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Recommendations on the Cleaning of the Interior of Public Transport Vehicles and Further Measures to Prevent Spreading of Infectious Diseases

Overall revision
Committee on Depots and Workshops

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Recommendations on the Cleaning of the Interior of Public Transport Vehicles and Further Measures to Prevent Spreading of Infectious Diseases

Overall revision

Committee on Depots and Workshops

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Preface

Clean vehicles are *the* advertisement for each public transport company. Passengers hold public transport vehicles in high regard and like to stay in them. A pleasant environment in public transport vehicles is important to increase the desired higher modal split share and to acquire more customers. Consequently, both the visible and the perceptible cleanliness as well as hygiene measures are of high importance. Moreover, practical experience has shown that the passengers leave less rubbish and dirt in clean vehicles and that they are less destructive in clean vehicles.

The COVID-19 pandemic forced public transport companies to take up many new and unprecedented challenges. The primary objective of the public transport companies is to protect passengers and drivers from getting infected with SARS-CoV-2. To keep up public life and the services for the public, it is essential to offer suitable public transport services that consider the pandemic situation. Moreover, it is crucial to reduce the passengers' feeling of uncertainty to which this exceptional situation has led and to win back lost customers.

This VDV Report is intended to support the public transport companies in their effort to purposively clean and disinfect public transport vehicles to a sufficient degree. On the one hand, it sums up initial knowledge and experience and, on the other hand, it includes recommendations on how public transport vehicles can be designed to facilitate easy cleaning and how the drivers can be protected during a pandemic caused by a virus infection.

Table of Contents

Preface	4
Table of Contents	5
1 Introduction	7
2 Medical Background	9
3 Cleaning of the Interior of Public Transport Vehicles	11
3.1 General	11
3.2 Handling of a Public Transport Vehicle in which an Infected Person has Stayed	12
3.3 Cleaning of Floors	12
3.4 Cleaning of the Driver's Workplace	12
3.5 Cleaning of Heating Elements	13
3.6 Cleaning of Upholstery and Seat Shells	13
3.7 Cleaning of Side Walls	14
3.8 Cleaning of Glass Areas (Partition Panes and Windows)	14
3.9 Cleaning of Stanchions	14
3.10 Cleaning of Plastic Surfaces in the Ceiling Area	15
3.11 Cleaning and Maintenance of Recirculation Air Filters	15
3.12 Removal of Graffiti, Tags and Stickers	15
3.13 Cleaning Classes und Cleaning Intervals	15
4 Disinfection according to the Recommendations of the RKI and the VDV	26
5 Disinfection of the Interior of Public Transport Vehicles	28
5.1 General	28
5.2 Disinfection by way of Liquid Disinfectants	28
5.3 Disinfection of Surfaces by way of Artificial UV-C Radiation	29
5.4 Disinfection of Room Air by way of Ionizers	29
5.5 Disinfection with Gaseous Disinfectants	29
6 Coating	31
6.1 General	31
6.2 Coating of Plastic Parts	33
6.3 Coating of Fabrics	33
6.4 Coating of Stanchions	33
7 Heating, Ventilation and Air Conditioning	34
7.1 General	34

7.2	Setting of the HVAC System	35
7.3	Filter Systems with Additional Disinfection	35
7.4	Air Filters with a Higher Deposition Rate	35
7.5	Air Cleaning Methods	35
8	Further Protective Measures	38
8.1	General	38
8.2	Protective Panes at the Driver's Workplace	38
8.3	Barriers to the Passenger Compartment of a Bus	40
8.4	Additional Partition Panes in the Passenger Compartment	40
8.5	Fitting of Disinfectant Dispensers for Passengers	40
9	Designs Enabling Easy Cleaning and Allowing Passengers' "Contactless" Use of Public Transport Vehicles	41
9.1	General	41
9.2	Foldable Rear Seats	41
9.3	Vandalism-proof Seat Covers	41
9.4	Smooth Surfaces	42
9.5	Floor Covering Welded on the Rear Side	42
9.6	Central Opening of All Passenger Doors	42
9.7	"Contactless" Door Opening	42
9.8	Partition Walls at Back Rests	42
10	Health and Safety Measures during a Pandemic	43
10.1	General Occupational Safety and Health Measures	43
10.2	Preventive Occupational Medical Care and Protection of Particularly Vulnerable Groups of Employees	49
10.3	Preventive Occupational Safety and Health Measures for Drivers	51
10.4	Special Organisational Measures for Workshops	52
10.5	Preventive Occupational Safety and Health Measures for Cleaning Staff	54
11	Summary	55
	Legislative Rules – Acts, Regulations and Directives	56
	Technical Rules – Standards and Recommendations	57
	List of Figures and List of Sources	58
	List of Abbreviations	60
	Imprint	61

Translator's note:

In case of doubt or differences to the German version of this Recommendation the German version is valid.

1 Introduction

Due to the COVID-19 pandemic the cleaning and the design of interior of public transport vehicles have been brought into public focus.

Numerous studies in Germany and abroad have dealt with the risk of transmitting SARS-CoV-2 in public transport and long-distance vehicles and concluded that the risk of getting infected with SARS-CoV-2 in these vehicles is extremely low. No case of catching SARS-CoV-2 in a public transport vehicle became known during the first big pandemic wave, which was e. g. a result of the fact that nearly all passengers observed the following recommendations on hygiene:

- keep distance to other people;
- stay in if you are ill;
- avoid bodily contact;
- mind your hygiene by coughing and sneezing;
- keep your hands away from your face;
- wash your hands at regular intervals;
- use a face covering or a face mask.

Another reason for the very low risk of getting infected is the very good natural and forced ventilation of public transport vehicles and the – generally – short period of stay in such a vehicle.

These aspects are well illustrated in a Japanese study, in which people are requested to avoid the “three Cs”.

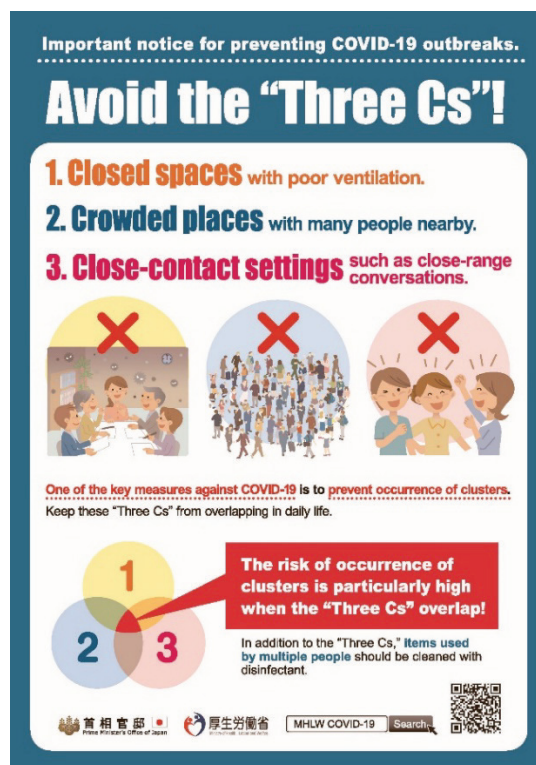


Figure 1: Avoid the "Three Cs"!, published by the Japanese Ministry of Health, Labour and Welfare

A study of the Deutsche Bahn AG sums up a further important result: Minimise the amount of air emitted by potentially infected people and maximise the circulation of fresh air in the relevant areas.

Other studies, e. g. the Heinsberg study by Prof. Dr. H. Streeck, conclude that there is only a low risk of getting infected via a smear infection.

Nevertheless, it is extremely important to look into the subject of vehicle cleaning to win new customers. Clean public transport vehicles are of utmost importance for people's well-being in the vehicles. Moreover, the cleaning of the interior of a public transport vehicle contributes to maintaining the value of the vehicle. If the environment is always clean, passengers do not make the interior dirty and do not smear it beyond the usual degree. Clean vehicles are an important element in the traffic transition to win new customers. However, "clean" does not only mean a clean vehicle from the point of view of the environment, but also a freshly cleaned vehicle that is inviting.

On the occasion of the outbreak of the COVID-19 pandemic many public transport companies have decided to take additional cleaning and disinfection measures.

Additional cleaning of the interiors of vehicles at the terminals creates confidence and proves that the public transport companies take the passengers' anxiety and needs seriously. This additional cleaning before the eyes of the public stresses the importance of this aspect. Moreover, additional suitable measures have to be taken at the driver's workplace. A hygiene concept for the driver's workplace that is adapted to the situation increases the drivers' objective and subjective feeling of safety.

Thus, public transport companies are faced with the challenge of providing consensus between hygienic and medical requirements, political requirements, the customers' expectations and the general economic conditions.

Lately, many air cleaning devices and many antibacterial and antiviral coatings are offered for public transport vehicles. It is essential to question whether these technical innovations and concepts are necessary and to verify not only the functionality, but also the effectiveness of the complete system for the inactivation of viruses and – if relevant – to have the necessity for such an innovation or concept examined by an independent testing institute.

This VDV Report compiles the initial experience with the new situation and is intended for public transport companies. It informs of possible cleaning methods, possible disinfection methods, technical innovations and other helpful procedures that contribute to increasing the cleanliness in public transport vehicles and to decreasing the risk of getting infected. Moreover, it goes into detail with the present requirements for occupational safety and health on the basis of the guidelines published by the German Federal Ministry of Labour and Social Affairs (BMAS).

2 Medical Background

The severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) belongs to the corona virus family. A SARS-CoV-2 infection can lead to the COVID-19 respiratory disease. SARS-CoV-2 has been classified in risk class 3 pursuant to TRBA 462 just as many other influenza viruses. Risk group 3 includes “biological agents that can cause severe human disease and present a serious hazard to employees; they may present a risk of spreading to the community, but there is usually effective prophylaxis or treatment available” (BioStoffV, Section 3 (1) No. 3)).

According to the scientific state of the art, SARS-CoV-2 can be transmitted in several ways. Firstly, it can be transmitted via droplets (coughing and sneezing). Secondly, it can be transmitted via aerosols (via the respiratory tract). Thirdly, it can be transmitted via surfaces (smear infection). However, it is assumed that this third way is of minor importance. SARS-CoV-2 is mainly transmitted from one person to another person via air-borne droplets and aerosols coming from infected people’s respiratory tracts. The risk of infecting other persons via droplets and aerosols is considered to be relatively high. The exposed mucous membranes of the recipients, i. e. mouth, nose and eyes, are considered to be the portals of entry. The virus is mainly transmitted between persons being close to one another, i. e. between persons who are within the usual conversation distance or even closer. It has turned out that a person mainly transmits and spreads the virus to other persons in closed spaces via droplets and aerosols. The transmission via contaminated surfaces and hands is of less importance, but, of course, this aspect also has to be considered.

Not only persons with the COVID-19 disease, but also persons who are infected, but do not show symptoms can transmit the virus. There is often a high virus load one or two days before the symptoms appear. The risk of getting infected depends on the number of contacts with infected persons and on the contact duration.

The transmission via droplets and aerosols can be minimised by way of frequent air exchange either in a natural way, i. e. by opening doors, windows and roof hatches, or in a forced way, i. e. by using HVAC systems with a high share of fresh air. Due to their tiny size of $\sim 0.16 \mu\text{m}$ viruses of the SARS-CoV-2 type cannot be retained by the standard filters in HVAC systems. However, they need not retain the virus because it is always emitted as droplets or aerosols. As the droplets are relatively big and heavy ($\sim 5\text{--}10 \mu\text{m}$), they drop down to the bottom after a short air route. Most aerosols ($\sim 1.0 \mu\text{m}$) can be sucked in by the HVAC system and bound in the filters. Moreover, the air is dried by the HVAC system.

Both the spreading and the breathing in of droplets and aerosols can be reduced if people wear face coverings or medical face masks.

As the genetic make-up (genome) of SARS-CoV-2 and many other viruses, e. g. influenza viruses, is enveloped by a layer of fat (lipid layer, virus membrane), these enveloped viruses usually act sensitively to fat-dissolving substances like tensides (soap) or alcohols. Therefore, fat-dissolving cleaning agents can be used for cleaning activities.

In the past, all pandemics caused by virus infections since the Spanish flue in 1918 (influenza A virus N1H1) were virus infections caused by enveloped viruses. Therefore, it is very likely that future virus infections will also be caused by enveloped viruses.

If, however, disinfection of public transport vehicles should be ordered officially, e. g. if it is suspected that contamination with germs cannot be eliminated via cleaning, care shall be taken that the only disinfectants and disinfection methods that are used are those listed in the List of Tested and Approved Disinfectants and Disinfection Methods Published by the RKI (date: 31.10.2017) (RKI list).

3 Cleaning of the Interior of Public Transport Vehicles

3.1 General

A concrete work plan concerning the cleaning of the interior of public transport vehicles shall be prepared. It shall especially detail the cleaning scope, the intervals between the cleaning activities, the cleaning methods and the cleaning agents. If service providers are entrusted with cleaning activities, it is also important to determine the required cleaning state and the degree of supervision to ensure that the requirements for cleaning are fulfilled. In practice, it has turned out to be meaningful to determine a quality assurance system, which can be integrated into the existing quality management system of the public transport company. To achieve a good cleaning quality, it can be necessary to adapt the inspection intervals and to realise supervision on the spot, especially at night time.

It is important to ensure that only cleaning agents and cleaning methods that have been recommended or accepted by the vehicle manufacturers are used by cleaning activities. Upon request, the vehicle manufacturers can hand out a list of accepted cleaning agents. Moreover, care shall be taken that the cleaning agents meet the wastewater disposal requirements.

The following recommendations are based on the scientific state of the art as per July 2020. They have been prepared on the basis of sources published by the Robert Koch Institute (RKI), Deutsche Bahn AG (DB), the German Social Accident Insurance Institution for the Administrative Sector (VBG), the Association of German Engineers (VDI) as well as manufacturers of vehicles and components.

As SARS-CoV-2 is enveloped by a layer of fat, it is sufficient and purposive to clean with fat-dissolving cleaning agents (tensides and alcohols). The manufacturers' instructions concerning the application times and the dosages shall be observed. According to the scientific state of the art further disinfection with disinfectants is not necessary. It has to be born in mind that disinfectants do not have a cleaning effect and that the cleaning has to be performed before the disinfection. Therefore, vehicle manufacturers often recommend combined products for disinfection and cleaning. It also has to be born in mind that disinfectants can damage vehicle parts and surfaces.

It is not allowed to clean vehicles with cleaning agents with solvents or a pH value under 6 (acidic) or over 10 (strongly alkaline) because they can lead to ugly or rougher surfaces, to which dirt, bacteria and viruses can stick more easily. Moreover, it has to be considered that many surfaces require cleaning in a certain direction.

Finally, it has to be born in mind that it shall be possible to clean the interior of the vehicles without much water. It is strictly forbidden to use water hoses and high-pressure cleaning devices inside the vehicles. Water shall neither penetrate into gaps or areas with electrical or electronic equipment nor shall it be collected in bellows.

3.2 Handling of a Public Transport Vehicle in which an Infected Person has Stayed

A public transport vehicle in which an infected person has stayed shall be handled with utmost care. The vehicle or at least the part in which the infected person stayed shall be put out of operation and parked as fast as at all possible. Then, it shall be well ventilated, e. g. by opening the windows, doors and roof hatches. Barrier tapes and prohibition signs at the doors shall prevent persons from entering the vehicle. If possible, nobody shall enter it for four hours. Thereafter, it can be cleaned and disinfected in accordance with the instructions of the RKI. In this particular case dry cleaning methods like vacuum cleaning or sweeping shall be avoided. Only instructed persons, who wear personal protective equipment (PPE), may clean the vehicle.

3.3 Cleaning of Floors

The following recommendations only apply to vehicles with sprayed or bonded floors made of polyurethane (PUR) or polyvinyl chloride (PVC).

Before the floor is cleaned, it is swept or vacuum-cleaned, loose waste is removed and the interior is vacuum-cleaned.

The general wet cleaning of the floor, which is performed once a day or one or several times per week depending on the instructions of the public transport company and the necessity, is made with a neutral cleaning agent and a cleaning mop on a folding support. It shall be possible to remove the cleaning agent in a residue-free way.

The thorough cleaning, which is performed e. g. once a month, shall be made with a suitable alkaline cleaning agent and a scrubbing brush or a one-disc cleaning machine. The application time of the cleaning agent according to the manufacturer's instructions shall be observed. It shall be possible to remove the residuals of the cleaning agent and the dirt that has come loose with much water and a cleaning mop on a folding support or a wet vacuum cleaner.

The cleaning shall always be made in such a way that the anti-skid properties of the floor are neither mechanically damaged (by the cleaning machine) nor modified by film-forming cleaning agents.

It is also possible to apply an anti-skid sealing coat on the floor after the cleaning at regular intervals. This measure facilitates future cleaning activities and reduces the cleaning effort. Of course, the vehicle manufacturer's instructions about such sealing coats shall always be observed.

It shall be possible to remove stains and adhesive materials like chewing gum in accordance with the vehicle manufacturer's instructions.

3.4 Cleaning of the Driver's Workplace

The driver's workplace is of utmost importance. The applied cleaning agents shall always be tolerable by the skin and compatible with plastics. If not, they might attack operating elements like the steering wheel or switches and buttons. Consequently, it is also important that the drivers do not themselves purchase cleaning agents and disinfectants for uncontrollable use at

his/her workplace. This aspect has to be considered because some drivers might be allergic to such products and might experience e. g. skin irritation on their hands if they have been applied on surfaces. The public transport company can counteract such private actions by purposively distributing acceptable cleaning utensils to the drivers. Moreover, it can extensively inform the drivers about the cleaning activities that it has realised to make it clear to them that additional cleaning and/or disinfection of the driver's workplace is not necessary. It is meaningful to include the works council in this communication. Experience has shown that it is a good idea to hand out microfibre cloths and additional means for disinfection of the hands to the drivers for cleaning and disinfection purposes, respectively. These measures are to be described in the hygiene concept.

Uncontrollable use of disinfectants harms the protective dermal layer and can lead to allergy and eczema. Disinfectants make the skin dry and chapped so that germs can more easily go into the body. Moreover, the content in some disinfectants, e. g. triclosan, are suspected of doing harm to the hormone balance.

Covers, if any, on steering wheels in buses shall always have been approved. According to StVZO, Section 35b (equipment for safe driving of vehicles) and Section 38 (steering gear) it shall be easy and simple to drive a vehicle safely. It is not allowed to use film covers, which are used to keep away dirt when the vehicle is in the workshop, on streets to which the StVO applies. To avoid direct contact with the steering wheel (if desired), it is recommended to use (leather or cloth) gloves. Permanent use of disposable or rubber gloves can harm the skin.

The driver's seat shall be cleaned as described in 3.6.

Cleaning agents on a soap basis can be used to clean the operating elements, e. g. buttons, switches, rotary knobs and levers. However, it is important only to use little water (moist, soft cloths) because the electrical and electronic equipment in the vehicle can be damaged otherwise.

The protective panes at the driver's workplace shall be cleaned as described in 3.8. It is important not to damage coatings, e. g. anti-reflection coatings on the protective panes.

3.5 Cleaning of Heating Elements

The air filters of heating elements, e. g. the underseat heater fans, have to be changed at regular intervals in accordance with the manufacturer's instructions. When they are being changed, it is meaningful also to clean the housings (with a neutral cleaning agent) and to remove the dust inside the heating elements by way of a vacuum cleaner. It is not allowed to use compressed air because it would lead the dust to the fan motors and the interior of the vehicle.

3.6 Cleaning of Upholstery and Seat Shells

Dust can be removed from upholstery by way of a vacuum cleaner or a knock sweep piston. To generally clean the upholstery, a spray with a soap-based cleaning agent can be used. This cleaning agent is removed after the application time by brushing a soft, absorbent white cloth in the wrong brush direction.

Spray extraction cleaners have proved their worth for thorough cleaning of upholstery. The (soap-based) cleaning agent is sprayed onto the upholstery. After the application time the

upholstery is vacuum cleaned with the extraction function to remove the cleaning agent. Thereafter, the upholstery has to dry for a specified period. It is important that the extraction function of the spray extraction cleaners allows a high vacuum power.

Stains shall be removed in accordance with the instructions of the manufacturer of the vehicle and/or the upholstery.

The seat shells (backs) can be cleaned in the same way as roof hatches. A smooth plastic surface structure of the seat shells makes it easier to clean them and/or remove tags and stickers.

3.7 Cleaning of Side Walls

Side walls of many different designs are used in public transport vehicles. Side walls made of plastic or plastic-coated hard fibreboards can be cleaned by way of moist, soft cloths in the same way as other plastic surfaces in public transport vehicles. Side walls with textile coatings can be cleaned with a suitable cleaning agent by way of a spray extraction cleaner in the same way as the upholstery. It is recommended always to follow the manufacturer's cleaning recommendations for the various materials.

3.8 Cleaning of Glass Areas (Partition Panes and Windows)

Usually, a soft cloth or a sponge and a soap-based cleaning agent suffice to clean glass areas (partition panes and windows). Dirt can also be removed with a microfibre cloth. Moreover, special glass cleaners (with alcohol) can be used to clean glass surfaces. It is important to ventilate the workplace for a sufficiently long period afterwards.

Disinfectants with bleaching agents can damage glass surfaces.

Scouring agents and similar agents with a polishing effect can scratch glass surfaces.

3.9 Cleaning of Stanchions

Stanchions of many different designs are used in public transport vehicles. Distinction is made between powder-coated stanchions and stanchions made of stainless steel. Stanchions made of stainless steel have different surface designs, i. e. they can have brushed surfaces or shot-blasted surfaces. The brushed surface is bigger than the shot-blasted surface. Therefore, shot-blasted surfaces should be preferred in a cleaning sense.

Stanchions can be cleaned by way of moist, soft cloths, sponges soaked with a cleaning agent or microfibre cloths.

Handholds and straps fitted on stanchions need intensive cleaning. Therefore, the number of handholds and straps on stanchions should be reduced to the legal minimum. Moreover, the stanchions should be fitted at a height that makes it superfluous to fit handholds and/or straps.

3.10 Cleaning of Plastic Surfaces in the Ceiling Area

Just as the side walls made of plastic or plastic-coated hard fibreboards plastic surfaces in the ceiling area (ceiling and roof hatches) can be cleaned with a moist, soft cloth. Ceilings with hole patterns (, via which the circulating air for the HVAC system is sucked in in some vehicle designs,) need intensive cleaning. It is important that they are not too wet-cleaned because water would penetrate into the hard fibreboards in this case and let them swell. In case of such a design it can be meaningful to clean the holes with a vacuum cleaner.

As roof hatches often have anti-graffiti coating, it is important that this coating is not unduly damaged during the cleaning. If necessary, the coating has to be replaced.

3.11 Cleaning and Maintenance of Recirculation Air Filters

Just as the fresh air filters the recirculation air filters shall be changed at regular intervals in accordance with the vehicle manufacturer's instructions. When recirculation air filters, which are fitted in the ceiling area of the vehicle, are to be changed, care shall be taken that the filter frames are so downwards removed that no dust falls down. Suitable covers or foils can be used for this purpose. The filter frames shall be cleaned with a moist, soft cloth and a soap-based cleaning agent.

3.12 Removal of Graffiti, Tags and Stickers

Graffiti, tags and stickers should be removed as promptly as possible to minimise the imitation effect. Anti-graffiti coatings or foils can make it easier to remove graffiti and stickers. Anti-graffiti coatings can either be applied by the vehicle manufacturer right from the beginning or later by the public transport company.

Special cleaning methods are used by the removal of e. g. graffiti. It has to be ensured that they do not damage the foundations and that all occupational health and safety aspects as well as all environment protection aspects are considered.

3.13 Cleaning Classes und Cleaning Intervals

3.13.1 Cleaning Classes for Buses

It has turned out to be practical to use cleaning classes. The following example of cleaning classes applies to buses.

3.13.1.1 Definition of the Term "Result-oriented Cleaning"

There is no place for the following kinds of dirt in the interior of a vehicle, i. e. on the floor, on horizontal areas with or without floor covering, on wheel cases, on landings, on seats, on/in waste bins, on trays and racks, on stanchions and on door leaves:

- coarse and fine dirt like dust, pollen, hair, cobwebs, sand, chips, leaves, paper, newspapers etc., paper cups, packaging materials, beverage bottles and cans etc.;

- sticking dirt like stains from food and beverages, water-bound road dirt, chewing gum, stickers, soiling from dirty shoes, rubber abrasion from items, finger prints, traces of wiping on the floor and other surfaces, deposited mineral dirt, e. g. chalk, graffiti, e. g. tags (if they cannot be removed by off-the-shelf cleaning agents);
- disgusting dirt, e. g. saliva, vomit and urine.

The driver's workplace and the passenger compartment as well as the fittings shall be optically clean.

3.13.1.2 Cleaning Class A – daily cleaning (removal of coarse and fine dirt)

Cleaning class A includes the following cleaning activities:

- cleaning, e. g. sweeping or preferably vacuum cleaning, of the interior of the vehicle, inclusive of the driver's workplace, wheel cases, landings, horizontal areas with or without floor covering, accessible heat boxes as well as the boarding and alighting areas. It is important to remove road grit in the winter, also from all edges and floor depressions;
- cleaning of the driver's workplace, inclusive of the instrument panel with the button group on the left side, the steering wheel, the doors and protective panes as well as the driver's shelf;
- cleaning of the stanchions (without making the seats dirty), the partition walls of the ticket vending machine, the ticket validators, the seat supports and the interior mirrors (thoroughly, no finger prints);
- cleaning of the steering wheel, inclusive of any sticking dirt. The customer and the contractor shall agree on the cleaning method and the cleaning agents before the cleaning activities;
- removal of waste from e. g. trays and racks, gaps (also under luggage racks) and rear (foldable) seats. Reusable materials like paper waste or beverage cans shall be collected separately and placed in suitable containers to meet the statutes for commercial waste. The other waste shall be collected in rubbish containers;
- cleaning of the outside mirror;
- removal of stickers and chewing gum, also from the upholstery of seats, backs of furnishings and lean supports.

It shall be avoided to soil parking halls and depot areas. If necessary, the contractor shall remove the waste immediately free of charge. After the cleaning all doors and windows shall be closed.

3.13.1.3 Cleaning Class B – thorough cleaning/cleaning of the interior (removal of coarse and fine dirt as well as sticking dirt)

Cleaning class B includes the following cleaning activities:

- thorough cleaning of the ceiling, roof hatches (roof duct), the floor, landings, horizontal areas with or without floor covering, heat boxes, the folding ramp in the retracted and extracted position, respectively, walls, the windscreen, rear windows and side windows, inclusive of window frames and rubber profiles, partition walls/partition panes, stanchions and handholds, the driver's workplace, inclusive of the instrument panel and the steering wheel, seat frames and seat shells of upholstered seats, transparent boards for advertisements, the door at the driver's workplace, lamps as well as other fittings like interior mirror and sun shade;
- removal of chewing gum and stickers;

- cleaning of the bellows in articulated buses.

The cleaning agents shall always be compatible with the materials applied in the interior of the bus. The vehicle manufacturer shall always approve of the cleaning agents. Moreover, the requirements for environmental protection and the customer's instructions shall always be observed.

To protect the floor, the interior fittings and – above all – the electrical and electronic equipment, it shall be avoided to make them more wet than absolutely necessary. It is not allowed to rinse the interior with a hose.

3.13.1.4 Cleaning Class C – cleaning of upholstery (removal of coarse and fine dirt as well as sticking dirt)

Cleaning class C includes the following cleaning activities:

- thorough cleaning of upholstered seats, armrests, lean supports and the driver's seat by way of suitable devices and cleaning agents;
- removal of chewing gum etc.

The period for drying of wet-cleaned upholstered seats shall not exceed three hours (throughout the year). Consequently, the cleaning shall be made so timely that the buses can take up their line service with dry seats.

3.13.1.5 Cleaning Class D – cleaning of the windscreen on the inside (removal of sticking dirt)

Cleaning class D includes the following cleaning activities:

- cleaning and drying of the windscreen on the inside with appropriate cleaning agents (fat-dissolving and antistatic glass cleaner).

3.13.1.6 Cleaning Class E – cleaning of windows on the inside (removal of sticking dirt)

Cleaning class E includes the following cleaning activities:

- cleaning and drying of rear windows, side windows, glass partitions and the protective pane at the driver's workplace, inclusive of the frames and the rubber profiles.

3.13.1.7 Cleaning Class F – cleaning of the floor (removal of coarse and fine dirt as well as sticking dirt) as well as cleaning of glass partitions

Cleaning class F includes the following cleaning activities:

- sweeping of the floor and all horizontal areas with floor covering followed by thorough cleaning by means of suitable cleaning agents;
- cleaning of glass partitions, the protective pane at the driver's workplace and the vertical plastic partition behind the driver's workplace.

The cleaning agents shall always be compatible with the materials applied in the interior of the bus. The vehicle manufacturer shall always approve of the cleaning agents. Moreover, the requirements for environmental protection and the customer's instructions shall always be observed.

3.13.2 Supplementary Information about the Cleaning Classes D, E and F

3.13.2.1 Cleaning of Glass Surfaces

Glass surfaces shall be cleaned with water and a suitable cleaning agent. The cleaning solution shall be changed frequently. Depending on the kind of dirt, the cleaning is made with a cleaning agent suited for the surface in question, e. g. an all-purpose cleaning agent, an alcohol-based cleaning agent or a special cleaning agent.

Depending on the nature of the surface to be cleaned, the panes are either dried with a wiper or a leather cloth. Special attention shall be paid to edges and borders. After the cleaning the glass surfaces shall be dry, clear, free from dirt and film as well as superfluous humidity. Dirty water shall be removed from the rubber borders of the panes.

Minor impurities like flyspeck shall be removed by the cleaning of the windows free of charge.

3.13.2.2 Cleaning of Frames and Rubber Borders of Panes

The cleaning of the frames includes cleaning of the inside frames and rubber borders of the panes with water and a suitable cleaning agent. The cleaning solution shall be changed frequently. Depending on the kind of dirt, the cleaning is made with a cleaning agent suited for the surface in question, e. g. an all-purpose cleaning agent, an alcohol-based cleaning agent or a special cleaning agent. After the cleaning loose dirt is rinsed off. Thereafter, the frames and rubber borders are dried again. They shall be free from film. Dirty water shall be removed from the rubber borders of the panes.

3.13.2.3 Payment on the basis of the Number of Hours Worked

If a service provider is entrusted with the cleaning, the customer and the contractor should agree on the price for a man hour before the cleaning activities are performed. The price for a man hour can vary depending on the conditions, e. g. work on Sundays and public holidays, night work, work within the route network. Moreover, they can agree on further cleaning activities at short notice, if need be.

3.13.3 Intervals between Cleaning for Buses

Cleaning class	Cleaning scope	Cleaning intervals
A	daily cleaning	daily
B	thorough cleaning/cleaning of the interior	6 - 12 times a year
C	cleaning of upholstery	3 - 6 times a year
D	cleaning of windscreen on the inside	as necessary
E	cleaning of windows on the inside	as necessary
F	cleaning of floor and glass partitions	once a week

3.13.4 Cleaning Classes and Intervals between Cleaning for Urban Rail Vehicles

3.13.4.1 Description of the Cleaning Classes

The work to be performed is laid down in binding working standards, i. e. the services shall always be performed constantly and result-oriented.

3.13.4.2 Definition of the Term “Result-oriented Cleaning”

There is no place for the following kinds of dirt in the interior of a vehicle, i. e. on the floor, on walls, on the ceiling, on trays and racks, on landings, on seats, on/in waste bins, on stanchions and on door leaves:

- coarse and fine dirt like dust, pollen, hair, cobwebs, sand, chips, leaves, paper, newspapers etc., paper cups, packaging materials, beverage bottles and cans etc.;
- sticking dirt like stains from food and beverages, water-bound road dirt, chewing gum, stickers, soiling from dirty shoes, rubber abrasion from items, finger prints, traces of wiping on the floor and other surfaces, deposited mineral dirt, e. g. chalk, graffiti, e. g. tags (if they cannot be removed by off-the-shelf cleaning agents);
- disgusting dirt, e. g. saliva, vomit and urine.

In case of disgusting or strongly smelling dirt, the odour shall always be neutralised with a suitable cleaning agent and disinfected afterwards. The driver’s workplace and the passenger compartment as well as the fittings shall be optically clean.

3.13.4.3 Cleaning Activities by Regular Cleaning

The following cleaning classes, cleaning activities and cleaning results apply to urban rail vehicles.

3.13.4.3.1 Cleaning Class D-1 – daily cleaning

Cleaning class D-1 includes the following cleaning activities:

- driver’s workplace:
 - general cleaning:
 - sweeping of the floor, inclusive of all recesses and steps, also under the footrest, and wiping of these areas with a moist cloth with a cleaning agent or a care product;
 - removal of waste on the floor, other horizontal surfaces as well as recesses and edges;
 - removal of waste as well as impurities, if any, from cup holders;
 - removal of coarse impurities from all surfaces;
 - removal of chewing gum etc.;
 - cleaning of glass areas:
 - not necessary;
- passenger compartment:
 - general cleaning:
 - sweeping of the floor, inclusive of all recesses, edges, borders, boarding and alighting areas, and wiping of these areas with a moist cloth with a cleaning agent or a care product;
 - removal of sticking remains, if any, and all liquids on the floor;
 - removal of waste on the floor, other horizontal surfaces as well as recesses, edges, gaps, spaces behind seats etc.;
 - removal of impurities between side wall covers and seats;

- removal of dust/sand particles from the upper sides of sand boxes, inclusive of recesses at the opening, with a brush;
- emptying of the waste bins;
- removal of coarse impurities from the outside of dust bins, information boxes, all surfaces, seats, backs of furnishings and lean supports, bellows, boards/boxes for advertisements;
- removal of vomit etc.;
- removal of chewing gum etc.;
- cleaning of glass areas:
 - removal of coarse impurities on the interior side of the windows, the passenger doors and the door to the driver's workplace;
 - removal of coarse impurities on both sides of the panes at the boarding and alighting areas.

3.13.4.3.2 Cleaning Class D-8 (interval between cleaning activities: 8 days)

Cleaning class D-8 includes the following cleaning activities:

- driver's workplace:
 - general cleaning:
 - cleaning according to cleaning class D-1 as well as the following cleaning activities:
 - wiping of the complete footrest with a moist cloth;
 - wiping of all side walls to the lower edges of the windows with a moist cloth;
 - wiping of all horizontal surfaces, inclusive of recesses and edges, with a moist cloth;
 - wiping of the complete instrument panel, inclusive of the actuators, with a suitable moist cloth only used for this purpose. The displays shall always be cleaned without a cleaning agent;
 - wiping of the arm rests, head restraint and frame, exclusive of the upholstery, with a moist cloth;
 - cleaning of the upholstered seat with a powerful battery-operated vacuum cleaner;
 - removal of stickers, apart from the ones fitted by the public transport company itself, and graffiti on all surfaces;
 - wiping of the air ducts in the ceiling and the lamps with a moist cloth;
 - cleaning of glass areas:
 - cleaning and filmless drying of the windscreen and side windows with a fat-dissolving and antistatic glass cleaner;
 - cleaning and filmless drying of the interior mirror with a glass cleaner;
 - cleaning and filmless drying of the panes in the door at the driver's workplace, inclusive of the frame and the door knobs, on both sides with a fat-dissolving and antistatic glass cleaner;
- passenger compartment:
 - general cleaning:

- cleaning according to cleaning class D-1 as well as the following cleaning activities:
- wiping of the waste bins, inclusive of the covers, inside and outside with a moist cloth;
- wiping of the landings under the seats horizontally and vertically with a moist cloth;
- wiping of the landings under the ticket vending machines horizontally and vertically with a moist cloth;
- wiping of the sand boxes and other landings between the seats with a moist cloth;
- wiping of all vertical and horizontal stanchions at the ceiling, the side walls and the doors as well as all door pushbuttons with a moist cloth;
- wiping of the handholds at the seats with a moist cloth;
- wiping of the heater covers and the lower ventilation slots with a moist cloth;
- wiping of the seat frames and seat supports with a moist cloth;
- wiping of wooden seats (front and rear sides) with a moist cloth;
- wiping of the rear sides of all (wooden or upholstered) seats with a moist cloth;
- removal of impurities from cavities between sand boxes and seats as well as from cavities between the seats; if relevant by vacuum cleaning;
- wiping of areas hidden behind longitudinal seats horizontally and vertically with a moist cloth;
- wiping of the lateral and/or intermediate metallic frames of upholstered seats with a moist cloth;
- wiping of the undersides of foldable seats, inclusive of hinges and frame parts, with a moist cloth;
- wiping of the gap between wooden double seats (seats and lean supports) with a moist cloth;
- vacuum cleaning of the gaps between side wall covers and seats;
- wiping of the rear wall of the driver's workplace in the passenger compartment with a moist cloth;
- wiping of the side walls to the upper edges of the side windows with a moist cloth;
- wiping of the door and device boxes with a moist cloth;
- wiping of the reversing controller with a moist cloth;
- wiping of the ticket vending machine with a moist cloth. The displays shall always be cleaned without a cleaning agent;
- wiping of the ticket validators with a moist cloth;
- wiping of the boxes for information papers with a moist cloth;
- removal of stickers, apart from the ones fitted by the public transport company itself, and graffiti on all surfaces up to a total area of 0.5 m²;
- cleaning of glass areas:
 - cleaning according to cleaning class D-1 as well as the following cleaning activities:
 - cleaning and filmless drying of the interior sides of the passenger compartment doors, inclusive of metallic/frame surfaces, with a fat-dissolving and antistatic glass cleaner;

- cleaning and filmless drying of the interior sides of the windows with a fat-dissolving and antistatic glass cleaner;
- cleaning and filmless drying of both sides of the panes at the boarding and alighting areas with a fat-dissolving and antistatic glass cleaner.

3.13.4.3.3 Cleaning Class M-6 (interval between cleaning activities: 6 months)

Cleaning class M-6 includes the following cleaning activities:

- driver's workplace:
 - general cleaning:
 - cleaning according to cleaning classes D-1 and D-8 as well as the following cleaning activities:
 - intensive wiping of the floor, inclusive of all recesses, edges and borders, with a wet cloth with an alkaline cleaning agent (pH 10) twice and then wiping of these areas with a care product. The non-slip properties shall always be kept;
 - wiping of the side walls from the lower edge of the windows with a moist cloth;
 - vacuum cleaning of the driver's seat and then tenside-free spray extraction; maximum drying period of 2 h;
 - vacuum cleaning of the ventilation slots and then wiping of the ceiling, inclusive of ventilation slots with a moist cloth;
 - cleaning of glass areas:
 - only cleaning according to D-1 and D-8;
- passenger compartment:
 - general cleaning:
 - cleaning according to cleaning classes D-1 and D-8 as well as the following cleaning activities:
 - intensive wiping of the floor, inclusive of all recesses, edges and borders, with a wet cloth with an alkaline cleaning agent (pH 10) twice and then wiping of these areas with a care product. The non-slip properties shall always be kept;
 - vacuum cleaning of the upholstered seats and then tenside-free spray extraction; maximum drying period of 2 h;
 - wiping of the gaps between side wall covers and seats with a moist cloth;
 - intensive wiping of all side walls, inclusive of e. g. flanges, frame parts and bellows covers, with a wet cloth with an (alkaline) deep cleaning agent suited for the materials;
 - wiping of the emergency hammers, emergency brake handles and emergency door interlock bypasses with a moist cloth;
 - wiping of the line display boxes at the side walls with a moist cloth;
 - wiping of the infotain displays, if any, with a moist cloth without a cleaning agent/care product;
 - wiping of the ceiling, inclusive of edges, frame parts and camera, with a moist cloth;
 - wiping of the roof hatches with a moist cloth;

- wiping of the bellows and/or bellows covers with a moist cloth;
- wiping of the closed-designed lighting covers with a moist cloth;
- dusting/vacuum cleaning of the screen-designed lighting laminations in the mounted state;
- vacuum cleaning of the ventilation slots and then wiping of the ventilation slots beside the ceiling lamps with a moist cloth;
- cleaning of the boards/boxes for advertisements, inclusive of the frames;
- cleaning of glass areas:
 - cleaning and filmless drying of the top-hung windows in the open state on both sides with a fat-dissolving and antistatic glass cleaner;
 - wiping of the handles and rubber frames of the top-hung windows in the open state with a moist cloth.

3.13.4.3.4 Cleaning Class D-1N (mobile daily cleaning at night)

Cleaning class D-1N includes the following cleaning activities:

- driver's workplace:
 - general cleaning:
 - not necessary;
 - cleaning of glass areas:
 - not necessary;
- passenger compartment:
 - general cleaning:
 - collection of waste on the floor, on landings, on seats and in recesses;
 - wiping of the ticket validators with a moist cloth;
 - removal of coarse impurities like vomit and wiping of spilt beverages;
 - cleaning of glass areas:
 - not necessary.
- general:
 - collection of the waste in rubbish bags and taking it along for correct disposal.

3.13.4.3.5 Cleaning class D-1M (daily cleaning in the morning after the rush hours)

Cleaning class D-1M includes the following cleaning activities:

- driver's workplace:
 - general cleaning:
 - not necessary;
 - cleaning of glass areas:
 - not necessary;

- passenger compartment:
 - general cleaning:
 - collection of waste on the floor, on landings, on seats and in recesses;
 - wiping of the ticket validators with a moist cloth;
 - removal of coarse impurities like vomit and wiping of spilt beverages;
 - removal of coarse impurities on the floor, side walls, landings and seats;
 - removal of coarse impurities on stanchions, panes and doors in the passenger compartment;
 - cleaning of glass areas:
 - not necessary.

3.13.4.3.6 Cleaning Class A – services performed according to additional cleaning orders

The cleaning to be made pursuant to cleaning class A is explicitly requested by the customer.

Cleaning class A includes the following subclasses:

- cleaning class A-BV (order for brush vacuum cleaning of upholstered seats):
The cleaning includes mechanical brushing of the upholstered surfaces and dry vacuum cleaning of loose impurities on the surface and of impurities sticking mechanically onto the surface by way of a brush vacuum cleaner. Distinction is made between:
 - brush vacuum cleaning of all seats (seat and armrests) in the urban rail vehicle;
 - brush vacuum cleaning of a single seat (seat and armrests) in the urban rail vehicle.
- cleaning class A-DS (order for dry shampooing of upholstered seats):
The cleaning includes shampooing of the upholstered seats with a relatively dry shampooing preparation that allows fast availability of the vehicle. Distinction is made between:
 - dry shampooing of all seats in the urban rail vehicle;
 - dry shampooing of a single in the urban rail vehicle.
- cleaning class A-SE (order for spray extraction of upholstered seats):
The cleaning includes spraying of the cleaning solution under pressure and simultaneous vacuum cleaning of the upholstered seats. After the cleaning the upholstery may only be a little wet. The period for drying shall amount to maximum two hours (throughout the year). Distinction is made between:
 - spray extraction of all seats in the urban rail vehicle;
 - spray extraction of a single seat in the urban rail vehicle.
- cleaning class A-WS (order for wet shampooing of upholstered seats):
The cleaning includes shampooing of the upholstered seats with a wet foam for thorough cleaning followed by spray extraction with clear water. After the cleaning the upholstery may only be a little wet. The period for drying shall amount to maximum two hours (throughout the year). Consequently, the cleaning shall be made so timely that the urban rail vehicle can take of its line service with dry seats. Distinction is made between:
 - wet shampooing of all seats in the urban rail vehicle;
 - wet shampooing of a single seat in the urban rail vehicle.

- cleaning class AZ-FC (order for thorough cleaning of the floor covering):
The cleaning includes thorough cleaning and care of the floor, inclusive of all edges, at the driver's workplace and in the passenger compartment, inclusive of the boarding and alighting areas. The care product shall not impair the non-slip properties of the floor covering. The customer can specify standards for the slip resistance. Distinction is made between:
 - cleaning of the floor, exclusive of landings;
 - cleaning of the floor, inclusive of landings, i. e. inclusive of all vertical and horizontal surfaces of all landings (with/without seats).
- cleaning class A-BE-I (order for thorough cleaning of all bellows inside the vehicle):
The cleaning includes thorough cleaning of the bellows inside the vehicle, i. e. all surfaces of the bellows in the passenger compartment shall be thoroughly cleaned with a deep cleaning agent that is suited for the bellows materials to remove deep dirt. Distinction is made between:
 - cleaning of the bellows once, inclusive of application of a care product;
 - cleaning of the bellows twice, inclusive of application of a care product;
 - cleaning of all bellows in the complete vehicle.

4 Disinfection according to the Recommendations of the RKI and the VDV

According to the publication of the RKI entitled “Reinigung und Desinfektion von Oberflächen außerhalb von Gesundheitseinrichtungen im Zusammenhang mit der COVID-19-Pandemie” (eng: Cleaning and Disinfection of Surfaces Outside Health Care Facilities in connection with the COVID-19 Pandemic) it has not been proved that SARS-CoV-2 can be transferred via surfaces in public areas. However, contamination of surfaces in the immediate vicinity of infected persons cannot be generally excluded. Viruses can be found on surfaces, but the risk of getting infected depends on the number of viruses and their virulence. The environmental stability (tenacity) is important in this connection. It depends on various factors like temperature, humidity, nature of the surfaces and concentration of viruses at a certain spot. Viruses are not very stable on dry surfaces. As aerosols viruses of the type SARS-CoV-2 stay in the air up to three hours, on copper up to four hours, on paper and cardboard up to 24 hours and on stainless steel and plastics up to three days.

The RKI still stresses that consequent hand hygiene is the most effective measure against the transmission of germs on/through surfaces. Therefore, focus is on the cleaning of surfaces in areas outside health care facilities and in public areas. According to the RKI this measure also applies to surfaces with antimicrobial properties because secretion and dirt have to be removed mechanically.

The RKI does not recommend to disinfect public areas, not even areas touched frequently and not even in the present COVID-19 pandemic. Suitable cleaning is the better alternative.

If it is considered to be necessary to disinfect a public area in an exceptional case, the disinfection method should usually be wipe disinfection. According to the RKI disinfectants with proved effectiveness against enveloped viruses (“antiviral to a limited degree”) should be used. Disinfectants with a broader effective range against viruses (“antiviral PLUS to a limited degree” or “antiviral”) can also be used. Suitable disinfectants are listed in the RKI list and the VAH list. It shall be borne in mind that it is only allowed to use alcohol-based disinfectants on small surfaces for fire protection reasons.

According to the RKI spray disinfection, i. e. moistening of surfaces without mechanical action, is less effective and also problematic from the point of view of occupational health because disinfectants can be breathed in.

Moreover, the RKI says that it is not necessary to treat rooms with gas for disinfection purposes.

Other disinfection methods are being presented in the media and the impression is given that further disinfection methods shall be used according to the principle of “more is better”. Besides the treatment of rooms with gas the following methods are being presented as disinfection methods:

- antibacterial/antiviral surface treatment;
- UV irradiation;
- ozone treatment;
- ionization of room air.

As it has already been mentioned, it has not been proved that SARS-CoV-2 can be transmitted via surfaces within public transport. Although contamination of surfaces in the immediate vicinity of infected persons cannot be generally excluded, the VDV Subcommittee on Occupational and Traffic Medicine still recommends the present method of cleaning with a soap sud and, if necessary, wipe disinfection of electronic components, i. e. buttons and actuators. Moreover, it is important to ventilate the vehicles by opening the doors and – if the vehicle is equipped with an HVAC system – to ensure that as much fresh air as possible is taken in.

5 Disinfection of the Interior of Public Transport Vehicles

5.1 General

Routine disinfection of surfaces in public areas, inclusive of surfaces frequently touched, e. g. stop request buttons and door opening buttons, is not recommended by the RKI in the present COVID-19 pandemic. Suitable cleaning is the better alternative. It should be decided from case to case on the basis of the actual contamination of the surface whether it is at all necessary to disinfect it. Focus should be on contamination by respiratory secretion and contamination of surfaces which a disinfected person has often touched with his/her hands.

5.2 Disinfection by way of Liquid Disinfectants

There are two methods of disinfecting with liquid disinfectants, i. e. spray disinfection and wipe disinfection.

5.2.1 Advantage of Spray Disinfection

The advantage of spray disinfection is the easy handling of the disinfectant.

5.2.2 Disadvantages of Spray Disinfection

The advantage of spray disinfection shall be considered in view of the severe disadvantages of this disinfection method. Thus, the user might breathe in the disinfectant during the spraying or it might deposit on his/her skin, in his/her respiratory tract or in his/her alimentary canal. Of course, it is undesirable that disinfectants, which are to kill or at least harm e. g. bacteria, viruses and fungi, might also impair the user's health. Thus, e. g. the respiratory tract might be irritated or even cauterised and an allergic reaction might be provoked. In extremely seldom cases the intensive contact with a disinfectant with chlorofen can cause cancer or harm the genetic make-up. Moreover, a spray-disinfected surface might be insufficiently disinfected if the user does not wipe and distribute the disinfectant with a cloth after the spraying. If the disinfectant is not wiped and distributed evenly on the entire surface after the spraying, the surface is often not completely moistened. However, it has to be completely moistened to kill (nearly) all microorganisms on a surface. If an alcohol-based disinfectant is generously sprayed on e. g. big surfaces, there is also a fire and explosion risk.

If the interior of public transport vehicles is spray-disinfected, it is important that the air is exchanged frequently during the spraying, particularly if this spray disinfection takes place in a parking hall. It is meaningful to open the gates and – if any – the dormers.

5.2.3 Wipe Disinfection versus Spray Disinfection

Due to the above-mentioned disadvantages of spray disinfection the interior of public transport vehicles should be wipe-disinfected. The wipe disinfection method minimises the health hazards and ensures (nearly) complete moistening and disinfection of the surfaces. Only if hardly accessible surfaces have to be disinfected, should spray disinfection be applied. Thus, spray disinfection is only a supplementary disinfection method at the most.

As soon as a spray disinfectant is used, care should be taken that it is sprayed as close as possible to the surface to be disinfected. Thus, it shall not be sprayed into the air, but only onto the surface to be disinfected. Moreover, it shall be sprayed in such a way that the surface is fully moistened and the user's respiratory tract strained as little as at all possible. If a spray disinfectant is to be used, the disinfectant should be an alcohol-based disinfectant with as few additives as at all possible.

If it is considered to be imperative, cloths packaged individually and ready for use can be distributed to the staff of the public transport company to wipe-disinfect e. g. the driver's workplace or the work environment. It is meaningful also to distribute lockable bin liners to the drivers for the disposal of the cloths after use. Suitable measures for the disposal of used cloths shall always be taken.

5.3 Disinfection of Surfaces by way of Artificial UV-C Radiation

Artificially generated UV-C radiation can be used to disinfect surfaces (just as water and air). This technology is mainly used in works and laboratories. It can also be used to disinfect moving handrails of escalators. The luminous intensity has to be relatively strong to ensure efficient disinfection. As UV-C radiation is harmful to persons, such an application has to be encapsulated or performed without persons on the spot. Furthermore, it can be necessary to close all windows in the vehicle in a light-proof way to avoid scattered radiation. UV-C radiation has not been used in the interior of public transport vehicles yet, but the method is being developed. The UV-C robots planned for hospitals cannot be used in public transport vehicles at the present stage of development.

Finally, it has to be considered that UV-C radiation damages plastics and rubber.

5.4 Disinfection of Room Air by way of Ionizers

This disinfection method envelopes viruses in the air by way of anions emitted by ionizers to render the viruses harmless. The efficiency of this method has already been proved by flu viruses, noroviruses, rotaviruses and the very similar SARS virus. Ionizers are devices that generate positive and negative ions and emit them to the air. Especially the negative ions (anions) improve the air quality of the room air. When it has been proved that ionisation is effective against SARS-CoV-2, it should be possible to disinfect the air in offices and theoretically also in public transport vehicles like buses and urban rail vehicles by way of ionizers. However, it seems that they do not have been used in public transport vehicles because the room air in these vehicles can be exchanged more easily and more practically via forced ventilation or open doors.

5.5 Disinfection with Gaseous Disinfectants

5.5.1 Ozone Treatment of the Interior of Public Transport Vehicles

The cleaning effect of ozone is sufficiently well-known from the car sector. This disinfection method kills germs in the air and on surfaces much more effectively than chlorine. However, ozone has the disadvantage that it is harmful to persons if it is used in a wrong way. Ozone devices may only be handled by instructed skilled persons. Another disadvantage is that it is not allowed to enter rooms treated with ozone for at least one day after the treatment.

5.5.2 High-temperature Steam Cleaning

It has long been known that high-temperature steam cleaning kills bacteria, viruses and other germs. The main advantage of this disinfection method is that it does without chemicals. However, high-temperature steam cleaning is not suited for all kinds of surfaces because its steam is at least 105 °C hot.

6 Coating

6.1 General

The measures listed below are hygiene measures in addition to the passengers' obligation to observe the hygiene rules. It is a fact that viruses on the skin are not the cause of an infectious disease; viruses can only penetrate into the human body via the mucous membranes.

Generally, it applies to antimicrobial surfaces that they are only a supplement to the surface hygiene and do not replace the hygiene measures, i. e. cleaning and disinfection. Coatings are probably without effect if there are layers of coarse dirt on the surface and they do not replace cleaning. On the contrary, to remain effective, coated surfaces have to be carefully wiped.

In principle, antimicrobial materials are classified after their basic mode of action, i. e. they can be "active", which means that they release an agent and are contact-active, or they can be "passive". The surface design, i. e. the chemical or structural modification of the surface, is of high importance. The structure/topography can e. g. have positive influence on the hygienic state of the surface, for example by reducing the microbial adhesion. Special attention has to be paid to the wear properties of the surfaces because they influence the soil resistance and the cleanability considerably.

Passive coatings are based on the principle of reducing the contact force between microorganisms and the coating by optimising the surface structure/function (anti-adhesion). This kind of coating makes it easier to remove bacteria from the surface, even before a biofilm can develop. Moreover, various technologies can be purposively combined. Thus, it is e. g. possible to embed materials releasing agents into an anti-adhesive surface or to purposively reduce the surface energy and increase the polarity of a surface, which can reduce the wettability and thus the adhesion of bacteria considerably.

Active materials are substances that can release an agent at surfaces. The best-known technology uses metal-based (nano-)particles, which are applied to the surface or integrated into the surface by way of a suitable coating process. Released metal ions are the agent in this case. The advantage of contact-active substances or coatings is that they only have an antimicrobial effect after contact with the organism or virus and thus do not constantly release the agent at the surface. However, it is a disadvantage of this technology that organic antimicrobial molecules lose activity as soon as they are bound to a surface.

According to the RKI the use of antimicrobial surfaces implies the risk of a decreasing effect due to:

- wear of the antimicrobial coating or dirt;
- cross-reaction with chemical substances;
- stimulation of the development of resistance;
- unsolved ecological/human toxicity;
- imparting of false safety;
- neglect of the evidence-based standard hygiene.

When antimicrobial agents and surfaces are to be used, Regulation (EU) No. 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products shall be observed to ensure that biocidal products are good for harmful organisms and that they can be safely handled, especially in respect of their effect on health and environment.

It is very important to examine the effectiveness of such surface coatings. Therefore, the product descriptions and the expert opinions shall be scrutinised, especially with a view to the effectiveness of the products against viruses.

Antibacterial/antiviral surface coatings are especially used in areas with high bacterial loads, e. g. emergency wards and operating areas in hospitals. Surface coatings are available with different agents. The following list of coatings and their agents is not exhaustive:

a) copper alloy (invisible special surface on a copper basis for metallic surfaces)

The antibacterial effect is based on the property of copper and copper-alloy surfaces to hold back or disable bacteria/viruses. The use of copper alloys is an additional measure and do not replace the cleaning and disinfection of contact surfaces.

b) silver nanoparticle coating

The functionality of this coating is based on the release of silver ions, which then penetrate into the bacteria and kill them. The coating cannot replace the existing hygiene and cleaning measures, but can supplement them to reduce the number of germs and infectious materials, especially at critical surfaces, right from the beginning.

c) surface coating with Dyphox (photocatalysis)

Dyphox photocatalysts continuously transmit the energy of the incident light to the oxygen molecules in the immediate vicinity and move them up an excited state. The oxygen activated by Dyphox, which is also called Singlet oxygen, reacts with the grease (lipid) coating of microorganisms and kills them in this way. Singlet oxygen is a strong oxidant and adds to many organic bonding systems (cyclo-addition or ene reaction).

d) coating with titanium dioxide

The coating with titanium dioxide is an odourless and colourless suspension consisting of titanium dioxide (TiO₂) (2 %) and water (98 %). The hydrophilic property of the coating prevents that germs are passed on from the surface to the room air. The cationic character of TiO₂ leads to structural modification of the outer membrane, which in turn kills the germs. According to the manufacturers' information the coating is effective against *saccharomyces albicans*, fungi, bacteria and noroviruses. The disadvantage of this coating is that treated surfaces look "dirty".

e) antimicrobial polymer coating

When microorganisms are in contact with a special polymer-coated surface, they are killed by a physical effect. The polymer penetrates into the cell membrane and harms it so that the microorganism is killed. According to the manufacturers' information it is not a chemical reaction, not an ionic interaction, not a biocidal product and not nanotechnology. The polymer coating is said to be effective against viruses and bacteria.

f) antimicrobial powder coating

According to the manufacturers' information the antimicrobial powder coating protects from bacteria, viruses, fungi and algae. This kind of coating is mainly used in medical and laboratory areas. The addition of an additive with an antimicrobial effect to the powder coating increases the permanent formation of highly active ions, which kill the cell structure of primitive organisms.

6.2 Coating of Plastic Parts

Plastic parts can be provided with antibacterial and antiviral coatings, which are effective in different ways (see 6.1). If such coatings are applied, it always has to be considered that plastic parts like roof hatches and seat backs often have an anti-graffiti coating, which makes it impossible or difficult to apply an antibacterial and antiviral coating.

6.3 Coating of Fabrics

Meanwhile, textile manufacturers offer coatings and hygiene equipment for textiles like seat covers and curtains as special equipment. This coating prevents mould and unpleasant odours caused by bacteria and slows down the growth of microorganisms. It is effective on the cell membrane of bacteria and either dissolves the cell membrane or decomposes the cell. There is no information about the effectiveness of this kind of coating.

There are also dirt-repellent coatings on the market. These coatings make the seat covers resistant to dirt, humidity, colour smears and liquids as well as dents. Dirt can be removed faster, which reduces the cleaning effort and the absorption of moisture.

A dirt-repellent coating can be used together with the hygiene equipment. The effectiveness of the coating might be gradually reduced due to frequent cleaning and the use of graffiti removers.

It always has to be borne in mind that the products shall meet the relevant fire protection standards, e. g. UN-ECE-R 118/FMVSS 302.

6.4 Coating of Stanchions

By analogy to the coating of plastic parts, stanchions can also be provided with a coating. However, it has to be considered that a cream layer is formed on a stanchion if a person with hand cream on his/her hands grasps the stanchion, which puts a stop to the effectiveness of the antibacterial/antiviral coating. Moreover, respiratory secretion has to be removed by the cleaning.

7 Heating, Ventilation and Air Conditioning

7.1 General

Constant air exchange in the interior of a public transport vehicle is of particular importance. Good and fresh air in the public transport vehicles is an important quality feature.

If the vehicles have not been equipped with HVAC systems, it shall be possible to exchange the air via roof hatches, rear fans and top-hung windows. Depending on the design, e. g. a line-service bus with a powerful HVAC system can exchange its air completely in one minute in the full-load mode. This result can also be achieved with a 100 % fresh air share. The HVAC system can also dehumidify the air in the cooling mode. Viruses bound in droplets and aerosols can be bound in filters and deposited to heat exchangers. Usually, air-conditioned air is let into a bus by the HVAC system via the ceiling of the vehicle or at the side windows top down, and the outgoing air is extracted via the ceiling over the aisle of the bus. HVAC systems in public transport vehicles are mostly equipped with class G3 air filters. It is not possible to use HEPA filters because they are a too big flow resistance and might lead to malfunction of the HVAC system. HEPA filters of class H-14 pursuant to EN 1822-2 are suited for reliable removal of SARS-CoV-2 from the air. The staff exchanging the filters shall wear suitable PPE.

The above description of the mode of operation relates to HVAC systems fitted by the vehicle manufacturer. Electric modular HVAC systems, which are offered for the retrofit of buses and partially also fitted by vehicle manufacturers, are not comparable with regular HVAC systems and do not reach their performance. Modular HVAC systems mainly use circulating air and have a very low share of fresh air.

It is neither technically nor economically meaningful to retrofit line-service buses with HVAC systems because it is only possible to fit modular HVAC systems, which do not fulfil the requirement for the fresh air share, and because the costs for a retrofit with a regular HVAC system are far too high.

Another important aspect is that energy-efficient heating and air conditioning of public transport vehicles has always been important to the public transport companies. Energy-efficient heating and air conditioning is even more important in electric buses as the range of the bus is reduced if the heaters and air conditioners consume much energy. Therefore, intelligent HVAC control units, which reduce the share of fresh air, and alternative air-conditioning concepts have been introduced. The aspect of higher energy consumption due to the new requirement for a high fresh air share should be considered when future decisions are to be made.

The media often refer to the high performance of HVAC systems in airplanes. In a modern airplane the room air is exchanged about every five minutes, in an ICE it is exchanged about every 6 – 8 minutes and in a line-service bus with an HVAC system in the full-load mode it is exchanged once per minute. Here the natural exchange of air that takes place when the doors are open for passenger boarding and alighting at the stops is even left out of consideration. Thus, these figures say that the exchange of air in public transport vehicles is much higher than the exchange of air in e. g. airplanes.

7.2 Setting of the HVAC System

The HVAC system is to be operated with a maximum degree of fresh air. However, this mode of operation is only meaningful in times with an increased risk of infection (pandemic or flu) because the energy consumption of an HVAC system is very high in the full-load mode. To be able to operate the HVAC system in the full-load mode, its setting might have to be modified via the software of the control unit. Another reason why an HVAC system should not be permanently operated in the full-load mode is that it is very noisy in this mode of operation.

7.3 Filter Systems with Additional Disinfection

Outdoor air is harmless in the present pandemic. Therefore, it is only meaningful to treat the circulating air share.

Meanwhile, the first filter systems with integrated disinfection via UV-C light are being offered for retrofit. Future HVAC systems will probably be offered with integrated UV-C lamps/LEDs to disinfect the air (aerosols). It remains to be seen whether the use of such systems is meaningful and purposive.

7.4 Air Filters with a Higher Deposition Rate

Most HVAC systems in public transport vehicles are equipped with air filters of class 3 pursuant to EN 779. It is of utmost importance that these filters always are maintained on time in accordance with the manufacturer's instructions. HEPA filters of class H-14 pursuant to EN 1822-2 are suited to reliably remove SARS-CoV-2 from the air.

Filters with an activated carbon layer can be purchased as retrofit, but they can only deposit harmful gases, bacteria, moulds and odours. These filters are only effective against viruses that are bound to aerosols or droplets with a size of more than 0.5 µm.

Meanwhile, high-performance multi-layer particulate air filters with an antiviral functional layer are offered for existing roof-mounted HVAC systems, front boxes at the driver's workplace and recirculation air filters in the passenger compartment. However, the exact classification of these filters is not known yet.

7.5 Air Cleaning Methods

Several manufacturers now offer air cleaning devices for retrofit in existing public transport vehicles. These devices are based on different physical principles. Most air cleaning devices are cylindrical, longitudinal devices, which are to be operated in the roof area or in the underseat area. They do not nearly reach the air flow rate of an HVAC system or the flow rate that is realised by ventilation. They only clean the air that is already in the vehicle.

Another disadvantage of these air cleaning devices is that they increase the need for electrical energy considerably due to their physical mode of operation.

Harmful side effects also have to be considered when it is intended to purchase such devices. As regards air cleaning devices with UV-C light there is the risk of emission of UV-C light. As regards

other kinds of air cleaning devices functioning with e. g. ozone generators, ionisers or photocatalytic oxidation there is the risk of increase in ozone and other harmful substances.

Moreover, the costs for the maintenance of the air cleaning devices have to be taken into consideration. Often the costs for e. g. filters are very high.

It is also imperative to ensure that the effectiveness of the air cleaning devices for inactivation of viruses has been sufficiently demonstrated and substantiated. It does not suffice to demonstrate the mode of operation in an expert opinion.

The VDV cannot recommend the retrofit or fitting of such air cleaning devices before studies and field tests that prove their practicability and effectiveness have been published.

The below-described modes of operation and the said effectiveness of the devices are mainly based on the manufacturers' information. The following list of air cleaning methods is not exhaustive.

7.5.1 Air Cleaning with UV-C Light

Air cleaning devices based on UV-C light lead the air to be cleaned through an enclosure by way of fans. The air is irradiated by UV-C radiators and disinfected in this enclosure. The UV-C irradiation is to deactivate or kill viruses, bacteria and moulds. It is important that the air to be cleaned remains in the air cleaning device until it is sufficiently disinfected and that the enclosure is designed in a light-proof way as a hazardous situation with emitted UV-C light might occur otherwise.

7.5.2 Air Cleaning with Additional Filters

An air cleaning device with an additional filter usually consists of one or several fans, a tubular enclosure and a cylindrical filter. Usually, HEPA filters, e. g. class 14 HEPA filters, are used.

7.5.3 Air Cleaning with Hydroxyl Radicals (OH)

Hydroxyl radicals (OH) form a reactive oxygen connection. The hydroxyl radicals (OH) generated by the air cleaning device envelope viruses and/or bacteria. They are to react with the hydrogen of the cell walls and to destruct viruses and/or bacteria in that way. The reaction product is water (H₂O). These air cleaning devices are to deactivate or reduce the amount of viruses, bacteria, moulds, dust, unpleasant odours and a few chemical connections.

7.5.4 Air Cleaning with Heated Nickel Air Filters

This air cleaning method has been developed in the USA. The air is cleaned by way of a filter with a superfine nickel foam, which has been heated to 200 °C. Thermal insulation is important to avoid heating of the environment.

7.5.5 Combination of Several Methods

7.5.5.1 Air Cleaning with Plasma Air Disinfection and Filters

The air is to be cleaned from viruses, bacteria and germs by a combination of plasma technology, HEPA filters and activated carbon filters. The plasma is generated by adding energy to a gas so that electrons leave the atomic shells. The result is positively loaded ions surrounded by free electrons. In addition, the air is cleaned by way of HEPA filters and activated carbon filters.

7.5.5.2 Air Cleaning with Photochemical Disinfection and Bipolar Ionisation

This kind of air cleaning is a combination of five components, i. e. coarse filtering, photochemical disinfection, catalytic oxidation, a high-performance microfilter and bipolar ionisation. Viruses, bacteria and other germs in the air are to be deactivated and reduced. The viruses are to “clump together” with the ionisation so that the retransmission and thus the infection hazard is reduced considerably.

8 Further Protective Measures

8.1 General

The protective measures described in 8.2. and 8.3 are to protect bus drivers from getting infectious diseases that are transmitted by droplets and aerosols.

Usually, tramcars, LRVs and metro vehicles have closed driver's cabs. Therefore, the protective measures described below do not apply to them. If, however, rail vehicle drivers sell tickets, too, it shall be examined whether further protective measures shall be taken for them.

The protective measures described in 8.4 and 8.5 are to protect the passengers and the drivers. Before they are realised, their benefit shall be keenly questioned and analysed. The passengers should not get the impression that they are necessary and that it is risky to go by bus or train.

8.2 Protective Panes at the Driver's Workplace

The public transport companies are introducing protective panes at the driver's workplace to protect the drivers from getting infectious diseases. The present technical solutions and further general conditions are explained below.

8.2.1 Technical Solutions

Generally, three different technical solutions are possible. Distinction is made between the materials used:

- safety glass;
- acrylic glass;
- PVC foil.

In principle, it is always possible to fit protective panes in buses, but the retrofit depends on the vehicle type and the equipment in the vehicle.

To avoid an adverse dazzling effect of the protective pane, it is recommended to use laminated glass anti-glared on both sides or tempered safety glass. It has to be examined whether it would be meaningful to realise a mobile solution; i. e. a solution that allows dismounting of the protective pane in the summer to improve the climate at the driver's workplace and remounting in the winter and in times with higher infection hazards.

8.2.2 Juridical Status of the Retrofit

Usually, protective panes made of safety glass have been type-approved and can therefore be retrofitted without hesitation. Any novel protective pane made of either safety glass, acrylic glass or PVC foil shall be tested by a test institute, e. g. the TÜV, for each vehicle type of identical design and the result of this test shall be published in a test report. Thus, it has to be demonstrated by an independent engineering test institute that a retrofit fulfils the provisions of StVZO, StVO and BOKraft to keep the type approval.

It is especially important to demonstrate the following:

- there is no hazard pursuant to StVZO, Section 19;
- type-approved materials have been used; it is especially important that the conditions for safety glazing materials are observed, e. g. pursuant to ECE-43, and that the flammability of the materials used are in compliance with the valid regulations, e. g. ECE-R 118;
- the driver's visibility conditions pursuant to StVZO, Sections 35b and 56, have been observed and – depending on the passengers to be transported – the “Anforderungskatalog für Kraftomnibusse und Kleinbusse, die zur Beförderung von Schülern und Kindergartenkindern besonders eingesetzt werden” (eng: Catalogue of Specifications for Omnibuses and Minibuses Operated especially for the Transport of Pupils and Nursery School Children) has been observed.

Upon request by the VDV, the Association of Technical Inspection Associations (VdTÜV) has informed the VDV that it has now published an inspection note concerning the requirements for protective panes, which is entitled “„Anforderungen an Trenneinrichtung, Trennwand/-scheibe od. Tröpfchen-/Spuckschutz in Taxen und Mietwagen und andere Fahrzeuge zur Personenbeförderung“ (eng: Requirements for Partitions, Protective Panes or Droplet/Saliva Protection in Taxis, Hire Cars and Other Vehicles for the Transport of Persons).

If a protective pane has not been type-approved, it is recommended to have the installation of the protective pane/foil registered in the vehicle documents. In this case all retrofitted buses have to be approved individually on the basis of the type report for the vehicle type in question.

8.2.3 Selection Criteria

The public transport companies have discussed possible selection criteria for the various solutions and believe that the following has to be considered:

- costs for the retrofit, e. g. for:
 - the material;
 - the work time;
 - the effects on the fastening of the cash box and/or ticket printer, if any;
 - the test report, if any;
 - individual approval, if any;
- period of use:
 - short: 1 – 2 months (PVC foil);
 - medium-long: up to one year (acrylic glass);
 - long: more than one year (safety glass);
- operational factors:
 - driver's comfort (e. g. dazzling effect, haptics, visual appearance);
 - flexible mounting and dismounting necessary.

The costs for mounting a protective pane made of PVC foil amounts to 100 – 200 euros, for a pane of acrylic glass to 500 – 1,000 euros and for a pane of safety glass to 2,000 – 10,000 euros. A solution made by the public transport company itself can cost less, but it always has to be borne in mind that a type approval is needed for the protective pane.

The present state concerning retrofit with protective panes for drivers is found on VDV's internet page in its password-protected member area (<https://www.vdv.de/fahrerschutzscheiben-in-bussen.aspx>).

8.3 Barriers to the Passenger Compartment of a Bus

If no special protective measure, e. g. driver's cab, protective pane or protective foil, has been taken at the driver's workplace in the bus in periods with a high infection hazard, other measures can be taken to protect the drivers.

In case of a pandemic the first passenger door can be locked if it is in the immediate vicinity of the driver's workplace. Moreover, the aisle to the passenger compartment can be blocked behind the driver's workplace and/or the first seat row behind the driver's workplace can be blocked to protect the driver from getting infected. However, it has to be ensured that the driver can still see what is going on in the passenger compartment and that he/she can still shoulder his/her responsibility, e. g. safeguarding of the primary right. In practice, it has turned out to be advantageous to fit "partition walls" made of transparent foils (with or without additional plastic windows), to fit barriers between stanchions in the form of red-white barrier tapes or to fit plastic chain barriers or lashing straps. When such barriers are being fitted, it shall be ensured that they can be removed fast and easily in an emergency. Moreover, it is important that the barrier has a low fire load. If foils are used, their suitability at night-time and in the event of rain should be tested beforehand in a bus.

8.4 Additional Partition Panes in the Passenger Compartment

Additional partition panes for the passenger compartment of a bus are being offered on the market. According to the manufacturers' information they are to be fitted transversely, i. e. between the seat rows, and longitudinally, i. e. in the direction of travel between seats. It is the intention to create separate rooms for the passengers at the height of their heads. However, partition panes fitted at the seat backs have no effect in case of vis-à-vis seating.

The objective of preventing transmission of germs is achieved with the passengers' obligation to wear face coverings or medical face masks in public transport vehicles. Moreover, the risk of injury by emergency braking and accidents increases if such partition panes are fitted in a public transport vehicle. A protective pane at the driver's workplace is a practicable solution because the drivers do not wear face coverings or medical face masks and stay much longer in the vehicle than the passengers. Moreover, additional partition panes in the passenger compartment hinder the ventilation and the exchange of air.

8.5 Fitting of Disinfectant Dispensers for Passengers

Sensor-controlled disinfection dispensers for public transport vehicles are an example of a product offered on the retrofit market nowadays. Usually, they have the size of ticket validators. The passengers can disinfect their hands in a contactless way if they hold their hands in this dispenser. One filling suffices for spraying the hands of up to 1,000 passengers. It is rather complicated and expensive to operate disinfectant dispensers, but they can increase the passengers' subjective feeling of safety.

9 Designs Enabling Easy Cleaning and Allowing Passengers' "Contactless" Use of Public Transport Vehicles

9.1 General

The present COVID-19 pandemic has increased the importance of the cleaning of the interior of public transport vehicles. Focus is now on designs enabling easy cleaning and allowing passengers' "contactless" use of public transport vehicles. It is the objective to clean the interior of a public transport vehicle as fast and efficiently as possible and to allow passengers' "contactless" use of the vehicles, e. g. via intelligent door control units with sensors on the inside and outside of the vehicle as well as stop request detection via an app on the mobile phone, e-ticketing etc.

9.2 Foldable Rear Seats

Practical experience has shown that it is advantageous to install rear seats on rear benches or engine housings in the line-service bus as this design makes it much easier to remove loose waste between and behind the seats. The folding mechanism shall be so designed that the seats are stable and easy to fold down and up. Integration of the seat shells into plastic mouldings facilitates the cleaning further because there is no space between and behind the seats. However, this solution is not offered by all vehicle manufacturers and is not suited for all applications.

9.3 Vandalism-proof Seat Covers

So-called vandalism-proof seat covers have been on the market for a few years. This kind of seat cover does without foam padding and it is therefore not possible to cut up the seat cover. Another advantage is that it is easier to clean them. In the standard seat upholstery dust and dirt are collected and remain in the foam under the seat cover or the foam begins to crumble when it gets older. Therefore, the passengers often have the impression that they have been poorly cleaned. The only disadvantage of the vandalism-proof seats is that they do not have upholstery and are hard. As, however, most passengers only stay for a short time in a public transport vehicle, this disadvantage is acceptable.

To increase easy cleaning, urban rail vehicles can be equipped with wooden or plastic seats. Before they are equipped, it shall be tested whether the passengers' safety is sufficiently ensured in consideration of the seat arrangement and the surface structure of the seats as well as in consideration of fast acceleration or braking of the vehicles. If necessary, further handholds have to be fitted.

9.4 Smooth Surfaces

If possible, the interior of public transport vehicles should have smooth surfaces. Shagreened surfaces often make it more difficult to remove graffiti and stickers. Fabrics, carpets and textile surfaces should only be used at surfaces at which they are imperative, e. g. for seat covers.

9.5 Floor Covering Welded on the Rear Side

As from a certain number of identical vehicles it is also possible to weld the floor covering on the rear side. Usually, floor covering segments are welded by way of a filler filament on the upper side, but this method often leads to cold welds and surface defects, via which water can easily penetrate into the floor substructure. The floor covering then peels off from the substructure. Thus, floor covering welded on the rear side is more resistant and easier to clean.

9.6 Central Opening of All Passenger Doors

Some infected persons can transmit viruses via a smear infection. To reduce the contact with door opening buttons and stop request buttons, all doors can be opened by the driver via a single switch/button. Depending on the vehicle design, the doors are closed again via the switch/button for manual closing of doors (usually, the first bus door and often also the second bus door are closed manually) and for initiation of the closing of the automatic doors by releasing the hold-open time. The light barriers/panels/grids remain active during the closing.

It is meaningful always to consider this (additional) function by the purchase of new vehicles.

It is not meaningful to use the central door opening function for the opening of all passenger doors during normal operation because the energy consumption for heating and air conditioning is higher when all doors are frequently opened. Therefore, this function should only be used in times with high infection hazards and in special cases. The drivers should always receive unambiguous instructions concerning the use of this function.

9.7 “Contactless” Door Opening

Systems that control the opening and closing of doors via sensors on the inside and outside of the vehicle are available on the market or will be ready for the market soon. These sensor systems can monitor the boarding and alighting inside and outside the vehicle. Moreover, they can detect passengers in wheelchairs or with prams and they can trigger the extension and retraction of an electrically retractable ramp for safe boarding and alighting.

9.8 Partition Walls at Back Rests

Often partition walls or panes are fitted in the passenger compartment, i. e. in passenger door areas. It shall always be ensured that they are easily accessible for cleaning. There is often a space between the rear side of a back rest and the partition pane that is difficult to clean. In this case it can be meaningful to fit a partition pane that stops at the upper edge of the back rest.

10 Health and Safety Measures during a Pandemic

10.1 General Occupational Safety and Health Measures

To fight diseases caused by viruses in the best possible way, each employee of a public transport company shall:

- observe the hygiene rules;
- wash his/her hands as often as necessary and possible;
- cough and sneeze in accordance with the cough and sneeze etiquette. This etiquette also applies if he/she wears a medical face mask or a face covering;
- avoid to touch his/her face with the hands;
- keep distance, if possible;
- handle the medical face mask or face covering correctly.

Employees with customer contact shall always observe the hygiene rules particularly carefully. It can be necessary to ensure sufficient protection at customer contact points by way of additional structural measures, e. g. protective panes.

Moreover, it is recommended that the employees use the Corona warning app as they have to access to information via this app.

10.1.1 Terms and Definitions

The terms used in this VDV Report are defined as follows:

- face covering:

A face covering is a piece of clothing that covers at least the nose and the mouth and is suited to clearly reduce the speed of the respiratory flow or the saliva/phlegm/droplet sputum. It protects other persons. It is neither a medical product nor a piece of personal protection equipment. Face coverings are also known under the term of “community face coverings” and are made of one or multiples fabric or paper layers. Face coverings can also be home-made.

- medical face mask, e. g. according to EN 14683:

A medical face mask is a medical product and therefore subject to the MPG. It protects other persons against infectious droplets, if any, emitted by the person wearing it. Medical face masks are subject to an approval procedure.

- filtering half mask, e. g. according to EN 149:

A filtering half mask, e. g. FFP, is a respiratory mask. Being a piece of personal protective equipment (PPE), it protects the wearer against droplets and aerosols. Filtering half masks are classified e. g. on the basis of their filter performance, which allows classification into several device classes with increasing filter performance. Filtering half masks are subject to an approval procedure. A filtering half mask with an exhalation valve only protects the wearer and is not suited for mutual infection protection (protection of other persons). Filtering half masks are classified in the classes FFP1 to FFP3 and are personal protective equipment, which shall be placed at the employees’ disposal by the employer.

- respiratory protective device with exchangeable particle filter, e. g. according to EN 140 and in connection with EN 143:

A respiratory protective device with exchangeable particle filter is a piece of personal protective equipment. The air flows through the particle filters into the respiratory connection. The exhalation air flows through an exhalation valve or another device to the surrounding atmosphere. Thus, a respiratory protective device with exchangeable particle filter does not protect other persons. It protects the wearer from droplets and aerosols. Respiratory protective devices with exchangeable particle filters are subject to an approval procedure.

- face shield, e. g. according to EN 166:

A face shield (face visor) is a piece of personal protective equipment. Usually, it consists of a suitable headband, forehead protection, helmet/head protection and a protective cover or another suitable holding device. The wearer of a face shield is to be protected against infection hazards caused by other persons, e. g. via droplets and splashes. Face shields are subject to an approval procedure.

- distance rule/minimum distance:

A distance of at least 1.5 m between employees or employees and other persons, e. g. customers, suppliers or third-party employees, which reduces the risk of transmitting SARS-CoV-2. A bigger distance can be necessary in the event of certain activities with higher aerosol emission, e. g. professional singing.

- short-time contact/encounter:

A short-time contact/encounter is a face-to-face contact/encounter between persons with a total duration of less than 15 minutes. According to the scientific state of the art, the risk of transmitting SARS-CoV-2 is reduced in case of a short-time contact/encounter. This definition is also used by the RKI for contact tracing.

10.1.2 Ventilation

Pursuant to ArbStättV there shall be sufficiently healthy breathing air in workplace rooms. ASR A3.6 entitled “Technische Regeln für Arbeitsstätten – Lüftung” (eng: Technical Rules for Workplaces – Ventilation) specifies the basic requirements for ventilation.

Increased ventilation can reduce the concentration of virus-loaded aerosols, if any, in the room air. It can be realised by increasing the frequency of ventilation, prolonging the ventilation periods or increasing the air volume flow.

The easiest kind of ventilation is window ventilation. Window ventilation shall be made at the start of work and thereafter at regular intervals. ASR A3.6 e. g. recommends that office rooms are ventilated every 60 minutes and conference rooms every 20 minutes. This frequency should be increased in times with a pandemic. So-called intermittent ventilation, i. e. opening the windows completely, shall be realised. A ventilation period of 3 – 10 minutes is recommended.

A conference room shall always be ventilated before it is used, especially if other persons were in the room beforehand.

The overall risk of transmitting SARS-CoV-2 via air-conditioning plants is low if these plants are equipped with suitable filters or let in a high share of fresh air. Air conditioning plants shall not be switched off during the hours of operation/work because the concentration of viruses in the

room air – and thus the infection hazard – would be increased then. If the air-conditioning plant cannot be permanently operated, its periods of operation shall be prolonged before and after the use of the rooms.

If it is technically possible, the recirculated-air mode shall be avoided for air-conditioning plants without suitable filtration to avoid that further (virus-loaded) aerosols are led to the room. Suitable filters are e. g. HEPA filters. The fresh air share of an air-conditioning plant with a fresh air share shall be increased to reduce the concentration of (virus-loaded) aerosols as much as at all possible.

Air-conditioning plants in sanitary rooms shall be permanently operated during the working hours at the workplace.

Devices operated the recirculated-air mode, e. g. (pedestal) fans, personal cooling devices like mobile and split air-conditioning plants and heaters, may only be installed in rooms for use by a single person because they do not lead fresh air into the room to reduce the concentration of aerosols and because the air flow spreads aerosols in the room.

10.1.3 Assessment of Hazards

Due to the pandemic and in view of the publication of the “SARS-CoV-2-Arbeitsschutz-Regel” (eng: Occupational Health and Safety Standard in Connection with SARS-CoV-2) by the BMAS pursuant to ArbSchG, Sections 5 and 6, the employer shall examine and, if necessary, update the existing assessment of hazards and the specified occupational health and safety measures to include measures for protection against infectious diseases. Further information about these measures is found in sector-specific publications of the German social accident insurance institutions.

The employer shall involve the expert for occupational health and safety and the company doctor in the examination and update of the assessment of the hazards and in the specification of further measures for protection against infectious diseases. The employer shall involve (representatives of) the employees in the process. Suitable bodies for the exchange of information and coordination of measures are the industrial safety committee and/or the crisis/pandemic management group.

The assessment of the hazards shall include assessment of the work task realisation, the work time, the integration of employees in home office into the operational processes and – due to the pandemic situation – the psychological stress factors. Managers are in special demand.

Persons employed pursuant to ArbSchG, Section 15, are obligated to cooperate. As they are involved in the realisation and observance of conduct-related measures, they have to develop and adhere to safety awareness. This obligation also applies third-party to employees, borrowed workforce and employees active within the scope of service and works contracts.

If activities with a particularly high risk of getting infected with SARS-CoV-2 are performed, e. g. work with direct personal contact to (perhaps) infected persons or work in a laboratory, the relevant regulations for assessment of hazards pursuant to BioStoffV and TRBA apply.

It shall be examined whether and to which extent individual measures have to be taken in addition to the collective measures to protect particularly vulnerable groups of employees from getting infected with an infectious disease through colleagues or customers. As regards the protection of pregnant women reference is made to MuSchG, Section 10, which deals with the

protection of mothers within the scope of the general assessment of hazards upon informing about pregnancy.

Interactions with other occupational safety and health measures and goal conflicts, if any, shall be considered. An example is the wearing of a face covering or a medical face mask under unfavourable ambient conditions.

10.1.4 Basic Measures

The principles of ArbSchG also decide the order of occupational health and safety measures against infectious diseases in a company. Accordingly, individual protective measures are subordinate to other measures. Technical measures take precedence over organisational measures, which in turn take precedence over personal measures (TOP principle). The measures shall be appropriately interconnected. Which measure is meaningful and appropriate in the concrete situation on the job depends on the assessment of the local hazards.

The employer shall especially take measures that minimise non-protected contact between persons, inclusive of indirect contact via surfaces, and the concentration of air-borne viruses in the work environment. Suitable measures are e. g. realisation of the distance rule, working in fixed teams, separation of breathing zones by a technical measure, realisation of remote contact, increased ventilation, insulation of sick employees, intensified surface cleaning and additional hand hygiene.

If it is neither possible to observe the distance rule nor to take technical measures like separation of workplaces, the employees shall wear face coverings or medical face masks to protect one another.

As regards the basic, technical, organisational and personal occupational health and safety measures especially the following aspects shall be considered:

- 1) design of the work environment, e. g. arrangement of workplaces ensuring sufficient distance between persons, sufficient ventilation, provision of e. g. partitions or barriers and – if relevant – determination of fixed routes in the company;
- 2) reduction of personal contact, e. g. digital communication, formation and preservation of working teams, spreading of the work time, home office;
- 3) hygiene and cleaning, e. g. thorough washing of the hands at regular intervals; if this measure cannot be realised, suitable and lipid-regulating hand disinfectants shall be placed at the employees' disposal and the cleaning intervals shall be adapted;
- 4) general rules of conduct, e. g. observance of the distance rule, avoidance of salutations with direct physical contact, coughing and sneezing into the crook of the arm or a paper tissue and staying at home in the event of symptoms of illness.

10.1.5 Hand Hygiene

Washing of hands is a basic hygiene measure and therefore of particular importance. The following five steps are recommended to ensure that people wash their hands correctly:

- step 1: make your hands wet under running water and pre-clean them thoroughly so that the skin is completely wet;
- step 2: soap your hands on all sides, i. e. inside and outside, fingertips and spaces in between to the wrist;

- step 3: take your time; thorough soaping takes 20 – 30 seconds;
- step 4: rinse your hands thoroughly under running water;
- step 5: dry your hands carefully with a clean cloth.

To remove germs, hands shall be thoroughly washed with soap and water at regular intervals.

If the hands are disinfected, e. g. because it is not possible to wash them, they shall be so disinfected that the hand disinfectant can have an effect on all surfaces of the hands. Full distribution of the disinfectant is only possible in a purposive, step-by-step procedure.

10.1.6 Consideration of Psychological Stress

To protect employees from getting infected with SARS-CoV-2 at work as far as possible, many companies have to re-organise workplaces and work routines. Often the work organisation, the arrangement of the workplace and the work time as well as the communication methods and the cooperation at work are significantly modified, which can lead to psychological stress.

Further work aspects that might affect the employees' psychological stress and that have to be considered are e. g. possible conflict situations with customers, a permanently high level of work intensity in system-relevant sectors and effects of contact restrictions like social insulation in home office.

These additional psychological stress factors shall be considered by the assessment of the employees' stress situation and suitable measures shall be taken.

Immediate consequences of the increasing psychological stress can be a conduct that ignores safety rules, increasing accident hazards and increasing health hazards.

Especially managers have to be made sensitive to continuously observing the effects of the work processes on occupational safety and health. If necessary, occupational safety and health experts and company doctors as well as other experts shall be heard.

Finally, it is important that colleagues show some understanding and consideration for anxious colleagues.

10.1.7 Face Coverings, Medical Face Masks and Personal Protective Equipment (PPE)

If technical and organisational protective measures cannot minimise the infection hazard at work, individual protective measures shall be taken, e. g. wearing of a face covering, a medical face mask, a filtering half mask or a face shield. The instructions as to how to put it on/off and how to clean it shall always be observed.

If the employee has to perform activities that do not allow wearing of e. g. a face covering, alternative measures of equal quality shall be taken in consideration of the assessment of the hazards. The sector-specific advice of the German social accident insurance institutions shall be considered.

Wearing of a face covering, a medical face mask or a filtering half mask increases the wearer's strains, e. g. higher respiratory resistance due to the filter resistance of the filter materials or higher thermal and moisturizing load of the protective equipment. It is recommended to reduce the wearing period by allowing other activities or regular breaks. Face coverings, medical face masks and filtering half masks shall always be changed when they are soaked, at the latest.

A face shield protects the wearer from exterior hazards. The approval procedure for face shields does not include demonstration of protection of other persons. Face shields do not have a filtering effect. To supplement the wearer's personal protection, they can be used as PPE for splash protection, especially in combination with filtering half masks (at least FFP2 or a similar degree of protection) by activities during which aerosols are emitted. In this way they can be a supplement to the wearer's personal protection.

10.1.8 Instructions and Active Communication

Occupational health and safety instructions pursuant to ArbSchG, Section 12, as well as specific occupational health and safety instructions shall also be given during a pandemic. The general and specific requirements for instructions, e. g. for documentation, still apply. It is possible to give instructions via an electronic means of communication during a pandemic. However, it is important to ensure that the employees have understood the instructions correctly and that it is always possible to put and answer questions.

If the updated assessment of hazards reveals that there is an infection hazard at the workplace due to the pandemic situation and that further measures for infection protection have to be taken, the employees shall be instructed accordingly before they take up their work and then at regular intervals and upon major modifications.

The employer can be advised by the expert for occupational health and safety and/or the company doctor by the preparation of the instructions. The doctor's advice is mainly needed if special measures have to be taken for particularly vulnerable groups of employees due to the SARS-CoV-2 infection hazard. To fight the employees' unease and anxiety due to partially contradictory information about the hazards caused by SARS-CoV-2, the employees have to be actively informed about the health hazard and the protective measures that have been taken.

To ensure protection from work-related hazards caused by SARS-CoV-2, it is important that all employees of a company are always informed about the possible transmission hazards and actively put the preventive measures into practice. The borrower of a borrowed workforce is directly responsible for the instruction of the borrowed workforce. The borrower and the employer of the borrowed workforce shall agree on the relevant contents of the instructions to be given to employees active within the scope of service and works contracts and it shall be ensured that the contractor instructs his staff.

Protective measures shall be explained and be understandable in the form of references, e. g. signs, notices or marks on the floor. The instructions shall be unambiguous, clear and easily understandable.

In case of activities pursuant to BioStoffV the instructions shall include general occupational medical advice. The company doctor who is responsible for the occupational medical care shall be involved in the preparation of these instructions.

Information about the scientific state of the art, the risk of getting infected and the risk that persons who have been infected by COVID-19 viruses infect other persons when they get back to work shall be part of the instructions.

The importance of the observance of the personal and organisational hygiene rules, i. e. the distance rule, the cough and sneeze etiquette, the hand hygiene and the wearing of a medical face mask, shall be stressed. Information from the German Federal Centre for Health Education (BZgA) about instructions is also helpful.

10.2 Preventive Occupational Medical Care and Protection of Particularly Vulnerable Groups of Employees

10.2.1 General Preliminary Remarks

During a pandemic the requirements for infection protection of the people overlap the occupational safety and health measures in a company. The company doctor advises the employer by the realisation of his obligations in consideration of the occupational safety and health measures and supports by the preparation of operational instructions for action, inclusive of the access to tests for a SARS-CoV-2 infection.

10.2.2 Preventive Occupational Medical Care

10.2.2.1 General

In a pandemic situation the provisions specified in ArbMedVV still apply to the personal clarification and advice of employees about individual, work-related health hazards.

Beside the normal tasks of the company doctor, inclusive of preventive occupational safety and health care offers, additional preventive occupational medical care is important during a pandemic. An employee shall be given the opportunity of receiving additional preventive occupational medical care irrespective of his/her tasks, unless a health hazard is unlikely according to the assessment of the working conditions and due to the protective measures taken. Additional preventive occupational medical care can e. g. be information about the infection hazard, advice on pre-existing conditions as well as on anxiety and psychological stress.

The periods for arranging / offering preventive medical care pursuant to AMR 2.1 entitled "Fristen für das Angebot oder die Veranlassung von Vorsorge nach der Arbeitsmedizinischen Regel" (eng: Terms for Arranging / Offering Preventive Occupational Medical Care pursuant to the Rules for Occupational Safety and Health), which has been published by the BAuA, remain valid. Medical appointments concerning preventive occupational medical care, which are postponed for personal or organisational reasons during the SARS-CoV-2 pandemic, shall be caught up within a short period of time and be continued at the original time interval. If the assessment of the hazards necessitates preventive occupational medical care of employees, these medical examinations shall take place as one appointment.

To relieve the company doctor of activities in his/her consulting room and thus to avoid possible infection chains, it is recommended to handle medical consultations that are not required by law via phone/telemedicine or to postpone them. Moreover, preventive occupational medical care can be made as anamnesis inquiries and advice by phone/telemedicine.

The employer is under an obligation to inform the doctor entrusted with the preventive occupational medical care about the conditions at the workplace, e. g. the plan for the company or a facility in the event of a pandemic. The doctor considers all working conditions and work-related hazards in his/her work anamnesis.

The company doctor shall evaluate the preventive occupational medical care at appropriate time intervals to identify special hazard priorities and to recommend protective measures, if any.

10.2.2.2 Preventive Occupational Medical Care due to Work Activities with Infection Hazards caused by SARS-CoV-2 or Other Viruses

In case of purposive work activities with SARS-CoV-2 pursuant to BioStoffV preventive occupational medical care shall be offered. In case of non-purposive work activities this care shall also be offered if the activities are assigned to protection class 3. If they are assigned to protection class 2, it shall be examined within the scope of the assessment of hazards whether there is an infection hazard despite the protective measures taken.

Work activities during which the infection hazard exclusively arises due to contact to colleagues or customers are not work activities pursuant to BioStoffV. Therefore, they do not constitute a reason for compulsory or voluntary preventive occupational medical care pursuant to ArbMedVV, annex, part 2.

10.2.3 Evaluation of Employees' SARS-CoV-2 Infection

The company doctor shall evaluate employees' SARS-CoV-2 infection when he/she is informed accordingly to identify work activities that might constitute a higher hazard and to derive recommendations on measures, if necessary.

10.2.4 Protection of Particularly Vulnerable Groups of Employees

Particularly vulnerable groups of employees are dealt with as follows:

- 1) The assessment of hazards shall be examined and updated in consideration of special hazards for particularly vulnerable groups of employees (on the basis of the recommendations of the RKI on occupational safety and health from July 2020) and suitable measures shall be taken;
- 2) the TOP principle shall be realised, i. e. technical measures take precedence over organisational measures, which in turn take precedence over personal measures;
- 3) situational prevention takes precedence over behavioural prevention;
- 4) the occupational safety and health protection shall be optimised to keep the workplace;
- 5) the individual need for protection shall be considered by the preventive occupational medical care.

Individual measures shall be realised if the individual hazard characteristics are brought on, e. g. when an employee presents a medical certificate. If the situation is not clear, he/she should be offered consultation with the company doctor.

10.2.5 Infection Being an Occupational Accident or an Occupational Disease

During a pandemic, infection with the viruses in question, i. e. at present SARS-CoV-2, constitutes a general hazard, which threatens everybody in the same way. Therefore, disease due to infection is not an occupational accident. If, however, the employee has been exposed to a much higher hazard due to his/her insured work activities, e. g. if he/she has often transported patients, his/her disease might be regarded as occupational disease No. 3101. In such a case an occupational disease can be notified on the basis of a positive test, the relevant signs of the disease and an assumption of infection due to the occupational activities.

10.3 Preventive Occupational Safety and Health Measures for Drivers

10.3.1 General

Drivers' safety and health is of utmost importance. A driver's infection hazard is low if he/she is shielded from the passengers at his/her workplace. Therefore, it is neither necessary nor meaningful that he/she wears a face covering or a medical face mask when he/she is driving a bus or an urban rail vehicle. However, he/she shall always wear a face covering or a medical face mask when he/she is not at his/her workplace, e. g. if he/she has to:

- help a passenger with reduced mobility;
- give a person information;
- stay in the passenger compartment, in a station or at a stop for an official reason.

The hygiene concepts of many public transport companies recommend that the drivers wear medical face masks and not face coverings. It shall be examined whether it is necessary to equip drivers with (disposable) gloves for activities apart from their workplaces. Usually, this examination is based on the assessment of the hazards.

A hand disinfectant shall be handed out to public transport employees because they cannot wash their hands everywhere. Moreover, the public transport vehicles shall be equipped with utensils for hand hygiene and disinfection as well as paper tissues and lockable bin liners. It shall be ensured and considered by the route planning that the employees can use sanitary facilities. If portable toilets without water connection are placed at the disposal of the employees, they shall have hand wash facilities. A portable toilet without a hand wash facility does not fulfil the present hygienic requirements. According to ASR A4.1 entitled "Technische Regeln für Arbeitsstätten – Sanitärräume" (eng: Technical Rules for Workplaces – Sanitary Rooms) a hand wash facility is a wash hand basin with running water and a closed sewage system, which shall be equipped with liquid soap and disposable towels.

The requirements for portable toilets have been cited from the document entitled "SARS-CoV-2-Arbeitsschutzregel" (eng: Rules for Occupational Safety and Health Measures with SARS-CoV-2), which has been published by the BMAS.

If it is required by the pandemic situation, the cleaning scope for sanitary rooms and the intervals between cleaning them shall be adapted.

10.3.2 Preventive Occupational Safety and Health Measures for Bus Drivers during a Pandemic

The following shall be observed for bus drivers during a pandemic:

- The assessment of the hazards for the drivers shall be so updated that the infection hazard and the operating conditions, especially the design of the vehicles, are considered.
- If the vehicles do not have driver's cabs or sufficient protective panes/foils or another kind of driver protection, it is recommended to keep door 1 locked.
- If the driver's workplace is not protected by a driver's cab or a sufficiently big protective pane made of glass or a suitable plastic, it can be necessary to block the area directly behind the driver's workplace, i. e. the first seat row, to ensure that the distance rule is observed.
- The drivers should only sell tickets if they are sufficiently protected, e. g. by a driver's cab or a sufficiently big protective pane made of glass or a suitable plastic.

- If a driver has to help a passenger, e. g. by the operation of the foldable ramp for wheelchair users, he/she shall wear a face covering or a medical face mask.
- The drivers should always open all doors for ventilation of the buses. If it is technically possible, the doors should be opened automatically. If possible, door 1 (locked) should also be opened. The HVAC system, if any, remains switched on.
- It shall be possible for the drivers to wash their hands at regular intervals or to disinfect them.
- The company shall place cleaning agents and, if necessary, disinfectants and skin protection products at the disposal of the drivers.
- The stay in break rooms shall be so organised that it is possible to observe the hygiene standards.

10.3.3 Additional Information for Drivers of Urban Rail Vehicles

Drivers of urban rail vehicles, i. e. tramcars, LRVs or metro vehicles, have less contact to passengers than bus drivers. Nevertheless, the above-mentioned measures shall also be observed for them.

If the urban rail vehicle does not have a separate door to the driver's cab through which the driver can enter and leave the vehicle, the driver shall always wear a face covering or a medical face mask when he/she leaves the driver's cab, e. g. to set points. This requirement does not apply to empty running and shunting movements. To change driver's cabs, the driver should preferably walk along the platform and not inside the vehicle with passengers.

10.4 Special Organisational Measures for Workshops

10.4.1 Ensuring Observance of the Distance Rule

The routes in the workshop shall be so adapted that the employees and other persons can observe the distance rule, e. g. by determining and marking routes in the workshop as one-way roads/routes, if it is likely that they are often used by many people. If the routes cannot be realised in such a way that the distance rule can be observed, ventilation shall be intensified in the workshop.

The distance rule shall be observed in areas in which employees and other persons, e. g. customers, wait or stay, e. g. central print and copy rooms, time recording areas and canteens. Sufficient ventilation shall be ensured in these areas. Marks should be provided in these areas to ensure that the distance rule is observed. Such marks can be e. g. marks on the floor or barrier tapes. If several employees work together, e. g. during assembly, it should be ensured that the minimum distance of 1.5 m between employees is observed.

Due to the limited ventilation of lifts, lifts should only be used by several persons if they can observe the distance rule.

If it is not possible to observe the distance rule, the employee shall wear a face covering or a medical face mask.

10.4.2 Work Equipment/Tools

Proper work organisation shall ensure that work equipment is only used by one person to reduce the risk of a smear infection. Thus, it can e. g. be necessary to provide further work equipment.

If person-based use of work equipment is not possible, it shall be cleaned with an off-the-shelf (household) cleaning agent before it is passed on to another employee. Especially surfaces with which the employees have had contact, e. g. by emitting droplets during speaking, shall be considered by the cleaning. Such surfaces are e. g. tabletops, IT devices, telephone receivers, steering wheels, switch levers and tools. Control panels of work equipment that are used by several employees shall be cleaned at regular intervals. Preventive disinfection of surfaces is not necessary according to the scientific state of the art.

10.4.3 Arrangement of the Work Time and Breaks

The arrangement of the work time is of high importance due to the additional stress that arises because there is no infrastructure to support the home and because of many employees' general uncertainty and accompanying psychological stress.

At the beginning of the work time, at breaks and at the end of the work time it shall be avoided that employees encounter too many colleagues, e. g. in break rooms, canteens, dressing rooms, wash rooms and shower rooms, that it is difficult for the employees to observe the distance rule and that they are significantly delayed.

So-called thinning out of groups of employees shall be realised by the preparation of shift schedules and the setting up of working groups. To further reduce contacts between employees in the company, the employees should be grouped to fixed shift/working teams. The number of persons in a shift/working team shall be reduced to a minimum.

When measures are taken to distribute the number of employees more evenly, it shall always be considered by the assessment of the hazards that an added working burden due to the work time, e. g. at night, or the duration of the work time, e. g. longer shifts or shorter breaks, constitutes an additional hazard. The effectiveness and/or the consequences of these measures to employees' health, the occurrence of accidents and/or hygiene faults shall be examined and considered by the assessment of the hazards, if necessary.

10.4.4 Storage of Work Clothes and Personal Protective Equipment (PPE)

It shall be ensured that personal protective equipment (PPE) and work clothes are always used by the same person. The employer shall ensure that the employee can store his/her PPE and work clothes at another place than the one at which he/she stores his/her street clothes.

10.4.5 External Persons' Access to Workplaces and Premises

To reduce the infection hazard from external persons' access to workplaces, the following measures shall be taken:

- contact to external persons and access of external persons to the premises and facilities should be avoided or minimised;
- electronic media should be used for the contact to perform the work task, if possible;
- partitions, e. g. transparent partitions, should be provided if it is not possible to observe the distance rule,

- the number of external persons who may be present in the company should be restricted so that it is possible for everybody to observe the distance rule;
- a face covering or a medical face mask shall be worn if it is not possible to observe the distance rule and if there is no continuous effective partition between persons;
- if necessary, e. g. if required by the local health authority, a list of external persons on the premises shall be provided to be able to trace infection chains.

If the contact is not a short-time contact, e. g. in case of a delivery, the employer shall inform external persons about the special protective measures of the company in a suitable way. If relevant, the external persons shall especially be informed about the local conditions, the possibility of using sanitary facilities and the hand hygiene rules.

10.5 Preventive Occupational Safety and Health Measures for Cleaning Staff

10.5.1 General

Usually, cleaning of the interior of public transport vehicles is a work activity to which a protection class is not assigned (see BioStoffV, Section 6). Information about the assessment of hazards is found in TRBA 400. Information about protective measures is found in TRBA 500.

10.5.2 Skin Protection

Frequent and intensive hand washing is a further strain to a cleaner's hands in addition to the high strain to which he/she is often exposed. Therefore, careful protection and intensive care of the skin is very important. The following applies:

- cleaners shall wear suitable gloves by all moistening and disinfection activities to prevent that their hands get into contact with a cleaning agent;
- the gloves shall be and remain dry inside. Cotton undergloves, frequent change of gloves and special skin protection products can prevent that the cleaner gets sweaty hands. If a cleaning agent penetrates into a glove, the gloves shall be changed immediately;
- cleaners shall rub cream into their hands even more frequently. It is particularly important to rub cream onto the spaces in between the fingers, which are very sensitive. It can be necessary to wear cotton undergloves.

10.5.3 Surface Hygiene

Hygiene measures for surfaces are only effective if they realised exactly. It shall be ensured that the suitable agent is always used in the correct concentration. The following applies:

- only if the cleaning agent is used in the correct dosage, can it be effective. The principle of "more is better" is incorrect. A too high dosage can even be harmful to surfaces, the skin or the respiratory tract;
- wiping instead of spraying: Spraying of cleaning agents and disinfectants should be questioned even more than usual. Spraying does not ensure full moistening of the surface so that wiping is often necessary, too. Droplets of the cleaning agent can also reach the employees' respiratory tracts, which damages their mucous membranes. Thus, it should always be avoided. It is of particular importance to ventilate the work areas in case of spraying.

11 Summary

Passengers and employees' strict observance of the hygiene rules and good ventilation of the public transport vehicles are the most important hygiene measures to protect passengers and employees from getting infected with SARS-CoV-2.

Generally, additional complicated cleaning and disinfection measures neither have to be taken nor are they recommended by the RKI. However, additional cleaning measures can increase the subjective feeling of safety and thus contribute to winning back lost customers.

Our customers appreciate clean vehicles with a pleasant environment. Consequently, both the visible and the perceptible cleanliness as well as hygiene measures are of high importance. However, in the end the visible cleanliness after cleaning is a more important and more effective hygiene measure than all disinfection measures.

According to the scientific state of the art, the risk of getting infected with SARS-CoV-2 in a public transport vehicle is very low. No case of catching SARS-CoV-2 in a public transport vehicle became known during the first big pandemic wave, but nevertheless it is important to take measures to increase the passengers' feeling of safety and to initiate appropriate communication activities.

Hygiene concepts shall be further developed upon new knowledge. The single measures of the hygiene concept shall be flexibly adapted to the need and the situation. Installations in vehicles, e. g. protective panes at the driver's workplaces, will probably also be relevant after the present COVID-19 pandemic.

The technical solutions described in sections 6, 7 and 8 of this VDV Report and the descriptions of the operating/functional principles are only intended to be information for the public transport companies at present and to provide them with an overview of practical examples and concepts presented by manufacturers. As there is too little practical experience and as products have not been finally developed at present, the VDV cannot make recommendations on the operation or use of novel products/principles (yet). It is imperative to analyse the necessity of many of these novel products/concepts, not only in respect of their mode of operation, but also in respect of verification and demonstration of the effectiveness of the complete system for inactivation of viruses. Independent testing institutes should be involved in this examination.

Legislative Rules – Acts, Regulations and Directives

StVO	Straßenverkehrsordnung (eng: German Road Traffic Regulations)
StVZO	Straßenverkehrs-Zulassungs-Ordnung (eng: German Road Traffic Licensing Regulations)
BOKraft	Verordnung über den Betrieb von Kraftfahrunternehmen im Personenverkehr (eng: German Federal Regulations on the Operation of Motor Transport Companies for Passenger Services)
ArbSchG	Arbeitsschutzgesetz (eng: German Act on the Implementation of Measures of Occupational Safety and Health to Encourage Improvements in the Safety and Health Protection of Workers at Work)
MuSchG	Gesetz zum Schutz von Müttern bei der Arbeit, in der Ausbildung und im Studium (eng: German Act on the Protection of Mothers Working, Studying or under Education)
MPG	Gesetz über Medizinprodukte (eng: German Law on Medical Products)
ArbMedVV	Verordnung zur arbeitsmedizinischen Vorsorge (eng: German Ordinance on Preventive Occupational Health Care)
ArbStättV	Verordnung über Arbeitsstätten (eng: German Ordinance on Workplaces)
BioStoffV	Biostoffverordnung (eng: German Ordinance on Safety and Health Protection at Workplaces Involving Biological Agents (Biological Agents Ordinance))
TRBA 400	Handlungsanleitung zur Gefährdungsbeurteilung und für die Unterrichtung der Beschäftigten bei Tätigkeiten mit biologischen Arbeitsstoffen (eng: Guideline for Risk Assessment and for the Instruction of Employees regarding Activities Involving Biological Agents)
TRBA 462	Einstufung von Viren in Risikogruppen (eng: Classification of Biological Agents in Risk Groups)
TRBA 500	Grundlegende Maßnahmen bei Tätigkeiten mit biologischen Arbeitsstoffen (eng: Basic Measures to be Taken for Activities Involving Biological Agents)
ASR	Technische Regeln für Arbeitsstätten (eng: Technical Rules for Workplaces) (ASRs are published by the BAuA in consultation with the BMAS)

Technical Rules – Standards and Recommendations

EN 140	Respiratory protective devices - Half masks and quarter-masks - Requirements, testing, marking
EN 143	Respiratory protective devices - Particle filters - Requirements, testing, marking
EN 149	Respiratory protective devices - Filtering half masks to protect against particles - Requirements, testing, marking
EN 166	Personal eye-protection - Specifications
EN 779	Particulate air filters for general ventilation. Determination of the filtration performance
EN 1822	High efficiency air filters (EPA, HEPA and ULPA)
EN 13549	Cleaning services - Basic requirements and recommendations for quality measuring systems
EN 14683	Medical face masks - Requirements and test methods
EN 14885	Chemical disinfectants and antiseptics - Application of European Standards for chemical disinfectants and antiseptics
EN ISO 15858	UV-C Devices - Safety information - Permissible human exposure (ISO 15858:2016)
DIN 58214	Eye-protectors - Helmets - Terms, forms and safety requirements
CIE 155	Ultraviolet air disinfection
UN ECE-R 43	Regulation No 43 of the Economic Commission for Europe of the United Nations (UN/ECE) - Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles
UN ECE-R 118	UN Regulation No 118 - Uniform technical prescriptions concerning the burning behaviour and/or the capability to repel fuel or lubricant of materials used in the construction of certain categories of motor vehicles
FMVSS 302	Flammability of interior materials

List of Figures and List of Sources

List of Figures

Figure 1: Avoid the „Three Cs“!, published by the Japanese Ministry of Health, Labour and Welfare

List of Sources

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Product information about TiTANO, UVIS UV-Innovative Solutions GmbH

List of Abbreviations

BAuA	German Federal Institute for Occupational Safety and Health
BMAS	German Federal Ministry of Labour and Social Affairs
CIE	International Commission on Illumination
Covid-19	corona virus disease 2019
FMVSS	Federal Motor Vehicle Safety Standards
HEPA	high-efficiency particulate air/arrestance
HVAC	heating, ventilation, air conditioning
LRV	light rail vehicle
PPE	personal protective equipment
RKI	Robert Koch Institute
RKI list	List of Tested and Approved Disinfectants and Disinfection Methods Published by the RKI
SARS-CoV-2	severe acute respiratory syndrome corona virus 2
TRBA	Technical Rule for Biological Agents (published by BAuA)
VAH	Association for Applied Hygiene
VAH list	List of Disinfectants Published by the VAH

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