Stáisiún Uí Chonghaile, Baile Átha Cliath 1, D01 V6V6
Connolly Station, Dublin 1, D01 V6V6
T 01 703 nnnn F 01 703 nnnn E info@irishrail.ie W www.irishrail ie

12th November 2020

[redacted]
Email: [redacted]

Re: FOI request IE_FOI_407

I refer to your request dated October 2020 made under the Freedom of Information Act 2014, which was received by my office on the 12th October, for records held by Iarnród Éireann.

Request:

All relevant documentation relating to:

• Correspondences between the Rail Delivery Group UK and Irish Rail regarding ventilation on trains in relation to the aerosol spread of Covid-19 onboard
• Correspondences between the The European Centre for Disease Control and Irish Rail regarding ventilation on trains in relation to the aerosol spread of Covid-19 onboard
• Correspondences between the the World Health Organisation and Irish Rail regarding ventilation on trains in relation to the aerosol spread of Covid-19 onboard

Response:

- Please see enclosed emails and / or attachments providing the relevant information requested along with schedule of records.

Rights of appeal

In the event that you are not happy with this decision you can make an appeal in relation to this matter, you can do so by writing to the FOI Unit, Corporate Communications, Iarnród Éireann Irish Rail, Connolly Station, Amiens St, Dublin 1 or by e-mail to foi@irishrail.ie. You should make your appeal within 4 weeks (20 working days) from the date of this notification, where a day is defined as a working day excluding, the weekend and public holidays, however, the making of a late appeal may be permitted in appropriate circumstances.
The appeal will involve a complete reconsideration of the matter by a more senior member of the staff of this body.

Stáisiún Uí Chonghaile, Baile Átha Cliath 1, D01 V6V6
Connolly Station, Dublin 1, D01 V6V6
T 01 703 nnnn **F** 01 703 nnnn **E** info@irishrail.ie **W** www.irishrail ie

Should you have any questions or concerns regarding the above, please contact the FOI Officer on 01- 7034293.

Yours sincerely,

Mr. Peter Smyth,
Decision Maker,
CME Dept,
Iarnród Éireann

Freedom of Information Request:
Schedule of Records for IE_FOI_407 : Summary for Decision Making

Record No.	Date of Record	Brief Description	No. of Pages	Decision: Grant/Part Grant/Refuse	Section of Act if applicable	Record Edited/Identify Deletions
1	28.05.2020	1 3 ORR Letter to Tus on rail vehicle HVAC Systems COVID risk	3	Part	S37 - Personal Information of Others	Personal Information of Others
2	19.03.2020	COVID_19 Redacted	15	Part	S37 - Personal Information of Others	Personal Information of Others
3	29.05.2020	FW_Wabtec HVAC Advanced Filtration System - Blue Filter Redacted	21	Part	S37 - Personal Information of Others	Personal Information of Others
4	21.05.2020	KBRS - HVAC Systems & Covid-19 Redacted	10	Part	S37 - Personal Information of Others	Personal Information of Others
5	27.05.2020	RDG Guidance on Maintenance of On-Train HVAC Modules & Filters v1.1 Redacted	7	Part	S37 - Personal Information of Others	Personal Information of Others
6	~	RDG Guidance on Maintenance of On-Train HVAC Modules and Filters (2) Redacted	6	Part	S37 - Personal Information of Others	Personal Information of Others
7	18.05.2020	RDG Guidance on Rolling Stock Ventilation during the Covid 19 Pandemic - Redacted	6	Part	S37 - Personal Information of Others	Personal Information of Others
8	30.04.2020	RDG Train Interiors Cleaning Guidance issue v1.5 Redacated	7	Part	S37 - Personal Information of Others	Personal Information of Others
9	22.04.2020	TOC Train Cleaning Products Processes Guidance (2) Redacted	7	Part	S37 - Personal Information of Others	Personal Information of Others

10	16.06.2020	Updated RDG Guidance on Maintenance of On-Train HVAC Modules & Filters v1.2 Redacted	8	Part	S37 - Personal Information of Others	Personal Information of Others
11	29.05.2020	Updated TOC Cleaning COVID-19 Guidance Document v1.6 Redacted	7	Part	S37 - Personal Information of Others	Personal Information of Others
12	01-Sep-20	Covid 19 bulletin_ventilation in railway vehicles en	4	~	~	~
13	22.06.2020	Ventilation in the context of COVID 19	5	~	~	~
14	15.05.2020	WHO - 2019 - nCov - Disinfection 2020.1	8	~	~	~

Signed

Freedom of Information / Data Protection Executive

[redacted]
HM Chief Inspector of Railways
[redacted]

OFFICE OF RAIL AND ROAD

[redacted] General Secretary RMT [by email]

Cc: [redacted] Secretary General ASLEF
Cc: [redacted] General Secretary TSSA
Cc: [redacted] National Officer Unite

28 May 2020

Dear [redacted]

Air conditioning and ventilation systems

Thank you for raising these important issues around air conditioning and ventilation systems on trains.

You asked about common industry standards for rail vehicle ventilation systems. The diverse mix of rolling stock across the rail network means that not all rail vehicles will have modern heating, ventilation and air conditioning systems (HVAC) to the latest design standard. The current applicable standard for the authorisation of new passenger rail vehicles is the LOC&PAS TSI (*Commission Regulation (EU) No 1302/2014 of 18 November 2014 concerning a technical specification for interoperability relating to the 'rolling stock — locomotives and passenger rolling stock' subsystem of the rail system in the European Union* as amended), which is available in a consolidated form at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02014R1302-20190616&from=EN. Section 4.2.5.8 covers internal air quality and addresses the need for acceptable levels of carbon dioxide to be maintained inside carriages and driving cabs rather than any potential exposure to external airborne contaminants.

Train operators are required to carry out a risk assessment under the common safety method for risk evaluation and assessment to assess the hazards applicable to the use of the vehicle in the particular circumstances for which it is intended. ORR's guidance is at https://orr.gov.uk/rail/health-and-safety/health-and-safety-laws/european-railway-safety-legislation/csm-for-risk-evaluation-and-assessment

In common with most non-specialised applications (road vehicles, offices, and public buildings) train HVAC systems are not typically designed with high efficiency particulate air (HEPA) filters suitable for fine particulates and airborne pathogens. Under normal operation the air on trains is not fully recirculated, but is mixed with fresh air from outside the vehicle in order to maintain the levels of carbon dioxide at comfortable and safe levels. The 'safety' of the internal air is achieved

Head Office: 25 Cabot Square, London E14 4QZ T: 020 7282 2000 www.orr.gov.uk

through correct use and appropriate maintenance of the HVAC system, and this control is down to each rail vehicle operator to manage.

The latest advice from HSE at https://content.govdelivery.com/accounts/UKHSE/bulletins/28ce71a is that is that the risk of HVAC systems spreading coronavirus is very low but, where centralised ventilation systems remove and circulate air to different rooms or enclosed spaces, it is recommended that the recirculation mode should be switched off and a fresh air supply used. HSE advice is that other air conditioning systems do not need to be adjusted.

We are aware of emerging research on the potential for HVAC systems to affect the transmission of the virus within buildings, but not specifically within trains. The Federation of European HVAC Associates (REHVA) has published a rapid evidence review and guidance 'How to operate and use building services in order to prevent the spread of the coronavirus disease (COVID-19) virus (SARS-CoV-2) in workplaces' at https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_ver2_20200403_1.pdf. The CIBSE, as UK member of REHVA, has published similar guidance at https://www.cibse.org/coronavirus-covid-19/coronavirus-covid-19-and-hvac-systems.

The current evidence supports the general principles of reducing recirculating air and increasing fresh air flow within indoor spaces in order to minimise risk of coronavirus transmission. For cleaning and maintenance operations on HVAC systems, the HVAC industry guidance above suggests that appropriate personal protective equipment should be worn and all materials, including old filters, carefully bagged and disposed of safely.

As part of covid-19 specific risk assessments, we expect rail vehicle operators to work with their rolling stock suppliers and/or fleet engineers to consider how best to optimise ventilation and fresh air flow within vehicles in line with the DfT safer transport guidance for operators at https://www.gov.uk/government/publications/coronavirus-covid-19-safer-transport-guidance-for-operators/coronavirus-covid-19-safer-transport-guidance-for-operators.

Consideration should be given to the reasonable practicability of adjustment to recirculating air conditioning systems to increase fresh air flow, and to the use of enhanced filtration; and opening of windows where possible and safe to do. Any proposed adjustments to vehicle ventilation systems will need to be risk assessed to consider and mitigate any consequential impact on non-covid risks, for example on noise, temperature, fire suppression, and any physical hazards (for example from droplights).

Risks to staff maintaining HVAC systems should also be risk assessed with particular consideration to social distancing, hand and respiratory hygiene, suitable personal protective equipment, and safe disposal of potentially contaminated filters.

We will continue to use best available evidence and guidance from HSE and other expert bodies to inform our advice to dutyholders and trade union representatives on this issue.

Yours sincerely

From: [redacted]
To: [redacted]
Cc: [redacted]
Subject: Covid 19
Date: 19 March 2020 09:33:14
Attachments: uic-management-of-covid-19-guidance-for-railway-stakeholders.pdf

---

All
Please see attached UIC guidelines for Covid 19 for information. It might act as a completeness check on each of our Covid strategies
Stay well
Regards
[redacted]

MANAGEMENT OF COVID-19

GUIDANCE FOR RAILWAY STAKEHOLDERS

A series of potential measures published by the International Union of Railways

March 2020

INTERNATIONAL UNION
OF RAILWAYS

1. CONTEXT

OBJECTIVES

Amid the coronavirus disease outbreak, UIC has set up a task force combining UIC member companies, experts and other relevant stakeholders (ALAF, APTA, CER, CIT, IATA, and UITP[1]) to work together to find ways to respond to this crisis that are adapted to the railway sector.

In the frame of prevention and fight against diseases and other crises, continuity of rail operations is key to provide mobility and to guarantee the continuation of critical activities, whilst taking into account the trend of absenteeism and maintaining public health. Rail operators are likely to be required to adapt their services to ensure both cargo and passengers services. This should consider the operator's resources and measures taken by authorities. Hence, this collection of potential measures to help railway stakeholders maintain resilience.

The potential measures contained in this guidance, published by UIC, were collected in February-March 2020 with the aim to assist railway stakeholders and provide reliable information about the specific challenges for rail when it comes to this communicable disease.

The objectives of this document are therefore two-fold:

- To collect and share practices from UIC members on actions already in place; and
- To provide potential measures which could be implemented according to the risk level in full coordination with and the guidance of competent health authorities.

This document is intended for guidance only. Its contents shall be neither considered as definitive nor as requirements. These potential measures are provided as examples and could evolve overtime, depending on changes to the risk level. Measures provided here within are to be used by railway stakeholders as seen fit and on their own responsibility.

METHOD

In the spirit of sharing current practices, UIC members and partner organisations provided information through many means: during the Task Force meetings, directly with an email to the Task Force members, or through the UIC Security Division Network of Quick Responders & UIC special group COLPOFER jointly developed questionnaire (see Annex).

Therefore, this document has been enriched with information from all possible sources (whether official, informal, through the press, through social networks, or originating from exchanges between Task Force participants) as long as these sources provide relevant, additional elements to our (on-going) collection of measures and practices.

1 ALAF: Latin American Railway Association, APTA: American Public Transportation Association, CER: Community of European Railway and Infrastructure Companies, CIT: International Rail Transport Committee, IATA: International Air Transport Association, UITP: international organisation for public transport authorities and operators.

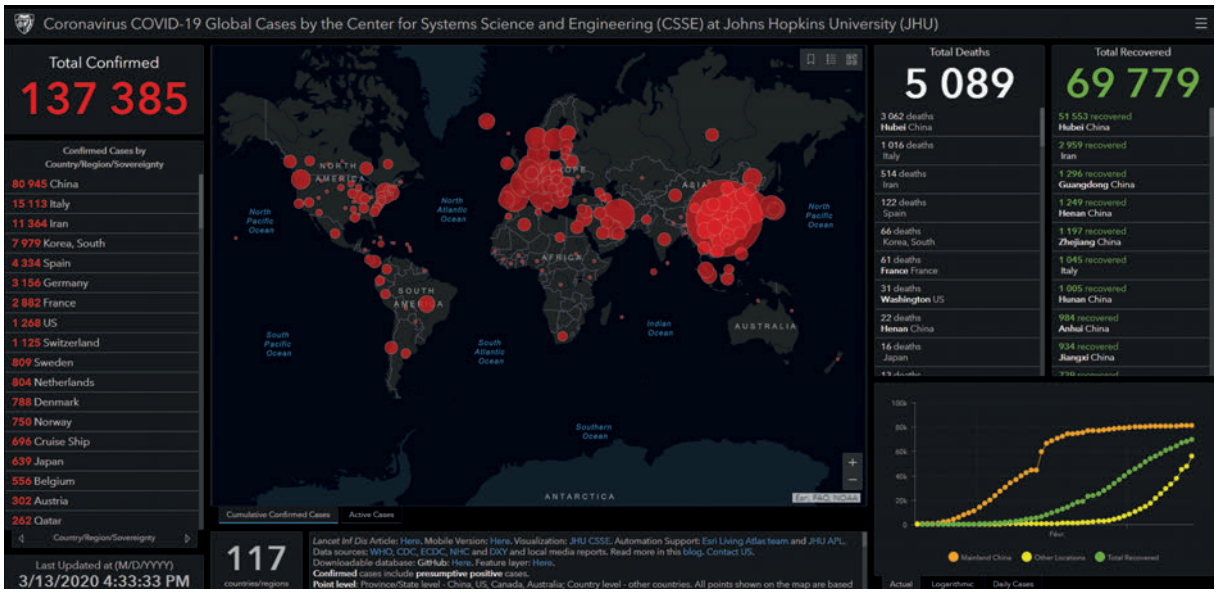
COVID-19: WHAT WE KNOW

Colloquially referred to simply as coronavirus disease, Covid-19 is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) of the Coronaviridae family according to WHO. The outbreak began in December 2019 and has since spread to become a global issue, with outbreaks in several countries. Since the last week of February 2020, Europe has been highly impacted as well.

Based on current medical reports the virus spreads by direct contact with respiratory droplets, generated by the coughing or sneezing of an infected person, or indirectly as smear infection by touching contaminated hands or surfaces.

The most common Covid-19 symptoms include fever, fatigue and dry cough. Some patients may have aches and pains, nasal congestion, runny nose, sore throat or diarrhoea. These symptoms are usually mild and begin gradually. Some people become infected but do not develop any symptoms and do not feel unwell.

It is not certain how long the virus that causes Covid-19 survives on surfaces, but it seems to behave like other coronaviruses. Studies suggest that coronaviruses (including preliminary information on the Covid-19 virus) may persist on surfaces for a few hours or up to several days. This may vary under different conditions (e.g. type of surface, temperature or humidity of the environment).



Update *13/03/2020.*

Source*: CSSE https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6*

2. POTENTIAL MEASURES

2.1 PREPAREDNESS

It is highly recommended that any preparedness measures taken by individual companies should be seen as an integral part of existing crisis management structures and consistent with existing national procedures.

Preventive measures/procedures

A company task force could be created to monitor the evolution of the situation.

Ideally, the task force could be made up of the Board of Directors and heads of or key members of operational departments.

Some examples of issues that the task force could address include:

- Identifying the main partners and contacts
  - For example, authorities (local and national government, public health authorities), Trade Unions/Work Councils/Representatives (to ensure the commitment of staff), Associations (people with reduced mobility and other disabilities to avoid exclusion), and international correspondents for cross-border operations
- Ensuring that personnel in critical functions (control room, signalling centres…) are carefully handled for business continuity
- Identifying employees who could back up critical positions
- Establishing how to deal with absenteeism
- Identifying the preventive measures and procedures to be taken (see below)

Preventive measures and procedures should be defined depending on the location.

Some examples of preventive measures and/or procedures may include:

- Designing a social distancing policy, for example:
  - Pomoting greetings and farewells that do not include handshakes, kisses, etc;
  - Using touch-free devices whenever possible (e.g. touch-free thermometers);
  - Staying more than 1 meter (5 feet) away from colleagues;
- Designing a single-use policy for restaurants on board trains to avoid kitchen contamination
  - For example, single-use plates, glasses, cutlery, and condiments
- Deciding when and how quarantine may apply to staff
  - For example, if a staff member has been in contact with an infected person
- Policies to reduce the likelihood of transmission, for example:
  - Removing magazines, booklets, menus, blankets, pillows, headphones, etc. from the carriages; and in night trains change the blankets after every single use;
  - Changing toilet paper from rolls to individual ply
  - Checking before travel starts that all staff onboard are healthy (via e.g. temperature screening);
  - Using disposable rubber or nitrile gloves to unpack deliveries;
  - Wearing single-use gloves for ticket controlling, or stop controlling tickets to avoid touching;
- Developing staff training specific to Covid-19 for example:
  - How to protect themselves;
  - How to deal with the various situations they will face in the course of their work;
  - How, to avoid discrimination, to learn appropriate gestures for taking care of a sick person (e.g. to wear a mask or not), etc.

Guidance on how to clean and disinfect frequently touched surfaces should be clearly defined.

Some examples of preventive cleaning measures may include:

- Special cleaning of areas where passengers, public and staff are frequently present (stations, mess rooms…)
- Providing a list of surfaces presenting special risks (e.g. toilets, ticketing machines, waiting areas, windows, lockers, magazine racks, try tables, door handles/buttons, soap dispensers, arm rests, …) and having them cleaned regularly
- Ensuring that cleaning personnel are on board during travel (not only between travels)
- Providing access to disinfectant spray to be used by the staff without restriction in those places
- How and where to dispose of biohazards (e.g. used tissues, used masks)
- Cleaning of air conditioning filters in passenger vehicles and in driving cabs

Note: Night Trains can be especially at risk. Special attention must be paid to disinfecting the compartments as people stay longer.

A Business Continuity Plan that takes into account the special circumstances of Covid-19 (if this is not already the case) could be created to respond to the needs of social and economic life while satisfying safety requirements.

Business Continuity Plans already created by railway companies should be applicable to the Covid-19 crisis. That said, some examples of things that may be especially relevant include:

- Reduce the work force
- Consider paying overtime
- Reduce train occupancy
- Promote telework (ensuring staff has the correct software, VPNs, teleconferencing software can handle increased workload, etc.)
- How to ensure access to medical care even if low ridership

Provision of Material

Which personal-protective equipment (PPE) should be made available and where should be defined depending on the location and should be available on trains and at stations for use if an infection is suspected. This should be based on the recommendations of national authorities.

Some examples of material provision measures may include:

- A continuous monitoring of specific supplies, including a plan covering their distribution and refill.
- Defining what protection kits should include, for example:
  - Masks, single-use disposable rubber or nitrile gloves, alcohol-based gel and/or soap, biohazard bags, disinfectant spray and touch-free (non-contact infrared) thermometers;
  - Providing protection kits on board;

2.2 RESPONSE

Implement the (adapted) business continuity plan

Once the crisis has begun, implement the (adapted) business continuity plan.

Management of suspected infected passengers on railway premises

In Stations and on-board trains

Clear protocols should be in place and executed by staff for:

- How to look after staff;
  - For example, one may assign dedicated workers on site designated and trained to support staff in case the encountered suspected cases require urgent medical care
- How to detect ill travellers;
  - For example, via temperature screenings
- How to handle a suspected case, for example:
  - WHO guidelines suggest implementing preventative isolation and to keep ill persons at a distance of 1.5 meters (5 feet) from others and to disinfect the area straight away;
  - Ill travellers may be interviewed to provide authorities with a preliminary analysis of the situation;
  - How the transfer to health care premises will be undertaken;
- How staff should get in contact with the health authorities.

Most of these protocols could already have been decided upon during the preparedness phase.

Cleaning and disinfection of railway assets

Implement the guidance on cleaning and disinfecting frequently-touched surfaces, for example:

- Continuous disinfection (Toilets, handrail, elevator button etc.);
- Deep cleaning;
- Increased frequency of cleaning and disinfection of coaches;
- Disinfection of all public places.

Work together with cleaning providers to ensure a reinforced, coordinated response

For example, ensure that staff in charge of the cleaning are well trained to be self-protected against contaminations and to use cleaning products and processes adapted to the risk level.

2.3 COMMUNICATION

Alongside cooperation among relevant stakeholders, internal and external communication are the best tools to fight this kind of crisis situation. It should be highlighted that good crisis management will be greatly maximised through well-handled communication.

The spread of misinformation is more dangerous than the virus itself and can lead to panic. Fear is one of the most powerful emotions and is rapidly fed by the lack of information and inaccuracies. In order not to be anchored in collective panic, people need valid information from trusted sources. A lack of communication from relevant stakeholders can lead to the rise of fake news and even conspiracy theories. The best way to counteract rumours is to share official information from official sources, with the railway operator being considered one such source (supported by credible facts from credible sources such as the WHO). Thus, one important challenge for the railway operator is to obtain fast and reliable information from the respective national authorities and relay it to both staff and end-users.

Internal Communication

Why communicate?

Internal communication is targeted at railway staff. The better informed the staff, the more likely they are to follow recommended actions and remain at their posts, limiting absenteeism. Staff also need to be able to share company policy with the public and passengers and thus need to be informed ahead of time of company policy and measures taken.

What to communicate?

Information which may be relevant to railway staff could include:

- Sharing information about the current situation in the country (e.g. The Public Health Authority confirms that there are X cases in our country; travel advice; chance of a new outbreak in X country)
- Informing about any special measures for cross border services
- Explaining which measures are being taken by the company to reduce risks of speading infection
- Pre-planned questions and answers for routine questions staff may be asked by passengers and the general public
- Hygiene measures required
- How to report suspected cases of fellow staff and/or passengers
- Continual updates

On which channels to communicate?

Information on Covid-19 should be readily available on all communication channels regularly used by the company (e.g. social media, INTRANET, electronic screens, email, SMS, team meetings)

How to communicate?

Use clear, concise language

When to communicate?

At all stages of the crisis.


TEMPSRÉEL

SNCF SÉCURITÉ

ÉPIDÉMIE COVID-19 : RENFORCEMENT DES MESURES DÉCIDÉES PAR L'ENTREPRISE À COMPTER DU LUNDI 16 MARS


TEMPSRÉEL

SNCF SÉCURITÉ

Mesures sanitaires

Réunions

Déplacements

Visiteurs dans les locaux

External Communication

Why communicate?

External communication is targeted at railway passengers and the general public. Railway undertakings and infrastructure managers are viewed as trustworthy, reliable sources by the public and as such there is an expectation for information to be shared. Meeting this expectation helps to combat the spread of misinformation & rumours and also to maintain corporate reputation both during and after a crisis event. Thus, one important challenge for the railway operator is to obtain fast and reliable information from the respective national authorities and relay it to both staff and end-users.

What to communicate?

Types of information railway undertakings and infrastructure managers might be expected to provide to the public and passengers could include:

- Providing simple means for the public to become part of the solution:
  - Stay at home if you are sick;
  - Use of the flexed elbow method to cough;
  - Clean hands with soap and water or with alcoholic-based gel (ensure availability);
  - Take social distancing measures;
- Explanation of Covid-19 symptoms
- Encourage customers to use online ticket purchasing (to avoid gathering in the railway station ticket offices)
- A clear cancellation policy (refund or exchange)
- Stating what clients should do if symptoms appear during their travel
- Sharing information about the current situation in the country
- Informing on any special measures for cross border services
- Providing information on who to contact for medical advice
- Reassuring users of the railway system as to the additional/reinforced cleaning regimes in place (e.g. what time the cleaning person passed)

On which channels to communicate?

In a crisis, people tend to use the same communication means that they use in their everyday life and thus information on Covid-19 should be readily available on all communication channels regularly used by the company (website, social media, apps, in station announcements, via press releases, etc.).

How to communicate?

At a general level, visual communication (infographics, videos and pictograms) is recommended. Visual communication helps to avoid language and other functional needs barriers. They can be provided by the National Authorities or International Health Organisations (WHO or ECDC[2]). For example, cartoons depicting how to cover one's mouth when sneezing or coughing using the elbow technique are particularly relevant to the Covid-19 outbreak.

It is also recommended to use easy to understand language (use laypeople's language and not technical terms), be concise, and adapt communication to people with specific special needs (deaf, blind, etc.). Collaboration with national associations of people with reduced mobility and special needs is strongly recommended.

When using social media, keep in mind relevant hashtags. Examples currently (12/03/2020) trending on twitter include #covid_19, #CoronavirusPandemic, #COVID19. Sometimes a location is added to a hashtag when relevant, for example #covid19fr is trending in France.

When to communicate?

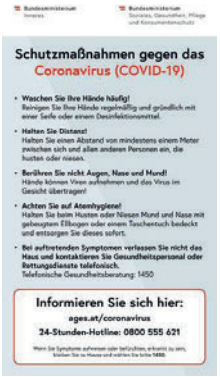
During all stages of the crisis.

2 WHO: World Health Organization, ECDC: European Centre for Disease Prevention and Control

2.4 EXAMPLES OF COMMUNICATION MATERIAL FROM UIC MEMBERS

Below, some examples of communication materials used by UIC members to increase awareness of staff and the public.

Austria

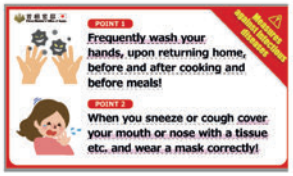


Canada

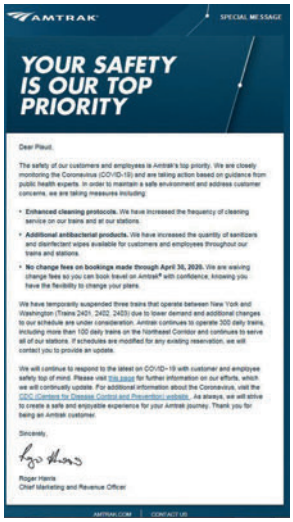
Denmark

France

Japan



United States



South Korea

3. CASE STUDIES AND PRACTICES

All practices collected by UIC are available on the dedicated Covid-19 workspace at: https://extranet.uic.org/

As well was the UIC mediacenter at: https://mediacenter.uic.org/

For now, contributions have been sent by Railway Companies from all over the world, including Austria, Bulgaria, Canada, China, Denmark, France, Germany, Hungary, Iran, Israel, Italy, Japan, Norway, Poland, Slovakia, South Korea, Spain, the Netherlands and the United States of America.

4. ETHICAL AND LEGAL CONSIDERATIONS

All measures should be developed within the framework of national rules and regulations and taking into account national and corporate ethical considerations.

In Europe, normally both PRR (Passenger Rail Rights) & GDPR (General Data Protection Regulation) are especially relevant, however the full application of these regulations could be affected by the Covid-19 crisis.

CONTACT: COVID19@UIC.ORG

5. REFERENCES

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IATA (2014). Crisis Communications and Social Media: A Best Practice Guide to Communicating In An Emergency.

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Petersen, L., Fallou, L., Reilly, P., & Serafinelli, E. (2017). European Expectations of Disaster Information provided by Critical Infrastructure Operators: Lessons from Portugal, France, Norway and Sweden. International Journal of Information Systems for Crisis Response and Management (IJISCRAM), 9(4), 23-48. doi:10.4018/IJISCRAM.2017100102.

Petersen, L., Fallou, L., Reilly, P., Serafinelli, E. (2018). Public expectations of critical infrastructure operators in times of crisis. Sustainable and Resilient Infrastructure. doi: 10.1080/23789689.2018.1469358

UITP (2020). MANAGEMENT OF Covid-19: GUIDELINES FOR PUBLIC TRANSPORT OPERATORS.

UIC (2017). Recommendations on Crisis Management (additional programme 2016-2017) https://uic.org/IMG/pdf/crisis_management_report.pdf

WHO (2020). https://www.who.int/fr

6. ANNEX

UIC, together with UIC Special Group COLPOFER, developed a questionnaire regarding the measures that have been put in place in different companies.

- **1. Which Public Authorities in your country are involved in the management of the Covid-19 outbreak?**
- **2. Which obligations have been issued by your National Public Authorities on railway transportation?**
- **3. Which measures have you adopted to prevent Covid-19 spreading:**

  - on board? (e.g. hand sanitising dispensers, waterproof rubbish bags, further sanitising inter vention from cleaning companies)

  - in stations? (e.g. hand sanitising dispensers, waterproof rubbish bags, , temperature monitoring)

  - in critical sites (e.g. Railway Traffic Circulation Control Rooms)? (e.g. sanitation protocols, working space segregation)

  - in HQs? (e.g. creation of a specific task force and Covid-19 protocols, specific access regula tions, teleworking, meeting organisation rules)

  - for front-line staff? (e.g. operational guidelines, provision of specific personal protective equipment)

  - among all your staff? (e.g. teleworking, limited travel)

- **4. Which procedures have you adopted for dealing with Covid-19 suspected cases?**

  - on board? (e.g. communication with Public Health Authorities and Law Enforcement)?

  - in station? (e.g. communication with Public Health Authorities and Law Enforcement, tempo rary isolation, sanitation protocols)?

  - in railway premises? (e.g. disinfection protocols, co-workers of the suspected case support)

  - amongst Railway Traffic Circulation Control Rooms' staff? (Please give a brief description of the business continuity plan)

- **5. Passengers awareness**

  - Which suggestions or advice have you given to railway passengers (e.g. general health ad vices from Public Health Authorities, use of online ticket selling channels)?

  - Please send us examples of communication material used to raise awareness among railway passengers (e.g. posters, leaflets of recommendations, short videos)

  - Which information channels do you use? (e.g. station displays and displays on trains (including international sign language for cross border connections), voice communication in station and into the trains, social networks)?

- **6. Staff awareness**

  - Please send us examples of communication material used to raise awareness among staff (e.g. poster, leaflets of recommendations, videos, tutorials)

  - How do you update your staff in real time on the topic (for example train staff)?

- **7. Open suggestion**

  - Please indicate any information/best practice regarding railway transportation not mentioned in the previous questions.

INTERNATIONAL UNION
OF RAILWAYS

EUROPEAN UNION AGENCY FOR RAILWAYS

COVID-19 INFORMATION BULLETIN

VENTILATION IN RAILWAY VEHICLES

Sept. 2020

Introduction

On 21 July 2020, the European Union Agency for Railways (ERA) and the European Centre for Disease Prevention and Control (ECDC) published the COVID-19 Rail Protocol, which provides operational guidelines for the resumption of railway operations in Europe after the COVID-19 pandemic lockdown. This protocol complements measures taken by the European Commission to support Member States in re-launching mobility and tourism across Europe. We strongly recommend consulting the COVID-19 Rail Protocol before reading this Information Bulletin, as it contains complementary information.

ERA's COVID-19 Information Bulletins provide detailed non-binding information to safeguard the health and safety of passengers, transport workers and staff, and to re-establish trust in rail services.

The present Bulletin focuses on ventilation systems for railway vehicles, providing non-binding guidance on the optimal system settings and on related operational procedures and maintenance measures. ECDC contributed where appropriate.

ERA provides expertise to support the efforts of European railway companies to reduce the risk of spreading COVID-19, and facilitates the international exchange of COVID-19 relevant information, experience and best practice.

General advice

Railway undertakings, infrastructure managers, other railway stakeholders and National Safety Authorities (NSAs) - if this is in their national mandate -, taking into account the information in this bulletin, should coordinate their actions with the relevant national, regional or local public health authorities in order to effectively mitigate risk while complying with national requirements.

To efficiently reduce the risk of spread of the COVID-19 virus, it is essential that passengers and staff adopt appropriate behaviour such as physical distancing, respiratory etiquette, use of face masks and frequent hand hygiene. We have described this in the joint ERA/ECDC COVID-19 Rail Protocol. This Information Bulletin does not replace the protocol but complements it with additional recommendations on ventilation systems.

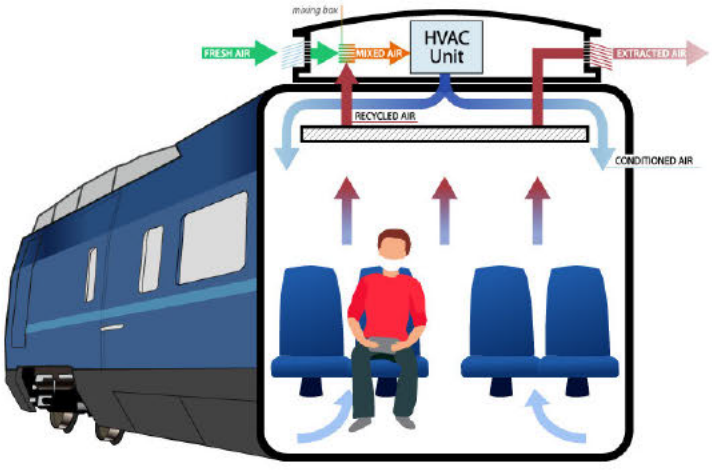

Fig.1: Typical situation in a passenger vehicle

Ventilation & air distribution systems

The current Technical Specifications for Interoperability for locomotives and passenger rolling stock [1] (TSI LOC&PAS) impose a maximum CO_2 level of 5000 parts per million (ppm) inside the vehicle's passenger area, but they do not impose any specific measures to prevent the spread of micro-organisms. Railway vehicles are already designed to allow optimal ventilation. Adapting some aspects of the train design, ensuring its proper maintenance and influencing certain settings may contribute to further reduce the risk of spreading of the COVID-19 virus. Where applicable, railway staff should be clearly instructed about specific settings as mentioned below.

Main ventilation concepts in railway vehicles

Various concepts of air distribution systems exist in the rail vehicle fleet today:

- Natural ventilation: Windows or transoms that can be opened;
- Forced air ventilation systems, sometimes with air refresher devices;
- Air conditioning (Heating, Ventilation, and Air Conditioning - HVAC) systems with various air circulation layouts depending on the type of vehicle, e.g. single deck or double deck, applying partial re-circulation of passenger compartment air.

Similar systems manage the air distribution in the driver's cab, either dedicated to that cab alone or shared with passenger air treatment units.

The majority of ventilation systems in rolling stock do not generate direct airflow towards the travellers but conditioned air is led indirectly into the passenger compartment from the ceiling along the walls, thereby reducing the risk of spreading droplets from one traveller to another (Fig 1).

In the rare case of a train equipped with individual ventilation nozzles the EASA ECDC COVID-19 Aviation Health Safety Protocol recommends that individual air-supply nozzles for passengers should be turned off. The same recommendation applies to railways.

All the air inside the rolling stock is usually renewed at least every ten minutes depending on the type of train, which limits accumulation or stagnation of infectious droplets in the train cars. The relative contributions of aerosol and fomite transmission routes for SARS-CoV-2 infection and the spread of the COVID-19 pandemic have not yet been determined. Aerosols are diluted with increasing distance from the source but may be concentrated in confined, poorly ventilated spaces.

Droplet infection is the main route of transmission, however, the World Health Organization (WHO) recently acknowledged the importance of potential airborne transmission of aerosols containing SARS-CoV-2 [2].

Because of this possibility there is consensus among experts that it is better to keep ventilation systems 'on' to evacuate potentially harmful aerosols. Switching off ventilation systems may keep those aerosols in the passenger compartment.

It is recommended to switch on the ventilation as soon as possible before the passengers enter, to keep the ventilation working between two trips and as much as possible at the end of the service day.

Natural ventilation (doors, windows, transoms)

Even though highly recommended, the efficiency of natural ventilation is dependent on:

- Speed and direction of the vehicle
- Landscape (tunnel, mountains, flatlands, etc.)
- External wind and its direction.

It is not easy to predict the airflow from natural ventilation as well as the effect of other ventilation systems when combined with natural ventilation. However, as natural ventilation is very likely to reduce the concentration of aerosols that could potentially carry the virus, we recommend to use natural ventilation as much as possible, for example by opening the access doors during train stops in stations as well as in the terminal station between two trips to accelerate air renewal inside the vehicle.

We recommend to use natural ventilation as much as possible during train stops. Natural ventilation should be used also during travel time, particularly in instances of overcrowding, when operational limitations inhibit sufficient physical distancing. e.g. high density of passengers standing.

Air re-circulation inside passenger vehicles

In many trains Heating, Ventilation, and Air Conditioning (HVAC) systems are operating using both fresh outside air and recycled air. Up to 90% of the total ventilated volume of air can be recycled air. This is either a fixed ratio or automatically adjusted by HVAC regulation.

Air recycling is often used to:

- Lower the energy consumption,
- Increase passenger comfort (airflow from the cooling unit is dry and cold) - mixed air offers better comfort.

Maximising the ratio of fresh air can be achieved by different means such as:

- Settings in the ventilation / HVAC control panel,
- Physical reduction of the recycled air intake,
- Disconnecting CO2 sensors and setting HVAC to recovery mode.

[1] TSI LOC&PAS; [2] WHO; [3] Legionellosis [4] WHO

Current automated climate control systems may require software adjustments to increase the amount of fresh air. These changes should be performed as soon as feasible by the train operator, taking into account the heterogeneity and number of vehicles/fleets.

Forcing the fresh air intake to a maximum may lead to some issues, such as:

- Lower performance of the system: the temperature might not reach the expected values, especially in extreme weather conditions (low or high external temperature, high humidity) or with high passenger density;
- Slight overpressure inside the compartment may delay the closing of the doors. (Not causing any safety issue once closed);
- Overpressure while entering tunnels and during crossing of two trains possibly causing ear discomfort.

That is why we recommend to test and verify the behaviour of the ventilation / HVAC unit as well as the level of performance with maximum fresh air intake and to ask the manufacturer of the system for advice. Manufacturers can provide guidance on the best settings to be applied. In addition, railway staff should be clearly instructed about specific settings to be applied.

We recommend to maximise the percentage of fresh air inside the vehicle and to minimise the amount of recycled air.

Air distribution through ducts (forced air & HVAC systems)

Air outlets and inlets are usually not placed all along the vehicle but in specific areas optimally directing the airflow throughout the passenger compartment. In most cases inlets are placed along the windows and not directly in the direction of the passengers.

Movements of passengers and staff can change the airflow in the vehicle, for example when entering and exiting the train, or walking to the toilets. As mentioned in the COVID-19 Rail Protocol those movements should be limited, if possible. Read the Protocol to learn more about our recommendations concerning passenger behaviour during travels and usage of face masks.

In order to remove any particles that could have accumulated inside the duct network, ducts have been made accessible for cleaning following the lessons learned from Legionellosis outbreaks in early 2002[3][4]. Specific cleaning procedures exist for recently built rolling stock, while for older rolling stock procedures may still need to be developed.

Please refer to the manufacturer's guidelines for frequency and procedure to clean the air distribution ducts and outlets of the HVAC.

Air Filtration (forced air & HVAC systems).

In many air-distribution systems, both outside air and recycled air are filtered with the aim to limit dust concentration in the compartment and in the system itself. HVAC units are designed to perform with a defined filtering class. Filters generally installed on rolling stock are designed to block dust, which means 40 to 60% of the particles of 10 micrometres (µm). Filtration efficiency depends on airflow, air pressure and speed. Passive filter efficiency has a direct impact on air pressure and comfort.

High-efficiency particulate air (HEPA) filters can retain aerosols containing SARS-CoV-2. To be able to filter properly, several parameters like air pressure and speed, or the effective surface of the filters have to reach specific values. HEPA filters need high air pressure and speed to function, and current ventilation systems in trains are not designed to generate such airflow. Upgrading the HVAC system to allow the use of HEPA filters is a significant operation that may entail:

- Upgrade of the fans,
- Changes in the duct network,
- Increase of energy consumption,
- Increase of noise level,
- Changes in the thermal comfort.

In addition, depending on the type of train (double deck or low floor trains) the upgrade may not be possible due to the lack of available space to install the upgraded HVAC system.

Alternative solutions to neutralise pathogens exist, like e.g. ultraviolet lights mounted in ducts, thermal exposition or ionised purifiers, however their efficiency against SARS-CoV-2 has not been sufficiently demonstrated yet in the railway environment. For more detailed information please refer to REHVA (Federation of European Heating, Ventilation and Air Conditioning Association) COVID-19 guidance document, August 3, 2020

By maximising the fresh air intake into vehicles, and depending on the external environment, the amount of particles to be filtered, coming from outside, increases. Extra maintenance may be needed to replace, clean or disinfect the filters. Manufacturers may help or provide guidance. During maintenance, the manufacturer's specified procedures have to be followed. The system has to be turned off and the maintenance personnel has to wear adequate protective equipment (gloves, facemask). The used filters have to be disposed in sealed bags.

Failure of the ventilation system

Every effort should be undertaken to minimise the duration of stay of passengers on-board a train without ventilation. In case of a main ventilation system failure, train staff shall use emergency ventilation (battery powered ventilation or natural ventilation) in order to decrease the concentration of

[1] TSI LOC&PAS; [2] WHO; [3] Legionellosis [4] WHO

aerosols that might contain viruses. The trip shall be aborted as soon as possible and the passengers shall be evacuated from the train to the closest suitable and safe place.

The EASA ECDC COVID-19 Aviation Health Safety Protocol is giving a similar advice with a maximum duration of 30 minutes of ventilation failure before evacuation of passengers. TSI LOC&PAS [1] § 4.2.5.8. requires a minimum of 30 minutes emergency ventilation in case of main ventilation failure.

In the case of a train stopped on tracks outside a station and in order to ensure the safety of the passengers, it is highly recommended to:

- Keep the ventilation on and to open windows if possible;
- Provide general safety information to train passengers about the behaviour to adopt when the train is stopped on tracks (e.g.: not to use the emergency opening function of the doors to exit the train) and remind the passengers of specific measures (e.g. wearing masks and not moving through the train) to limit COVID-19 spreading;
- Provide updates about the rescue operations.

Summary of recommendations/mitigation measures:

- Evacuate passengers from a train without functioning ventilation system as soon as possible.
- Do not switch off the ventilation/air conditioning systems.
- If possible, operate the HVAC unit with 100% fresh (outside) air.
- Verify (with the manufacturer or by means of test) the behaviour of the units working with the advised 100% fresh air (from outside) and adapt the percentage of fresh air as well as the maintenance plan if needed.
- Open the windows / transoms to maximise fresh air in the vehicle, especially where other means of ventilation do not exist or if high passenger density cannot be avoided.
- Perform a specific analysis of the ventilation and air flows in long tunnels.
- Limit as much as possible the use of individual air supply nozzles (if available), unless it conflicts with the recommendations from the train manufacturer.
- Follow the advice of manufacturers for the maintenance of the HVAC system and the type of filter to be installed.

Acknowledgements

We would like to acknowledge the assistance of ECDC expert colleagues in formulating the text of this bulletin.

Note from the editors

This bulletin is the result of a fruitful collaborative effort among experts from the European Union Agency for Railways (ERA) and the European Centre for Disease Prevention and Control (ECDC) with contributions from the European Commission, National Safety Authorities and railway sector representatives. It reflects the current status of knowledge about the COVID-19 disease and its pandemic effect. It summarises preventive measures considered effective at the date of publication. While the herein proposed COVID-19 mitigating measures are not legally binding, they represent harmonising measures and may serve as reference for the European railway sector.

It is fully acknowledged that railway undertakings assume their legal responsibility in the context of national regulations, and may use the proposed measures at their own discretion and risk. For questions and feedback, please contact COVID-RAIL@era.europa.eu. We invite you to use this mailbox to also share your best practices and lessons learned with our team, enabling us to share those with the sector to the benefit of all.

Making the railway system work better for society.

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linkedin.com/company/81030/

From: [redacted]
To: [redacted]
Cc: [redacted]

Subject: FW: Wabtec HVAC Advanced filtration system - Blue Filter
Date: 29 May 2020 16:23:21
Attachments: We sent you safe versions of your files.msg
Wabtec Blue Filter Presentation 29.05.20.pdf

Mimecast Attachment Protection has deemed this file to be safe, but always exercise caution when opening files.

Colleagues
I have been asked by Wabtec/Faiveley to make you aware of this new product offering from them re on train HVAC filtration, and given the current Covid-19 pandemic, I have agreed to do this – if you are interested, pls make contact with them directly
Regards

[redacted]

From: [redacted]
Sent: 29 May 2020 15:58
To: [redacted]>
Cc: [redacted]
Subject: Wabtec HVAC Advanced filtration system - Blue Filter
This Message originated outside your organization.

[redacted]
I have been asked to make contact with yourself by [redacted] to introduce to you the Wabtec advanced filtration system for HVAC. Please find attached the Wabtec presentation on our Blue Filter product for your review.
I hope the product is of interest to you and I would be happy to discuss in more detail, please contact me when convenient.
Kind Regards

[redacted]

BlueFilter

Advanced air filtration solution in public transportation

Wabtec CORPORATION

General context

Wabtec CORPORATION

Air filtration onboard

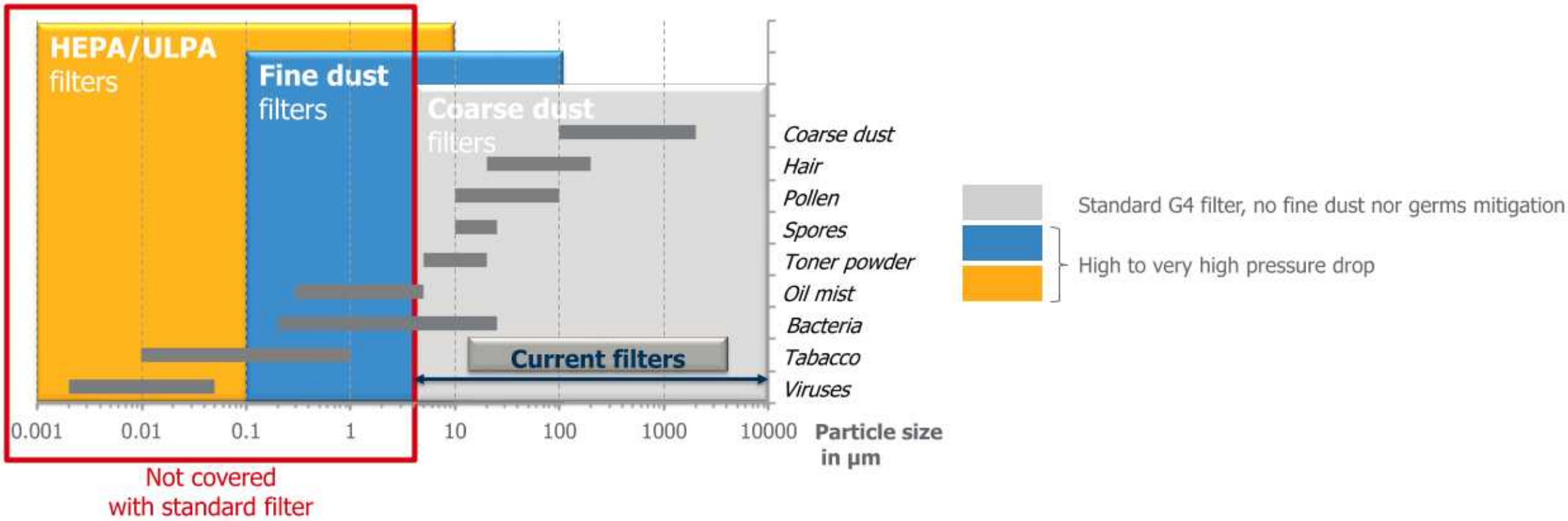
General context

- **Air quality in public transportation might be a major concern** *(epidemics, fine particles, seasonal allergies…)*
- **Air filtration in HVAC** systems is basic and provides very limited protection to passengers
- **Public Transportation** can create a crowded **environment contributing to contamination** *(dissemination of germs through HVAC return air)*
- **For rail operators,** it is both a risk and an opportunity **:**
  - **Risk to deteriorate company image**
    i.e : incidents reported in media & social networks / Seasonal flue, SARS, H1N1, COVID-19 etc…
  - **Opportunity to promote a safer public transportation** environment & **reassure their passengers**

Air filtration onboard

General context – mechanical filtration solutions

Standard HVAC filtration system does not reduce air germ/viral load



Our solution

Wabtec CORPORATION

BlueFilter – Advanced filtration

Description of our solution

BlueFilter key characteristics:

- Eliminates **up to 92% of viruses** and **83% of bacteria** per air cycle
  - Tests done by 2 independent laboratories, one is part of TÜV North group.
    - Virus type tested: lambda phage (size 250nm)
    - Bacteria type tested : Bacillus subtilis
  - Presented at Innotrans (Berlin) in 2016

End Filter type	Eff. On viruses	Eff. On bacterias	Pressure drop impact	Maintenance interval
Standard	**73%**	**19%**	No impact or improvment	No impact or improvment
Premium	**92%**	**83%**	+90 to 120 Pa @ 2,5m/s	Depending on application Dedicated to pandemy situtation

- Captures **up to 15% of fine particles** per air cycle*
- Filtration performance on particles **close to M5 (EN779)**
- No ozone generation

Improvement vs standard filter for particle size < 1µm

BlueFilter – Advanced filtration

Description of our solution

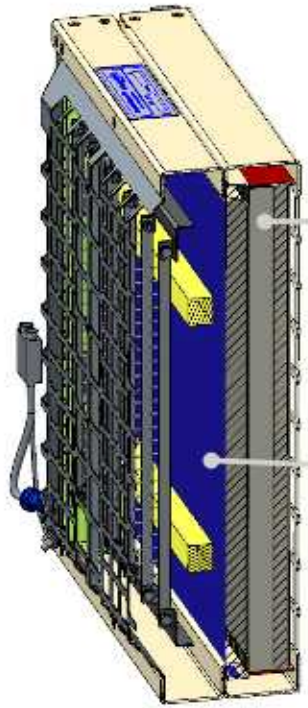
BlueFilter installation:

- Integration into existing filter envelope, **adaptable to most HVAC units**
- **Installation in 2-4 hours** (integration pending)
  - **Mechanical :** removing of existing filters cassettes / fixing of new ones
  - **Electrical :** cabling 110Vdc to DC/DC inverter, in serial with ventilation authorization or cover opening sensor if it exists. Electrical grounding of the cassettes

BlueFilter – Advanced filtration

Mechanical layout

BlueFilter 3D view

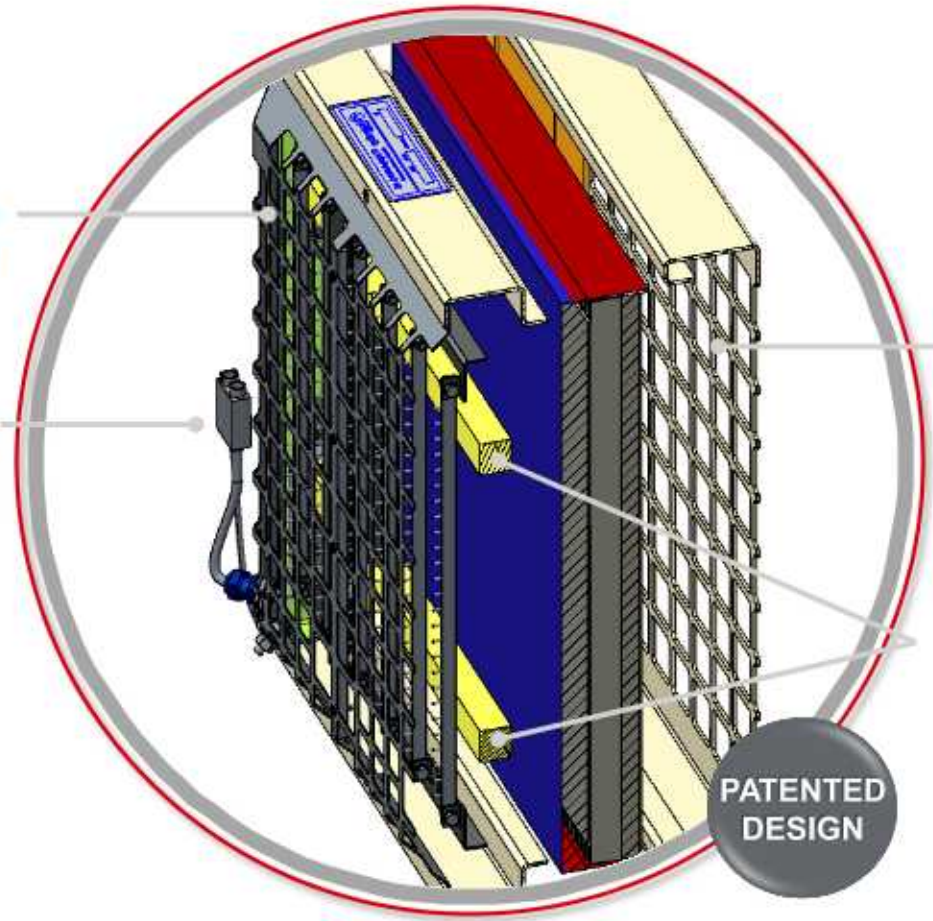


AIRFLOW

Cassette filter

Electrostatic chamber

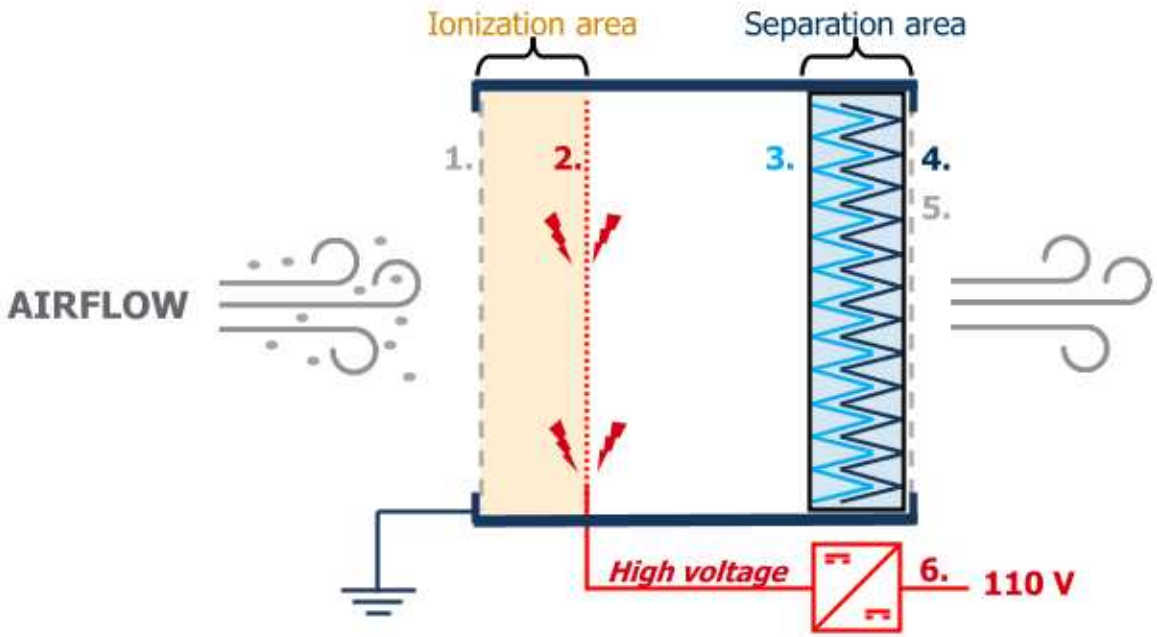
BlueFilter exploded view



Main patent claim:
unique combination of electrostatic field & mechanical filtering system

BlueFilter – Advanced filtration

Schematics & principle



(1) Control electrode (inlet protection grid)
(2) Discharge electrode
(3) Filter element
(4) Activated layer
(5) Grounding electrode (outlet protection grid)
(6) DC-DC converter

1/ Electrostatic field between control & discharge electrodes

2/ Ionization of the air flow

- Electrostatic charge of particles
- Inactivation of bacteria & viruses

3/ Mechanical and electrostatic separation of particles through the combined filter element

BlueFilter – Advanced filtration

Example of integration – High speed train in Germany

Initial configuration **BlueFilter installed**

Standard BlueFilter: Maintenance interval can be increased by up to 20% vs original filter mat design *(as shown on picture above)*

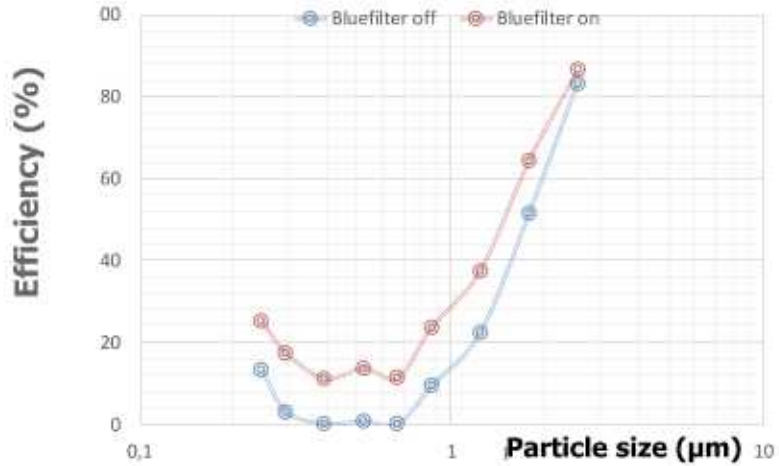
Premium BlueFilter: Field test has to be made to identify the maintenance interval *(predicted to be shorter, depending on operation environment)*

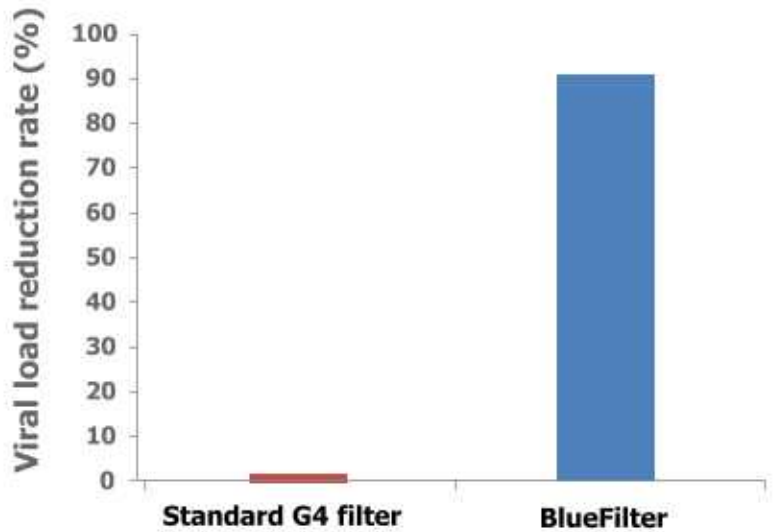
Customer benefits

Wabtec CORPORATION

BlueFilter – Advanced filtration

Characteristics & Performances





15% reduction of fine particles per air cycle with standard filter panel when electrostatic filtration energized

(0,25µm to 1 µm)

- **90% reduction in** viral load per air cycle
- Multiple air cycles could approach 100% reduction of viral load

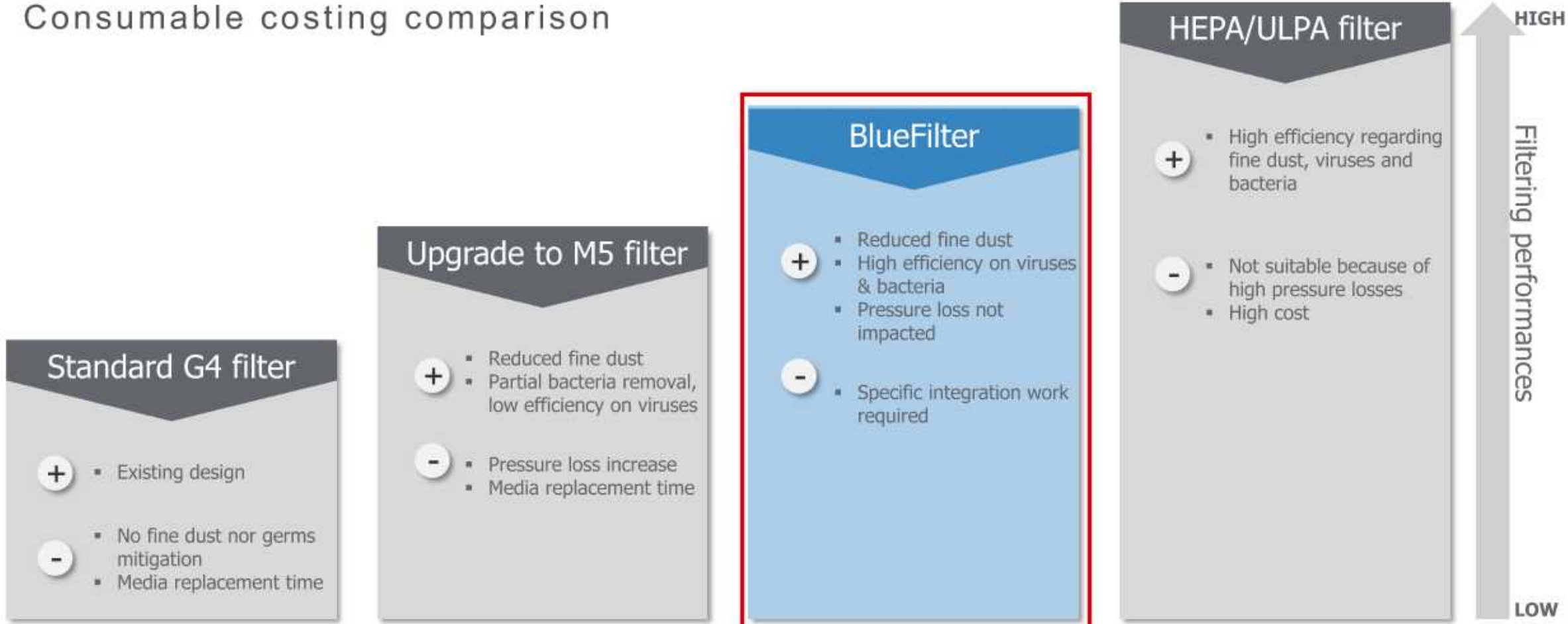
BlueFilter – Advanced filtration

Comparison with alternative technologies

Technology	UV lights	Plasma tubes
Drawbacks	▪ **High power consumption** ▪ Efficiency drops with dust settlement / distance from bulb / shadow effect in ducts ▪ **More than 2 seconds of exposure needed** to kill germs *(not practical for HVAC airflow management)* ▪ **Degradation of light bulb environment** *(e.g. mechanical filter becomes brittle)* ▪ **Not maintenance friendly** *(light bulb is fragile and has to be replaced)*	▪ Cumbersome / **difficult to integrate in HVAC envelope** ▪ **Very intrusive** *(Requires installation in airducts)* ▪ Heavy unit **requiring extra ventilation power*** ▪ Standard filter still needed to catch corse/medium size particles ▪ High pressure drop / **air flow significantly reduced*** **Airflow reduced by at least 20%*
Rail Applications	Exclusively in Russia	No successful application in rail

BlueFilter – Advanced filtration

Consumable costing comparison



TCO

- Depends on size & processed air volume
- Media change labor cost

- Media & change labor cost
- More frequent replacements
- Double filter setup

- **Cassette filter cost** *(no labor for media replacement)*
- **Less frequent replacements** *(est. 20% reduction)*

Not applicable in rail applications

BlueFilter – Advanced filtration

Key benefits to operators & passengers

- **For train operators:**
  - **Air quality breakthrough in rail industry**
    (market differentiator, competitive advantage)
  - Promotes ridership
  - Adaptable to most HVAC unit
  - Homologation ready
- **For passengers:**
  - Reassuring environment
  - Healthier & safer ground transportation
  - Reduction of allergies
  - Special care of pollution sensitive people *(children, asthmatic)*

Solution deployment

Wabtec CORPORATION

BlueFilter – Advanced filtration

Solution deployment

Phase 1 – Prototype (4-5 months)

- **Study of the integration** on existing HVAC
- **Installation on car** of BlueFilter & **replacement** of regular filters on train
- Performance monitoring starts, **filter saturation comparison** (additional 3 to 4 months)

Phase 2 - Deployment

- **Gradual installation** on fleet & customer **training**
- Possibility to install a **filter saturation detection system**
- 12 months operation equipment inspection

Appendix

Wabtec CORPORATION

BlueFilter – Advanced filtration

Technical solution datasheet

Electrical interface	
Voltage	Train battery voltage (24,48,72,110VDC)
Integrated circuit breaker protection	
Power consumption	75W
Other characteristics	
Additional weight vs existing filter	8 kg-10 kg (HVAC configuration pending)
Air flow pressure drop vs G4 filter	Negligible
Protection	IP20
Consumable	Filter cassette
Filter grade equivalent M5 (EN 779)	
Standards	
EN 50121-3-2	Electromagnetic compatibility
EN 50124-1	Creepage/clearance distances
EN 50155	Electronic equipment design
EN 61373	Shock and vibration
EN 45545	Fire, smoke and toxicity
ISO 16890	Air filters for general ventilation

For further details, please contact

[redacted]

Wabtec CORPORATION

From: [redacted]
To: [redacted]
Cc: [redacted]

Subject: KBRS - HVAC Systems & Covid-19
Date: 21 May 2020 17:42:00
Attachments: image001.jpg
We sent you safe versions of your files.msg
2020 May KBRS Filter technologies v4 tris.pdf

Colleagues
We have recently been made aware of the attached products and systems by various KBRS global subsidiaries that they claim will have a positive impact on airborne viral contamination of on train HVAC air systems – these were developed to address earlier SARS viral epidemics and are thus already in production and are variously fitted on some fleets in China, Russia, Belorussia and Finland
This is not to be taken as an endorsement by RDG of these products, or the claims made for them ,but to bring thm to your attention
Regards
[redacted]

From: [redacted]
Sent: 18 May 2020 16:51
To: [redacted]
Cc: [redacted]
Subject: RDG Guidance on Rolling Stock Ventilation during the Covid-19 Pandemic
Colleagues
Recently developed RDG guidance for train operators and maintainers on rolling stock ventilation during the Covid-19 pandemic is attached for your information – like much RDG guidance, it has been developed to aid, advise and guide our members and their suppliers. It is not to be regarded, nor is it intended to be a minimum standard to conform to, nor instructions to be complied with
We are very happy to receive feedback on its content for possible inclusion in future issues of this guidance
Regards
[redacted]
Head of Engineering

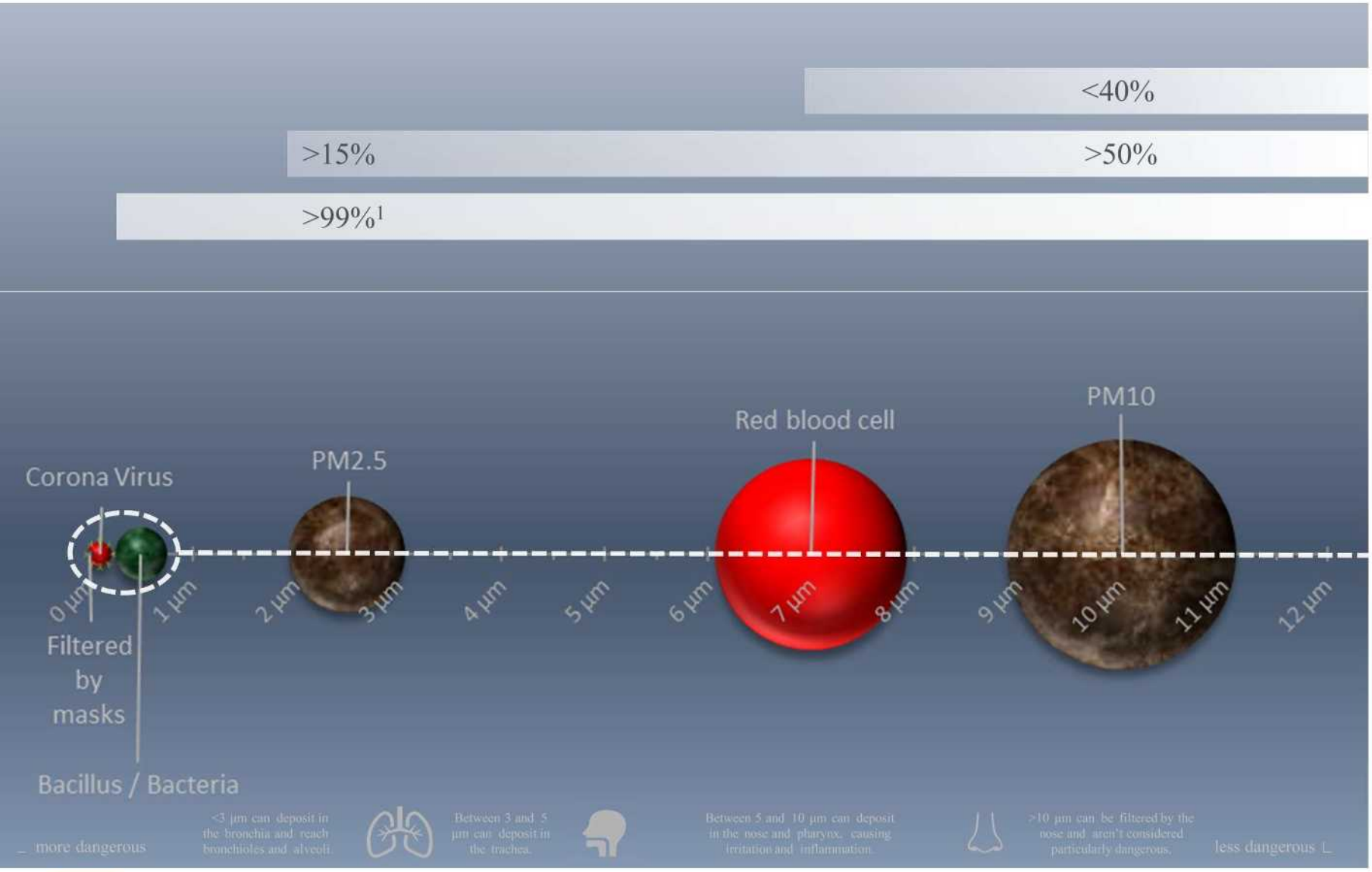
[redacted]

[redacted]

2nd Floor, 200 Aldersgate St, London EC1A 4HD

RDG Logo

Particle Size Challenge and Efficiency



Regulation

Merak Optimized Mix

Filtration

Standard G4 Filter

Merak Long Life Filter

Pre-Filter + MIFD

Purification

MDBD[2]

Merak UV-C Lamp[2]

1. Efficiency assessment according to ISO standards to be completed.

2. The specific action against Corona Virus has yet to be validated, but both technologies have demonstrated to inactivate viral and bacterial organisms.

Merak Optimized Mix

How it works
Adjust airflow to prioritize maximum fresh air and extraction over energy efficiency during periods demanding sanitation (parametrizable).

Value proposition
In most of our systems, this only requires a software adjustment and allows to balance air quality and climate comfort.

Applicability to new HVAC (OE) and/or retrofit (RS)
Can be added as new functionality (e.g. like emergency mode) or fitted to existing systems.

Status
Ready for roll-out, though available capacity and performance t.b.c.

Application samples
Various, incl. complete fleet upgrade of 5.452 HVACs on 590 trains during Chinese New Year.

MIFD (Merak Intense Field Discharge)

How it works
A 1st layer (pre-filter) arrests bigger particles.
A 2nd layer has holes and pin electrodes in the middle of the holes: the air and dust passing through the holes are charged positively.
A 3rd layer has insulated electrodes to collect the charged particles. This layer has a deep honeycomb structure to improve dust accumulation.

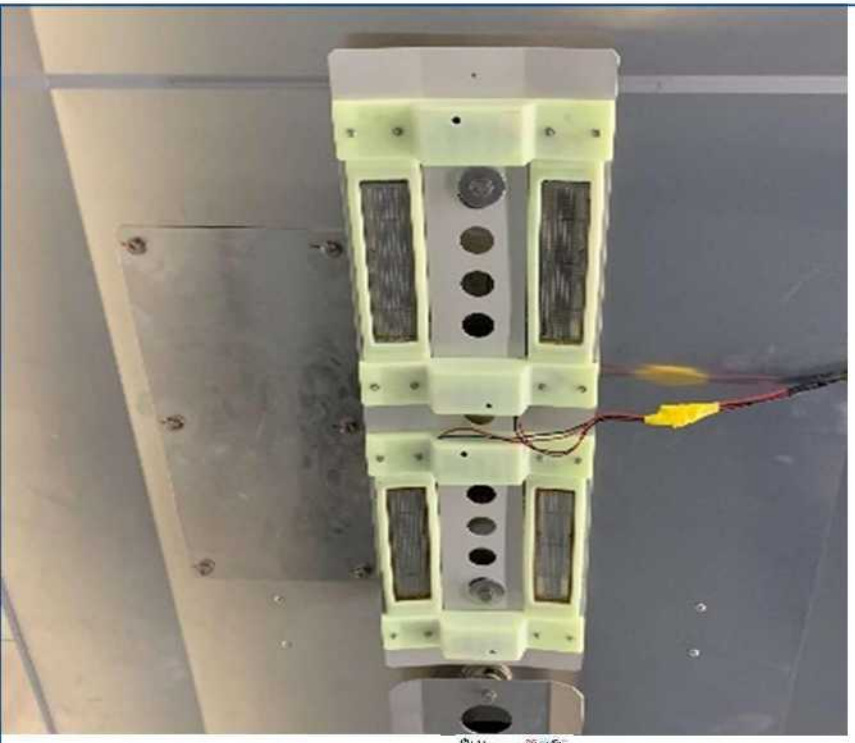
Value proposition
Reach very high filtering efficiency (like HEPA) with very small pressure drop and longer duration.

Applicability to new HVAC (OE) and/or retrofit (RS)
Can be applied to both OE and RS by a modification of the frame that holds the filter and if some more space is available (total depth between 60-100mm versus standard 50mm).

Status
Ready for series delivery pending lead time/conditions of supplier

Application samples
Metro Wuxi, CRH380.

MDBD (Merak Dielectric Barrier Discharge)



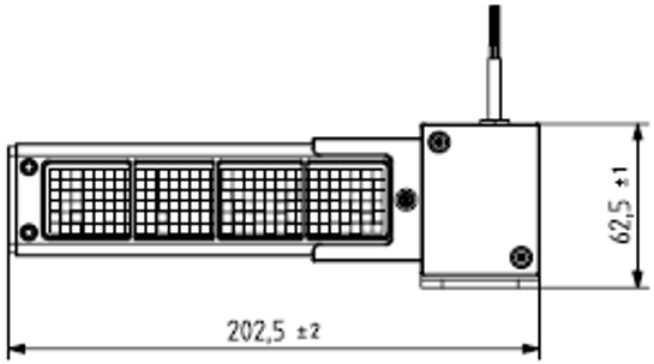
How it works
Air in contact with the device is ionized, creating a plasma (gas containing electrons and ions).
Molecules of various compounds (such as formaldehyde, ammonia, bacteria, etc.) are attacked by the ions and reduced to not harming substances.

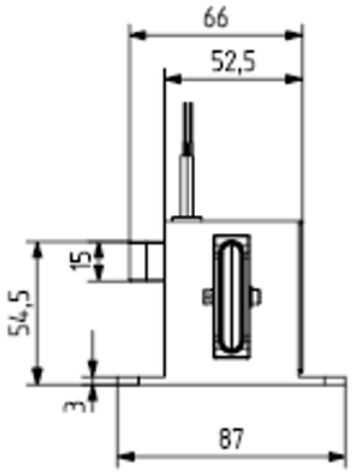
Value proposition
Improve air quality, by suppressing smells and killing bacteria, with a small device that can be integrated in existing units and/or car ducts.

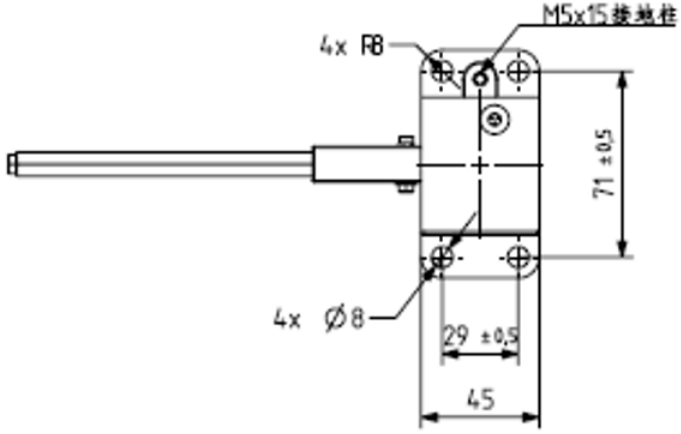
Applicability to new HVAC (OE) and/or retrofit (RS)
Can be applied to both OE and RS by choosing a proper position in the supply air (can be inside the HVAC unit or in the car ducts).

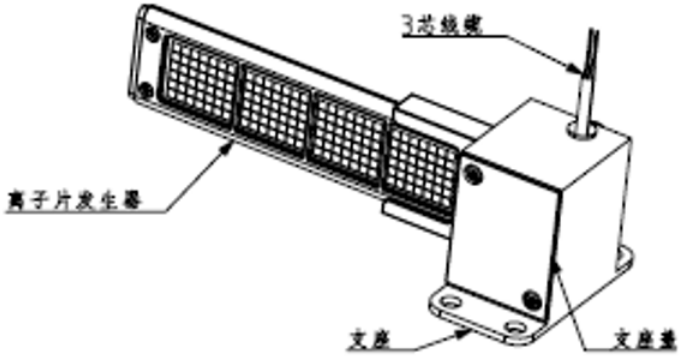
Status
Under field testing pending conformity check with EN standards and supplier conditions

Application samples
Metro Wuxi, CRH380, CFX600 Maglev, TRC Sleeper Car.



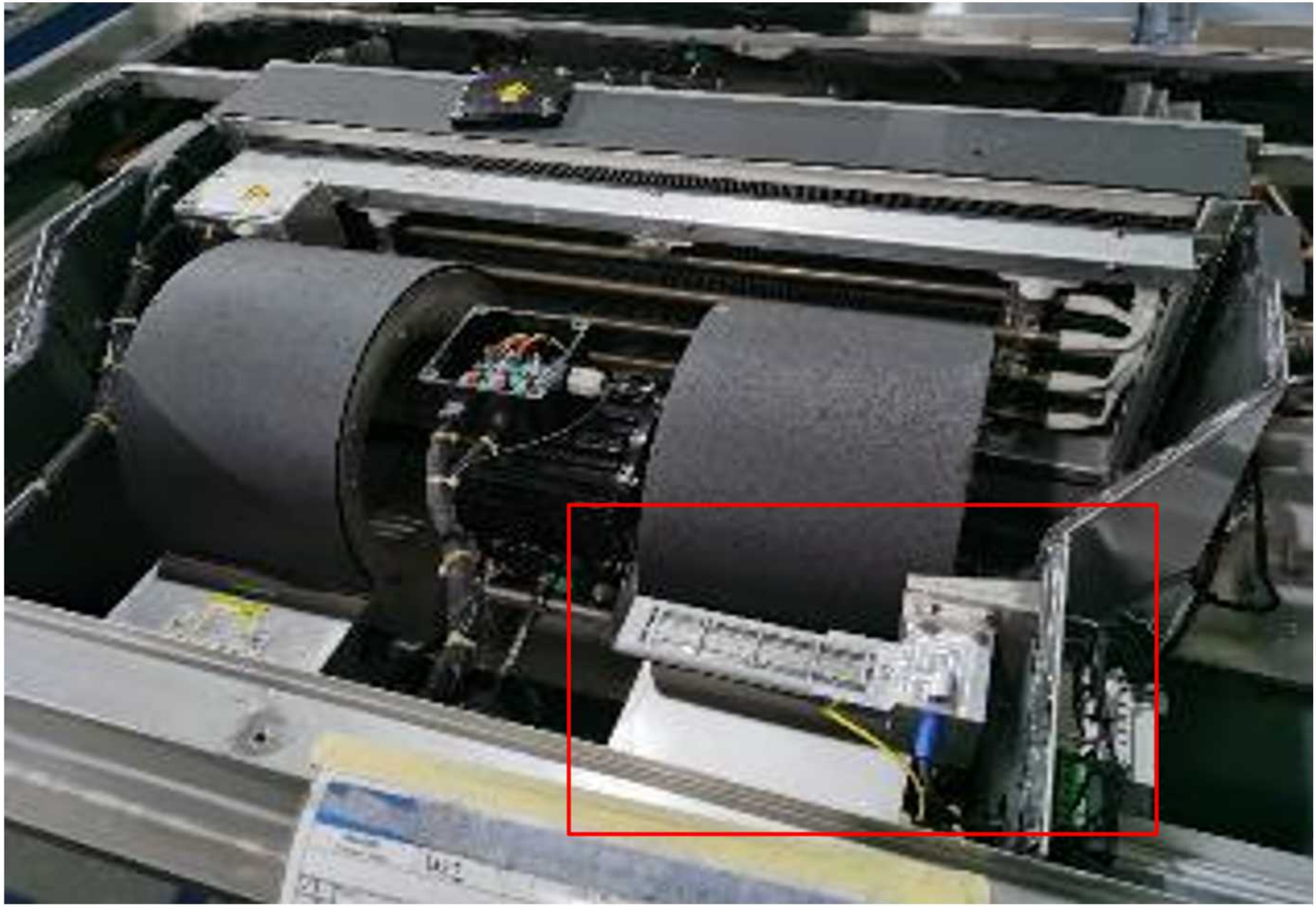




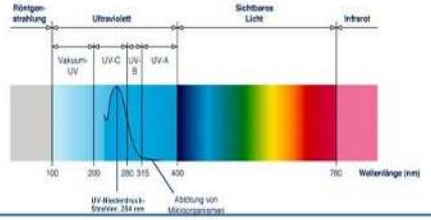


Suitable for:	LIFE STATE CYCLE 1050 (Released) REVISION FOR PROTOTYPE 1035 STATE B.-	Edition Date
H0166569	Unspec. Tolerances ISO2768-cK	Scale: 1:2 Weight: kg Surf. fin.

技术要求：



Merak UV-C Lamp



How it works
Low-pressure mercury lamps emit light in the UV-C spectrum (200 – 280 nm) which inactivates viral, bacterial, and fungal organisms.

Value proposition
Disinfects filters (lamp in front of the filters) or air (UV air sterilization module or lamps inside car ducts), by killing bacteria and viruses.
It can be integrated in existing units and/or car ducts.

Applicability to new HVAC (OE) and/or retrofit (RS
Can be applied to OE and RS as lamps in front of filters or integrated in car ducts. By OE can be also offered as a dedicated air treatment unit.

Status
Ready for series delivery

Application samples
SAPSAN Russia, R&C Belarus, Metro Helsinki.

For further information please contact

[redacted]

From: [redacted]
To: [redacted]

Subject: RDG Guidance on Maintenance of On-Train HVAC Modules & Filters v1.1
Date: 27 May 2020 16:09:06
Attachments: image001.jpg
We sent you safe versions of your files.msg
RDG Guidance on Maintenance of On-Train HVAC Modules and Filters.pdf

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Colleagues

At the request of the members of RDG's Technical & Standards Forum the attached RDG Guidance on the maintenance of on-train heating, ventilation and air conditioning (HVAC) systems during the current Covid-19 pandemic has been developed and is now published

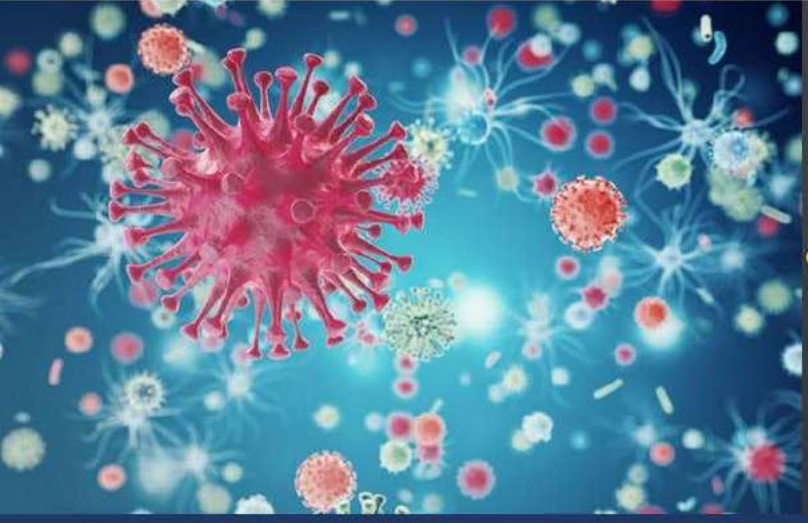
Like much RDG guidance, content is advisory, for guidance and is not mandatory

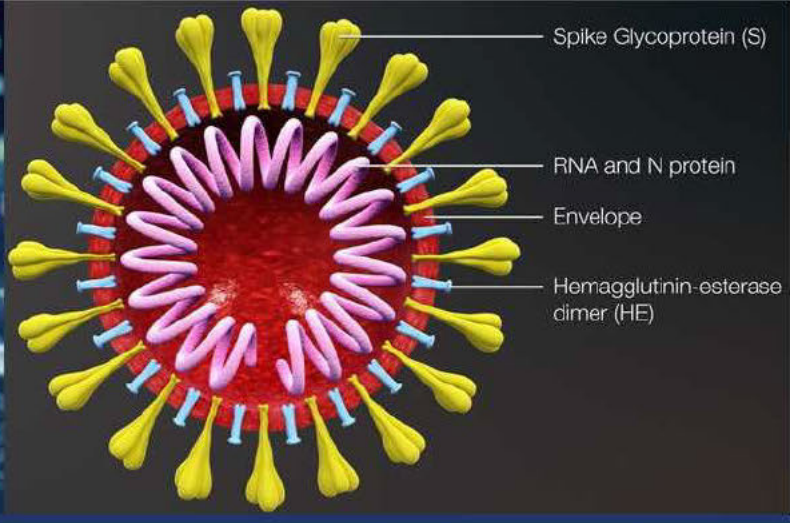
Your comments, feedback etc are very welcome

Regards

[redacted]

RDG Logo





Rail Delivery Group

National Rail

RDG Guidance: Maintenance of On-Train HVAC Modules & Filters during the COVID-19 Pandemic

Version	Date	Author	Comment	Reviewed by	Authorised by
1.1	26/05/2020	[redacted]	Initial Draft	[redacted]	[redacted]

1. Purpose and Scope

This Guidance Note describes good practice that organisations should consider when reviewing their Heating, Ventilation, and Air Conditioning (HVAC) maintenance instructions during the current COVID-19 pandemic. The information provided is based on advice given by the World Health Organisation (WHO) and Public Health England (PHE) on the COVID-19 virus, together with analysis of information provided by GB Train Operating Companies regarding maintenance regime, frequency, required minimum Personal Protective Equipment (PPE) and filter grades.

As the country gradually recovers from the pandemic and rail transport returns to normal operation, organisations need to ensure that depot staff are continued to be provided with relevant, necessary PPE and that take all the necessary health and safety precautions while carrying out their day to day maintenance tasks.

2. Modes of Transmission of the COVID-19 Virus

According to the World Health Organisation (WHO)[1] the COVID-19 virus transmission is mainly through respiratory droplets propagated by coughing or sneezing which contaminates surfaces which is spread via hand to mouth, nose or eyes after contact. The respiratory droplet ranges in size from >5µm - 10µm in diameter. Tests have shown detection of the COVID-19 virus in an aerosolised air sample (pressurised), generally considered to be particles <5µm in diameter and that can remain in the air for a period of time.

A recent publication from Harvard Medical School[2] notes that "*A person infected with coronavirus — even one with no symptoms — may emit aerosols when they sneeze, cough or talk. Aerosols are infectious viral particles less than 2.5 microns that can float or drift around in the air for up to three hours*".

Virus Decay Rate

The decay rate of the virus varies based on the materials that they land on and end up in contact with. A recent publication[3] by the New England Journal of Medicine on aerosolised air virus samples on different materials showed viral viability as follows:

Material	Viral Viability (hours)
Aluminium	1.1
Cardboard	3.5
Steel	5.6
Plastic	6.8

Transmission of the COVID-19 virus can occur by direct contact with infected people emitting the virus and also by indirect contact with surfaces on which the virus is resting, in the

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https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations
[2] How does coronavirus spread?
https://www.health.harvard.edu/diseases-and-conditions/covid-19-basics
[3] https://www.nejm.org/doi/suppl/10.1056/NEJMc2004973/suppl_file/nejmc2004973_appendix.pdf

immediate environment. However, the amount of virus decreases over time, as described above, on contact surfaces, therefore implying that the risk of infection from touching these surfaces would also decrease over time.

3. Key Areas to Consider

3.1. HVAC Filters

It is reported by Train Operating Companies that the HVAC filters used in the rail industry are made from pleated paper, foam and fabrics (synthetic & polyester) framed in a cardboard (Figure 1). This filter media can filter untreated air to a level at least equivalent to grade G4 in accordance with the EN779 classifications (now superseded by ISO 16890), which is within the COVID-19 respiratory droplet size, but potentially above the Covid-19 aerosol size, as shown in the table below.

EN779	ISO 16890	Particles size	Filtration Efficiency
COVID-19 Respiratory Droplet		>5µm - 10µm	
COVID-19 Aerosol		0.1µm < 5µm	
Filter Grade G4	ISO Coarse	>5µm	High

Therefore, it is plausible that the filter and its frame and associated ductwork may contain traceable viral droplets where air recirculation within the passenger saloon or cab has been occurring. However, the viral droplet viability on filter and duct material is very low, given the materials it is made from, but not zero.

Figure 1: HVAC Filter Samples

Comparison to Other Alternative Filters

Air filters are classified based on the '*Minimum Efficiency Reporting Value* (*MERV) Rating system'* which is used internationally as a standard means of evaluating their efficiency. This system measures an air filters ability to capture particles and pollutants of different sizes (Figure 2) and trap them within the filter. The MERV scale for pleated filters starts from 6 and goes up to 16. The table below shows filters MERV ratings and their equivalent EN779 & ISO 16890 classifications.

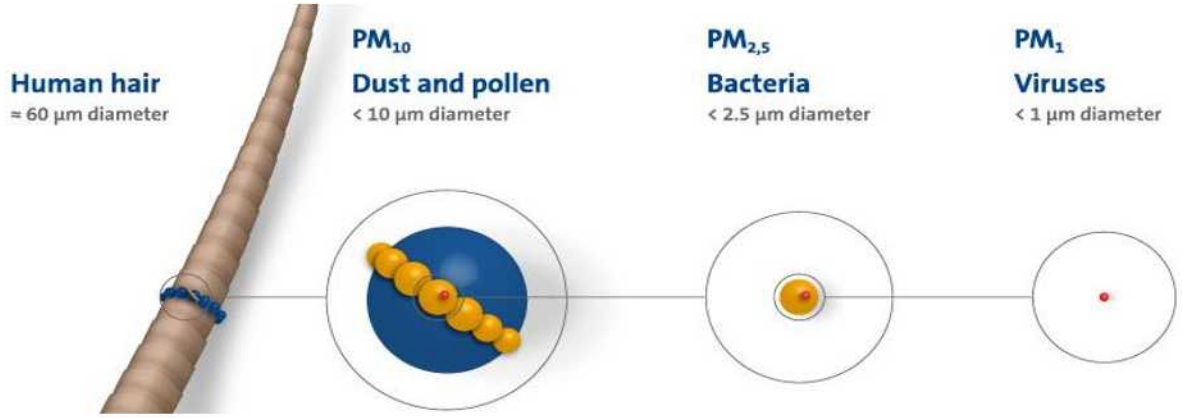

Figure 2: Particle sizes sample

Group	MERV Rating	EN779 Class	ISO 16890 Rating	Particles size - Efficiency		
				.3 – 1.0µm	1 - 3.0µm	3 - 10µm
Coarse	1 - 4	G1	ISO Coarse	-	-	< 20%
	5	G3				
Coarse	6 - 8	G4 (As typically fitted to train HVAC systems)	ISO Coarse	-	-	35% – 49% 50% – 69% 70% - 85%
Medium	9	M5 – M6	ISO ePM10 (≤10µm)		35% - 49%	≥ 85%
	10				50% - 64%	≥ 85%
	11			20%	65% - 79%	≥ 85%
	12			35%		≥ 90%
	13			50%	80%	≥ 90%
Fine	14	F7 – F8	ISO ePM2.5 (≤2.5µm)	75% – 84%	90%	95% & above
	15			85% – 94%	90%	
	16	F9		95% & above	95%	
HEPA	-	H10 – H14	ISO ePM1 (≤1µm)	≥99.5%	≥99.95%	≥99.5%
ULPA		U15 – U17		≥99.99%	≥99.99%	≥99.99%

3.2. Air extraction components

These are the air extraction ducts, vents, fans and grilles within the passenger saloon, cab and kitchen (onboard catering), where the COVID-19 virus viability time will depend on the material as outlined in section 2.

4. Maintenance Task

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To be risk assessed and the following options taken into account

- To have some time gap between end of service and maintenance to account for the viral viability timeframe
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4.3. HVAC Module Repair and Change.
Same as in *section 4.1 and 4.2*

5. Personal Protective Equipment (PPE)

The minimum PPE required to carry out HVAC maintenance tasks shall align with the perceived level of potential exposure to the virus, and to other hazards directly or indirectly. Suitable risk assessments may identify that some or all of the following PPE should be provided to all staff participating in HVAC modules and filters maintenance tasks:

- Disposable gloves in compliance with EN374 requirements
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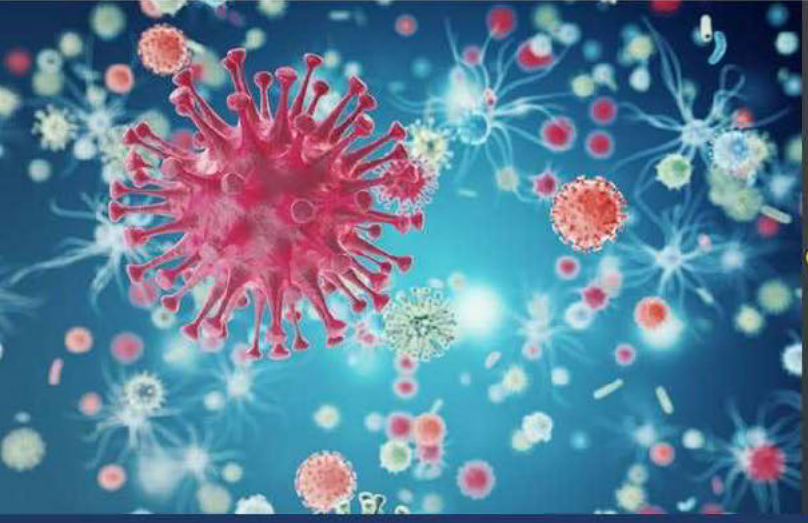
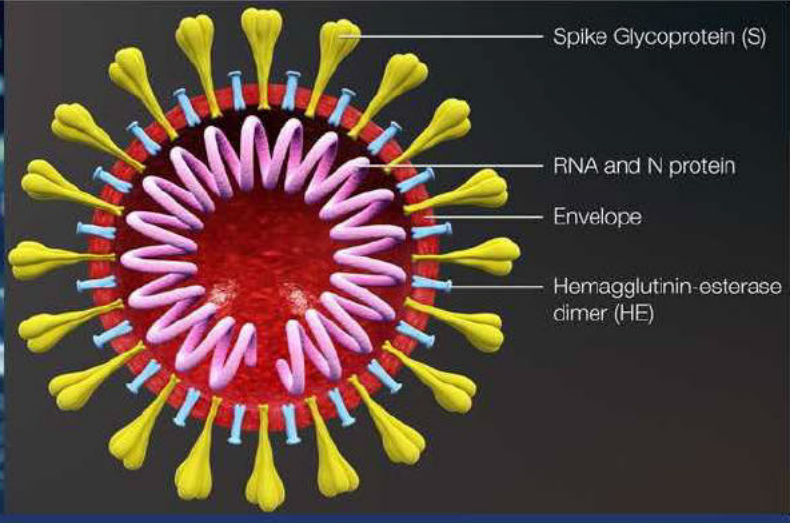
Regarding the *disinfectant chemicals* - The appropriate risk assessments informed by supplier COSHH documents should be carried out to determine any additional PPE, or procedures required when using the product(s).

Hand hygiene - Hands should be washed with soap and water for a minimum of 20 seconds after all PPE is removed.

6. Maintenance Regime - Filters and Air Extractors

The maintenance regime is designed to keep the HVAC system performing at an optimal level as documented in the vehicle maintenance instructions. However, Train Operating Companies that have chosen to implement changes to the operation of the on-train HVAC system and/or to air filtration equipment as per the considerations contained in the RDG guidance on rolling stock ventilation during the COVID-19 pandemic; should review the associated vehicle maintenance instructions – since they may no longer be appropriate to keep the modified HVAC system performing at an optimal level.





Rail Delivery Group

National Rail

RDG Guidance: Maintenance of On-Train HVAC Modules & Filters during the COVID-19 Pandemic

Version	Date	Author	Comment	Reviewed by	Authorised by
1.1	26/05/2020	[redacted]	Initial Draft	[redacted]	[redacted]
1.2	16/06/20	[redacted]	COVID-19 virus viability on material clarifications (Section 2).		[redacted]

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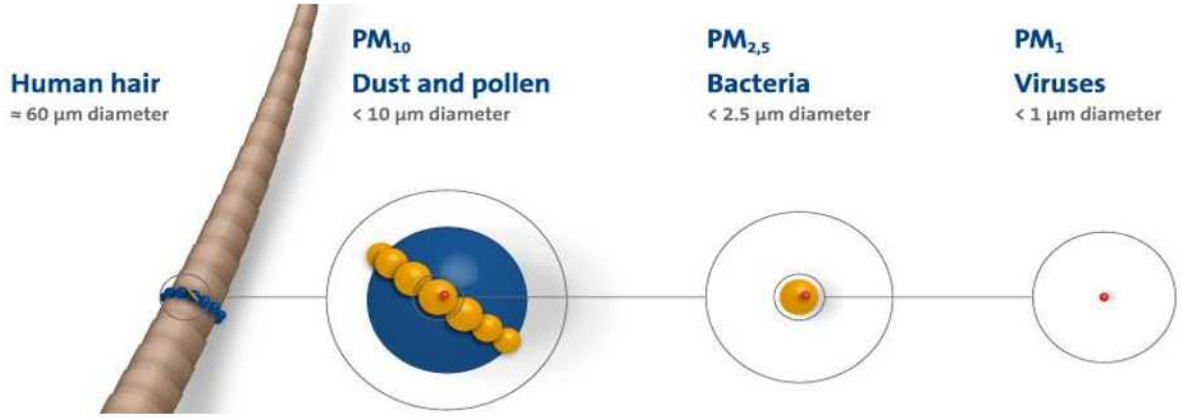

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From:	[redacted]
To:	[redacted]
Cc:	[redacted]
Subject:	RDG Guidance on Rolling Stock Ventilation during the Covid-19 Pandemic
Date:	18 May 2020 16:53:08
Attachments:	image001.jpg We sent you safe versions of your files.msg HVAC Systems and COVID-19 v1.2.pdf

Colleagues

Recently developed RDG guidance for train operators and maintainers on rolling stock ventilation during the Covid-19 pandemic is attached for your information – like much RDG guidance, it has been developed to aid, advise and guide our members and their suppliers. It is not to be regarded, nor is it intended to be a minimum standard to conform to, nor instructions to be complied with

We are very happy to receive feedback on its content for possible inclusion in future issues of this guidance

Regards

[redacted]

RDG Logo

Rail Delivery Group
National Rail

RDG Guidance: Rolling Stock Ventilation during the COVID-19 Pandemic

Version Control

Version	Date	Author	Comment	Approved By
1.2	18/05/2020	[redacted]	First Issued Version	[redacted]

Purpose and Scope

As the UK moves into the recovery stage of the COVID-19 pandemic, staff and customer usage of rail services will increase. The subject matter of on-train ventilation and its possible relationship with the transmission of SARS-CoV-2 (which causes the disease known as COVID-19) has been raised, particularly in densely populated built, and transportation environments. Preliminary research based on previous experience with SARS-CoV-1, as well as current theoretical data, and UK Government guidelines, have been used to provide guidance for onboard ventilation of GB Rolling Stock. This document notes recent research, guidance, etc that has been published that may potentially benefit Train Operators when considering and then drawing up possible options for on-train ventilation, including if and how these may mitigate the risk of airborne pathogen transmission on rail vehicles.

Table of Contents

Background

The role of ventilation and air flow rate in the transmission of airborne pathogens in enclosed spaces has been extensively studied. Currently, SARS-CoV-2, which causes the disease known as COVID-19, is thought to be largely transmitted via droplet form, which can then either be directly inhaled, depending on proximity to the source, or contaminate surfaces by landing on them. While many precautions typical for halting or reducing the spread of respiratory pathogens are already being implemented, other less understood but potential transmission pathways should be considered and addressed. Research is still being conducted into the size and behaviour of SARS-CoV-2 droplets once airborne, however, studies have suggested that due caution should be observed when considering and before implementing any changes to ventilation in built environments – the same would apply to rail vehicles.

The two key areas of ventilation that should potentially be considered are *air ventilation rate* and *fresh air supply*. Many preliminary studies into the relationship between COVID-19 and ventilation systems have cited that increased ventilation may potentially reduce the risk of exposure and transmission of the virus. Indeed, previous research relating to the SARS-CoV-1 outbreak of 2003 have concluded that increased air flow resulted in a lower infection risk. However, it is to be noted that the previous SARS disease was airborne, and the length of time that SARS-CoV-2 remains airborne is not yet fully understood.

Ventilation Rate

The UK Government's recently published 'Coronavirus (COVID-19): safer transport guidance for operators' document[1] explicitly states that '*Organisations should consider how to increase ventilation and air flow*.' This has been supported by several pieces of literature, which state that increasing ventilation rate may potentially result in the removal and reduction of pathogen-laden airborne droplet nuclei. Although COVID-19 droplets are hypothesised by the World Health Organisation (WHO) to be too large to be transmitted through air currents, the current approach supports erring on the side of caution, due to the lack of conclusive evidence that fully supports this hypothesis.

The 'COVID-19: infection prevention and control guidance'[2] published in April 2020 states: '*The rate of clearance of aerosols in an enclosed space is dependent on the extent of any mechanical or natural ventilation – the greater the number of air changes per hour (ventilation rate), the sooner any aerosol will be cleared… A single air change is estimated to remove 63% of airborne contaminants, after 5 air changes less than 1% of airborne contamination is thought to remain' (*in hospital settings) as well as '*The control of exposure at source, including adequate ventilation systems and effective environmental decontamination will physically reduce exposure to infection*.'

[1] 'Coronavirus (COVID-19): safer transport guidance for operators' ; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/884370/coronavirus-covid-19-safer-transport-guidance-for-operators.pdf

[2] 'COVID-19 infection prevention and control guidance' ; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/881489/COVID-19_Infection_prevention_and_control_guidance_complete.pdf

More recently, the publication of the UK Government's recovery strategy[3], which outlines several times that evidence indeed suggests that the virus is less likely to be transmitted in well-ventilated areas. There is currently very little evidence regarding a minimum value for the optimum ventilation/airflow rate and the subsequent impact of different rates on virus transmission. Nevertheless, an increase in ventilation rate resulting in several air changes has been stated to potentially have a positive impact on the transmission of the COVID-19 virus and thus potentially reduce the risk of cross-infection.

Therefore, in light of recent publications of guidance by the UK Government, it may be beneficial to look at how the ventilation rate can be increased on Rolling Stock, particularly as there is likely to be an increase in staff and customer footfall due to the easing of previously imposed lockdown restrictions.

Fresh Air vs. Recirculated Air

The case of introducing a continuous flow of fresh air versus largely, or exclusively recirculated air has also been extensively studied in different environments and conditions. Many ventilation systems within built environments predominantly use recirculated air for various reasons. However, studies have indicated that increasing the intake and flow of fresh air, thereby reducing the amount, or fraction, of recirculated air, may potentially reduce the risk of cross-infection and transmission of pathogens.

The UK Government's COVID-19 recovery strategy document advises organisations to '*(…)make sure that ventilation systems are set to maximise the fresh air flow rate.*'[3] This is also supported by research, which generally states that higher outside air fractions may potentially dilute viral particle loads in the environment. The COVID-19 safer transport operator guide[1] also explicitly states that '*transport operators and businesses should ensure that a fresh air supply is consistently flowing through vehicles, carriages, transport hubs and office buildings*.' The aim of this general recommendation is to supply as much fresh air as is reasonably and practicably possible.

Application to Rolling Stock

The variety of age, refurbishment status, designs, and maintenance arrangements of current GB Rolling Stock will introduce a series of challenges when addressing on-train ventilation considerations. In most cases, if not all, full adherence to all of these guidelines may not be practicable and may result in substantial hardware and/or software modifications needing to be made. This could also potentially lead to non-compliance with other applicable standards or requirements, may result in other hazards to staff or customers being introduced, or may introduce reduced system performance or reliability. Therefore, the legality, practicability, and implications of implementation will need to be considered, and appropriate risk assessments carried out, which need to be documented.

However, it is good practice to ensure that on-train heating, cooling (where fitted) and ventilation systems are operating correctly, where minimum design ratios of fresh to recirculated air are being achieved as a basic requirement. The practicalities, legalities, and consequences of increasing fresh air and reducing recirculated air should be reviewed, as

[3] 'Our Plan to Rebuild: The UK Government's COVID-19 recovery strategy' ; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/884171/FINAL_6.6637_CO_HMG_C19_Recovery_FINAL_110520_v2_WEB__1_.pdf

these could potentially reduce the risk of COVID-19 transmission and the rationale taken for this review and the decisions taken as a consequence should be documented.

To further increase the flow of fresh air, windows in cabs/saloons should be encouraged to be opened, where possible. This includes during service, as well as during long dwell times at end of line stations to introduce as many air changes as possible. This could also include modifying the operation of the bodyside door 'auto-close' feature that is used on air-conditioned rolling stock to reduce the load on heating, ventilation and air conditioning (HVAC) systems to maintain stable on-board temperatures.

Consultation with the original equipment manufacturers and/or maintainers (where applicable) of on-train heating, ventilation and cooling systems should be considered due to their specific expertise and background knowledge of system design parameters, standards compliance, maintenance requirements, and implications. It is also possible that they are already working in other rail, or allied markets in the UK, or abroad, on proposals for, or on live projects to change the operating modes or philosophies of other heating, cooling, and ventilation products in line with some of the above considerations.

Whilst there is no conclusive evidence at this time to suggest that ventilation or air conditioning systems contribute to the spread of COVID-19., actions which organisations may wish to consider include:

- Ensuring ventilation systems are functioning as expected in compliance with relevant standards
- Consider how ventilation systems can be configured such that it would result in an increase in air ventilation rate thereby increasing the number of air changes (if possible)
- Consider how ventilation systems can be configured such that the proportion of fresh air to recirculated air is increased to maximise the amount of fresh air (if possible)
- Encouraging the intake of fresh air, where possible (i.e. by opening cab side windows, passenger saloon windows – if applicable)
- Disabling the bodyside door 'autoclose' functionality

Documented risk assessments should be carried out in light of any possible adjustments to ensure the safety of traincrew and customers alike.

HVAC systems could potentially play a critical role in possibly reducing the transmission of the COVID-19 disease. The following key documents may provide some guidance on the impact of ventilation, some of which have been cited in this document:

- UK Government: 'COVID-19 Infection Prevention and Control Guidance': https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/881489/COVID-19_Infection_prevention_and_control_guidance_complete.pdf
- 'Our Plan to Rebuild: The UK Government's COVID-19 Recovery Strategy': https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/884171/FINAL_6.6637_CO_HMG_C19_Recovery_FINAL_110520_v2_WEB__1_.pdf

- UK Government: 'Coronavirus (COVID-19): Safer Transport Guidance for Operators': https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/884370/coronavirus-covid-19-safer-transport-guidance-for-operators.pdf
- Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA): 'REHVA COVID-19 Guidance Document - How to operate and use building services in order to prevent the spread of the coronavirus disease (COVID-19) virus (SARS-CoV-2) in workplaces': https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_ver2_20200403_1.pdf

Note: while building-based HVAC systems will differ in many details from Rolling Stock HVAC systems, some guidance may potentially be useful and can be interpreted by HVAC specialists within the Railway Industry for possible application against on-train requirements.

From: [redacted]
[redacted]
[redacted]
Subject: RDG Train Interiors Cleaning Guidance - issue v1.5
Date: 30 April 2020 13:38:12
Attachments: image001.jpg
We sent you safe versions of your files.msg
TOC Cleaning COVID-19 Guidance Document v1.5.pdf

Colleagues

Revised and up issued – thanks for comments and suggestions received

Regards

[redacted]

RDG Logo

Rail Delivery Group
National Rail

RDG Guidance: The Cleaning of Train Interiors during the COVID-19 Pandemic

Version Control

Version	Date	Author	Comment	Approved By
1.4	07/04/2020	[redacted]	Initial Version	
1.5	27/04/2020	[redacted]	PPE/Cleaning Product clarifications	

Purpose and Scope

The objective of this document is to be a guide for collective use by Railway Undertakings (RU) when cleaning trains during the COVID-19 Pandemic. The information provided is based on advice given by the World Health Organisation (WHO) and Public Health England (PHE), as well as on preliminary studies carried out on the novel coronavirus referred to as COVID-19. Good practice has also been collated based on information provided by GB passenger Train Operators regarding types of train interior cleaning regimes, frequency, cleaning products used, Personal Protective Equipment (PPE) provided and other potentially useful material.

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Background

The 2019 novel coronavirus SARS-CoV-2, which results in the illness COVID-19 has resulted in the need for a more rigorous and effective train interior cleaning routines for GB mainline railways. Transmission of COVID-19 is thought to mainly occur through respiratory droplets generated by coughing or sneezing which contaminates surfaces which is spread via hand to mouth after contact. Experience from SARS-CoV and MERS-CoV, both previous novel coronaviruses, has also been used to theorise the possible viability of COVID-19 on different surfaces.

It is likely that the length of time the virus remains viable is important in allowing its spread. A study recently published by the New England Journal of Medicine documented the decay rates of aerosolised virus samples on five different materials, including plastic, stainless steel, copper and cardboard. Greater viral stability was observed on plastics and stainless steel compared to the other two surfaces, with a greater titre of viable virus found on plastic after 72 hours. "On copper, no viable SARS-CoV-2 was measured after 4 hours (…). On cardboard, no viable SARS-CoV-2 was measured after 24 hours (…)."[1] However, it is important to note that the amount of virus decreased rapidly over time on all the surfaces, therefore implying that the risk of infection from touching them would also decrease over time.

> NOTE: *Cleaning* refers to the removal of germs (bacteria, viruses etc.), dirt and impurities from surfaces. It does not 'kill' germs per se, but reduces the numbers, and therefore lowers the risk of spreading infection.
>
> *Disinfecting* refers to the use of chemicals to 'kill' germs (bacteria, viruses etc.) on surfaces. It does not necessarily clean dirty surfaces or remove germs, but by killing germs after cleaning, it can reduce the risk of infection further.

COVID-19 virus is an enveloped virus, which means it can be broken down more easily by cleaning products, including soap and warm water. Surface disinfection with 0.1% Sodium Hypochlorite (bleach) or 62-71% ethanol-containing products have been found to significantly reduce levels of the virus on surfaces within a 1-minute exposure time.[2]

Public Health England (PHE) has provided guidance on cleaning in a non-healthcare setting, which includes cleaning hard surfaces with warm, soapy water. This should be followed by disinfection with a disinfectant solution at a dilution of 1000 parts per million, or one that is effective against enveloped viruses.

The World Health Organisation has also stated that "*While little is known about this novel virus (Coronavirus COVID 19), in the light of the comparable genetic characteristics with SARS-CoV and MERS-CoV suggest that 2019-nCoV (Coronavirus COVID 19) may likely (be) susceptible to disinfectants with proven activity against enveloped viruses, including sodium hypochlorite (bleach) (e.g. 1,000 ppm (0.1%) for general surface disinfection and 10,000 ppm (1%) for disinfection of blood spills), 62-71% ethanol, 0.5% hydrogen peroxide, quaternary ammonium compounds and phenolic compounds, if used according to manufacturer's recommendations*". Frequency of cleaning regimes, as well as focusing on

[1] 'Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1' ; https://www.nejm.org/doi/full/10.1056/NEJMc2004973?query=featured_home

[2] 'Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents' ; https://www.sciencedirect.com/science/article/pii/S0195670120300463

surfaces which can be touched frequently by person(s), can also play a part in removing, or significantly reducing the risk of infection.

Cleaning and Disinfecting Regimes

It is imperative to carry out enhanced routine cleaning and disinfecting to maintain adequate hygiene standards during the pandemic. This may include increasing frequency of cleaning, changing cleaning products to ensure they are effective against COVID-19, and ensuring the right PPE is used while carrying out certain activities.

Cleaning and disinfecting may be carried out in different ways. However, the two main methods that have been identified are:

i. wiping down affected area(s) using a clean cloth and cleaning product(s) and/or
ii. spraying the affected area(s) with said cleaning products (also known as 'fogging'). The method used is dependent upon the size of the affected area(s).

Areas to focus on

Increasing the cleaning and disinfecting of 'common touch points', including (but not limited to):

Passenger saloons:
- Interior and exterior door open/close buttons
- Interior and exterior door handles
- All handrails around the door access area (including grab-poles and grab-rails)
- All handrails in the customer seating area (including grab-poles and grab-rails)
- All seat grab handles
- All metallic and plastic areas of arm rests
- All tabletop surfaces (including seat-back tables)
- The parts of waste bins passengers typically touch (e.g. lids or flaps)

Toilet areas:
- All handrails, grab poles, and grab rails
- Toilet seat and lid
- Toilet flush button
- Toilet door open/close buttons
- Toilet door handles
- Hand-wash basin controls
- The lids or flaps of any waste bins

Baby-changing facilities:
- Handles
- Table
- Nappy bin lids (where provided)

Drivers' cabs:
- All interior door handles
- All interior door open/close buttons
- Passenger door release/close buttons
- Driver's public address system/radio handset
- Driver's power brake controller handle
- Train management system touchscreens and buttons
- Cab seat armrests (where these are hard surfaces)

Guard/Senior Conductor Accommodation (if applicable)
- All interior door handles
- All interior door open/close buttons
- Passenger door close buttons
- Guard public address system/radio handset
- Interior and exterior door handles

This list is not exhaustive. Consideration should be given to the inclusion of handles, buttons, controls etc. on cab desks, which would normally be regarded as 'off-limits' to cleaning staff during cleaning procedures and the risks associated with doing this and any extra training necessary to facilitate it.

Frequency

Frequency of cleaning regimes is at the operator's discretion. However, a minimum of a daily as well as a separate turnaround cleaning routine during the current COVID-19 pandemic is recommended. Train operators should review the length of a turnaround and consider the opportunity of conducting a 'deeper' clean. The general guideline should be the more people who come into contact with surfaces, the more frequently that surface should be cleaned. It may also be helpful to develop different cleaning specifications for different times of day. For example, identifying key areas that need to be focused on during a clean on an 'in-transit' train in comparison to an 'overnight' regime, a 'turn-around', or a 'heavy clean' etc.

It is good practice to consider developing and leaving a copy of a record of when key areas of the train were cleaned, as well as who they were cleaned by. This is similar to records kept and made visible in public toilets and may ensure that cleaning frequency, standards, and accountability are met and that continued staff confidence in these is assured. Consideration should be given to primarily developing this practice for driving cabs before considering the possibility and practicability of extending it to passenger saloons. Making cleaning occurrences more visible for traincrew, as well as possibly passengers, may result in an increase in confidence on the UK Railway.

Cleaning Products

Various cleaning products are currently being used on the interiors of UK rolling stock, including those being operated/maintained by London Underground, GB train operators and the main UK train builders/maintainers. As mentioned previously, research is still underway regarding how effective certain cleaning products are against COVID-19. However, as the novel coronavirus behaves similarly to other coronaviruses, such as SARS-CoV and MERS-CoV, it is likely that products used to combat these are just as effective at doing the same for COVID-19.

Current cleaning guidelines provided by PHE state that hard surfaces should first be cleaned using warm soapy water. This should be followed by a detergent disinfectant solution at a dilution of 1,000 parts per million available chlorine, or an alternative disinfectant effective against enveloped viruses. However, soap and water may not be suitable for all surfaces, and although it can kill viral samples, it may have little to no residual effects. Therefore, the importance of using appropriate anti-viral cleaning products effective against enveloped viruses is imperative.

Products containing at least one of the following:

- 0.1% Sodium Hypochlorite (bleach)
- 62-71% Ethanol (alcohol)
- 0.5% Hydrogen Peroxide
- Quaternary Ammonium Compounds
- Phenolic Compounds

are highly likely to be effective against COVID-19 due to the virus's similarity in composition to previous known coronaviruses, if used according to the manufacturer's recommendations. Contact times (the time a surface should be treated for) differ depending on the product used. Using different cleaning products for different areas of the train may be considered if a

particular area is considered 'more contaminated'. Do not mix different cleaning products and avoid the use of spray for disinfection of highly contaminated areas. Manufacturer's instructions, including usage, PPE required, equipment needed, and any other special requirements must always be followed.

The following products are reportedly being used and are highly likely to be effective against COVID-19:

- Z-71 Microbe Shield (developed by Zoono Group Limited)
- Guardicide 2505 and 2506 (developed by Chela)
- Selgiene Ultra Virucidal Cleaner (developed by Selden)
- DuoMax (developed by DuoTech)
- Oxivir (developed by Diversey Inc) note: may not be available for use by rail industry yet

Please note that RDG does not endorse nor recommend any specific branded products or named suppliers, nor does RDG vouch for the effectiveness of individual named products. The products listed above are examples of what some operators are using to disinfect areas of trains, however, this list is not exhaustive. To reiterate previous points, PHE guidelines state that disinfecting a surface can be carried out by either a product containing 1000 parts per million available chlorine, or a product effective against enveloped viruses.

According to Public Health England, if items cannot be cleaned and/or disinfected using detergents or laundered, (e.g. seat fabric), steam cleaning should be considered. However, there is currently no conclusive evidence to suggest this eliminates the risk of infection.

Personal Protective Equipment (PPE)

The level of PPE used during cleaning procedures depends upon the type of product used, the cleaning method used, the perceived level of potential exposure to the virus and the general environment. The following PPE should be provided to all staff participating in cleaning routines:

- Disposable Nitrile Gloves (all tasks)
- Safety Footwear (all tasks)
- Safety Eyewear-as deemed necessary post risk assessment (during spraying/fogging of chemicals)
- Overalls-as deemed necessary post risk assessment (during spraying/fogging of chemicals)
- Facemasks-as deemed necessary post risk assessment (during spraying/fogging of chemicals)

Please note that some cleaning products may not require some forms of PPE listed above. The appropriate risk assessments informed by supplier COSHH documents should be carried out to determine the levels of PPE required when carrying out cleaning activities using the product(s).

Additional Processes for Suspected/Confirmed COVID-19 Contamination

If a train has been contaminated with a suspected/confirmed case of COVID-19, this may warrant 'Cause for Concern' cleaning, which is sufficient to fulfil the requirements set by Public Health England's 'COVID-19: cleaning in non-healthcare settings'. The following guidance must be followed:

- All surfaces that the symptomatic person may have come into contact with must be cleaned and disinfected with *disposable* paper roll/cloths and products effective against enveloped viruses, such as the ones listed in the 'Cleaning Products' section of this document.
- Avoid creating splashes and spray when cleaning.
- Any cleaning items used must be disposed of by following the waste guidance outlined below.

Those conducting 'Cause for Concern' cleaning should use a minimum of apron and gloves as PPE. Hands should be washed with soap and water for a minimum of 20 seconds after all PPE is removed. If a risk assessment of the setting indicates that a higher level of virus may be present or there is visible contamination with body fluids, then the need for additional PPE to protect the cleaner's eyes, mouth and nose might be necessary. The local Public Health England (PHE) Health Protection Team (HPT) can advise on this.

Waste from cleaning of areas where possible cases have been should be:

- Put in a plastic rubbish bag and tied when full.
- The plastic bag should then be placed in a second bin bag and tied.
- The waste should then be placed in a suitable and secure location away from communal areas for at least 72 hours or until negative test results are known.
- If 72-hour storage is not practicable, arrange for collection as a Category B infectious waste either by the local waste collection authority or a specialist clinical waste collector.

There may be occasions when Public Health England ask for a specialised COVID-19 deep clean. This is when a third-party specialist cleaning team is likely to be engaged. The specialist team will liaise with the local area premises manager to agree a methodology. They will use their own risk assessment to determine what cleaning is carried out, what cleaning products are used and what PPE is required. The management of staff on site during a clean and the length of time an area may need to be vacant for will vary between sites dependent on the results of the specialist team site survey and the operational requirements of the location.

From: [redacted]
[redacted]
[redacted]
Subject: TOC Train Cleaning Products & Processes Guidance
Date: 22 April 2020 15:40:19
Attachments: image001.jpg
We sent you safe versions of your files.msg
TOC Cleaning Covid19 guidence Document v1.3.pdf

Just issued for your reference and for your use on depots and at turnaround stations etc

Regards

[redacted]

RDG Logo

Rail Delivery Group
National Rail

RDG Guidance: The Cleaning of Train Interiors during the COVID-19 Pandemic

Version Control

Version	Date	Author	Comment	Approved By
1.4	07/04/2020	[redacted]	Initial Version	

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novel coronaviruses, has also been used to theorise the possible viability of COVID-19 on different surfaces.

It is likely that the length of time the virus remains viable is important in allowing its spread. A study recently published by the New England Journal of Medicine documented the decay rates of aerosolised virus samples on five different materials, including plastic, stainless steel, copper and cardboard. Greater viral stability was observed on plastics and stainless steel compared to the other two surfaces, with a greater titre of viable virus found on plastic after 72 hours. "On copper, no viable SARS-CoV-2 was measured after 4 hours (…). On cardboard, no viable SARS-CoV-2 was measured after 24 hours (…)."[1] However, it is important to note that the amount of virus decreased rapidly over time on all the surfaces, therefore implying that the risk of infection from touching them would also decrease over time.

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- The parts of waste bins passengers typically touch (e.g. lids or flaps)

Toilet areas:
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This list is not exhaustive. Consideration should be given to the inclusion of handles, buttons, controls etc. on cab desks, which would normally be regarded as 'off-limits' to cleaning staff during cleaning procedures and the risks associated with doing this and any extra training necessary to facilitate it.

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Products containing at least one of the following:

- 0.1% Sodium Hypochlorite (bleach)
- 62-71% Ethanol (alcohol)
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- Phenolic Compounds

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The following products are reportedly being used and are highly likely to be effective against COVID-19:

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- Guardicide 2505 and 2506 (developed by Chela)
- Oxivir (developed by Diversey Inc) note: may not be available for use by rail industry yet

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Personal Protective Equipment (PPE)

The level of PPE used during cleaning procedures depends upon the type of product used, the cleaning method used, the perceived level of potential exposure to the virus and the general environment. The following PPE should be provided to all staff participating in cleaning routines:

- Disposable Nitrile Gloves (all tasks)
- Safety Footwear (all tasks)
- Safety Eyewear (during spraying/fogging of chemicals)
- Overalls (during spraying/fogging of chemicals)
- Facemasks (during spraying/fogging of chemicals)

Additional Processes for Suspected/Confirmed COVID-19 Contamination

If a train has been contaminated with a suspected/confirmed case of COVID-19, this may warrant 'Cause for Concern' cleaning, which is sufficient to fulfil the requirements set by Public Health England's 'COVID-19: cleaning in non-healthcare settings'. The following guidance must be followed:

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- Avoid creating splashes and spray when cleaning.
- Any cleaning items used must be disposed of by following the waste guidance outlined below.

Those conducting 'Cause for Concern' cleaning should use a minimum of apron and gloves as PPE. Hands should be washed with soap and water for a minimum of 20 seconds after all PPE is removed. If a risk assessment of the setting indicates that a higher level of virus may be present or there is visible contamination with body fluids, then the need for additional PPE to protect the cleaner's eyes, mouth and nose might be necessary. The local Public Health England (PHE) Health Protection Team (HPT) can advise on this.

Waste from cleaning of areas where possible cases have been should be:

- Put in a plastic rubbish bag and tied when full.
- The plastic bag should then be placed in a second bin bag and tied.
- The waste should then be placed in a suitable and secure location away from communal areas for at least 72 hours or until negative test results are known.

- If 72-hour storage is not practicable, arrange for collection as a Category B infectious waste either by the local waste collection authority or a specialist clinical waste collector.

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From: [redacted]
To: [redacted]
[redacted]
Subject: Updated RDG Guidance on Maintenance of On-Train HVAC Modules & Filters v1.2
Date: 16 June 2020 14:50:09
Attachments: image002.jpg
image003.jpg
We sent you safe versions of your files.msg
RDG Guidance on Maintenance of On-Train HVAC Modules and Filters.pdf

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Dear All,
Please see attached an updated version of the RDG Guidance on Maintenance of On-Train HVAC Modules & Filters v1.2.
Like much RDG guidance, content is advisory, for guidance and is not mandatory.
Your comments and feedback are always welcome.
Kind regards,

[redacted]

From: [redacted]
Sent: 27 May 2020 16:07
To: [redacted]
Cc: [redacted]
Subject: RDG Guidance on Maintenance of On-Train HVAC Modules & Filters v1.1

Colleagues
At the request of the members of RDG's Technical & Standards Forum the attached RDG Guidance on the maintenance of on-train heating, ventilation and air conditioning (HVAC) systems during the current Covid-19 pandemic has been developed and is now published
Like much RDG guidance, content is advisory, for guidance and is not mandatory
Your comments, feedback etc are very welcome

[redacted]
Head of Engineering
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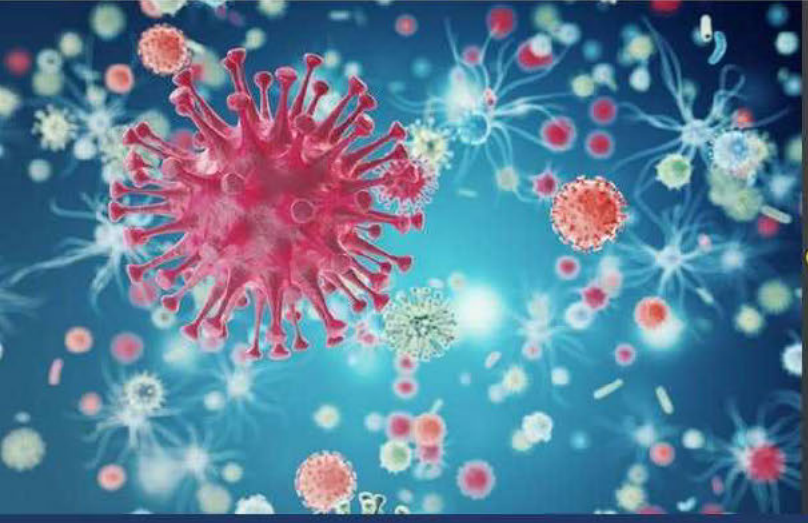

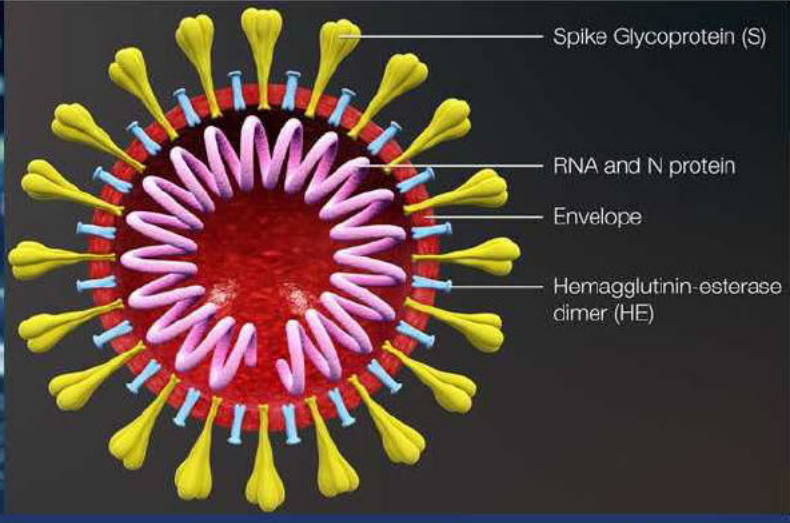

Rail Delivery Group

National Rail

RDG Guidance: Maintenance of On-Train HVAC Modules & Filters during the COVID-19 Pandemic

Version	Date	Author	Comment	Reviewed by	Authorised by
1.1	26/05/2020	[redacted]	Initial Draft	[redacted]	[redacted]
1.2	16/06/20	[redacted]	COVID-19 virus viability on material clarifications (Section 2).		[redacted]

1. Purpose and Scope

This Guidance Note describes good practice that organisations should consider when reviewing their Heating, Ventilation, and Air Conditioning (HVAC) maintenance instructions during the current COVID-19 pandemic. The information provided is based on advice given by the World Health Organisation (WHO) and Public Health England (PHE) on the COVID-19 virus, together with analysis of information provided by GB Train Operating Companies regarding maintenance regime, frequency, required minimum Personal Protective Equipment (PPE) and filter grades.

As the country gradually recovers from the pandemic and rail transport returns to normal operation, organisations need to ensure that depot staff are continued to be provided with relevant, necessary PPE and that take all the necessary health and safety precautions while carrying out their day to day maintenance tasks.

2. Modes of Transmission of the COVID-19 Virus

According to the World Health Organisation (WHO)[1] the COVID-19 virus transmission is mainly through respiratory droplets propagated by coughing or sneezing which contaminates surfaces which is spread via hand to mouth, nose or eyes after contact. The respiratory droplet ranges in size from >5µm - 10µm in diameter. Tests have shown detection of the COVID-19 virus in an aerosolised air sample (pressurised), generally considered to be particles <5µm in diameter and that can remain in the air for a period of time.

A recent publication from Harvard Medical School[2] notes that "*A person infected with coronavirus — even one with no symptoms — may emit aerosols when they sneeze, cough or talk. Aerosols are infectious viral particles less than 2.5 microns that can float or drift around in the air for up to three hours*".

Virus Decay Rate

The decay rate of the virus varies based on the materials that they land on and end up in contact with. A recent publication[3] by the New England Journal of Medicine on aerosolised air virus samples on different materials showed viral viability as follows:

Material	Viral Half-life (hours)
Aerosols	1.1
Cardboard	3.5
Steel	5.6
Plastic	6.8

Transmission of the COVID-19 virus can occur by direct contact with infected people emitting the virus and also by indirect contact with surfaces on which the virus is resting, in the

[1]Modes of transmission of virus causing COVID-19
https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations
[2] How does coronavirus spread?
https://www.health.harvard.edu/diseases-and-conditions/covid-19-basics
[3] https://www.nejm.org/doi/suppl/10.1056/NEJMc2004973/suppl_file/nejmc2004973_appendix.pdf

immediate environment. However, the amount of virus decreases over time, as described above, on contact surfaces, therefore implying that the risk of infection from touching these surfaces would also decrease over time.

3. Key Areas to Consider

3.1. HVAC Filters

It is reported by Train Operating Companies that the HVAC filters used in the rail industry are made from pleated paper, foam and fabrics (synthetic & polyester) framed in a cardboard (Figure 1). This filter media can filter untreated air to a level at least equivalent to grade G4 in accordance with the EN779 classifications (now superseded by ISO 16890), which is within the COVID-19 respiratory droplet size, but potentially above the Covid-19 aerosol size, as shown in the table below.

EN779	ISO 16890	Particles size	Filtration Efficiency
COVID-19 Respiratory Droplet		>5µm - 10µm	
COVID-19 Aerosol		0.1µm < 5µm	
Filter Grade G4	ISO Coarse	>5µm	High

Therefore, it is plausible that the filter and its frame and associated ductwork may contain traceable viral droplets where air recirculation within the passenger saloon or cab has been occurring. However, the viral droplet viability on filter and duct material is very low, given the materials it is made from, but not zero.

Figure 1: HVAC Filter Samples

Comparison to Other Alternative Filters

Air filters are classified based on the '*Minimum Efficiency Reporting Value* (*MERV) Rating system'* which is used internationally as a standard means of evaluating their efficiency. This system measures an air filters ability to capture particles and pollutants of different sizes (Figure 2) and trap them within the filter. The MERV scale for pleated filters starts from 6 and goes up to 16. The table below shows filters MERV ratings and their equivalent EN779 & ISO 16890 classifications.

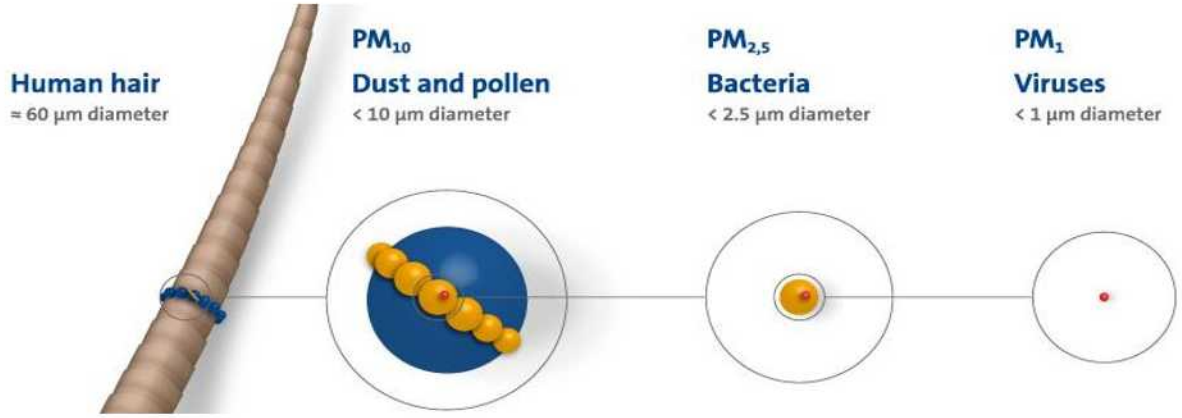

Figure 2: Particle sizes sample

Group	MERV Rating	EN779 Class	ISO 16890 Rating	Particles size - Efficiency		
				.3 – 1.0µm	1 - 3.0µm	3 - 10µm
Coarse	1 - 4	G1	ISO Coarse	-	-	< 20%
	5	G3				
Coarse	6 - 8	G4 (As typically fitted to train HVAC systems)	ISO Coarse	-	-	35% – 49% 50% – 69% 70% - 85%
Medium	9	M5 – M6	ISO ePM10 (≤10µm)		35% - 49%	≥ 85%
	10				50% - 64%	≥ 85%
	11			20%	65% - 79%	≥ 85%
	12			35%		≥ 90%
	13			50%	80%	≥ 90%
Fine	14	F7 – F8	ISO ePM2.5 (≤2.5µm)	75% – 84%	90%	95% & above
	15			85% – 94%	90%	
	16	F9		95% & above	95%	
HEPA	-	H10 – H14	ISO ePM1 (≤1µm)	≥99.5%	≥99.95%	≥99.5%
ULPA		U15 – U17		≥99.99%	≥99.99%	≥99.99%

3.2. Air extraction components

These are the air extraction ducts, vents, fans and grilles within the passenger saloon, cab and kitchen (onboard catering), where the COVID-19 virus viability time will depend on the material as outlined in section 2.

4. Maintenance Task

4.1. Filter Change

To be risk assessed and the following options taken into account

- To have some time gap between end of service and maintenance to account for the viral viability timeframe
- To be handled with caution and avoid stacking filters on seats.
- To be bagged once removed
- To be disposed of in accordance to each TOCs documented and risk assessed procedure

4.2. Air extraction components

To be risk assessed and the following options to be taken into account

- Where only a short time period, as informed by risk assessment, has elapsed between end of service and maintenance intervention. Surface disinfection with 0.1% Sodium Hypochlorite (bleach) or 62-71% ethanol-containing products, or products with similar performance should be considered. As these have been found to significantly reduce levels of the virus on surfaces within a 1-minute exposure time. For more details on the recommended cleaning products see - *RDG Guidance: The Cleaning of Train Interiors during the COVID-19 Pandemic*.

4.3. HVAC Module Repair and Change.
Same as in *section 4.1 and 4.2*

5. Personal Protective Equipment (PPE)

The minimum PPE required to carry out HVAC maintenance tasks shall align with the perceived level of potential exposure to the virus, and to other hazards directly or indirectly. Suitable risk assessments may identify that some or all of the following PPE should be provided to all staff participating in HVAC modules and filters maintenance tasks:

- Disposable gloves in compliance with EN374 requirements
- Safety Footwear
- Safety Eyewear
- Disposable Overalls
- Dust, or other masks
- Hard Hats – (during HVAC module change or repair)

Regarding the *disinfectant chemicals* - The appropriate risk assessments informed by supplier COSHH documents should be carried out to determine any additional PPE, or procedures required when using the product(s).

Hand hygiene - Hands should be washed with soap and water for a minimum of 20 seconds after all PPE is removed.

6. Maintenance Regime - Filters and Air Extractors

The maintenance regime is designed to keep the HVAC system performing at an optimal level as documented in the vehicle maintenance instructions. However, Train Operating Companies that have chosen to implement changes to the operation of the on-train HVAC system and/or to air filtration equipment as per the considerations contained in the RDG guidance on rolling stock ventilation during the COVID-19 pandemic; should review the associated vehicle maintenance instructions – since they may no longer be appropriate to keep the modified HVAC system performing at an optimal level.

From:	[redacted]
To:	[redacted]
Cc:	[redacted]
Subject:	Updated TOC Cleaning COVID-19 Guidance Document v1.6
Date:	29 May 2020 11:44:10
Attachments:	We sent you safe versions of your files.msg TOC Cleaning COVID-19 Guidance Document v1.6.pdf

Dear All,

Please see attached an updated version of the TOC Cleaning COVID-19 Guidance Document v1.6.

As always, comments and feedback are always welcome.

Best wishes,

[redacted]

Undergraduate Engineer|Rail Delivery Group

[redacted]

Rail Delivery Group
National Rail

RDG Guidance: The Cleaning of Train Interiors during the COVID-19 Pandemic

Version Control

Version	Date	Author	Comment	Approved By
1.4	07/04/2020	[redacted]	Initial Version	
1.5	27/04/2020	[redacted]	PPE/Cleaning Product clarifications	
1.6	28/05/2020	[redacted]	Aim of document clarified in Scope; PPE section also clarified	[redacted]

Purpose and Scope

The objective of this document is to be a guide for collective use by Railway Undertakings (RU) when cleaning trains during the COVID-19 Pandemic. This document is primarily aimed at, and is applicable to, cleaning staff who may incur the responsibility of cleaning trains or parts of a train. The information provided is based on advice given by the World Health Organisation (WHO) and Public Health England (PHE), as well as on preliminary studies carried out on the novel coronavirus referred to as COVID-19. Good practice has also been collated based on information provided by GB passenger Train Operators regarding types of train interior cleaning regimes, frequency, cleaning products used, Personal Protective Equipment (PPE) provided and other potentially useful material.

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Background

The 2019 novel coronavirus SARS-CoV-2, which results in the illness COVID-19 has resulted in the need for a more rigorous and effective train interior cleaning routines for GB mainline railways. Transmission of COVID-19 is thought to mainly occur through respiratory droplets generated by coughing or sneezing which contaminates surfaces which is spread via hand to mouth after contact. Experience from SARS-CoV and MERS-CoV, both previous novel coronaviruses, has also been used to theorise the possible viability of COVID-19 on different surfaces.

It is likely that the length of time the virus remains viable is important in allowing its spread. A study recently published by the New England Journal of Medicine documented the decay rates of aerosolised virus samples on five different materials, including plastic, stainless steel, copper and cardboard. Greater viral stability was observed on plastics and stainless steel compared to the other two surfaces, with a greater titre of viable virus found on plastic after 72 hours. "On copper, no viable SARS-CoV-2 was measured after 4 hours (…). On cardboard, no viable SARS-CoV-2 was measured after 24 hours (…)."[1] However, it is important to note that the amount of virus decreased rapidly over time on all the surfaces, therefore implying that the risk of infection from touching them would also decrease over time.

> NOTE: *Cleaning* refers to the removal of germs (bacteria, viruses etc.), dirt and impurities from surfaces. It does not 'kill' germs per se, but reduces the numbers, and therefore lowers the risk of spreading infection.
>
> *Disinfecting* refers to the use of chemicals to 'kill' germs (bacteria, viruses etc.) on surfaces. It does not necessarily clean dirty surfaces or remove germs, but by killing germs after cleaning, it can reduce the risk of infection further.

COVID-19 virus is an enveloped virus, which means it can be broken down more easily by cleaning products, including soap and warm water. Surface disinfection with 0.1% Sodium Hypochlorite (bleach) or 62-71% ethanol-containing products have been found to significantly reduce levels of the virus on surfaces within a 1-minute exposure time.[2]

Public Health England (PHE) has provided guidance on cleaning in a non-healthcare setting, which includes cleaning hard surfaces with warm, soapy water. This should be followed by disinfection with a disinfectant solution at a dilution of 1000 parts per million, or one that is effective against enveloped viruses.

The World Health Organisation has also stated that "*While little is known about this novel virus (Coronavirus COVID 19), in the light of the comparable genetic characteristics with SARS-CoV and MERS-CoV suggest that 2019-nCoV (Coronavirus COVID 19) may likely (be) susceptible to disinfectants with proven activity against enveloped viruses, including sodium hypochlorite (bleach) (e.g. 1,000 ppm (0.1%) for general surface disinfection and 10,000 ppm (1%) for disinfection of blood spills), 62-71% ethanol, 0.5% hydrogen peroxide, quaternary ammonium compounds and phenolic compounds, if used according to manufacturer's recommendations*". Frequency of cleaning regimes, as well as focusing on

[1] 'Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1' ; https://www.nejm.org/doi/full/10.1056/NEJMc2004973?query=featured_home

[2] 'Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents' ; https://www.sciencedirect.com/science/article/pii/S0195670120300463

surfaces which can be touched frequently by person(s), can also play a part in removing, or significantly reducing the risk of infection.

Cleaning and Disinfecting Regimes

It is imperative to carry out enhanced routine cleaning and disinfecting to maintain adequate hygiene standards during the pandemic. This may include increasing frequency of cleaning, changing cleaning products to ensure they are effective against COVID-19, and ensuring the right PPE is used while carrying out certain activities.

Cleaning and disinfecting may be carried out in different ways. However, the two main methods that have been identified are:

i. wiping down affected area(s) using a clean cloth and cleaning product(s) and/or
ii. spraying the affected area(s) with said cleaning products (also known as 'fogging'). The method used is dependent upon the size of the affected area(s).

Areas to focus on

Increasing the cleaning and disinfecting of 'common touch points', including (but not limited to):

Passenger saloons:
- Interior and exterior door open/close buttons
- Interior and exterior door handles
- All handrails around the door access area (including grab-poles and grab-rails)
- All handrails in the customer seating area (including grab-poles and grab-rails)
- All seat grab handles
- All metallic and plastic areas of arm rests
- All tabletop surfaces (including seat-back tables)
- The parts of waste bins passengers typically touch (e.g. lids or flaps)

Toilet areas:
- All handrails, grab poles, and grab rails
- Toilet seat and lid
- Toilet flush button
- Toilet door open/close buttons
- Toilet door handles
- Hand-wash basin controls
- The lids or flaps of any waste bins

Baby-changing facilities:
- Handles
- Table
- Nappy bin lids (where provided)

Drivers' cabs:
- All interior door handles
- All interior door open/close buttons
- Passenger door release/close buttons
- Driver's public address system/radio handset
- Driver's power brake controller handle
- Train management system touchscreens and buttons
- Cab seat armrests (where these are hard surfaces)

Guard/Senior Conductor Accommodation (if applicable)
- All interior door handles
- All interior door open/close buttons
- Passenger door close buttons
- Guard public address system/radio handset
- Interior and exterior door handles

This list is not exhaustive. Consideration should be given to the inclusion of handles, buttons, controls etc. on cab desks, which would normally be regarded as 'off-limits' to cleaning staff during cleaning procedures and the risks associated with doing this and any extra training necessary to facilitate it.

Frequency

Frequency of cleaning regimes is at the operator's discretion. However, a minimum of a daily as well as a separate turnaround cleaning routine during the current COVID-19 pandemic is recommended. Train operators should review the length of a turnaround and consider the opportunity of conducting a 'deeper' clean. The general guideline should be the more people who come into contact with surfaces, the more frequently that surface should be cleaned. It may also be helpful to develop different cleaning specifications for different times of day. For example, identifying key areas that need to be focused on during a clean on an 'in-transit' train in comparison to an 'overnight' regime, a 'turn-around', or a 'heavy clean' etc.

It is good practice to consider developing and leaving a copy of a record of when key areas of the train were cleaned, as well as who they were cleaned by. This is similar to records kept and made visible in public toilets and may ensure that cleaning frequency, standards, and accountability are met and that continued staff confidence in these is assured. Consideration should be given to primarily developing this practice for driving cabs before considering the possibility and practicability of extending it to passenger saloons. Making cleaning occurrences more visible for traincrew, as well as possibly passengers, may result in an increase in confidence on the UK Railway.

Cleaning Products

Various cleaning products are currently being used on the interiors of UK rolling stock, including those being operated/maintained by London Underground, GB train operators and the main UK train builders/maintainers. As mentioned previously, research is still underway regarding how effective certain cleaning products are against COVID-19. However, as the novel coronavirus behaves similarly to other coronaviruses, such as SARS-CoV and MERS-CoV, it is likely that products used to combat these are just as effective at doing the same for COVID-19.

Current cleaning guidelines provided by PHE state that hard surfaces should first be cleaned using warm soapy water. This should be followed by a detergent disinfectant solution at a dilution of 1,000 parts per million available chlorine, or an alternative disinfectant effective against enveloped viruses. However, soap and water may not be suitable for all surfaces, and although it can kill viral samples, it may have little to no residual effects. Therefore, the importance of using appropriate anti-viral cleaning products effective against enveloped viruses is imperative.

Products containing at least one of the following:

- 0.1% Sodium Hypochlorite (bleach)
- 62-71% Ethanol (alcohol)
- 0.5% Hydrogen Peroxide
- Quaternary Ammonium Compounds
- Phenolic Compounds

are highly likely to be effective against COVID-19 due to the virus's similarity in composition to previous known coronaviruses, if used according to the manufacturer's recommendations. Contact times (the time a surface should be treated for) differ depending on the product used. Using different cleaning products for different areas of the train may be considered if a

particular area is considered 'more contaminated'. Do not mix different cleaning products and avoid the use of spray for disinfection of highly contaminated areas. Manufacturer's instructions, including usage, PPE required, equipment needed, and any other special requirements must always be followed.

The following products are reportedly being used and are highly likely to be effective against COVID-19:

- Z-71 Microbe Shield (developed by Zoono Group Limited)
- Guardicide 2505 and 2506 (developed by Chela)
- Selgiene Ultra Virucidal Cleaner (developed by Selden)
- DuoMax (developed by DuoTech)
- Oxivir (developed by Diversey Inc) note: may not be available for use by rail industry yet

Please note that RDG does not endorse nor recommend any specific branded products or named suppliers, nor does RDG vouch for the effectiveness of individual named products. The products listed above are examples of what some operators are using to disinfect areas of trains, however, this list is not exhaustive. To reiterate previous points, PHE guidelines state that disinfecting a surface can be carried out by either a product containing 1000 parts per million available chlorine, or a product effective against enveloped viruses.

According to Public Health England, if items cannot be cleaned and/or disinfected using detergents or laundered, (e.g. seat fabric), steam cleaning should be considered. However, there is currently no conclusive evidence to suggest this eliminates the risk of infection.

Personal Protective Equipment (PPE)

The level of PPE used during cleaning procedures should depend upon the type of product used, the cleaning method used, the perceived level of potential exposure to the virus and the general environment. Suitable risk assessments may identify that some or all of the following PPE should be provided to all cleaning staff participating in train cleaning tasks:

- Gloves-to EN 374 standard (all tasks)
- Safety Footwear (all tasks)
- Safety Eyewear-as deemed necessary post risk assessment (during spraying/fogging of chemicals)
- Overalls-as deemed necessary post risk assessment (during spraying/fogging of chemicals)
- Facemasks-as deemed necessary post risk assessment (during spraying/fogging of chemicals)

Please note that some cleaning products may not require some forms of PPE listed above. The appropriate risk assessments informed by supplier COSHH documents should be carried out to determine the levels of PPE required when carrying out cleaning activities using the product(s).

Additional Processes for Suspected/Confirmed COVID-19 Contamination

If a train has been contaminated with a suspected/confirmed case of COVID-19, this may warrant 'Cause for Concern' cleaning, which is sufficient to fulfil the requirements set by Public Health England's 'COVID-19: cleaning in non-healthcare settings'. The following guidance must be followed:

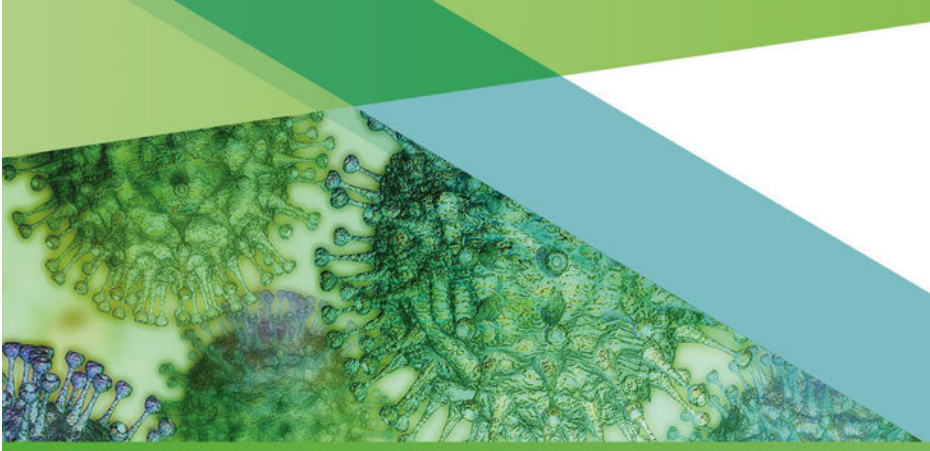
- All surfaces that the symptomatic person may have come into contact with must be cleaned and disinfected with *disposable* paper roll/cloths and mop heads, with products effective against enveloped viruses, such as the ones listed in the 'Cleaning Products' section of this document.
- Avoid creating splashes and spray when cleaning.
- Any cleaning items used must be disposed of by following the waste guidance outlined below.

Those conducting 'Cause for Concern' cleaning should use a minimum of apron and gloves as PPE. Hands should be washed with soap and water for a minimum of 20 seconds after all PPE is removed. If a risk assessment of the setting indicates that a higher level of virus may be present (e.g. on Sleeper services) or there is visible contamination with body fluids, then the need for additional PPE to protect the cleaner's eyes, mouth and nose might be necessary. The local Public Health England (PHE) Health Protection Team (HPT) can advise on this.

Waste from cleaning of areas where possible cases have been should be:

- Put in a plastic rubbish bag and tied when full.
- The plastic bag should then be placed in a second bin bag and tied.
- The waste should then be placed in a suitable and secure location away from communal areas for at least 72 hours or until negative test results are known.
- If 72-hour storage is not practicable, arrange for collection as a Category B infectious waste either by the local waste collection authority or a specialist clinical waste collector.

There may be occasions when Public Health England ask for a specialised COVID-19 deep clean. This is when a third-party specialist cleaning team is likely to be engaged. The specialist team will liaise with the local area premises manager to agree a methodology. They will use their own risk assessment to determine what cleaning is carried out, what cleaning products are used and what PPE is required. The management of staff on site during a clean and the length of time an area may need to be vacant for will vary between sites dependent on the results of the specialist team site survey and the operational requirements of the location.



Heating, ventilation and air-conditioning systems in the context of COVID-19

22 June 2020

Scope of this document

Guidance on ventilation of indoor spaces

Target audience

Public health authorities in EU/EEA countries and the UK

Evidence for transmission in closed spaces and the role of heating, ventilation and air-conditioning (HVAC) systems

Heating, ventilation and air-conditioning (HVAC) systems are used to provide comfortable environmental conditions (temperature and humidity) and clean air in indoor settings such as buildings and vehicles. HVAC systems can be configured in a variety of ways, depending on their application and functions of the building/vehicle. Ventilation systems provide clean air by exchanging indoor and outdoor air and filtering. Air-conditioning systems can be part of integrated HVAC systems or stand-alone, providing cooling/warming and dehumidification. Stand-alone systems usually recirculate the air without mixing it with outdoor air.

Poor ventilation in confined indoor spaces is associated with increased transmission of respiratory infections [1]. There have been numerous COVID-19 transmission events associated with closed spaces, including some from pre-symptomatic cases [2-4]. The role of ventilation in preventing COVID-19 transmission is not well-defined (i.e. by preventing dispersal of infectious particles to minimise the risk of transmission, or preventing transfer of an infectious dose to susceptible individuals). COVID-19 is thought to be primarily transmitted via large respiratory droplets, however, an increasing number of outbreak reports implicate the role of aerosols in COVID-19 outbreaks. Aerosols consist of small droplets and droplet nuclei which remain in the air for longer than large droplets [5,6].

Studies indicate that SARS-CoV-2 particles can remain infectious on various materials, as well as in aerosols in indoor environments, with the duration of infectivity depending on temperature and humidity [7]. So far, transmission through fomites has not been documented, but it is considered possible.

Several outbreak investigation reports have shown that COVID-19 transmission can be particularly effective in crowded, confined indoor spaces such as workplaces (offices, factories) and during indoor events - e.g. churches, restaurants, gatherings at ski resorts, parties, shopping centres, worker dormitories, dance classes, cruise ships and vehicles [8]. There are also indications that transmission can be linked to specific activities, such as singing in a choir [9] or during religious services that may be characterised by increased production of respiratory droplets through loud speech and singing.

In a study of 318 outbreaks in China, transmission in all cases except one occurred in indoor spaces [10]. The only case of outdoor transmission identified in this study involved two people. However, outdoor events have also been implicated in the spread of COVID-19, typically those associated with crowds, such as carnival celebrations [11] and football matches [12], highlighting the risk of crowding even at outdoor events. However, exposure in crowded indoor spaces is also very common during such events.

The length of time that people stay in indoor settings appears to be associated with the attack rate. For example, in a 2.5 hour choir practice in Washington, US, there were 32 confirmed and 20 probable secondary COVID-19 cases among 61 participants (85.2%). In an epidemiological investigation at a call centre in South Korea, there was an attack rate of 43.5% among 216 employees on the ninth floor of the call centre, indicating extensive transmission in a crowded indoor workplace environment [13]. Nearly all of the infected employees were sitting on the same side of the ninth floor. There was no obvious relationship between the risk of transmission and the distance from the index case on this side of the 9th floor. The authors also concluded that the length of time people were in contact played the most important role in spreading of COVID-19, since the cases were limited almost exclusively to the ninth floor, despite interaction with colleagues in other settings (such as in elevators and in the lobby).

From the reports published to date, it is not as yet possible to clarify the role of physical proximity and direct contact, and the possibility of indirect transmission through contaminated objects and surfaces, or longer distance transmission through aerosols. In addition, there is a potential for publication bias, with fewer communications of negative findings; and confirmation bias, with published studies re-confirming known science. However, the current body of evidence demonstrates the risk of transmission in crowded indoor settings and the importance of combining bundles of prevention measures.

Several studies have addressed the role of ventilation in COVID-19 outbreaks. Three outbreaks involved an index case that was reported to be pre-symptomatic, and ventilation in an enclosed space, aided by air conditioning.

In a restaurant outbreak in Guangzhou, China, there were 10 cases across three families [14]. They developed symptoms between 26 January and 10 February 2020, having eaten lunch on 23 January at the same restaurant, which is a five-floor building without windows. Their tables were more than a metre apart. The index case was pre-symptomatic, developing a fever and cough that evening. The secondary cases were sitting along the line of airflow generated by the air-conditioning, while diners sitting elsewhere in the restaurant were not infected. The authors of the report attribute transmission to the spread of respiratory droplets carrying SARS-CoV-2 via the airflow generated by the air-conditioning.

The authors of a pre-print manuscript describing two other outbreaks from China in January 2020 attribute air conditioning systems using a re-circulating mode as a probable aid to transmission [15].

The first outbreak was associated with a 150-minute event at a temple. The index case, who had previously visited Wuhan, was pre-symptomatic until the evening after the event. The attack rates in the outbreak were highest among those who shared a 100-minute bus ride with the index case (23 out of 67 passengers; 34%). Passengers sitting closer to the index case did not have a statistically higher risk of COVID-19 than those sitting further away. However, all passengers sitting close to a window remained healthy, with the exception of the passenger sitting next to the index case. This supports the hypothesis that the airflow along the bus facilitated the spread of the virus. In contrast, there were seven COVID-19 cases among 172 other people who attended the same 150-minute temple event, all of whom described having had close contact with the index case.

The second outbreak was associated with a training workshop from 12—14 January in Hangzhou city, Zhejiang province. It had 30 attendees from different cities, who booked hotels individually and did not eat together at the workshop facility. The workshop had four 4-hour group sessions, which were in two closed rooms of 49 square metres and 75 square metres. An automatic timer on the central air conditioners circulated the air in each room for 10 minutes every four hours, using 'an indoor re-circulating mode'. No trainees were known to be symptomatic during the workshop. During the period 16—22 January 2020, 15 of them were diagnosed with COVID-19.

High Efficiency Particulate Air (HEPA) filters have demonstrated good performance with particles of the SARS-Cov-2 virus size (approximately 70–120 nm) and are used in aeroplanes and in healthcare settings. The role of HEPA filters in buildings outside of healthcare settings in preventing transmission of infectious diseases is unclear. A modelling study of the infection risk from SARS-CoV-1, the virus causing SARS, conferred by three types of ventilation systems in relatively large commercial aeroplanes, found that mixing ventilation systems had the highest risk and conventional displacement systems had the lowest risk. The authors recommended personalised ventilation systems for airline cabins, as they were best in maintaining thermal comfort, while also reducing the infection risk [16].

In conclusion, the available evidence indicates that:

- Transmission of COVID-19 commonly occurs in closed indoor spaces.
- There is currently no evidence of human infection with SARS-CoV-2 caused by infectious aerosols distributed through the ventilation system ducts of HVACs. The risk is rated as very low.
- Well-maintained HVAC systems, including air-conditioning units, securely filter large droplets containing SARS-CoV-2. It is possible for COVID-19 aerosols (small droplets and droplet nuclei) to spread through HVAC systems within a building or vehicle and stand-alone air-conditioning units if air is recirculated.
- Air flow generated by air-conditioning units may facilitate the spread of droplets excreted by infected people longer distances within indoor spaces.
- HVAC systems may have a complementary role in decreasing transmission in indoor spaces by increasing the rate of air change, decreasing recirculation of air and increasing the use of outdoor air.

Guidance

Infection control measures with proven evidence for reducing the risk of SARS-CoV-2 transmission should be emphasised. Organisers and administrators responsible for gatherings and critical infrastructure settings should provide guidance material to participants regarding the application of the preventive measures, including:

- Physical distancing
- Meticulous hand hygiene
- Respiratory etiquette
- Appropriate use of face masks, if required for staff, and in areas where physical distancing cannot be maintained due to structural or functional impediments.

Building administrators should maintain heating, ventilation, and air-conditioning systems according to the manufacturer's current instructions, particularly in relation to the cleaning and changing of filters [17]. There is no benefit or need for additional maintenance cycles in connection with COVID-19. Energy-saving settings, such as demand-controlled ventilation controlled by a timer or CO2 detectors, should be avoided. Consideration should be given to extending the operating times of HVACs before and after the regular period [17,18].

Direct air flow should be diverted away from groups of individuals to avoid pathogen dispersion from infected subjects and transmission.

Organisers and administrators responsible for gatherings and critical infrastructure settings should explore options with the assistance of their technical/maintenance teams to avoid the use of air recirculation as much as possible [17,18]. They should consider reviewing their procedures for the use of recirculation in HVAC systems based on information provided by the manufacturer or, if unavailable, seeking advice from the manufacturer.

The minimum number of air exchanges per hour, in accordance with the applicable building regulations, should be ensured at all times. Increasing the number of air exchanges per hour will reduce the risk of transmission in closed spaces. This may be achieved by natural or mechanical ventilation, depending on the setting [4,18,19].

The application of the above guidance should be in accordance with national and local regulations (e.g. building regulations, health and safety regulations) and appropriate to local conditions.

Technical specifications and standards for mechanical ventilation systems to reduce the risk of COVID-19 transmission in indoor spaces still need to be defined on the basis of scientific studies that are tuned to COVID-19 research developments. The technical specifications will need to be defined for categories of room or location type, taking into account the room size, the degree of enclosure and non-mechanical ventilation, and the probable purpose for which the room will be used. Moreover, options should be provided for protected buildings that be subject to engineering modifications. The technical standards should ideally recommend minimum criteria to be met in order for authorities to permit the intended use of an enclosed space.

The technical specifications regarding the logistical arrangement of enclosed spaces, including the physical placement of mechanical ventilation systems, also need to be informed by scientific evidence and technical expertise, so as to minimise the risk of transmission. These specifications will also need to take into account the expected number of users, the types of user and the user activity. For example, in supermarkets, cashiers and customers have different levels of mobility and durations of occupancy. As a general principle, mechanical ventilation should be arranged to minimise the direction of sustained air flow for stationary persons.

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Appendix

Table 1. Retention capacity of different filter types used in HVAC system

Ventilation system	Typical filter type	Retention capacity			
		MERV rating [a]	Degree of separation [b]	SARS-CoV-2 containing droplets (> 5µm)	SARS-CoV-2 containing aerosol [c] (< 5µm)
Specialised HVAC systems (operating theatres, special laboratories)	H13 -14 [DIN EN]	16–20	99.99%	Yes	
HEPA filter	H13 [DIN EN]	16–20	99.95 %	Yes	
HVAC systems for office buildings, churches, cruise ships, etc.	ePM1 [EN ISO]	9–13	>80 %	Yes	No
Standalone air-conditioner (e.g. apartments, shops, restaurants)	- Fiberglass - Polyester/pleated air filters	1–4 8–13	<40% 45%	Yes	No
Pedestal fans	n/a	n/a		No	

a) Minimum Efficiency Reporting Value (MERV), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE);
b) Minimum separation efficiency for test particles, EN ISO 16890 (particle sizes 0.2 to 1.0 µm, depending on the filter type);
c) Particles, droplet nuclei of different sizes.

Cleaning and disinfection of environmental surfaces in the context of COVID-19

Interim guidance

15 May 2020

World Health Organization

Background

Coronavirus disease 2019 (COVID-19) is a respiratory infection caused by SARS-CoV-2 (COVID-19 virus). The COVID-19 virus is transmitted mainly through close physical contact and respiratory droplets, while airborne transmission is possible during aerosol generating medical procedures.[1] At time of publication, transmission of the COVID-19 virus had not been conclusively linked to contaminated environmental surfaces in available studies. However, this interim guidance document has been informed by evidence of surface contamination in health-care settings[2] and past experiences with surface contamination that was linked to subsequent infection transmission in other coronaviruses. Therefore, this guidance aims to reduce any role that fomites might play in the transmission of COVID-19 in health-care[3] and non-health care settings.[4]

Environmental surfaces in health-care settings include furniture and other fixed items inside and outside of patient rooms and bathrooms, such as tables, chairs, walls, light switches and computer peripherals, electronic equipment, sinks, toilets as well as the surfaces of non-critical medical equipment, such as blood pressure cuffs, stethoscopes, wheelchairs and incubators.[5] In non-healthcare settings, environmental surfaces include sinks and toilets, electronics (touch screens and controls), furniture and other fixed items, such as counter tops, stairway rails, floors and walls.

Environmental surfaces are more likely to be contaminated with the COVID-19 virus in health-care settings where certain medical procedures are performed.[6-8] Therefore, these surfaces, especially where patients with COVID-19 are being cared for, must be properly cleaned and disinfected to prevent further transmission. Similarly, this advice applies to alternative settings for isolation of persons with COVID-19 experiencing uncomplicated and mild illness, including households and non-traditional facilities.[9]

Transmission of the COVID-19 virus has been linked to close contact between individuals within closed settings, such as households, health facilities, assisted living and residential institution environments.[10] In addition, community settings outside of health-care settings have been found vulnerable to COVID-19 transmission events including publicly accessible buildings, faith-based community centres, markets, transportation, and business settings.[10,11] Although the precise role of fomite transmission and necessity for disinfection practices outside of health-care environments is currently unknown, infection prevention and control principles designed to mitigate the spread of pathogens in health-care settings, including cleaning and disinfection practices, have been adapted in this guidance document so that they can be applied in non-health care setting environments.* In all settings, including those where cleaning and disinfection are not possible on a regular basis due to resource limitations, frequent hand washing and avoiding touching the face should be the primary prevention approaches to reduce any potential transmission associated with surface contamination.[21]

Like other coronaviruses, SARS-CoV-2 is an enveloped virus with a fragile outer lipid envelope that makes it more susceptible to disinfectants compared to non-enveloped viruses such as rotavirus, norovirus and poliovirus.[22] Studies have evaluated the persistence of the COVID-19 virus on different surfaces. One study found that the COVID-19 virus remained viable up to 1 day on cloth and wood, up to 2 days on glass, 4 days on stainless steel and plastic, and up to 7 days on the outer layer of a medical mask.[23] Another study found that the COVID-19 virus survived 4 hours on copper, 24 hours on cardboard and up to 72 hours on plastic and stainless steel.[24] The COVID-19 virus also survives in a wide range of pH values and ambient temperatures but is susceptible to heat and standard disinfection methods.[23] These studies, however, were conducted under laboratory conditions in absence of cleaning and disinfection practices and should be interpreted with caution in the real-world environment.

The purpose of this document is to provide guidance on the cleaning and disinfection of environmental surfaces in the context of COVID-19.

This guidance is intended for health-care professionals, public health professionals and health authorities that are developing and implementing policies and standard operating procedures (SOP) on the cleaning and disinfection of environmental surfaces in the context of COVID-19. †

* The topics of current WHO interim guidance documents for non health care setting environments, including environmental cleaning and disinfection recommendations, include faith-based community settings,[12] funerary services,[13] workplaces,[14] food sector,[15] accommodation sector,[16] aviation sector,[17] maritime sector,[18] schools,[19] prisons and other places of detention.[20]

† This document is not intended to be comprehensive guidance on the practice of environmental cleaning and disinfection, which is covered in other relevant guidelines

Principles of environmental cleaning and disinfection

Cleaning helps to remove pathogens or significantly reduce their load on contaminated surfaces and is an essential first step in any disinfection process. Cleaning with water, soap (or a neutral detergent) and some form of mechanical action (brushing or scrubbing) removes and reduces dirt, debris and other organic matter such as blood, secretions and excretions, but does not kill microorganisms.[25] Organic matter can impede direct contact of a disinfectant to a surface and inactivate the germicidal properties or mode of action of several disinfectants. In addition to the methodology used, the disinfectant concentration and contact time are also critical for effective surface disinfection. Therefore, a chemical disinfectant, such as chlorine or alcohol, should be applied after cleaning to kill any remaining microorganisms.

Disinfectant solutions must be prepared and used according to the manufacturer's recommendations for volume and contact time. Concentrations with inadequate dilution during preparation (too high or too low) may reduce their effectiveness. High concentrations increase chemical exposure to users and may also damage surfaces. Enough disinfectant solution should be applied to allow surfaces to remain wet and untouched long enough for the disinfectant to inactivate pathogens, as recommended by the manufacturer.

Training in health-care settings

Environmental cleaning is a complex infection prevention and control intervention that requires a multipronged approach, which may include training, monitoring, auditing and feedback, reminders and displaying SOPs in key areas.

Training for cleaning staff should be based on the policies and SOPs of the health-care facility and national guidelines. It should be structured, targeted, and delivered in the right style (e.g. participatory, at the appropriate literacy level), and it should be mandatory during staff induction to a new workplace. The training programme should include instructions on risk assessment and ensure demonstrative competencies of safe disinfectant preparation, mechanical cleaning and equipment use, standard precautions and transmission-based precautions. Refresher courses are recommended to encourage and reinforce good practice. In health-care facilities and public buildings, posters or other guidance should be visible to cleaning workers and others to guide and remind them about the proper procedures on disinfectant preparation and use.

Cleaning and disinfection techniques and supplies

Cleaning should progress from the least soiled (cleanest) to the most soiled (dirtiest) areas, and from the higher to lower levels so that debris may fall on the floor and is cleaned last in a systematic manner to avoid missing any areas. Use fresh cloths at the start of each cleaning session (e.g., routine daily cleaning in a general inpatient ward). Discard cloths that are no longer saturated with solution. For areas considered to be at high risk of COVID-19 virus contamination, use a new cloth to clean each patient bed. Soiled cloths should be reprocessed properly after each use and an SOP should be available for the frequency of changing cloths.

Cleaning equipment (e.g. buckets) should be well maintained. Equipment used for isolation areas for patients with COVID-19 should be colour-coded and separated from other equipment. Detergent or disinfectant solutions become contaminated during cleaning and progressively less effective if the organic load is too high; therefore, the continued use of the same solution may transfer the microorganisms to each subsequent surface. Thus, detergent and/or disinfectant solutions must be discarded after each use in areas with suspected/confirmed patients with COVID-19. It is recommended that fresh solution be prepared on a daily basis or for each cleaning shift. Buckets should be washed with detergent, rinsed, dried and stored inverted to drain fully when not in use.[28]

Products for environmental cleaning and disinfection

Follow the manufacturer's instructions to ensure that disinfectants are prepared and handled safety, wearing the appropriate personal protective equipment (PPE) to avoid chemical exposure.[26]

The selection of disinfectants should take account of the microorganisms targeted, as well as the recommended concentration and contact time, the compatibility of the chemical disinfectants and surfaces to be tackled, toxicity, ease of use and stability of the product. The selection of disinfectants should meet local authorities' requirements for market approval, including any regulations applicable to specific sectors, for example health-care and food industries.[‡]

The use of chlorine-based products

Hypochlorite-based products include liquid (sodium hypochlorite), solid or powdered (calcium hypochlorite) formulations. These formulations dissolve in water to create a dilute aqueous chlorine solution in which undissociated hypochlorous acid (HOCl) is active as the antimicrobial compound. Hypochlorite displays a broad spectrum of antimicrobial activity and is effective against several common pathogens at various concentrations. For example, hypochlorite is effective against rotavirus at a concentration of 0.05% (500 ppm), however, higher concentrations of 0.5% (5000 ppm) are required for some highly resistant pathogens in the health-care setting such as *C. auris* and *C. difficile.*[30,31]

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including the WHO's *Essential environmental health standards in health care*[25] and the joint U.S. Centers for Disease Control and Prevention & Infection Control Africa Network's document *Best practices for environmental cleaning in healthcare facilities in resource-limited settings.*[26] This guidance does not address the procedures for decontamination of instruments and semi-critical and critical medical devices, which can be found in the WHO document on *Decontamination and reprocessing of medical devices for health-care facilities.*[27]

[‡] A list of disinfectants for use against the COVID-19 virus is currently being actively updated by the U.S. Environmental Protection Agency (EPA) with caution that inclusion of a disinfectant within this list does not constitute endorsement by their agency.[29]

The recommendation of 0.1% (1000 ppm) in the context of COVID-19 is a conservative concentration that will inactivate the vast majority of other pathogens that may be present in the health-care setting. However, for blood and body fluids large spills (i.e. more than about 10mL) a concentration of 0.5% (5000 ppm) is recommended.[26]

Hypochlorite is rapidly inactivated in the presence of organic material; therefore, regardless of the concentration used, it is important to first clean surfaces thoroughly with soap and water or detergent using mechanical action such as scrubbing or friction. High concentrations of chlorine can lead to corrosion of metal and irritation of skin or mucous membrane, in addition to potential side-effects related to chlorine smell for vulnerable people such as people with asthma.[32]

Commercial sodium hypochlorite products with different levels of concentration may be readily available for use in a variety of settings. In Europe and North America chlorine concentrations in commercially available products vary between 4% and 6%.[34] Concentration may also vary according to national regulations and manufacturers' formulations. To achieve the desired concentration, it is necessary to prepare sodium hypochlorite by diluting the basic aqueous solution with a given proportion of clean, non-turbid water to produce the final desired concentration (Table 1).[34]

Table 1. Calculation of sodium hypochlorite concentrations

[% chlorine in liquid sodium hypochlorite / % chlorine desired] − 1 = Total parts of water for each part sodium hypochlorite.
Ex: [5% in liquid sodium hypochlorite/ 0.5% chlorine desired] -1 = 9 parts of water for each part sodium hypochlorite

Solid formulations of hypochlorite (powder or granules) may also be available in a variety of settings. Solid formulations are available as concentrated, high-test hypochlorite (HTH) (65-70%) and as chlorine or calcium hypochlorite powder (35%). To produce the final desired concentration, the weight (in grams) of calcium hypochlorite that should be added per litre of water can be determined based on the calculation in Table 2.

Table 2. Calculation of chlorine solutions from calcium hypochlorite

[% chlorine desired / % chlorine in hypochlorite powder or granules] × 1 000 = grams of calcium hypochlorite powder for each litre of water.
Ex: [0.5% chlorine desired / 35% in hypochlorite powder] × 1 000 = 0.0143 × 1 000 = 14.3
Therefore, you must dissolve 14.3 grams of calcium hypochlorite powder in each litre of water used to make a 0.5% chlorine solution.

Chlorine can decay rapidly in solutions depending on the source of chlorine and environmental conditions, for example ambient temperature or UV exposure. Chlorine solutions should be stored in opaque containers, in a well-ventilated, covered area that is not exposed to direct sunlight.[35] Chlorine solutions are most stable at high pH (>9) but the disinfectant properties of chlorine are stronger at lower pH (<8). Solutions of 0.5% and 0.05% chlorine have been shown to be stable for more than 30 days at temperatures of 25-35°C when the pH is above 9. However, chlorine solutions at lower pH have much shorter shelf lives.[36] Thus, ideally chlorine solutions should be freshly prepared every day. If this is not possible and the chlorine solution must be used for several days, they should be tested daily to ensure that the chlorine concentration is maintained. Several tests can be used to gauge chlorine strength, and these include chemical titration, chemical spectrometry or colorimetry, colour wheels and test strips, in order of decreasing accuracy.[37]

Spraying disinfectants and other no-touch methods

In indoor spaces, routine application of disinfectants to environmental surfaces by spraying or fogging (also known as fumigation or misting) is not recommended for COVID-19. One study has shown that spraying as a primary disinfection strategy is ineffective in removing contaminants outside of direct spray zones.[38] Moreover, spraying disinfectants can result in risks to the eyes, respiratory or skin irritation and the resulting health effects.[39] Spraying or fogging of certain chemicals, such as formaldehyde, chlorine-based agents or quaternary ammonium compounds, is not recommended due to adverse health effects on workers in facilities where these methods have been utilized.[40,41] Spraying environmental surfaces in both health-care and non-health care settings such as patient households with disinfectants may not be effective in removing organic material and may miss surfaces shielded by objects, folded fabrics or surfaces with intricate designs. If disinfectants are to be applied, this should be done with a cloth or wipe that has been soaked in disinfectant.

Some countries have approved no-touch technologies for applying chemical disinfectants (e.g. vaporized hydrogen peroxide) in health-care settings such as fogging-type applications.[42] Furthermore, devices using UV irradiation have been designed for health-care settings. However, several factors may affect the efficacy of UV irradiation, including distance from the UV device; irradiation dose, wavelength and exposure time; lamp placement; lamp age; and duration of use. Other factors include direct or indirect line of sight from the device; room size and shape; intensity; and reflection.[5] Notably, these technologies developed for use in health-care settings are used during terminal cleaning (cleaning a room after a patient has been discharged or transferred), when rooms are unoccupied for the safety of staff and patients**.** These technologies supplement but do not replace the need for manual cleaning procedures.[44] If using a no-touch disinfection technology, environmental surfaces must be cleaned manually first by brushing or scrubbing to remove organic matter.[44]

Spraying or fumigation of outdoor spaces, such as streets or marketplaces, is also not recommended to kill the COVID-19 virus or other pathogens because disinfectant is inactivated by dirt and debris and it is not feasible to manually clean and remove all organic matter from such spaces. Moreover, spraying porous surfaces, such as sidewalks and unpaved walkways, would be even less effective. Even in the absence of organic matter, chemical spraying is unlikely to adequately

cover all surfaces for the duration of the required contact time needed to inactivate pathogens. Furthermore, streets and sidewalks are not considered to be reservoirs of infection for COVID-19. In addition, spraying disinfectants, even outdoors, can be harmful for human health.

Spraying individuals with disinfectants (such as in a tunnel, cabinet, or chamber) **is not recommended under any circumstances**. This could be physically and psychologically harmful and would not reduce an infected person's ability to spread the virus through droplets or contact. Moreover, spraying individuals with chlorine and other toxic chemicals could result in eye and skin irritation, bronchospasm due to inhalation, and gastrointestinal effects such as nausea and vomiting.[40, 45]

Health-care settings environment

Environmental cleaning and disinfection in clinical, non-traditional facilities and home-based health-care settings should follow detailed SOPs with a clear delineation of responsibilities (e.g. housekeeping or clinical staff), regarding the type of surfaces and frequency of cleaning (Table 3). Particular attention should be paid to environmental cleaning of high-touch surfaces and items, such as light switches, bed rails, door handles, intravenous pumps, tables, water/beverage pitchers, trays, mobile cart rails and sinks, which should be performed frequently. However, all touchable surfaces should be disinfected. Cleaning practices and cleanliness should be routinely monitored. The number of cleaning staff should be planned to optimize cleaning practices. Health workers should be made aware of cleaning schedules and cleaning completion times to make informed risk assessments when performing touch contact with surfaces and equipment, to avoid contaminating hands and equipment during patient care.[46]

Table 3. Health-care setting: Recommended frequency of cleaning of environmental surfaces, according to the patient areas with suspected or confirmed COVID-19 patients.

Patient area	Frequency [a]	Additional guidance
Screening/triage area	At least twice daily	• Focus on high-touch surfaces, then floors (last)
Inpatient rooms / cohort – occupied	At least twice daily, preferably three times daily, in particular for high-touch surfaces	• Focus on high-touch surfaces, starting with shared/common surfaces, then move to each patient bed; use new cloth for each bed if possible; then floors (last)
Inpatient rooms – unoccupied (terminal cleaning)	Upon discharge/transfer	• Low-touch surfaces, high-touch surfaces, floors (in that order); waste and linens removed, bed thoroughly cleaned and disinfected
Outpatient / ambulatory care rooms	After each patient visit (in particular for high-touch surfaces) and at least once daily terminal clean	• High-touch surfaces to be disinfected after each patient visit • Once daily low-touch surfaces, high-touch surfaces, floors (in that order); waste and linens removed, examination bed thoroughly cleaned and disinfected
Hallways / corridors	At least twice daily [b]	• High-touch surfaces including railings and equipment in hallways, then floors (last)
Patient bathrooms/ toilets	Private patient room toilet: at least twice daily Shared toilets: at least three times daily	• High-touch surfaces, including door handles, light switches, counters, faucets, then sink bowls, then toilets and finally floor (in that order) • Avoid sharing toilets between staff and patients

[a] Environmental surfaces should also be cleaned and disinfected whenever visibly soiled or if contaminated by a body fluid (e.g., blood); [b] Frequency can be once a day if hallways are not frequently used.

Selecting a disinfectant product for environmental surfaces in health-care settings should consider the logarithmic (decimal order of magnitude) reduction for the COVID-19 virus, and also for other health care-associated pathogens, including *Staphylococcus aureus*, *Salmonella sp*, *Pseudomonas aeruginosa*, *Acinetobacter baumannii,* and hepatitis A and B viruses. In some contexts, environmentally persistent organisms, such as *Clostridioides difficile* and *Candida auris*, that are resistant to certain disinfectants, should also be considered when selecting a disinfectant. Thus, appropriate disinfectants need to be carefully selected for health-care facilities.[47]

After cleaning, the following disinfectants and defined concentrations can be used on environmental surfaces to achieve a >3 $\log^{10}$ reduction of human coronavirus,[33] and they are also effective against other clinically relevant pathogens in the health-care setting.[22]

- Ethanol 70-90%
- Chlorine-based products (e.g., hypochlorite) at 0.1% (1000 ppm) for general environmental disinfection or 0.5% (5000 ppm) for blood and body fluids large spills (See section: The use of chlorine-based products)
- Hydrogen peroxide ≥0.5%

Contact time of a minimum of 1 minute is recommended for these disinfectants[21] or as recommended by the manufacturers. Other disinfectants can be considered, provided the manufacturers recommend them for the targeted microorganisms, especially enveloped viruses. Manufacturers' recommendations for safe use as well as for avoiding mixing types of chemical disinfectants should always be considered when preparing, diluting or applying a disinfectant.

Non-health care settings environment

There is no evidence for equating the risk of fomite transmission of the COVID-19 virus in the hospital setting to any environment outside of hospitals. However, it is still important to reduce potential for COVID-19 virus contamination in non-healthcare settings, such as in the home, office, schools, gyms or restaurants. High-touch surfaces in these non-health care settings should be identified for priority disinfection. These include door and window handles, kitchen and food preparation areas, counter tops, bathroom surfaces, toilets and taps, touchscreen personal devices, personal computer keyboards, and work surfaces. The disinfectant and its concentration should be carefully selected to avoid damaging surfaces and to avoid or minimize toxic effects on household members or users of public spaces.

The environmental cleaning techniques and cleaning principles should be followed as far as possible. Surfaces should always be cleaned with soap and water or a detergent to remove organic matter first, followed by disinfection. In non-health care settings, sodium hypochlorite (bleach) may be used at a recommended concentration of 0.1% (1000 ppm).[5] Alternatively, alcohol with 70%-90% concentration may be used for surface disinfection.

Personal safety when preparing and using disinfectants

Cleaners should wear adequate personal protective equipment (PPE) and be trained to use it safely. When working in places where suspected or confirmed COVID-19 patients are present, or where screening, triage and clinical consultations are carried out, cleaners should wear the following PPE: gown, heavy duty gloves, medical mask, eye protection (if risk of splash from organic material or chemicals), and boots or closed work shoes.[48]

Disinfectant solutions should always be prepared in well-ventilated areas. Avoid combining disinfectants, both during preparation and usage, as such mixtures cause respiratory irritation and can release potentially fatal gases, in particular when combined with hypochlorite solutions.

Personnel preparing or using disinfectants in health care settings require specific PPE, due to the high concentration of disinfectants used in these facilities and the longer exposure time to the disinfectants during the workday.[49] Thus, PPE for preparing or using disinfectants in health care settings includes uniforms with long-sleeves, closed work shoes, gowns and/or impermeable aprons, rubber gloves, medical mask, and eye protection (preferably face shield)[§].

In non-health care settings, resource limitations permitting, where disinfectants are being prepared and used, the minimum recommended PPE is rubber gloves, impermeable aprons and closed shoes.[34] Eye protection and medical masks may also be needed to protect against chemicals in use or if there is a risk of splashing.

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WHO continues to monitor the situation closely for any changes that may affect this interim guidance. Should any factors change, WHO will issue a further update. Otherwise, this interim guidance document will expire 2 years after the date of publication

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