Technical Note

Personal Protective Equipment for Activities Related to H_2O_2-Based Room Disinfection

FH, Steinemann Disinfection, 2026

Steinemann Disinfection (CleanService Group AG) | Wilerstrasse 2180 | 9230 Flawil | Switzerland | +41 71 555 11 30 | disinfection@steinemanngroup.com | steinemann-disinfection.ch

Steinemann DISINFECTION

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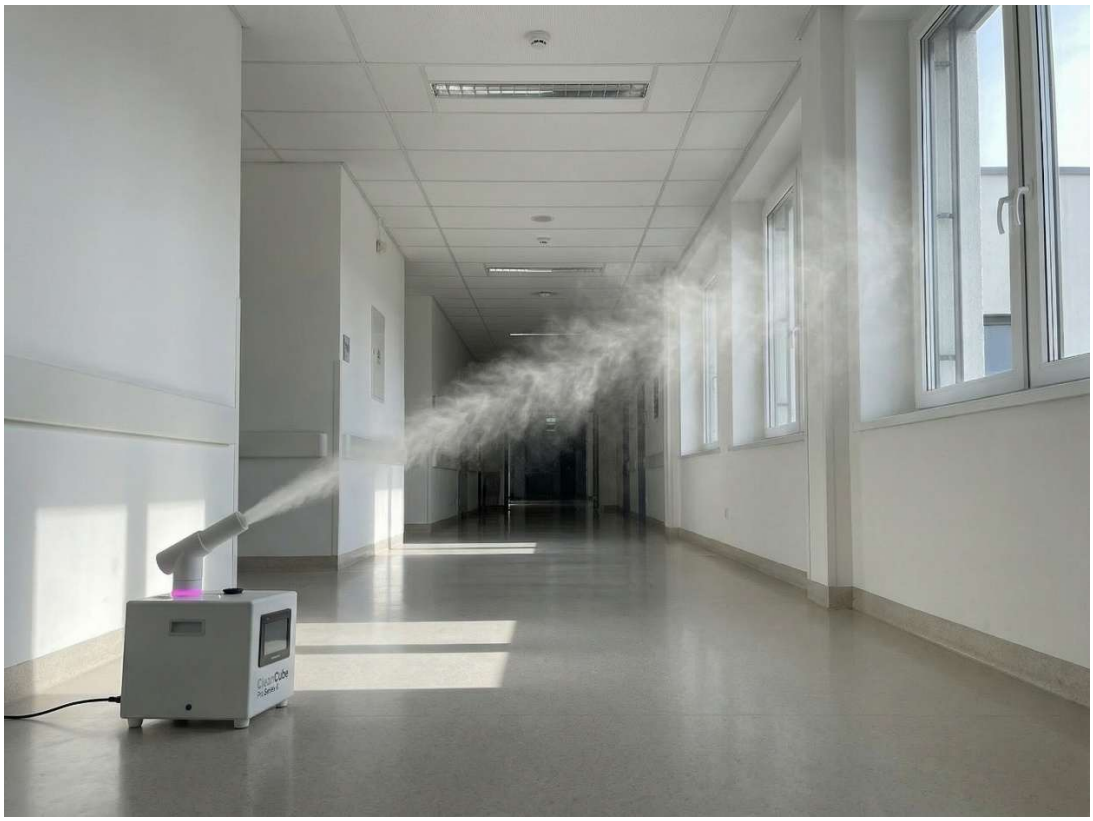
Steinemann Disinfection (CleanService Group AG) | Wilerstrasse 2180 | 9230 Flawil | Switzerland | +41 71 555 11 30 | disinfection@steinemanngroup.com | steinemann-disinfection.ch

1 Introduction and Objectives

H_2O_2-based room disinfection processes are used to treat enclosed rooms and the exposed surfaces within them automatically.



During the actual application and the intended contact phase, no persons or animals should normally be present in the treated room.

The question of **personal protective equipment (PPE)** therefore arises primarily when a room must be entered before full release or when there is uncertainty about the residual concentration still present.

After completion of the active treatment, the concentration of hydrogen peroxide in the room decreases over time. Hydrogen peroxide is not permanently stable and ultimately decomposes into water and oxygen. Depending on the process, reactions with surfaces, natural ventilation, mechanical ventilation or specific aeration systems additionally contribute to reducing the concentration in the room air. [5][6]

However, this reduction in concentration does not proceed in the same way in every room. A small, well-ventilated treatment room may behave differently from a laboratory, a cleanroom or a technically enclosed system. Room volume, geometry, airflow, temperature, relative humidity, surfaces and furnishings can influence the concentration profile over time. Studies and technical documentation on H_2O_2 room treatment processes show that aeration, material loading and flow conditions can all be relevant to the concentration profile. [5][6]

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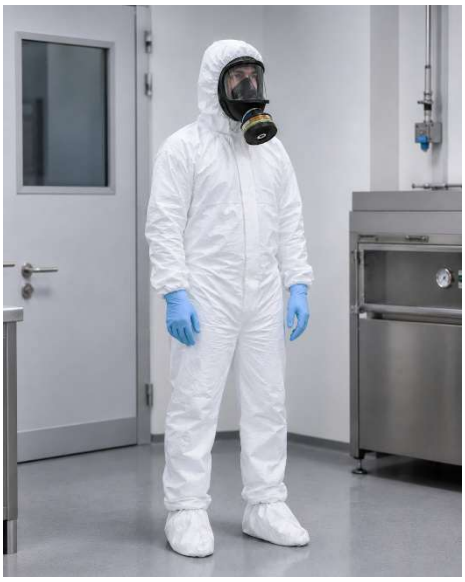
For this reason, no universally applicable waiting time can be specified after which every treated room, irrespective of process and environment, can be safely entered without special H_2O_2-related protective measures. Elapsed time alone is not a reliable substitute for knowing the concentration actually remaining. The waiting time will, however, certainly be several hours.

Where normal release of the room is intended, instrumental assessment of the residual concentration is therefore an essential element of the safety concept.

If it has been demonstrated after the intended decay or aeration phase that the defined release criteria have been met, normal entry without special H_2O_2-related personal protective equipment may be possible.

Earlier entry while residual concentrations are still elevated, on the other hand, requires a separate exposure assessment and, where necessary, suitable PPE.



This Technical Note explains the relevant principles. It first describes how a room is returned from the treated state to normal reuse and the role that measurement and exposure limits play in this process.

It then provides an accessible overview of respiratory protection, filter classes, chemical protective gloves and protective clothing. Specific products are mentioned only where they are useful as documented practical examples. The selection of any particular manufacturer is not the focus.

The assessment is deliberately limited to hazards directly associated with H_2O_2-based room disinfection. Additional requirements of a specific site, for example a biological high-containment laboratory, a cleanroom, a pharmaceutical production facility or an area involving other hazardous substances, must be considered independently within the relevant safety concept.

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2 From Room Disinfection to Safe Reuse

2.1 The Normal Process Sequence

In simplified terms, H_2O_2-based room disinfection can be divided into several consecutive phases. After preparing the room, the disinfectant is applied. This is followed by a defined contact phase. Once this has been completed, the decay or aeration phase begins before the room is released again for normal use.
During active application and the contact phase, the room forms part of the ongoing disinfection process. Routine entry is not intended during this time. The required microbiological effect is intended to take place while exposure of persons and animals is avoided.
After these active process phases have been completed, the H_2O_2 concentration begins to decrease. Reduction can occur through various mechanisms. Hydrogen peroxide decomposes into water and oxygen and also reacts with materials and surfaces. Depending on the process used, the decrease in concentration can be supported by natural ventilation, mechanical ventilation or technical aeration systems. [5][6]

An important point can therefore be established: the H_2O_2 concentration present during room disinfection does not remain permanently unchanged in the room. The converse point is equally important. The natural degradability of H_2O_2 does not allow a universally applicable time to be derived after which every room is automatically safe.

2.2 Why Rooms Behave Differently

The decrease in concentration is influenced by a wide range of factors. Room size and room geometry play a role, as do airflow and the actual mixing of air within the room. Areas with little air movement may behave differently from well-ventilated zones.

The materials present in the room are also relevant. Surfaces and furnishings can interact with H_2O_2 in different ways. Studies of material sorption of vaporised hydrogen peroxide show that different materials can influence H_2O_2 dynamics over time. [6]

Temperature and relative humidity may also be significant. There are also differences between natural and mechanical ventilation systems. A well-ventilated examination room with windows behaves differently from a controlled cleanroom or laboratory area where airflow forms part of the safety or containment concept.
Accordingly, a statement such as “The room can be re-entered after two hours” would only be reliable if it had been validated for a specific process, a defined room and specified operating conditions. Such a statement would not be sufficient as a general recommendation for arbitrary rooms.

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2.3 The Role of Ventilation and Aeration

Where spatial, hygienic and operational conditions permit, ventilation can support the reduction of the remaining H_2O_2 concentration. For example, natural or mechanical ventilation may be available in a medical practice, a general treatment room, a residential or nursing home, or certain hospital areas.

In other areas, such an approach is not possible or only possible to a limited extent. In cleanrooms, uncontrolled window ventilation would call the existing room and hygiene concept into question. In laboratories or containment areas, aeration must be compatible with the existing airflow and safety concept. In such cases, technical aeration or controlled reduction within the existing ventilation system may be required.

The appropriate method therefore depends on the site and the process used. What matters is not how the concentration is reduced, but that the process takes place in a controlled manner and that the condition of the room can be reliably assessed before normal reuse.

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3 Measure Instead of Simply Waiting

After room disinfection, a person cannot determine the H_2O_2 concentration still present either by simply looking at the room or reliably on the basis of elapsed time. Odour is also not a suitable basis for a reliable safety decision.

Technical documentation for H_2O_2-based room treatment processes therefore provides for measurements or suitable H_2O_2 detection methods during or after aeration. [5][6]

For the operator, this results in three fundamentally different situations.

Scenario A

After sufficient decay or aeration time, measurements may confirm that the defined release criteria have been met. In this state, special H_2O_2-related PPE may no longer be required for normal entry. This is the intended normal condition after completion of the entire process.

Scenario B

A second situation arises when earlier entry is required even though an elevated residual H_2O_2 concentration may still be present. Such entry may, for example, be required for measurements, technical checks, inspections or certain operational activities. In this case, exposure must be assessed and the protective strategy defined accordingly.

Scenario C

The third situation exists when the atmosphere has not been adequately characterised. In this case, it should not be assumed solely on the basis of a presumed waiting time or a broadly designated filter class that a particular filtering respirator is automatically adequate. The hazardous substance, its concentration and the conditions of use must be taken into account when selecting a filter. [7][8]

Personal protective equipment is therefore not the starting point for every room disinfection procedure. However, it becomes relevant where potential exposure remains after technical and organisational measures have been completed or where entry is required before normal release.

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4 Exposure Limits and Their Significance

4.1 Why Different Concentration Values Must Not Be Confused

Different concentration values are used in connection with H_2O_2. An occupational exposure limit describes something different from an IDLH value. A filter test concentration, in turn, serves a different purpose from a room release criterion.

This distinction is essential for a sound assessment.

Term	Meaning
Occupational exposure limit	Assessment of occupational exposure under the applicable national regulations
Short-term exposure limit	Assessment of limited short-term exposures
IDLH	Reference for atmospheres that are immediately dangerous to life or health
Filter test concentration	Defined laboratory condition for testing a filter
Filter time specification	Product-specific specification under defined test conditions
Room release criterion	Criterion for reuse of a specific room or process

These values must not be used interchangeably. For example, a filter test at a particular concentration does not mean that this concentration is automatically a permissible entry concentration for every application.

4.2 Swiss Occupational Exposure Limits

In Switzerland, Suva publishes the current MAK and BAT values. The MAK value relates to the concentration of a substance in workplace air. Suva describes the MAK value as the average concentration at which the health of the vast majority of healthy exposed workers is not expected to be endangered, even in the case of long-term occupational exposure. [1][2]

At the same time, Suva points out that the health risk depends both on the properties of the substance and on the level and duration of exposure. Exposure limits are therefore an essential element of the assessment, but they do not replace consideration of the specific work situation. [2]

Because exposure limits may be adjusted in line with scientific knowledge, the current Suva exposure limit database must always be consulted for formal operational decisions. [1]

Occupational exposure limits are neither filter service lives nor automatic room release values. Nor can a universal entry limit for a person wearing respiratory protection be calculated from an occupational exposure limit alone.

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4.3 International Differences

Occupational exposure limits are not fully harmonised worldwide. In further developing Swiss exposure limits, Suva takes account, among other things, of scientific findings from international bodies as well as developments in other countries and in the European Union. [2]

For hydrogen peroxide, for example, NIOSH lists a Recommended Exposure Limit (REL) of 1 ppm as a time-weighted average. [3]

For applications outside Switzerland, the applicable national legal and technical requirements must therefore be taken into account. This Technical Note cannot replace a country-specific assessment.

4.4 IDLH

IDLH stands for Immediately Dangerous to Life or Health.
NIOSH lists an IDLH value of 75 ppm for hydrogen peroxide. [3][4]

The value is used to classify atmospheres in which there may be an immediate danger to life or health or to the ability to escape.

The IDLH value is not an occupational exposure limit and not a general use limit for any arbitrary respiratory filter. Nor should a simplified calculation be made on the basis that a mask protection factor can be multiplied by an occupational exposure limit to automatically produce a permissible entry concentration.

Such a simplification would, among other things, inadequately account for the specific filter capacity, suitability for the substance, possible concentration peaks, duration of use, actual tightness of the system and manufacturer limits.

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5 When Personal Protective Equipment May Be Required

After successful aeration and release based on measurements, a room may once again be accessible for normal use without special H_2O_2-related personal protective equipment. This condition is the goal of the complete disinfection and release process.

The question of special PPE arises in particular when a person has to make a controlled entry before this normal release. The protection required then depends on the actual situation. A low, known residual exposure must be assessed differently from an unknown atmosphere or ongoing active application.

Routine entry is not intended during active application and the contact phase. Any entry that is nevertheless necessary would require a separate risk assessment and, where appropriate, a different respiratory protection concept.

During the decay and aeration phase, defined early entry may be possible provided that the atmosphere has been adequately characterised, the activity has been clearly defined and a suitable protection concept is in place. Knowledge of mask types, filter classes, hand protection and protective clothing is required precisely for this situation.

The following chapters are therefore not intended as an instruction to wear full protective equipment after every room disinfection procedure. Rather, they explain which technical protection options exist where exposure cannot yet be ruled out.

Steinemann Disinfection (CleanService Group AG) | Wilerstrasse 2180 | 9230 Flawil | Switzerland | +41 71 555 11 30 | disinfection@steinemanngroup.com | steinemann-disinfection.ch

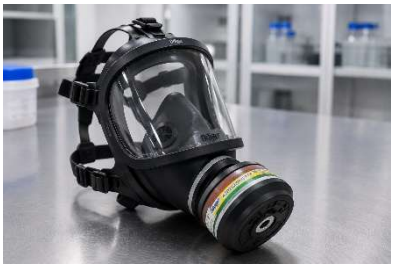
6 Respiratory Protection and Filters

6.1 Different Respiratory Protection Systems

Respiratory protection systems differ fundamentally in how they function.
A filtering half mask, for example an FFP mask, is primarily intended for exposure to particles. It is not a gas filter and does not protect the eyes.

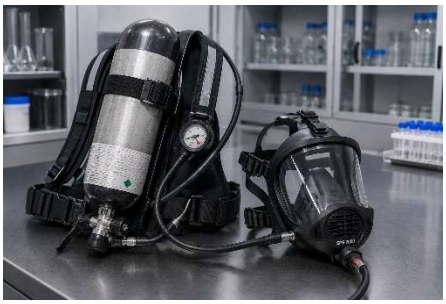
Depending on the system, a reusable half mask can be fitted with particle, gas or combination filters. The eye area, however, remains outside the mask.

A full-face mask combines respiratory protection with protection of the eyes and a larger area of the face. This may be relevant in the event of H_2O_2 exposure, since NIOSH lists contact with the eyes and skin, in addition to inhalation, as routes of exposure. [3]



Powered air-purifying respirators use a motor to draw ambient air through suitable filters. However, they remain dependent on the surrounding air. This must be distinguished from atmosphere-supplying respiratory protection, in which breathing air is supplied independently of the room air.

The choice of the appropriate system depends on the hazard situation. Filter-based respiratory protection requires that the hazardous substances present and the conditions of use are sufficiently known and that the system is suitable for those conditions. [7][8]



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6.2 Why a Full-Face Mask May Be Appropriate

Where both inhalation exposure to H_2O_2 and exposure of the eyes must be considered during controlled entry, a suitable full-face mask may offer advantages over a half mask.

However, the protective effect does not depend on the mask model alone. A correct seal is essential. The mask must fit the shape of the face, the sealing surfaces must be intact and the sealing area must not be impaired by a beard, hair or other obstructions. The manufacturer's instructions for fit checking and use of the system must be followed. [11][12]

A high-performance filter cannot compensate for an inadequate mask seal.

6.3 Particle, Gas and Combination Filters

When selecting filters, a distinction must be made between particles and gaseous or vapour-phase substances.

Particle filters are intended for airborne particles, aerosols and droplets. Gas filters use different filtration mechanisms and are selected according to the relevant substance groups. Combination filters combine both functions.

For room disinfection, this distinction is important because, depending on the process and process phase, both aerosol or droplet fractions and gas or vapour fractions may be relevant.

A P3 filter alone therefore does not demonstrate suitability for gaseous H_2O_2. Conversely, a pure gas filter does not replace any required particle filtration.

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6.4 Meaning of the A, B, E and K Markings

The European filter marking system uses letters for different groups of gases and vapours.

Marking	General protection range
A	certain organic gases and vapours
B	certain inorganic gases and vapours
E	certain acidic gases and vapours
K	ammonia and certain ammonia compounds

[7][8]

An ABEK filter combines several of these protection ranges and can therefore cover a broad general spectrum of protection. However, this marking must not be understood as specific proof of suitability for every possible chemical.

For H_2O_2, the additional decisive question is therefore whether manufacturer information or specific test data are available for the specific filter.

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6.5 Capacity Classes and Particle Filter Classes

The numbers following the gas filter letters indicate different capacity classes. Within category A, an A2 filter has a higher standardised capacity class than an A1 filter. The same applies, for example, to B1 and B2 or K1 and K2.

However, a higher class must not be interpreted as meaning that a filter provides proportionally greater protection against every chemical. Specific suitability for the substance remains decisive. Particle filters are divided into classes P1, P2 and P3, with P3 being the highest of the three classes. [8]

In an H_2O_2-based application, a P3 component may be relevant for aerosols and liquid droplets. However, the specific H_2O_2 gas filtration performance must be assessed separately.

6.6 Additional Filter Markings

In addition to A, B, E, K and P, filters may carry other markings.
Hg indicates a protective function against mercury vapour,
NO indicates a protective function against certain nitrogen oxides, and
CO indicates a special carbon monoxide function.

The R marking relates to the corresponding test of the particle filter component for reuse over more than one work shift. It does not mean that a filter may be reused indefinitely after arbitrary chemical exposure.

D indicates successful completion of the dolomite dust test. The marking does not stand for disinfection and does not constitute proof of suitability for H_2O_2.

6.7 Assessment of a Filter for H_2O_2 Applications

For defined entry where residual H_2O_2 exposure is possible, filter selection should not be based solely on the breadth of the general filter designation. A combined assessment is appropriate. First, it must be assessed whether gas or vapour exposure, aerosols or both forms may be relevant. It must then be checked whether H_2O_2-specific manufacturer data are available for the specific filter and whether the filter is compatible with the mask system used.

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Dräger, for example, has published a technical investigation of respiratory filters for hydrogen peroxide and certain mixtures containing acetic acid and peracetic acid. For the Rd40 filters examined against pure H_2O_2, the document specifies test conditions of 200 ppm H_2O_2, 20 °C, 70% relative humidity and a flow rate of 30 l/min. [9]

The filters listed there include Dräger filter article no. 6738814 with the marking:
A2B2E2K2 Hg NO P3 R D / CO 20
[9][10]

This filter is used as a practical example in the application concept described. Its selection is based on the combination of a broad general filter spectrum, a P3 particle filter component and available H_2O_2-specific manufacturer documentation.

Mentioning this product does not mean that only this model can be used. Other products can be assessed according to the same technical criteria. The decisive factors are the required protection classes, documented suitability for H_2O_2, compatibility with the mask system used and compliance with the relevant manufacturer limits.

For filter 6738814, Dräger lists a time value of eight hours in the H_2O_2 table. The associated footnote relates to the filter's special NO/CO configuration. [9] The value should therefore neither be interpreted automatically as an H_2O_2 breakthrough time nor extended to a longer operational service period without confirmation from the manufacturer.$

For a practical filter strategy, moisture and reuse must also be taken into account. The Dräger investigation was conducted at 70% relative humidity. At the same time, the manufacturer points to restricted reusability of the filter in question because of moisture-sensitive absorber material. [9]

An operational rule should therefore take account, among other things, of duration of use, cumulative use, possible condensation, interim storage and the manufacturer's instructions. The specific filter replacement and storage strategy belongs in an operational SOP.

A Dräger FPS 7000 RA with Rd40 connection may be cited as an example of a suitable full-face mask. [11][12] This too is a practical example. Other suitable mask and filter systems may be used provided that the technical requirements and system compatibility are met.

7 Hand Protection

During controlled entry, exposure of the hands may occur, for example, through wet surfaces, condensate, liquid splashes, chemical residues or handling of exposed components.

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The selection of a chemical protective glove should not be based solely on the material designation. The specific glove model, material thickness, concentration, contact duration, temperature and type of contact are relevant to chemical resistance.

For chemical protective gloves, distinctions are made, among other things, between penetration, permeation and degradation.

A glove may appear externally intact even though a substance is already passing through the material at molecular level.

The EN ISO 374 system is used to classify chemical protective gloves. In the corresponding list of test chemicals, 30% hydrogen peroxide is identified by code P. [13]

This marking does not mean that every glove made from the same base material automatically provides the same protective effect. The data for the specific product must be used for practical selection.

Suitable nitrile gloves are used in the application concept described. The correct statement is therefore not that nitrile is generally suitable for every H_2O_2 exposure. Rather, a specific nitrile glove may be used where its documented chemical resistance is sufficient for the relevant concentration, exposure duration and activity.

For defined activities, double gloving may also be used. Wearing two suitable glove layers can support controlled doffing and provide an additional reserve if the outer layer is mechanically damaged.

However, double gloving does not replace the chemical suitability of the gloves used. Two unsuitable gloves do not together provide suitable chemical protection.

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8 Protective Clothing and Foot Protection

8.1 Protective Suit Types

Chemical protective clothing is classified according to different protection types. These types primarily describe the physical form of exposure.

Type	General meaning
Type 1	gas-tight chemical protective clothing
Type 2	non-gas-tight special protection
Type 3	liquid-tight protective clothing against liquid jets
Type 4	spray-tight protective clothing
Type 5	protection against airborne solid particles
Type 6	limited protection against light liquid splashes

[14][15]

Type classification is an important selection criterion, but it is not a universal substance approval. A Type 4 protective suit is not automatically suitable for every H_2O_2 concentration and every exposure duration solely because of this designation.

The chemical resistance of the material, concentration, exposure duration, temperature, seam construction, closure system and specific activity must also be considered. Manufacturer guidance on selecting chemical protective clothing explicitly considers these factors alongside the type classification itself. [14]

8.2 Assessment for Controlled Entry

After H_2O_2-based room disinfection, different forms of exposure may exist depending on the process and the timing of entry. In addition to a possible residual concentration in the room air, condensate, wet surfaces, minor liquid splashes or residual aerosols may be relevant.

For defined post-treatment entry, properties of Types 4, 5 and 6 may therefore be appropriate depending on the risk assessment. However, this is not a blanket recommendation for every H_2O_2 application.

In the event of a leak, a liquid jet, an incident, direct contact with a higher-concentration product or an additional site-specific hazard, a different or higher level of protection may be required.

As an example of a protective suit combining several physical protection types, DuPont lists products classified as Types 3-B, 4-B, 5-B and 6-B. [15] Even for such products, the combined type classification does not replace assessment of the specific chemical resistance of the material for the actual H_2O_2 formulation.

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8.3 Foot Protection

Foot protection must also be adapted to the activity. Depending on the situation, chemical protection, slip resistance, cleanability and prevention of contamination transfer must be considered.

For defined activities, suitable closed, liquid-repellent footwear may be sufficient. Where greater liquid exposure is possible, chemically resistant boots may be required. Overshoes can contribute to contamination control but should not automatically be regarded as chemical protective boots.

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9 Practical Use of PPE

The specific protective configuration should always be derived from the actual situation. For a fully aerated and released room, special H_2O_2-related PPE may not be required. If controlled entry must take place before normal release, however, the measured or adequately characterised residual concentration, the activity, the duration of stay and the possible form of contact must be taken into account.

For such a defined activity, the protection strategy may, for example, include a suitable full-face mask with a combination filter covering both the relevant gas or vapour components and particles and aerosols. For H_2O_2 applications, specific manufacturer documentation demonstrating the suitability of the selected filter should also be available.

In the application concept described, a Dräger FPS 7000 Rd40 used in combination with filter 6738814 serves as an example. [9][10][11][12]

Specific chemically suitable gloves are selected for hand protection. Suitable nitrile products can be a practical solution provided their resistance to the actual exposure is documented. For defined activities, double gloving may be used as an additional organisational protective measure. [13]

Protective clothing is selected according to the actual form of exposure and documented material resistance. For controlled entry after completion of active treatment, properties of Types 4, 5 and 6 may be relevant depending on the scenario. In the event of greater liquid exposure or special incidents, the protection strategy must be expanded accordingly. [14][15]

These examples are intended as technical guidance. They are not a universal shopping list.

9.1 Donning, Doffing and Reprocessing

The protective effect of PPE depends not only on correct product selection but also on correct use.
A full-face mask must be in suitable condition, fit correctly and be used with the intended filter. The checks specified by the manufacturer must be performed before use. Sealing surfaces, visor, valves and filter connection must be intact. [11][12]

The condition of gloves and protective clothing must also be checked before use. Damaged gloves, defective closures or compromised seams can reduce the protective effect.
Doffing potentially exposed PPE is a critical work step. During removal, a person can contaminate themselves by touching the outside of gloves or protective clothing. The same applies to improper contact with the outside of the mask or uncontrolled handling of the filter.

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The doffing procedure should therefore be defined and practically trained for the PPE system actually used. Double gloving can form part of such a concept, with the outer glove layer removed in a defined step while the inner protective layer initially remains in place.

Reusable masks must be cleaned, disinfected where appropriate, dried, inspected and stored in accordance with the relevant manufacturer instructions. [11][12]

The specific procedures for donning, doffing, cleaning and filter management belong in an operational SOP. A Technical Note can explain the technical principles but should not replace a workplace-specific work instruction.

10 Limitations of this Technical Note

This Technical Note deliberately does not specify a universal waiting time after room disinfection. Nor does it define a globally valid room release concentration, a general maximum duration of stay or a filter replacement interval valid for every operation.

Such specifications depend on the disinfection process used, the specific product, the room, operating conditions, national regulations and the operational risk assessment.

The PPE assessment presented here is also deliberately limited to the immediate hazards associated with H_2O_2-based room disinfection.

A high-containment laboratory may have additional requirements due to biological hazards. A cleanroom may have specific requirements for contamination control and airflow. A pharmaceutical facility may impose additional quality and process requirements. A hospital may need to consider further hygiene and patient risks.

These requirements must be assessed in addition to the H_2O_2 protection concept described here.

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11 Conclusion

H_2O_2-based room disinfection should not be confused with a permanent state of chemical exposure. Treatment is normally performed automatically and without persons present in the room. After completion of the application and contact phase, the H_2O_2 concentration decreases through degradation processes and, depending on the process, through natural or technical aeration. [5][6]

The objective of the complete process is safe reuse of the room. If the defined release criteria are met on the basis of measurements after the intended decay or aeration phase, normal entry without special H_2O_2-related PPE may be possible.

However, a fixed waiting time cannot be used as a general safety guarantee for every room and every application. Room geometry, materials, airflow, temperature, humidity and ventilation options can influence the concentration profile over time. The actual concentration is therefore more important for assessment than a generally assumed number of minutes or hours.

If a room is entered before normal release, the situation must be assessed separately. Where residual exposure is known and adequately characterised, a suitable PPE strategy can be defined. Depending on the situation, this may include a full-face mask with a suitable combination filter, chemically resistant gloves, double gloving, suitable chemical protective clothing and adapted foot protection.

For filter selection, the general classes A, B, E, K and P are important guides. However, they do not replace evidence of the suitability of a specific filter for H_2O_2. The practical example described in this Technical Note using filter 6738814 has H_2O_2-specific manufacturer documentation and therefore serves as a traceable example of technical implementation. [9][10]

For gloves and protective clothing as well, the general material or type designation is only one part of the selection process. Documented chemical resistance, the form of exposure, concentration and duration of possible exposure remain decisive. [13][14][15]

The essential safety logic of this Technical Note can therefore be summarised as follows: room disinfection is carried out under controlled conditions, after which the H_2O_2 concentration is reduced through natural decay and, where appropriate, aeration. Release is based on suitable assessment and measurement. Suitable personal protective equipment is selected only where earlier entry is required or residual exposure cannot yet be ruled out.

Steinemann Disinfection (CleanService Group AG) | Wilerstrasse 2180 | 9230 Flawil | Switzerland | +41 71 555 11 30 | disinfection@steinemanngroup.com | steinemann-disinfection.ch

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Steinemann Disinfection (CleanService Group AG) | Wilerstrasse 2180 | 9230 Flawil | Switzerland | +41 71 555 11 30 | disinfection@steinemanngroup.com | steinemann-disinfection.ch

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Steinemann Disinfection (CleanService Group AG) | Wilerstrasse 2180 | 9230 Flawil | Switzerland | +41 71 555 11 30 | disinfection@steinemanngroup.com | steinemann-disinfection.ch

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