

# Operational hygiene in the course of firefighting

Short title: Operational hygiene  
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Change history:

**Version:4 (September 2020)**  
**Ersetzt: Version 3 (März 2014)**  
**Erste Version: Mai 1997**

Wesentliche Änderungen:

- Redaktionelle Änderungen

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## Note

A spelling that is equally fair to all genders is desirable. However, since corresponding newer spellings generally lead to major restrictions in readability, this has been dispensed with. Thus, for the entire document, the masculine form includes all genders, unless explicitly stated otherwise.

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**Content:**

**Decision support matrix for the Incident Commander’s contamination assessment..... 5**

**1. Aim of the Instruction Sheet ..... 6**

**2. Overview of harmful pollutants resulting from fires..... 6**

**3. Tasks of the Incident commander ..... 8**

    3.1. Assessment aids and advice for the Incident Commander ..... 8

    3.2. Hygiene measures to be observed by the Incident Commander ..... 9

**4. Hygiene measures to be observed by all fire fighters ..... 9**

    4.1. Operational hygiene at the fire ground ..... 9

    4.2. Operational hygiene at the fire station ..... 10

**5. Advice for superiors and decision makers ..... 11**

**6. Basis information ..... 11**

    6.1. Creation and distribution of fire by-products..... 11

    6.2. Risk assessment of cold fire grounds ..... 12

**7. Literature ..... 13**

**Appendix 1: Checklist for avoiding the spread of contamination in firefighting missions .... 14**

**Appendix 2: Situation-dependent detection methods ..... 21**

**Appendix 3: Substance- and incident-dependent recommendation..... 22**

**Appendix 4: Health and safety measures by hazard zone according to VdS 2357 - PPE matrix fire services ..... 23**

## Good practice of operational hygiene in the course of firefighting

If the following rules of conduct are observed, fire fighters can largely protect themselves:

- Positioning of vehicles: Vehicles have to be placed - if possible - outside the hazard zone, namely outside the smoke zone. The penetration of smoke gases into the interior of the crew cabin and equipment compartments must be avoided!
- During firefighting and as long as the fire ground is considered "warm" (1 - 2 hours after the fire has been extinguished), respiratory protection must always be worn in the area affected by the smoke (see Fire Service Regulation 7 (FwDV 7!))
- Before taking off the facepiece, it must be ensured that the turn out gear (PPE in accordance with vfdb guideline 08/10 and DGUV information 205-014) is well ventilated (goal: protection against smoke gas emissions).
- The incorporation of soot is to be avoided by any means, as this absorbs pollutants bound to the soot!
- Eating, drinking and smoking at the scene should only be permitted after removing contaminated clothing and thoroughly cleaning the face and hands outside the zones with soot deposits and smoke clouds!
- Incorporation of the majority of pollutants can be avoided by undressing!
- After the mission, a rough cleaning of boots, helmets and contaminated devices must be carried out at the scene. Contaminated PPE and devices are to be transported either outside the crew cabin else in airtight packaging!
- If the vehicle is exposed to soot from the outside, it is necessary to rinse it with water from the outside already at the incident site, otherwise at the latest before entering the garage of the fire station.
- Entering common rooms and social rooms is only permitted with clean clothing! Therefore, to protect against the spread of contamination, uniforms must be changed after the mission.
- Emergency personnel who have been exposed to smoke and soot should shower as soon as possible after their mission and change contaminated fire protection clothing and work clothing. **Note:** Fire protection clothing only provides limited protection against soot of fire smoke. Pollutants are dermally absorbed into the human body through skin contaminated with soot.
- A thorough cleaning of dirty devices must be carried out before they are stored back into the vehicles! If devices are free of soot after rinsing with water, they can be stowed in the vehicle's equipment compartments.
- In order to avoid the spread of contamination into the private area, uniforms worn during deployment must be taken off before leaving the fire station.

**Decision support matrix for the Incident Commander’s contamination assessment**

Type of fire	Contamination / What is at hand	Measures
<ul style="list-style-type: none"> <li>Food on stove</li> </ul>	<ul style="list-style-type: none"> <li>no relevant contamination to be expected</li> </ul>	<ul style="list-style-type: none"> <li>Normal cleaning if necessary</li> </ul>
<ul style="list-style-type: none"> <li>Container-fire („Standard“)</li> </ul>	<ul style="list-style-type: none"> <li>no relevant contamination of the PPE to be expected</li> <li>contaminated hoses/devices</li> </ul>	
<ul style="list-style-type: none"> <li>Grass fire</li> </ul>	<ul style="list-style-type: none"> <li>no relevant contamination of the PPE to be expected</li> <li>contaminated hoses/devices</li> </ul>	
<ul style="list-style-type: none"> <li>Room fire (1 crew)</li> </ul>	<ul style="list-style-type: none"> <li>contamination of the PPE is to be expected</li> <li>contaminated hoses/devices</li> </ul>	<ul style="list-style-type: none"> <li>Take off PPE before entering the vehicle</li> <li>Transport hoses/devices separately or sealed in bags</li> </ul>
<ul style="list-style-type: none"> <li>Apartment fire (multiple crews)</li> </ul>		
<ul style="list-style-type: none"> <li>Major fire</li> </ul>	<ul style="list-style-type: none"> <li>contamination of PPE is to be expected</li> <li>contaminated hoses / devices</li> <li>contaminated equipment compartments</li> <li>vehicle likely contaminated from the outside (wipe test - visual)</li> </ul>	<ul style="list-style-type: none"> <li>like yellow area and also</li> <li>Clean the affected equipment compartment</li> <li>Clean the vehicle at suitable washing sites</li> </ul>
<ul style="list-style-type: none"> <li>Major fire with massive exposure</li> </ul>	<ul style="list-style-type: none"> <li>contamination of PPE is to be expected</li> <li>contaminated hoses/devices</li> <li>vehicle is heavily contaminated inside and outside</li> </ul>	<ul style="list-style-type: none"> <li>like yellow area and also</li> <li>Have the vehicle cleaned by a specialist company (remains on the scene)</li> </ul>
<ul style="list-style-type: none"> <li>Major fire with extremely high levels of pollutants (Chemical plant, asbestos, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>contamination of PPE is to be expected</li> <li>contaminated hoses / devices</li> <li>contaminated equipment compartments</li> <li>vehicle is contaminated outside or vehicle contaminated outside and inside</li> </ul>	<ul style="list-style-type: none"> <li>like yellow area and also</li> <li>Have the vehicle cleaned by a specialist company (remains on the scene)</li> <li>Call in an expert if necessary</li> </ul>

## 1. Aim of the Instruction Sheet

Since the 1990s, the gfpa has been using this instruction sheet to inform fire fighters on firefighting missions about pollutants in smoke and hazard zones and given advice on the necessary operational hygiene.

Since then, nothing has fundamentally changed scientifically in this area and anyone who, as a fire fighter, applies the recommended operational hygiene measures, does a lot to maintain his health.

With the update of the information sheet, we would also like to provide further assistance to prevent the spread of contamination of harmful pollutants with the help of an optimized organizational structure. Also, during firefighting, the spread of contamination has to be kept to a minimum as described in Fire Service Regulation 500 "Units in NBC missions".

Please promote the necessary operational hygiene at the station - which is just as relevant today as it was in the 90s.

Pages 4 and 5 can be printed out as wall posters for the classroom or as pocket cards.

Note:

The cleaning processes for PPE must be checked for effectiveness from a scientific point of view, i.e. whether the polycyclic aromatic hydrocarbons PAH are also removed from the PSA.

The research project commissioned by the Conference of Ministers of the Interior to determine the tightness of PPE against pollutants such as PAHs has not yet been completed as of July 2020.

## 2. Overview of harmful pollutants resulting from fires

Fire smoke always contains harmful substances that can be absorbed into the body through the mouth, airways, mucous membranes or the skin. Particularly in hot smoke, the pollutants are present in higher concentrations in gaseous form and are therefore easily absorbed. In cold smoke, pollutants are mainly bound to soot, condensed water or fly ash. Additional hazards can arise from raw materials, auxiliary materials or consumables at the incident site, as well as from building materials that contain asbestos or old mineral wool as defined in TRGS 519 and TRGS 521.

### Lead substances in smoke

As scientifically described in gfpa guideline 10/03 "Pollutants resulting from fires", a large number of pollutants occur in fires. Experience shows that the following pollutants are of particular importance as lead substances in the smoke (see also Guideline vfdb-10/01 „Assessment von Schadstoffkonzentrationen im Feuerwehreinsatz“ ("Evaluation of Harmful Concentrations in Fire Service Operations")):

CO	Carbon monoxide
HCN	Hydrogen cyanide
HCl	Hydrogen chloride (hydrochloric acid)

The lead substances are substances in mixtures that can be used to detect the mixture or for a rough assessment of the risk posed by the mixture (see vfdb guideline 10/05 "CBRN Hazardous Substances Detection during Fire Service Operations"). The three lead substances can usually be detected by the fire services on site without complex measuring technology. However, the absence of these substances does not rule out the risk of fire smoke or the presence of other pollutants.

### Polycyclic Aromatic Hydrocarbons (PAH)

PAHs arise when organic substances are burned through condensation of carbon chains in the flame. As a result of the high stability of the aromatics, their formation is favoured in flames with a high fuel content.

Important to know for fire fighters:



**Low temperatures during combustion cause high PAH concentrations.**

PAHs are largely insoluble in water, soluble in fats and organic solvents and are sometimes regarded as carcinogenic substances. The lead substance effective in the lowest concentrations is benzo- (a) pyrene with a technical reference concentration (TRK value) of  $2 \mu\text{g}/\text{m}^3$ . PAHs are sedentary and biologically difficult to break down.

### **Polyhalogenated dibenzo-para-dioxins and dibenzofurans (dioxins and furans)**

**PCDD/PCDF (PBrDD / PBrDF)** are condensed aromatic compounds with different numbers of chlorine atoms in the molecule.

2,3,7,8-tetrachlorodibenzodioxin is the lead substance and most toxic representative (more information provided in gfpa guideline 10/03).

Important to know for fire fighters:



**The vapour pressure of these compounds is very low, so that dioxin vapours can only be expected in hot smoke or in burnt objects that have not yet cooled down.**

With PCDD / PCDF's, a **human carcinogenic risk and a toxic effect on the immune system** can only be assumed after high exposure. So far, the following have been observed during exposure:

- irritation of the mucous membranes, redness and swelling of the face;
- Chloracne (disease of the follicle and sebum);
- tiredness, excitability, muscle pain;
- Liver dysfunction, hyperlipidemia, neurasthenic and depressive syndromes, sensory impairments, disorders of the carbohydrate metabolism, the respiratory organs, disorders of the cardiovascular system, urinary tract and polyneuropathies are regarded as permanent consequences.

### **Building materials**

**Asbestos** was used on a large scale from the mid-1960s to the late 1980s. Fibre cement panels have mainly been used as roofing and facade cladding and as sewer pipes. These cement-bound products have an asbestos content of 10-15%, whereby the asbestos fibres are relatively firmly bound in the matrix.

Important to know for fire fighters:



**The health hazards when handling asbestos arise from inhaling the respirable fibre.**

The risk of fibre release in undestroyed material is relatively low with firmly bound asbestos fibres compared to weakly bound asbestos fibres, such as spray asbestos.

Destroying the materials can increase the risk of fibre being released, and at the same time fragments are spread in the surroundings due to the thermal effects of the fire.

Particular risks are posed from **fires in interior spaces** in which surfaces treated with spray asbestos were sealed in the course of renovation work. Because of fire damage or the opening of the cladding in the course of extinguishing work the risk of fibre release may significantly increase.

### Mineral wool

Mineral wool is used in the building sector in the form of glass wool or rock wool. These essentially consist of mineral fibres and, to a lesser extent, resins and other additives. Since mineral wool is used extensively in residential buildings, the fire service crews may always come into contact with mineral wool, e.g. during opening of cladding and walls (sloping ceilings, lightweight walls). Since the middle of 2000 there has been a ban on the use of old mineral wool, since 1996 mineral wool fabrics have been produced in Germany that are considered harmless. With old mineral wool there is a suspicion that released fibres are carcinogenic.

Important to know for fire fighters:



In the case of buildings that were erected before 2000, it must be assumed that old mineral wool (AMF - artificial mineral fibres) was installed and that there is an increased health risk in the event of a release.

### Glass fibre reinforced plastic (GRP)

GRP is a fibre-plastic composite made of a plastic and glass fibres. Mass production of the fibre-glass began in the 1930s. The first aircraft made of GRP was built in 1957. Today, GRP is used in boat hulls, aircraft, rotor blades for wind turbines, vehicle parts, shower trays, industrial doors, cooling towers, printed circuit boards, food and chemical tanks, components, etc.

If technical rescue occurs in the event of an accident, the use of hydraulic tools can result in very sharp-edged fractures and needlepoint spikes. In the event of a fire, respirable particles can be released, which can be spread in the surrounding area due to the thermal effects of the fire.

Important to know for fire fighters:



The health hazards associated with handling GRP arise from the absorption of the respirable particles.

A carcinogenic effect has not yet been proven with the fibres.

## 3. Tasks of the Incident commander

In order to protect the intervention crews, the Incident Commander has to consider the following in the initial risk assessment:

- Which pollutants are on hand (hazardous material store, construction material store, refrigerators, PVC, asbestos sheet roofing, others)?
- Which pollutants can be released in the course of the fire (fire pattern, fuel)?
- What effect do fire brigade measures have on the generation of pollutants (keywords: extinguishing agents, let burn under control, etc.)?
- Spread of contamination: How can pollutants be discharged from the fire ground? - **Appendix 1: Checklist for avoiding the spread of contamination during fire missions**
- Which pollutants can be expected at the cold fire ground?

### 3.1. Assessment aids and advice for the Incident Commander

- Information on the possible presence of pollutants in industrial sites is given in the safety data



sheets to be kept by the operator or in the fire brigade plan.

- A basic overview of the composition of fire smoke can be found in gfpa guideline 10/03 "Pollutants resulting from fires".
- Extinguishing measures lead the fire through a temperature range in which there is an increased generation of pollutants. This must be taken into account when assessing the situation. In particular, it must be considered whether, in individual cases, "controlled burning" can be more beneficial than extinguishing.
- If the proof of pollution in fire smoke is necessary for the Incident Commander in accordance with the requirements of the gfpa guideline 10/05 „Gefahrstoffnachweis im Feuerwehreinsatz“ "CBRN Hazardous Substances Detection during Fire Service Operations", this can be provided with classic detection and measuring devices of fire brigades - **Appendices 2 and 3**. This rough assessment is sufficient for the fire service. Values measured by the fire services are only indicative.
- The determination of the lead substances in the smoke can be useful for the decision of the Incident Commander
- The scene of the fire, i.e. the hazard zone must always be secured and cordoned off during the mission. Rooms exposed to fire must be ventilated at least 1 - 2 hours long after the fire has been extinguished in order to remove volatile pollutants (e.g. aromatic compounds).
- Advice on measures to avoid the spread of contamination is given on page 4 "Good practice of operational hygiene in the course of firefighting".

### 3.2. Hygiene measures to be observed by the Incident Commander

- The intervention crews in the hazard zone are to be reduced to the necessary minimum number.
- Backup crews are to be stationed outside the zone of soot precipitation and the spread of smoke gas.
- During the fire fighting and in the cool down phase, the complete PPE for firefighting (BBK1<sup>1</sup> or BBK2<sup>2</sup> according to vfdb guideline 08/10 „Auswahl von persönlicher Schutzausrüstung (PSA) auf der Basis einer Gefährdungsbeurteilung für Einsätze bei deutschen Feuerwehren“ "Selection of personal protective equipment (PPE) on the basis of a risk assessment for missions of German fire brigades") and always together with respiratory protection have to be used (see Fire Service Regulation 7 (FwDV 7)).
- Avoid exposure to soot of emergency vehicles and equipment if possible. If possible and recommended by the manufacturer, sooty devices can be pre-cleaned at the site by rinsing them with water. If devices are soot-free, they can be loaded into the equipment compartment.
- During overhaul operations and ventilation of fire compartments, the whirling up of soot or ash should be avoided. There is a particularly high risk of contamination with flocculated soot.
- A risk assessment of the cooled fire ground with allocation to the hazard zones HZ 0 to HZ 3 according to GDV guideline VdS 2357 is by any means not the responsibility of the fire brigade.
- When working on the cold fire ground, Annex 4 of the instruction sheet 10-13 "Operational hygiene" must be observed.
- The application of VdS 2357 comes into play for the fire services when they are active on the cold fire ground (e.g. implementation of safety measures; fire watch).

## 4. Hygiene measures to be observed by all fire fighters

**Decontamination** measures at the incident site during firefighting missions, i.e. the only possible rough cleaning, are to be classified as measures in accordance with Fire Service Regulation 500 (FwDV 500) „Einheiten im ABC-Einsatz“ ("Units in NBC missions").

**Thorough cleaning** in accordance with guidelines for occupational health and safety can only be carried out at the fire station.

### 4.1. Operational hygiene at the fire ground

- The prescribed personal protective equipment (PPE) including underwear must be worn during

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<sup>1</sup> Turnout-gear for use outside a building (BBK1)

<sup>2</sup> Turnout-gear for use inside al building (BBK2)

firefighting missions.

- The PPE in connection with the face piece should completely protect the skin from smoke gases and soot.
- **During firefighting and as long as the fire ground is considered "warm" (1 - 2 hours after the fire has been extinguished), respiratory protection must always be worn in the area affected by the smoke (see Fire Service Regulation 7 (FwDV 7!))**
- Before taking off the face piece, it must be ensured that the turn out gear (PPE in accordance with vfdb guideline 08/10 and DGUV information 205-014) is well ventilated (goal: protection against smoke gas emissions).
- The incorporation of soot is to be avoided by any means, as this absorbs pollutants bound to the soot!
- Incorporation of the majority of pollutants can be avoided by undressing!
- The crew cabin of the fire engine must be kept closed during the mission. After use, the cabins must be well ventilated for a short time and entered without sooty PPE.
- The longer the flaps of the equipment compartments are closed during use, the lower will be the level of contamination with smoke in there.
- **Deposit of devices:** Used devices are to be handed over to the next team at the border of the hazard zones in order to avoid the spread of contamination.
- **Establishment of a supply area:** Eating, drinking and smoking at the scene should only be permitted outside the zones with soot deposits and smoke clouds after removing contaminated clothing and thoroughly cleaning the face and hands! The criterion for adequate cleaning is that there are no visible traces of soot remaining.
- **Entry ban:** Contaminated PPE (especially fire protective clothing and boots that have not been cleaned) may not be worn in the crew cabin! Also contaminated gloves should be roughly cleaned.
- **Avoiding the spread of contamination:** After completing the extinguishing work, PPE and devices should be roughly cleaned of adhering soot on site. The removal of visible traces of soot is the criterion for cleaning success. Parts of the PPE with visible traces of soot should either be stored and transported outside of the crew cabin otherwise separately (then stowed in plastic bags). The pre-cleaned devices should also be transported separately and only loaded onto the vehicles after they have been thoroughly cleaned.
- Fire trucks that are contaminated from the outside should be rinsed with water before leaving the scene, so that only the interior needs to be cleaned at the station.
- These principles also apply to inspections of the incident site and overhaul operations as well as final inspections that take place after the fire fighting has ended and at least further one to two hours of tactical ventilation of the fire ground (cold fire ground).

#### 4.2. Operational hygiene at the fire station

- After each mission, both the equipment and vehicles used have to be thoroughly cleaned as well as personal cleaning of the staff in accordance with the guidelines for health and safety at workplace.
- The effectiveness of the recommendations for action from your own department can be checked using the attendance cycle (turn-out, arrival on scene, extinguishing measures, readiness for return, return, arrival at the station, readiness for deployment), see **Appendix 1:** - Checklist for avoiding the spread of contamination in firefighting missions.
- Entering common rooms and social rooms is only permitted with clean uniforms! Therefore, to protect against the spread of contamination, turn-out gear must be changed after the mission.
- The boots must be cleaned thoroughly. Dirt and soot (also at the soles) may have to be washed off with an aqueous soap solution. The boots should only be greased after the traces of soot and dirt have been removed because the pollutants dissolve in the grease.
- **Successful cleaning:** The criterion for adequate cleaning of the helmet and boots is that there are no visible traces of dirt after cleaning.
- The contaminated PPE should either be stored in an airtight packaging or in a well-ventilated area until it is washed. The need for tagging (traceability) the PPE should be checked on a case-by-case basis.
- Contaminated PPE must be changed after the firefighting mission.

- Prompt cleaning of contaminated parts of the body after the extinguishing operation is necessary. Body parts exposed to soot should first be locally pre-cleaned with cold water and soap, which allows to remove the soot easily. Only after the visible traces have been removed the body may be thoroughly cleaned with warm water. Skin care products may only be used after thorough body cleansing. Cleaning with organic solvents or fatty substances should also be avoided. Pollutants can dissolve in these products and then penetrate the skin. Thorough cleaning is considered successful if there are no more visible traces of soot after washing with commercially available shampoos/soaps.
- In the fire station it is necessary to separate personal and operational clothing. In order to avoid the spread of contamination into the private area, uniforms worn during deployment must be removed before leaving the station.
- A thorough cleaning of dirty devices must be carried out before they are stored back into the vehicles! If devices are free of soot after rinsing with water, they can be stowed in the vehicle's equipment compartments.
- If the vehicle is exposed to soot from the outside, it is necessary to rinse it with water from the outside at the incident site, otherwise at the latest before entering the garage of the fire station.

## 5. Advice for superiors and decision makers

Decontamination measures at the incident site during firefighting missions are to be classified as measures in accordance with Fire Service Regulation 500 (FwDV 500) „Einheiten im ABC-Einsatz“ ("Units in NBC missions"). They represent the rough cleaning of personnel, vehicles and devices that is only possible at incident sites.

The subsequent necessary thorough cleaning in accordance with the applicable guidelines for occupational health and safety must be specified by the superior or decision maker for the fire brigade (e.g. mayor of the community).

**Appendix 1** provides an overview of the possible contamination in the course of fire operations and technically meaningful decontamination and cleaning measures.

The whole process for this is broken down into sub-processes (attendance cycle) so that every person in charge and every platoon can crosscheck the effectiveness of their specified measures using the process structure.

## 6. Basis information

### 6.1. Creation and distribution of fire by-products

#### Hot fire phase

The pollutants that are formed during the combustion process are discharged in the hot phase in the form of smoke. The entire substance load is thus initially mobile. The toxic or irritating gases and vapours produced in high concentrations in this phase, such as Carbon monoxide (CO), carbon di-oxide (CO<sub>2</sub>), hydrogen chloride (HCl, condensed: hydrochloric acid), acrolein and hydrogen cyanide (HCN, condensed: hydrocyanic acid) represent a potential danger for the rescue and extinguishing forces. The PAH (see vfdb guideline 10/03) are deposited on and in the PPE or condense on surfaces and / or are deposited with the soot.

#### Cold fire ground

After the fire has been extinguished and the fuel has cooled down to ambient temperature, in particular organic pollutants are adsorptively bound to surfaces and, in particular, to soot particles. The strong adsorptive bond causes a significant reduction in their mobility. Details can be found in the gfpa guideline 10/03 "Pollutants resulting from fires".

#### Advice for Intervention crews

Even after the fire has been extinguished volatile pollutants are present in the smoke up to approx. 2 hours after extinguishing work and tactical ventilation; thus, during overhaul work in the hot zone at least a mask and filter and, if the air exchange rates are low, SCBA must be worn.

### **Distribution of fire by-products**

The type and amount of the fire material, the course of the fire and the evacuation of the smoke gases are of decisive importance for the amount of pollutants formed and the resulting pollution on the cooled fire site; these criteria shape the fire pattern. The less evidence there is of a fire with a lack of oxygen (smouldering fire), the less serious the suspicion factors for the occurrence of condensable by-fire products must be assessed. An early destruction and thus the opening of roofs and walls, a bright flame during the fire and a high fire load indicate a complete combustion at high temperatures and thus less pollutant formation.

Every cold fire ground should first be considered contaminated, thus a risk assessment outside the hot zone must be performed before carrying out any activities. Advice is given in Appendix 4.

### **6.2. Risk assessment of cold fire grounds**

According to the criteria outlined in VdS 2357, the areas affected by fire and its residual products at the cold fire site can be categorised into hazard zones HZ 0 to HZ 3. A hazard zone is an area contaminated with pollutants as a result of a fire, which can be separated from other areas.

The hazards at the cold fire ground result from the fire residues, the extent and the spatial distribution of the pollution by fire condensates. Accordingly, the following facts must be assessed:

- Expansion of the contaminated (“fire-polluted”) area
- Type and quantity of fuels involved, in particular hazardous substances (influence of fuels)
- Fire conditions
- Fire pollution to be encountered in the damaged area

The following hazard zones are defined in accordance with VdS guideline 2357:

#### **Hazard Zone 0 (HZ 0):**

Fires with a spatially limited extent (approx. 1 m<sup>2</sup>) of the clearly visible to heavily contaminated area, e.g. wastepaper basket, candle bouquet or stove-top fires or fires with a larger expansion area but minimal fire pollution.

#### **Hazard Zone 1 (HZ 1):**

Fires with clearly visible fire pollution and larger expansion of the contaminated area than HZ 0 in which standard household quantities of synthetic materials are burnt or with which no severe pollution is to be expected at the fire ground due to the fire conditions and pattern.

#### **Hazard Zone 2 (HZ 2):**

Fires with a larger expansion of the contaminated area and very severe fire pollution involving larger quantities of materials containing synthetic substances, in particular organochlorides and brominated substances, such as PVC (e.g. high-density cable routes, stored materials), and with which there is severe contamination with pollutants at the fire ground due to the fire pattern and progression. Typical HZ 2 fires are smouldering fires with which the shell of the building is largely left intact and which result in the contamination of walls, ceilings and floors.

#### **Hazard Zone 3 (HZ 3):**

Fires with which larger quantities of biological work materials and/or hazardous substances or materials containing hazardous substances are to be expected in addition to the normal by-products of a fire. These can exist in the form of raw, auxiliary or consumables either in the building or on the premises. The possibility of asbestos and man-made mineral fibres (MMMF) should therefore be given special consideration. In addition to this, critical biological working substances can either be released directly or develop through subsequent processes.

## 7. Literature

- VFDB-RICHTLINIE 10-03 SCHADSTOFFE BEI BRÄNDEN (2020) [VFDB GUIDELINE 10/03 "POLLUTANTS RESULTING FROM FIRES"]
- VFDB-RICHTLINIE 10-05 „GEFAHRSTOFFNACHWEIS IM FEUERWEHREINSATZ“ (2022) [VFDB GUIDELINE 10/05 "DETECTION OF POLLUTANTS IN FIRE SERVICE MISSIONS"]
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- TRGS 519 ASBEST - ABBRUCH-, SANIERUNGS- ODER INSTANDHALTUNGSARBEITEN [TRGS 519 ASBESTOS - DEMOLITION, RENOVATION OR MAINTENANCE WORK]
- TRGS 521 ABBRUCH-, SANIERUNGS- UND INSTANDHALTUNGSARBEITEN MIT ALTER MINERALWOLLE [TRGS 521 DEMOLITION, RENOVATION AND MAINTENANCE WORK WITH OLD MINERAL WOOL]
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- FEUERWEHRDIENSTVORSCHRIFT 7 (FwDV) „ATEMSCHUTZ“ [FIRE SERVICE REGULATION 7 "RESPIRATORY PROTECTION"]
- FwDV 500 „EINHEITEN IM ABC-EINSATZ“ [FIRE SERVICE REGULATION 500 "UNITS IN NBC-MISSIONS"]
- ARBEITSSTÄTTENVERORDNUNG (ARBSTÄTTV) [OCCUPATIONAL HEALTH AND SAFETY REGULATION]
- GESTIS-STOFFDATENBANK - GEFAHRSTOFFINFORMATIONSSYSTEM DER GEWERBLICHEN BERUFSGENOSSENSCHAFTEN; INSTITUT FÜR ARBEITSSCHUTZ (BGIA) DER DEUTSCHEN GESETZLICHEN UNFALLVERSICHERUNG; IM INTERNET ABRUFBAR UNTER: <http://www.dguv.de/bgia/de/gestis/stoffdb>.

## Appendix 1: Checklist for avoiding the spread of contamination in firefighting missions

### Basic assumptions:

Platoon<sup>3</sup> deployed as pre-determined attendance;

this does not include platoons that are not directly involved in the first attack; but transporting relief staff or reinforcement staff to the scene and are therefore further away from the scene in the staging area, as well as other operational resources that are outside the smoke cloud (such as command vehicles or others) in the cold zone.

In a typical firefighting mission (house fire in a multi-storey building), the entire staff on the fire engine is deployed as attack teams and the engine driver is also active in the hazard zone, so that only the personnel set out below needs to be considered.

Crew cabin and equipment compartments are separated; it is assumed that there is a smoke-tight partition between the crew cabin and the equipment compartment.

### Specifications:

Measure on the scene = **Decontamination** measure according to Fire Service Regulation 500 (FwDV 500); i.e. “**rough cleaning**” at the scene.

If the cleaning takes place either at the fire station, or at the cleaning company or in the technical department, then this cleaning (of PPE, devices, etc.) is regulated in labour law. Fire Service Regulation 500 (FwDV 500) does not apply here but the fire service has to obey the requirements of occupational safety regulations. In this case there is no rough cleaning according to FwDV 500 but state-of-the-art cleaning according to labour law.

### Assessment of contamination with pollutants in firefighting missions:

**Red - Contamination with pollutants is relevant** - Decontamination or cleaning necessary to avoid irreversible damage to firefighters

**Yellow - Contamination with pollutants** - Decontamination not necessary, no risk of irreversible damage to firefighters

**Green - Cleaned according to labour**

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<sup>3</sup> Platoon (German Löschzug (minimum 16 firefighters)), Crew (German Staffel (6 firefighters)), Team (German Trupp (2 or 3 firefighters))

Firefighting activity Platoon	Contaminated position/assessment	Recommendation of the measure Decontamination/cleaning
Sub-process A: Platoon leaves the station		
with crew, vehicle and equipment	<p><b>Condition</b> crew, vehicle and equipment</p> <p><b>Remark:</b> Basic contamination of relevant pollutants is present in the equipment compartments:</p> <ul style="list-style-type: none"> <li>• Combustion residues of diesel exhaust gases</li> <li>• Combustion residues of aggregate exhaust gases</li> <li>• fuels</li> <li>• Oils (e.g. hydraulic power pack, chainsaw, cut-off device, etc.)</li> </ul>	<p><b>Recommendation:</b> This condition must be established before the fire engines are deployed. Advice will be given hereafter.</p> <p>Once the basic contamination has been determined, the equipment department must be cleaned with common car washing agents.</p>
Sub-process B: The platoon arrives at the scene - Vehicle staging outside the smoke zone		
<p><b>Vehicle</b> Crew cabin</p> <p>Equipment compartment</p> <p>Devices</p> <p>(Teams, see sub-process C - assessment not meaningful here)</p>	<p><b>Condition / Assessment</b> Crew cabin</p> <p>Equipment compartment</p> <p>Not used devices</p>	<p><b>Recommendation:</b> Keep the doors closed after getting out! Only necessary flaps are opened and closed by the vehicle operator, if possible!</p>

Sub-process C: Fire fighting		
<p><b>Teams</b> Personnel</p>	<p><b>Condition</b> Personnel</p> <p><b>Assessment</b> What is visibly exposed to soot is contaminated. Personnel which has come into contact with smoke from fire or dirty devices is contaminated.</p> <p><b>Warning / building material:</b> artificial mineral fibre (AMF) In case of contamination with AMF; in individual cases also asbestos (spray asbestos).</p> <p><b>Assessment aids</b> AMF must be taken into account for every mission in which walls, ceilings, etc. with insulation are opened</p>	<p><b>Recommendation:</b> Decontamination at the scene as described in this Instruction Sheet after this phase C, i.e. before entering the crew cabin and before leaving the fire ground.</p> <p><b>Assessment aids</b> The fabrics do not easily penetrate the skin that massive incorporation has to be expected after the mission. BUT: The skin should be cleaned immediately afterwards (e.g. showering at the station) → Personnel should not be deployed to the next mission before cleaning.</p>
<p>Platoon leader, rear teams who are not deployed during this phase and who act outside the smoke zone</p>	<p>While staying outside the smoke zone during phase C, they will not receive any contamination.</p> <p>Support personnel directly exposed to smoke is contaminated. It must be taken into account that the relevant components of the contamination are bound to the soot. The surfaces that are exposed to soot are contaminated.</p>	



<p><b>Devices</b>  <b>Devices</b> (deployed)</p>	<p><b>Condition</b>                  All devices within the hot zone are considered as contaminated.</p> <p><b>Assessment:</b>                  No spread of contamination if devices are handed over before entering the hot zone (e.g. radio equipment) or remain in the danger area; see also corresponding measures of the Fire Service Regulation 500 (FwDV 500).</p>	<p><b>Recommendation:</b>                  Further use by other teams up to phase D (clearing) is not a problem, because other teams like the first team are protected and carry out the same activity in the hazard zone</p> <p>Framework for action:</p> <ul style="list-style-type: none"> <li>• Handover of the devices in the hot zone</li> <li>• Used devices remain within the hot zone until phase D</li> </ul> <p>→ Used devices</p>
<p><b>Vehicle</b>  <b>Equipment compartment</b>  <b>Not used devices</b></p>	<p><b>Condition/Assessment:</b>                  If no soot gets into the equipment compartment, there is no contamination.</p>	<p><b>Recommendation:</b></p> <ul style="list-style-type: none"> <li>• Doors and windows must generally be kept closed during phase C. Ventilation must be switched off when the vehicle is parked.</li> <li>• If possible, avoid positioning the vehicle in the path of the smoke cloud.</li> </ul> <p>→ Equipment compartment and unused devices</p>
<p><b>Crew cabin</b>  <b>Crew cabin and</b>  <b>PPE and devices in Crew cabin</b></p>	<p><b>Attention:</b>                  Contamination possible - avoid spreading of contamination</p>	<p><b>Recommendation:</b>  <b>Entry ban:</b> Contaminated PPE (especially jackets and boots) and/or SCBA do not belong in the crew cabin</p> <p>→ Crew cabin                  → PPE and devices</p>
<p>Vehicle (outside)</p>	<p><b>Condition</b>                  The vehicle is contaminated on the outside = soot layer is visible.</p>	<p><b>Recommendation:</b>                  Before leaving the scene, the outside of the vehicle is washed off with water. Cleaning of vehicles from the outside that have been in the smoke is required (at the station/usual washing area or at the fire ground).</p> <ul style="list-style-type: none"> <li>• Wiping handles before departure.</li> <li>• Use a pressure washer at the station</li> </ul> <p>→ Vehicle</p>

<p><b>On-scene Catering</b></p>	<p><b>Condition / Assessment:</b>                  Attention: Incorporation possible due to the spread of contamination</p>	<p><b>Recommendation:</b></p> <ul style="list-style-type: none"> <li>• Drinking, eating and smoking only in the specified area "refreshment point"</li> <li>• Cleaning of hands (possibly mouth) before entering the "refreshment point", supervision / control by a superior</li> </ul>
<p><b>Sub-process D:                  Establish readiness for departure</b></p>		
<p><b>Deployed teams</b> (sweaty, wet clothes, contaminated PPE)</p>		<p><b>Recommendation:</b>                  What is black has to be cleaned!                  Recommendation</p> <ul style="list-style-type: none"> <li>• Take off work clothing and pack it or transport it separately to the cleaning point.</li> <li>• Remove coarse dirt and soot from boots on site</li> <li>• Contaminated gloves of the rear troops should also be roughly showered.</li> <li>• Transport boots and gloves in a bag to the station (not in the crew cabin)</li> </ul> <p>→ Teams</p>
<p><b>Devices</b>  <b>Devices used</b> (hoses, PA, water-bearing fittings, radio lighting, etc.)</p>	<p><b>Condition:</b>                  The contamination on the <b>devices</b> used and the <b>PPE</b> is initially very immobile.                  Example: If a contaminated hose is stowed the hose compartment, the hose compartment is contaminated, but not the compartment next to it or equipment compartments further away.                  The compartment has to be cleaned afterwards.                  However, the vehicle is not be considered as completely contaminated, as this is the case with an ambulance immediately after an infection transport mission.</p>	<p><b>Recommendation:</b>                  Collect used <b>devices</b> separately and transport them to the cleaning point (large quantities). Small quantities can be put in a box, a hose or a garbage bag and transported away in your own vehicle; this corresponds to the behaviour of fire damage restoration workers.                  Be careful with visible AMF contamination, the fibres can only be removed with suction; i.e. qualified personnel must be deployed here.                  Trough → cleaning method</p>
<p><b>PPE</b> (contaminated with soot)</p>	<p><b>PPE</b> (contaminated with visible soot)</p>	<p><b>PPE</b> put in front of the vehicle                  → separate transport to the cleaning point, or, if only small quantities, in a box in the equipment compartment</p>

<p><b>Vehicle</b></p> <p>Equipment compartment</p>	<p><b>Condition / Assessment:</b></p> <p>If no soot gets into the equipment compartment, there is no contamination</p>	<p><b>Recommendation:</b></p> <ul style="list-style-type: none"> <li>• Doors and windows must generally be kept closed; ventilation switched off when the vehicle is parked</li> <li>• Only open the device flaps while putting away and close them again immediately.</li> </ul> <p>→ Equipment compartment and unused devices</p>
<p>Crew cabin</p>	<p><b>Condition</b></p> <p>Teams get on without equipment and without PPE</p> <p>→ Crew cabin</p>	
<p><b>Sub-process E: Return to station</b></p>		
<p>Teams in Crew cabin (Outgassing)</p> <p>Crew cabin</p>	<p><b>Assessment:</b></p> <p>Possible spreading of contamination into the crew cabin can be prevented.</p>	<p><b>Recommendation:</b></p> <p>On return, personnel should also sit on garbage bags, plastic film, etc. if they are very dirty. Return journey can only take place ready for deployment if the fire protection clothing is soiled.</p> <ul style="list-style-type: none"> <li>• A change of fire protection clothing and uniforms as well as timely showering of the emergency services is necessary.</li> <li>• Crew cabin</li> </ul> <p>For the removal of small amounts of volatile pollutants, the ventilation must be switched on during return</p> <p>→ Teams</p>

Arrival at the station		
<p><b>Vehicle</b></p>	<p><b>Condition:</b></p> <ul style="list-style-type: none"> <li>• Teams</li> <li>• Contaminated vehicle (contaminated with visible soot)</li> </ul> <p><b>Assessment:</b> Ready for deployment NO</p>	<p><b>Recommendation for making the vehicle ready for deployment</b></p> <ul style="list-style-type: none"> <li>• Vehicle cleaning, if necessary - from the outside in</li> <li>• from the outside with a high-pressure cleaner</li> <li>• Use a vacuum cleaner (dust class "H") to vacuum the equipment rooms</li> <li>• Wipe surfaces with a damp cloth</li> </ul> <p><b>In case of mission in Hazard Zone 2</b> At the station, the floor of the equipment compartment must be vacuumed with a vacuum cleaner (dust class "H") and wiped with a damp cloth (<b>DO NOT SWEEP!</b>).</p> <p>→ The clean vehicle can be driven into the garage!</p>
<p><b>Teams</b></p>		<p><b>Recommendation:</b> Cleaning at the station as described in this Instruction Sheet → Teams</p>
Sub-process F: Platoon ready for deployment		
<ul style="list-style-type: none"> <li>• Cleaned vehicle inside and outside.</li> <li>• Cleaned devices</li> <li>• Showered staff with new PPE</li> </ul>	<p><b>Readiness for deployment achieved when</b></p> <ul style="list-style-type: none"> <li>• Vehicle cleaned at the station</li> <li>• Team has showered and is wearing clean underwear</li> <li>• Cleaned PPE is available</li> <li>• Cleaned devices are loaded onto the vehicle.</li> </ul>	<p><b>Recommendation:</b> Have clean PPE ready <sup>(1)</sup> Upload cleaned devices on the vehicle</p> <p><sup>(1)</sup> Check cleaning procedure for effectiveness</p>

**Appendix 2: Situation-dependent detection methods**

		Fire 0 + 1 according to VdS 2357 / vfdb RL10-03	Fire 2 + 3 according to VdS 2357 / vfdb RL10-03	Fire in plant according to StörfallVO	Extinguishing water	Gaseous pollutant	Liquid pollutant	Liquid pollutant in soil	Solid pollutant	Liquid pollutant in water <sup>2</sup>	Transport accident	Radiation accident
Rapid test	pH indicator				x	(x)	x	x	(x)	x		
	Oil test paper						x	x		x		
	Tracing powder or paper						(x)	(x)				
	Leak detection spray					(x)						
Explosion limits warn- ing devices			x	x		x	x	x	(x)	x	(x)	
Test tubes			(xx)	(xx)	(xx)	xx	xx	(xx)		(xx)	(xx)	
Photoionization de- tector <sup>3</sup>						xx	xx	xx	(xx)	xx	(xx)	
IMS <sup>3</sup>			(xx)	(xx)		xx	(xx)	(xx)			(xx)	
Sampling	Wipe test		xx	xx			(xx)	(xx)	xx		(xx)	
	Collection tube <sup>1</sup>		xx	xx		xx	(xx)	(xx)		(xx)	(xx)	
	Glass bottle with wide neck				xx		xx	xx	xx	xx	(xx)	
	Disposable sy- ringe						xx	(xx)		(xx)	(xx)	
Test kits					(xxx)		(xx)	(xx)		(xxx)	(xxx)	
Electro-chemical sin- gle and multi-gas de- tectors			(xx)	(xx)		xx	xx	(xx)		(xx)	(xx)	
Radiation Direct Read- ing devices			(xx)	(xx)							(xx)	xx
GC/MS			(xxx)	(xxx)	(xxx)	(xxx)	(xxx)	(xxx)	(xxx)	(xxx)	(xxx)	
Luminous bacteria					(xxx)					(xxx)	(xxx)	
Thermo imaging cam- era / remote-reading thermometer			(xxx)	(xxx)								

Generally not suitable or recommended

<sup>1</sup> Activated charcoal, silica gel, Tenax

<sup>2</sup> also gases dissolved in water

<sup>3</sup> also equipment in CBRN-reconnaissance vehicle

X

Basic equipment

XX

Additional equipment

XXX

Special equipment

( ) no standard procedure, only use in special cases

**Appendix 3: Substance- and incident-dependent recommendation**

Substances or parameters	Fire 0 + 1 according to vfdb 10-03	Fire 2 + 3 according to vfdb 10-03	Fire in Plant according to StörfallVO	Gaseous pollutant (ex- cerpt, ref. to vfdb 10-01)	Liquid pollutant	Liquid pollutant in soil	Solid pollutant	Liquid pollutant in water <sup>2</sup>	Extinguishing water
Ammonia		XX	XX	XX	(XX)	(XX)		(XX)	
Hydrocyanic acid (hydrogen cyanide)		XX	XX	XX					
Chlorine		XX	XX	XX					
Formaldehyde		XX	XX	XX	(XX)	(XX)		(XX)	
Carbon dioxide		XX	XX	XX					
Carbon monoxide		XX	XX	XX					
Nitrous gases		XX	XX	XX					
Phosgene		XX	XX	XX					
Phosphine		XX	XX	XX					
Hydrochloric acid (hydrogen chloride)		XX	XX	XX	(XX)	(XX)		(XX)	
Sulphur dioxide		XX	XX	XX					
Hydrogen sulphide		XX	XX	XX					
Nitrogen dioxide		XX	XX	XX					
Gas: substance-specific, incident-de- pendent		(XXX)	(XXX)	XXX	(XXX)	(XXX)		(XXX)	
Warfare agents				XX	XX				
PH value					X	X		X	X
Oil content					X	X		X	
Temperature								X	(X)
Oxygen content								(XXX)	(XXX)
Conductivity								(XXX)	(XXX)
Chemical oxygen demand (COD)								(XXX)	(XXX)

generally, not suitable or recommended

<sup>2</sup> also gases dissolved in water

X Basic equipment

XX Additional equipment

XXX Special equipment

( ) no standard procedure, only use in special cases

**Appendix 4: Health and safety measures by hazard zone according to VdS 2357 - PPE matrix fire services**

<b>Special health and safety measures by hazard zones</b>					
The information only applies to the <b>cold</b> fire ground. Fire Service Regulations FwDV 1 and FwDV 7 and DGUV regulation 49 "Feuerwehr") apply when inspecting or working at fire grounds that are not cold! If restoration chemicals or decon agents are used, the PPE is also based on the safety data sheets and the manufacturer's instruction for use contained therein. More advanced PPE possible depending on the situation.					
<b>1 Minimum protective equipment according to FwDV 1, no. 2.1 )<sup>1</sup></b> <b>2 Type 2 body protection according to FwDV 500, at least cat. III, type 5 or 6</b> <b>3 Type 2 body protection according to FwDV 500, at least cat. III, type 4</b> <b>4 Splash protection apron</b> <b>5 Respiratory protection, full face mask, at least class 3 particle filter (e.g. ABEK 2-P3) )<sup>2</sup> )<sup>3</sup></b> <b>6 Chemical protective gloves instead of firefighter gloves according to FwDV 1, no. 2.1</b> <b>7 Foot protection S5d (rubber boots) instead of firefighter boots according to FwDV 1, no. 2.1</b> <b>8 Working clothes for working at the station (clothing as for 1, if applicable)</b>		<b>Hazard zone 0</b>	<b>Hazard zone 1</b>	<b>Hazard zone 2</b>	<b>Hazard zone 3</b>
<b>Inspections</b>	Inspection of the <u>cold</u> fire ground	1	1, (4)	1, 4, 5	Body protection according to FwDV 500 following specific hazard!
	Inspection of the <u>cold</u> fire ground incl. stagnant firefighting water		1, (4), 6	1, 4, 5, 6	
<b>Measures taken at over-haul work</b>	Work without contact with firefighting water or other liquids and without particular risk of contamination (e.g. shoring work, creation of safe access options or movement areas, stabilisation)	1	1, 4	4, 5	
	Work without contact with firefighting water but with risk of contamination caused by decomposition products (e.g. work with debris, dismantling or demolition of severely sooty objects, removal of strongly sooty equipment)		4	4, 5, 6	
	Work with contact with firefighting water (e.g. firefighting water retention, firefighting water removal, sealing measures, removal of equipment from stagnant firefighting water, relieving of water loads to components)		2, 4, 6	2, 4, 5, 6	
<b>Cleaning (used equipment)</b>	Rough cleaning at the scene (brushing off, sweeping off, hosing down, wiping off, etc.)	1	4, (5)	4, 5, 6	Decon measures according to FwDV 500 or gfpa guideline 10/04
	Thorough cleaning at the fire station (cleaning by hand)	7	7, (4), 5	4, 5	
	Thorough cleaning at the fire station (immersion bath or high-pressure cleaning)	7, 3	7, 3, (4), 5, 6	2, 3, 4, 5, 6	
		<b>( ) = hold available and use if needed</b>			
) <sup>1</sup> If increased levels of dust occur, it is recommended to wear additional protective clothing EC cat. I on top of the working clothes.					
) <sup>2</sup> Self-contained breathing apparatus or fan-supported respiratory protection devices should be used for very demanding or moderate work.					
) <sup>3</sup> If gases or vapours are present, a suitable gas filter according to DGUV 112-190 must be selected.					