2111 –** Construction machines backing up
- **TRBS 2121 –** Risk of anyone falling – general requirements
- **TRBS 2121 Part 1 –** Risk of anyone falling – provision and use of scaffolds
- **TRBS 2121 Part 2 –** Risk of anyone falling – provision and use of ladders
- **TRBS 2121 Part 3 –** Risk of anyone falling – provision and use of access and positioning procedures with the aid of ropes

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- **TRBS 2121 Part 4 –** Risk of anyone falling – lifting anyone with the aid of work equipment not intended for this purpose
- **TRBS 2152 –** Dangerous explosive atmosphere – general
- **TRBS 2152 Part 1 –** Dangerous explosive atmosphere – assessment of explosion hazard
- **TRBS 2152 Part 2 –** Avoidance and reduction of explosive atmosphere
- **TRBS 2152Part 3 –** Dangerous explosive atmosphere – avoidance of ignition of dangerously explosive atmosphere
- **TRBS 2210 –** Hazard by interaction

Internet: www.baua.de

Technical rules for hazardous substances

- **TRGS 40 –** Risks resulting from skin contact – identification, assessment, measures
- **TRGS 500 –** Protection measures
- **TRGS 519 –** Asbestos: Demolition, reconstruction or maintenance work
- **TRGS 521 –** Demolition, reconstruction and maintenance work with biopersistent mineral wools
- **TRGS 524 –** Protection measures for activities in contaminated areas
- **TRGS 555 –** Working instruction and information for workers
- **TRGS 900 –** Limit values at workplaces
- **TRGS 903 –** Biological limit values
- **TRGS 905 –** List of carcinogenic, mutagenic, or reproductively toxic substances
- **TRGS 906 –** List of carcinogenic activities or procedures pursuant to § 3, Paragraph 2, Item 3 GefStoffV (German Hazardous Materials Regulations)
- Supplement to TRGS 905 and 906:

  List of carcinogenic, mutagenic, or reproductively toxic substances, activities, and procedures pursuant to Annex I of the Directive 67/548/EEC, TRGS 905 and TRGS 906

Internet: www.baua.de

Technical regulations biological agents (TRBA)

- **TRBA 400 –** How to proceed in the risk assessment of activities with biological agents
- **TRBA 500 –** General hygiene measures: minimum requirements

Internet: www.baua.de

A10.3 Regulations, rules, and information of the statutory accident insurance institutions

Explanatory notes on titles of regulations, rules, and informative publications

The Employers' Liability Insurance Association being the statutory accident insurance institution for the sector of industry and trade on the one hand and the individual accident insurance associations of municipalities in Germany (GUVV) and the German accident insurances (UK) being the statutory accident insurance institution for the employees in the public sector on the other hand are independent corporations with their own regulations etc. Thus, not every regulation etc. issued by the Employers' Liability Insurance Associations has also been issued by the GUVV and UK but only those of

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importance to occupational safety and health of the insured with GUVV / UK. There result different correlations:

- Regulations, rules, and informative publications, which only the Employers' Liability Insurance Associations have issued and published are named BGV (regulations), BGR (rules), or BGI (informative publications).
- Regulations, rules, and informative publications, which the Employers' Liability Insurance Associations have issued and published in cooperation with the GUVV and UK are named BGV/GUV-V (regulations), BGR/GUV-R (rules), or BGI/GUV-I (informative publications).

Both former federations – the HBVG (Federation of the Statutory Accident Insurance Institutions of the Industrial Sector) and the BUK (Federation of Accident Insurers) in Germany – have merged into a common federation named DGUV – the German Social Accident Insurance. This fusion entails revision of the guidelines of each federation to bring them together:

Regulations, rules, and informative publications of the BG, GUVV, and UK already under one roof – that of the DGUV – are named DGUV-V (regulations), DGUV-R (rules), or DGUV-I (informative publications).

Regulations, rules, and information of the statutory accident insurance institutions

- **BGV/GUV-V A1 –** Prevention principles
- **BGR/GUV-R A1 –** Prevention principles
- **BGV C 22 –** Construction work
- **BGR 128 –** Contaminated areas
- **BGR 189 –** Use of protective clothing
- **BGR/GUV-R 190 –** Use of breathing apparatuses
- **BGR 192 –** Use of eye face shields
- **BGR 195 –** Use of protective gloves
- **BGR 208 –** Cleaning work involving a risk of infection in medical areas
- **BGR 209 –** Handling of cleaning and care agents
- **BGR 500 –** Operating work equipment
- **BGI 580 –** Work in third-party companies
- **BGI 581 –** Leaflet for driver's cabs featuring equipment for breathable air supply on earth-moving machinery and special machinery used for civil engineering works
- **BGI 583 –** Instructions on how to proceed in risk assessment according to the German Biological Agents Regulations
- **BGI 858 –** Risks to health due to biological agents during restoration of buildings – Instructions on how to proceed in risk assessment according to the German Biological Agents Regulations
- **BGI/GUV-I 868 –** Chemical protection gloves
- **BGI/GUV-I 8685 –** Chemical protective clothing for rehabilitation of contaminated sites, landfills, and buildings
- **Guidance document for works' doctors** on occupational medical examinations of workers working in contaminated areas
- **DGUV Regulation 2 –** Works' doctors and specialists for work safety

Internet: www.dguv.de

A10

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A10.4 Publications of GDV / VdS

- **VdS 2217 –** Presents how to handle cold fire grounds – example of an information leaflet for owners of a dwelling, tenants, property managers, as well as for trade and industrial establishments
- **VdS 2557 –** Planning and Installation of Facilities for Retention of Extinguishing Water, Guidelines for Loss Prevention by the German Insurers (GDV – German Insurance Association)

VdS Schadenverhütung, Verlag,
Amsterdamer Straße 174, D-50735 Cologne
Internet: www.vds-industrial.de

A10.5 Other standards, regulations, and recommendations

- **DIN ATV 18299 –** German construction contract procedures (VOB) – Part C: General technical specifications in construction contracts (ATV) – General rules applying to all types of construction work
- **LAGA PN 98 –** Presents a guideline for procedures of physical, chemical, and biological testing in connection with the recovery / disposal of waste

Beuth Verlag GmbH,
10722 Berlin
Internet: www.beuth.de

- The Gazette by the Federal Ministry 01/90, Page 30, 1990 presenting **recommendations for the cleaning of buildings after fire events**

German Federal Environmental Agency,
Press office,
P.O.Box 33 00 22,
D-14191 Berlin
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