
**Respiratory protective devices —
Performance requirements —**

**Part 9:
Special application chemical,
biological, radiological and nuclear
(CBRN) supplied breathable RPD**

Appareils de protection respiratoire — Exigences de performances —

*Partie 9: Appareils d'application spéciale de gaz respiratoire
nucléaire-radiologique, biologique, chimique (NRBC)*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 15, *Respiratory protective devices*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The personal protection requirements of personnel who respond to emergencies are recognised as being different from those of the regular workforce. With respect to response to incidents involving release of chemical, biological or radiological materials, or after nuclear events, specific requirements have to be established. The hazardous exposures occurring in such incidents can result in severe consequences for an improperly protected responder.

Specifically, for the types of protection required.

- a) Protection levels need to be high for those in the vicinity of an incident.
- b) Materials used in construction of the equipment shall withstand permeation by highly aggressive chemicals.

These requirements in the ISO system summarized in this document cover the special application CBRN. This document is an adjunct to other parts of ISO 17420 and should be read together with them.

This document provides classification of equipment, performance requirements and specific test methods for respiratory protective devices (RPD) for use in CBRN response. Selection requirements are addressed in separate documents.

NOTE The performance requirements included in this document refer to laboratory testing using specified test agents under specified conditions which might not indicate the performance of the device in actual usage.

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Respiratory protective devices — Performance requirements —

Part 9:

Special application chemical, biological, radiological and nuclear (CBRN) supplied breathable RPD

1 Scope

This document specifies the requirements for respiratory protective devices for use by workers during response to incidents involving chemical, biological, radiological or nuclear (CBRN) materials used with intent to cause harm or in cases of accidental release outside traditional hazardous materials response categories. For the purposes of this specification, all incidents described here are named CBRN incidents.

This document is applicable to RPD for use by personnel in the following roles:

- First responders: including police, fire service, emergency medical, search and rescue, sampling and detection teams.
- Workers needed for specific roles during response (utility, transportation, service continuity).
- Medical personnel working with casualties of CBRN incidents.
- Responders to release incidents involving nuclear materials.
- Non-emergency but CBRN-related roles.
- Workers in need of protection during escape from a CBRN or radiological release incident.
- Workers in need of protection from nuclear materials.

The requirements for RPD use by the following groups are not addressed by this document:

- Military personnel outside of first responder roles.
- Children.
- Animals.

Requirements for the following are not covered by this document:

- Collective protection systems including ventilated casualty/body bags.
- Methods of and criteria for decontamination of RPD.
- Disposal of used or contaminated equipment.

This document is focused on respiratory protection requirements, but it is recognised that CBRN RPD are always used as part of an ensemble with protective clothing. The total ensemble effectiveness is not covered by this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16972, *Respiratory protective devices — Vocabulary and graphical symbols*

ISO/TS 16973, *Respiratory protective devices — Classification for respiratory protective device (RPD), excluding RPD for underwater application*

ISO/TS 16975-1:2016, *Respiratory protective devices — Selection, use and maintenance — Part 1: Establishing and implementing a respiratory protective device programme*

ISO 17420-1:2021, *Respiratory protective devices — Performance requirements — Part 1: General*

ISO 17420-4:2021, *Respiratory protective devices — Performance requirements — Part 4: Requirements for supplied breathable gas RPD*

ISO 17420-5:2021, *Respiratory protective devices — Performance requirements — Part 5: Special application fire and rescue services - Supplied breathable gas RPD and filtering RPD*

ISO 17420-6:2021, *Respiratory protective devices — Performance requirements — Part 6: Special application escape - Filtering RPD and supplied breathable gas RPD*

ISO/TS 17420-8, *Respiratory protective devices — Performance requirements — Part 8: Special application chemical, biological, radiological and nuclear (CBRN) filtering and radiological-nuclear (RN) filtering RPD*

EN 388, *Protective gloves against mechanical risks*

IEC 60721-1, *Classification of environmental conditions - Part 1: Environmental parameters and their severities*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in ISO 16972, ISO 17420-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

chemical material

substance that can be disseminated to cause harm, including chemical warfare agents and toxic industrial chemicals

3.1.2

biological material

micro-organism that is a pathogen and that has the potential to be used intentionally to cause harm

Note 1 to entry: Human pathogens are relevant to RPD selection.

3.1.3

radiological material

substance that emits ionizing radiation and that could be disseminated to cause harm

3.1.4**nuclear material**

radioactive matter resulting a nuclear explosion or accidental release from a nuclear facility

3.1.5**decontamination**

physical and/or chemical process of removing as much contamination as possible from people or equipment

3.1.6**gaseous**

material in the gaseous state may either be present as a gas or vapour

3.1.7**joint**

place at which two or more components or materials are connected or united, either rigidly or flexibly, separably or inseparably

3.1.8**manufacturer**

entity that directs and controls product design, product manufacturing, or product quality assurance; can also refer to the entity that assumes the liability for the product or provides the warranty for the product

3.1.9**penetration**

movement of a substance through closures, seams, pinholes, or other imperfections of a protective item, or the movement of a substance through an air-purifying element without being removed

3.1.10**hydration system**

system, usually consisting of a connector and tube attached to a reservoir, that when attached to an RPD permits the user to drink water or other liquids specified by the manufacturer while wearing the RPD

3.1.11**permeation**

process by which a chemical moves through a given material on a molecular level

3.1.12**responder**

personnel who intervene in an emergency

3.1.13**receiver**

medical professional who will normally remain in their place of work (rather than attending the incident)

3.1.14**sarin****GB**

extremely toxic and potentially lethal human-made chemical warfare agent, isopropyl methyl phosphonofluoridate [IUPAC: (RS)-propan-2-yl methylphosphonofluoridate], classified as a nerve agent

3.1.15**sulphur mustard****HD**

extremely toxic and potentially lethal human-made chemical warfare agent, IUPAC: bis(2-chloroethyl) sulphide, classified as a vesicant (blister agent)

3.1.16

non pre-conditioned state

without pre-conditioning but possibly modified to carry out tests or already used in non-destructive tests

Note 1 to entry: This includes e.g., cleaning and disinfection.

3.1.17

RPD in as worn state

RPD where all components are connected and assembled in the way that it is intended to be used (e.g. worn by the wearer, adapted to an RPD headform or RPD headform and torso or suitable holder)

Note 1 to entry: All of the various components (e.g. for an SCBA: cylinder, Respiratory Interface (RI), demand valve, harness etc.) have been completely assembled and then connected (RI connected to the demand valve) together in accordance with the information supplied by the manufacturer.

3.1.18

RPD in ready for use state

RPD ready to be donned as described by the manufacturer

Note 1 to entry: In line with the information supplied by the manufacturer for donning the RPD, further actions can be necessary.

3.1.19

ready for assembly state

RPD or components with seals, plugs or other environmental protective means, still in place ready to be assembled and/or donned

Note 1 to entry: RPD or components can remain sealed and plugged until donning if so stated in the information supplied by the manufacturer.

3.2 Abbreviated terms

CBRN	Chemical, Biological, Radiological, and Nuclear
FMEA	Failure Modes Effects Analysis
PPE	Personal Protective Equipment
GB	Sarin
HD	Sulphur mustard
RH	Relative Humidity
RN	Radiological and Nuclear
RI	Respiratory Interface

4 Designation and classification

4.1 General

The following classifications for RPD under special application CBRN and special application escape CBRN shall be used.

4.2 CBRN RPD

4.2.1 Special application CBRN1

CBRN1 “Receiver” RPD shall:

- incorporate RIs of classes cL, cT, dL, dT, eL or eT in accordance with ISO/TS 16973;
- provide a minimum protection class PC4 in accordance with ISO/TS 16973;
- provide a minimum flow corresponding work rate W1;
- provide resistance to gaseous chemical agent permeation and penetration;
- provide protection capability against hazardous gases, vapours and particulate matter.

4.2.2 Special application CBRN2

CBRN2 “Responder in known hazard environment” RPD shall:

- incorporate RIs of classes cL, cT, dL, dT, eL or eT in accordance with ISO/TS 16973;
- provide a minimum protection class PC5 in accordance with ISO/TS 16973;
- provide a minimum flow corresponding work rate W1;
- provide resistance to liquid and gaseous chemical agent permeation and penetration;
- provide protection capability against hazardous gases, vapours and particulate matter.

4.2.3 Special application CBRN3

CBRN3 “Responder in unknown hazard environment” RPD shall:

- incorporate RIs of classes cT, dT or eT in accordance with ISO/TS 16973;
- provide a minimum protection class PC5 in accordance with ISO/TS 16973;
- provide a minimum flow corresponding work rate W3
- provide an enhanced level of resistance to liquid and gaseous chemical agent permeation and penetration;
- provide protection capability against hazardous gases, vapours and particulate matter;
- meet the requirements of special application FF3 hazardous materials in accordance with ISO 17420-5.

NOTE Supplied breathable gas RPD can be classes CBRN1, CBRN2, or CBRN3, but filtering RPD are restricted to classes CBRN1 and CBRN2.

4.3 Special application Escape CBRN

Escape CBRN RPD shall:

- incorporate RIs of classes cL, cT, dL, dT, eL or eT in accordance with ISO/TS 16973;
- devices shall be self-contained in accordance with ISO 16972;
- provide a minimum protection class PC4 in accordance with ISO/TS 16973;
- provide resistance to liquid and gaseous chemical agent permeation and penetration;

— provide protection capability against gases, vapours and hazardous particulate matter.

Escape CBRN RPD operating in the supplied breathable gas mode is designated ES CBRN.

4.4 CBRN RPD summary of capabilities

Table 1 provides a matrix description of the minimum capabilities for CBRN RPD according to ISO/TS 16973.

Table 1 — Summary of minimum capabilities for CBRN supplied breathable gas RPD classes

Capability	CBRN1	CBRN2	CBRN3	ES CBRN
Permeation and penetration test	Gaseous ^a only	Gaseous ^a and liquid	Gaseous ^a and liquid	Gaseous ^a and liquid
RI Type	T ^b or L ^c	T or L	T	T or L
Protection class	≥PC4	≥PC5	≥PC5	≥PC4
Work rate	≥W1	≥W1	≥W3	Escape flow rate ^d
a	"Gaseous" refers to both gas and vapour states.			
b	Tight fitting.			
c	Loose fitting.			
d	In accordance with 8.1.			

4.5 CBRN RPD Classes

4.5.1 General

CBRN RPD and Escape CBRN RPD shall follow the system classification in 4.5.2 to 4.5.3 as below specific to CBRN requirement.

Combined CBRN RPD operate in both filtering and supplied breathable gas mode and are classified separately for each mode.

4.5.2 CBRN supplied breathable gas RPD

CBRN supplied breathable gas RPD shall follow the classification (protection class) (work rate class) (RI class) (CBRN class) (supplied breathable gas capacity class).

EXAMPLE PC5 W3 cT CBRN3 S1800.

4.5.3 Escape CBRN supplied breathable gas RPD

Escape CBRN RPD shall follow a classification incorporating the applicable designated duration *t* in accordance with ISO 17420-6:2021, 7.2.9. For ES CBRN, the minimum and maximum durations are superseded by those specified in 8.1.

For Escape CBRN supplied breathable gas RPD (protection class) (RI class) ES CBRN (duration).

EXAMPLE PC4 dL ES CBRN 15.

RPD may have combined capability for CBRN and escape in other classes in ISO 17420-6 and the classification shall indicate this, with CBRN being the first type listed.

EXAMPLE PC4 cT ES CBRN ES FF 20.

RPD for escape from CBRN incidents and fire.

5 Requirements

5.1 General

Unless specified in the individual clauses, CBRN RPD shall be tested as a system. Although it can be possible to use components of the same design in more than one configuration of RPD, the following shall apply:

- every configuration shall conform to the requirements of this document;
- components shall be marked appropriately in accordance with [Clause 15](#);
- information supplied by the manufacturer shall provide proper guidance on designed configurations and the protection provided.

Testing shall be performed in accordance with [Clause 13](#).

The requirements in [Clauses 7 to 11](#) shall be fulfilled by all RPD and components in accordance with their designated class.

Unless otherwise specified in the individual requirement clauses:

- testing shall be performed on test samples without pre-conditioning;
- each sample shall pass the test; and
- testing shall be performed at ambient laboratory conditions between 16 °C and 32 °C and a relative humidity of (50 ± 30) %.

If no tolerances are given, ±10 % shall be used.

For determination of pass/fail, conformity of quantitative test measurements with specification limits may be determined in accordance with [Annex B](#).

5.2 Test samples

Sample schemes are provided in relevant clauses and [Annex A](#).

5.3 CBRN RPD requirements

5.3.1 CBRN RPD operation

Where the RPD has the capability to be used with more than one mode of operation (see [clause 9](#)), only one may be actively used at any one time.

Testing shall be performed in accordance with [Clause 13](#) and ISO 17420-4:2021, 6.15.

5.3.2 CBRN supplied breathable gas RPD

CBRN supplied breathable gas RPD shall meet the requirements of:

- ISO 17420-1:2021, all Clauses;
- ISO 17420-4:2021, Clause 5;
- ISO 17420-4:2021, Clause 6 unless superseded by this document and indicated in the relevant clauses.

[Table 2](#) gives an overview about requirements and pre-conditioning of special application supplied breathable gas CBRN RPD.

In the first column the requirements are listed and in the third to fifth columns, the required pre-conditionings for different CBRN classes are listed, to be completed in the order specified (where & is used) before testing is performed, with the preconditioning details explained further in [Table 4](#).

For each requirement the preconditioning and the number of samples to be tested are given. The preconditioning abbreviations are shown at the end of the table. The number of samples is in parentheses if more than one sample.

EXAMPLE For the requirement [7.1.5.2](#) and class CBRN2 the following applies:

At least one sample shall be pre-conditioned to requirement VS2 (Exposure to vibration and shock – CBRN2) followed by requirement CE (exposure to a continuous corrosive environment).

At least one further sample shall be pre-conditioned DR (drop test).

NOTE 1 Requirements for optional features are also given in ISO 17420-4.

NOTE 2 Unless requirements are superseded by those in [Clause 7](#) of this document, the test schedules given in ISO 17420-4:2021, Annex C can be used as a guideline for testing.

Table 2 — Special application requirement overview — CBRN Supplied breathable gas RPD

Requirement	Title	Receiver	Responder in known hazard environment	Responder in unknown hazard environment
		CBRN1	CBRN2	CBRN3
		Protection class	Protection class	Protection class
		≥PC4	≥PC5	≥PC5
		Work rate class	Work rate class	Work rate class
		≥W1	≥W1	≥W3
Pre-conditioning ^a				
ISO 17420-4: 2021, 6.3	Work of breathing, breathing resistance (peak pressure) and elastance	TH & VS1	TH & VS2	TH & VS3
ISO 17420-4: 2021, 6.4	Determination of capacity of type Sxxxx RPD	TH & VS1	TH & VS2	TH & VS3
ISO 17420-5: 2021, 7.2.5	Hazardous materials chemical resistance	— ^b	AR/NP	AR/NP
ISO 17420-5: 2021, 7.2.8	Avoidance of frictional sparks	— ^b	AR/NP	AR/NP
ISO 17420-5: 2021, 7.2.9	Visor after chemical exposure	— ^b	AR/NP	AR/NP
7.1.2	Protection Class	AR/NP	AR/NP	AR/NP
^a	Minimum number of samples is indicated in parentheses, otherwise it is one.			
^b	Means that a test is not required for this combination of requirement and special application class.			
AR/NP	As received (not previously used for other tests) or in non pre-conditioned state.			
TH	Temperature and humidity conditioning.			
VS1	Exposure to vibration and shock CBRN1.			
VS2	Exposure to vibration and shock CBRN2.			
VS3	Exposure to vibration and shock CBRN3.			
CE	Enhanced resistance to corrosion – constant exposure.			
DR	Exposure to impact from drop.			

Table 2 (continued)

Requirement	Title	Receiver	Responder in known hazard environment	Responder in unknown hazard environment
		CBRN1	CBRN2	CBRN3
		Protection class	Protection class	Protection class
		≥PC4	≥PC5	≥PC5
		Work rate class	Work rate class	Work rate class
		≥W1	≥W1	≥W3
Pre-conditioning ^a				
7.1.3	Conformance with hazardous materials firefighting requirements: ISO 17420-5:2021 Class FF3	— ^b	— ^b	Reference ISO 17420-5:2021, 7.1.2
7.1.4	Provision of breathable gas	AR/NP	AR/NP	AR/NP
7.1.5.2	Temperature of operation	VS1 & CE	VS2 & CE	VS3 & CE
		DR	DR	DR
7.1.5.3	Optional temperature of operation	VS1 & CE	VS2 & CE	VS3 & CE
		DR	DR	DR
7.1.6	Chemical resistance CBRN – Hazardous materials	AR/NP	AR/NP	AR/NP
		TH & VS1 (2)	TH & VS2 (2)	TH & VS3 (2)
7.1.7	Practical performance testing	AR/NP	AR/NP	AR/NP
7.2.1	Connections	AR/NP	AR/NP	AR/NP
7.2.2	Chemical resistance CBRN – Cylinder permeation	AR/NP	AR/NP	AR/NP
^a	Minimum number of samples is indicated in parentheses, otherwise it is one.			
^b	Means that a test is not required for this combination of requirement and special application class.			
AR/NP	As received (not previously used for other tests) or in non pre-conditioned state.			
TH	Temperature and humidity conditioning.			
VS1	Exposure to vibration and shock CBRN1.			
VS2	Exposure to vibration and shock CBRN2.			
VS3	Exposure to vibration and shock CBRN3.			
CE	Enhanced resistance to corrosion – constant exposure.			
DR	Exposure to impact from drop.			

5.3.3 Escape CBRN supplied breathable gas RPD

ES CBRN supplied breathable gas RPD shall meet the requirements of:

- ISO 17420-1:2021, all clauses;
- ISO 17420-6:2021, Clause 5;
- ISO 17420-6:2021, Clause 6;
- ISO 17420-6:2021, Clause 7 for supplied breathable gas ESCAPE general

unless superseded by this document and indicated in the relevant clauses.

[Table 3](#) gives an overview about requirements and pre-conditioning of special application supplied breathable gas ES CBRN RPD.

In the first column the requirements are listed and in the third column, the required pre-conditionings for different CBRN classes are listed.

This table can be interpreted as described in 5.3.2.

Table 3 — Special application requirement overview — Supplied breathable gas ES CBRN RPD

Requirement	Title	Escape
		ES CBRN
		Protection class
		≥PC4
		Work rate class
		Escape
		Pre-Conditioning ^a
8.2.1	Determination of duration (t) of Escape RPD	TH & VSE & IE
		DR
8.2.2	Escape RPD performance requirements	TH & VSE & IE
		DR
8.2.3	Protection class	AR/NP
8.2.4	Chemical resistance CBRN hazardous materials	AR/NP
		TH & VSE (2)
8.2.5	Chemical Resistance CBRN - Cylinder permeation	AR/NP
8.2.6	Practical performance testing	AR/NP
^a Minimum number of samples is indicated in parentheses, otherwise it is one. AR/NP As received (not previously used for other tests) or in non pre-conditioned state. TH Temperature and humidity conditioning. VSE Exposure to vibration and shock ES CBRN. IE intermittent salt spray exposure. DR Exposure to impact from drop.		

6 Pre-conditioning

6.1 General

Pre-conditioning exposure conditions applied to different RPD classes, and required RPD configuration or packaging states are indicated in Table 4. These are referenced in Table 2 and Table 3 using the abbreviations indicated.

RPD testing in accordance with the requirement clauses shall follow the pre-conditioning sequences given in Tables 2 or 3. Each stage is separated by an “&” sign.

RPD shall be inspected after each stage of pre-conditioning exposure in accordance with Clause 13.

At inspection steps after exposure, there shall be no obvious distortion.

The number of samples is given in Table 2 and Table 3.

6.2 Sample preparation for pre-conditioning

All pre-conditioning shall be performed with RPD in the carrying case (if provided) in the ready for assembly state. Gas cylinders are allowed to be charged to 50 % of working pressure during pre-conditioning. The number of samples will be given in the relevant requirement clauses.

6.3 Components excluded from pre-conditioning

The following components may be excluded from the exposure to vibration:

- RIs, if separable;
- hoses and other breathable gas supply chain components without control function;
- body harness (without carrying plate).

6.4 CBRN RPD — Specific temperature and humidity pre-conditioning

The RPD in its ready for use state and components in the assembly state shall undergo temperature and humidity pre-conditioning in the following order:

- dry heat cyclic conditioning comprising 12 h at (35 ± 2) °C followed by 12 h at (70 ± 2) °C repeatedly for 21 d;
- cold constant conditioning comprising constant (-30 ± 2) °C for 3 d;
- humidity conditioning comprising 12 h at (30 ± 2) °C, RH (90 ± 2) % followed by 12 h at (40 ± 2) °C, RH (60 ± 2) % repeatedly for 5 d;
- stabilization to ambient temperature and humidity until temperature is equilibrated.

In order to ensure that there is no temperature shock during the conditioning of the samples, the temperature gradient shall not be greater than 3 °C/min between phases at different temperatures, and between the beginning and the end of a thermal cycle.

Table 4 — References to pre-conditioning requirements and applicability for CBRN and ES CBRN RPD

Type of Pre-Conditioning	Abbreviation ^a	Application				Reference	Configuration/Packaging ^b			
		CBRN1	CBRN2	CBRN3	ES CBRN		CC	RU	AW	CA
Temperature and humidity	TH	X	X	X	X	As specified in 6.4 .	X	X		X
Vibration and shock ^c	VS1	X				Vibration as specified in ISO 17420-4:2021, 6.11.1.1.3.1; shock as specified in ISO 17420-4:2021, 6.11.1.1.3.2.		X		X
	VS2		X	X		As specified in ISO 17420-5:2021, 7.3.2 (IEC 60721-1) excluding temperature and humidity stage		X		X
	VS3		X	X		As specified in ISO 17420-5:2021, 7.3.2 (IEC 60721-1) excluding temperature and humidity stage		X		X
	VSE				X	As specified in ISO 17420-5:2021, 7.3.2 (IEC 60721-1) excluding temperature and humidity stage		X		X
Corrosive environment	CE		X	X		As specified in ISO 17420-5:2021, 7.3.5.			X	
	IE				X	As specified in ISO 17420-6:2021, 7.3.3.			X	
Drop	DR		X	X	X	As specified in ISO 17420-5:2021, 7.3.4.		X		
^a Abbreviation key: CE Enhanced resistance to corrosion – constant exposure; DR Exposure to impact from drop; HR Radiological gas test pre-humidification; IE Enhanced resistance to corrosion - intermittent exposure; TH Temperature and humidity; VS1 Exposure to vibration and shock CBRN1; VS2 Exposure to vibration and shock CBRN2; VS3 Exposure to vibration and shock CBRN3; VSE Exposure to vibration and shock ES CBRN.										
^b RPD configuration or packaging states – refer to definitions as cited in other parts of ISO 17420. CC RPD in carrying case, if applicable. RU RPD in ready for use state. AW RPD in as worn state. CA Components in ready for assembly state.										
^c See excluded components in 6.3 .										

7 CBRN supplied breathable gas RPD

7.1 Requirements for supplied breathable gas CBRN RPD

7.1.1 General

CBRN supplied breathable gas RPD shall meet requirements identified in [5.3.2](#).

Where requirements from other parts of ISO 17420 are referenced, applicable test methods are defined in that document, and they are not reproduced here.

7.1.2 Protection Class

RPD protection class shall be determined in accordance with ISO 17420-1:2021, 5.7.

Each CBRN class shall meet the following minimum requirements.

CBRN1	PC4
CBRN2	PC5
CBRN3	PC5
ES CBRN	PC4

7.1.3 Correspondence with hazardous materials firefighting RPD

Requirements for CBRN3 RPD include the requirements of Class FF3 hazardous materials firefighting RPD in accordance with ISO 17420-5:2021, Clauses 5, 6 and 7 with the exception that the protection class of [7.1.2](#) applies.

7.1.4 Provision of breathable gas

CBRN supplied breathable gas RPD may be of class Sxxxx, where xxxx is the amount of breathing gas available in l, or type SY where Y is the indication for airline devices.

Where CBRN RPD can operate in either filtering or supplied breathable gas modes, they shall meet the requirements of this document and ISO/TS 17420-8 when tested separately in their respective modes. Breathing and other air supplying hoses shall be considered as part of the RPD.

Breathing and other air supplying hoses that have connections which protect from interrupted supply shall be:

- self-sealing (double-end sealing) to protect from contamination when not in use;
- disconnectable under pressure with gloved hands using gloves which conform to EN 388, class 4131.

Check in accordance with [Clause 13](#).

7.1.5 Temperature of operation

7.1.5.1 General

The information supplied by the manufacturer shall indicate the temperature of operation of the RPD.

7.1.5.2 Temperature of operation

Unless indicated in succeeding clauses, where test temperature criteria are indicated, CBRN RPD shall be tested in accordance with ISO 17420-4:2021, 6.1, at values of 35_{-2}^0 °C as the upper temperature requirement and -5_{0}^{+2} °C as the lower temperature requirement.

7.1.5.3 Optional Extended Temperature of operation

RPD may be evaluated to an optional extended temperature range at a special application level 0 in accordance with ISO 17420-5:2021, 7.2.1.3, at values of 60_{-2}^0 °C as the upper temperature requirement and -32_{0}^{+2} °C as the lower temperature requirement.

A wider temperature range extending beyond these upper and lower limits can be offered by a manufacturer as an optional feature. These shall meet the requirements according to either:

- manufacturer-selected ranges in ISO 17420-4:2021, 6.16.5, and ISO 17420-4:2021, 6.16.6; or
- specified levels in ISO 17420-5:2021, 7.2.1.

7.1.6 Chemical agent resistance

7.1.6.1 General

CBRN RPD shall be resistant to the permeation and penetration effects of highly toxic chemical agents. Distilled Sulphur Mustard (HD) and Sarin (GB) as the test agents shall be used.

CBRN1 RPD shall be resistant to the permeation and penetration of highly toxic chemical agents in vapour form.

CBRN2, CBRN3 and ES CBRN RPD shall be resistant to the permeation and penetration of highly toxic chemical agents in liquid and vapour form.

7.1.6.2 CBRN RPD chemical agent resistance requirements

7.1.6.2.1 CBRN RPD chemical agent resistance test samples

For CBRN1 RPD, a minimum of three CBRN RPD shall be tested for permeation with HD vapour and a minimum of three RPD shall be tested for GB vapour penetration in accordance with the test methods in [Clause 14](#).

For CBRN2 and CBRN3 RPD, a minimum of three CBRN RPD shall be tested for permeation with HD vapour and liquid, and a minimum of three RPD shall be tested for GB vapour penetration in accordance with the test methods in [Clause 14](#).

For each agent, a minimum of one RPD shall be tested without pre-conditioning, and a minimum of two tested after pre-conditioning as specified in [Table 2](#).

All components and accessories claimed as part of the RPD by the manufacturer shall be tested in the ready for use state. This may result in the need to test more than three systems if the submitted systems represent more than one completely assembled individual respirator.

Where the RI is designed so that there are barriers between different spaces of air management, the requirements of this clause apply in all spaces. For example, if the oro-nasal and eye spaces have separate breathable gas supplies, then both spaces shall be sampled.

7.1.6.2.2 Testing and pass/fail criteria

The maximum levels of permeation in [Table 5](#) shall not be exceeded.

Either of the following criteria shall constitute a failure

- three consecutive sequential instantaneous concentration data points during execution of the test at or exceeding the value in [Table 5](#), or
- exceeding the maximum breakthrough dosage (concentration integrated over test duration) as shown in [Table 5](#) calculated after completion of the test.

Testing shall be performed in accordance with [Clause 14](#).

Table 5 — Liquid and vapour test requirements for CBRN RPD

RPD Type	Agent	Challenge	Challenge duration	Breathing machine airflow rate	Maximum peak excursion	Maximum breakthrough (concentration integrated over test duration)	Test duration	Number of RPD tested
CBRN1	GB	210 mg/m ³	30	40	0,087	2,1	8	3
	HD Vapour	50 mg/m ³	30	40	0,60	6,0	8	3
CBRN2	GB	210 mg/m ³	30	40	0,087	2,1	8	3
	HD Vapour	50 mg/m ³	30	40	0,60	6,0	8	
	HD Liquid	≥0,86 ml ^b	120	40	0,60	6,0	8	
CBRN3	GB	2 000 mg/m ³	30	40	0,087	2,1	6	3
	HD Vapour	300 mg/m ³	30	40	0,60	6,0	6	
	HD Liquid	≥0,86 ml ^b	360	40	0,60	6,0	6	

^a Sinusoidal flow. The setting of the breathing machine shall be (36 × 1,1) l/min.

^b This volume depends on the minimum number of droplets for this class specified in [14.2.5.3.3.1](#), but more droplets may be applied based on RPD design where necessary.

7.1.7 Practical performance testing

The RPD without pre-conditioning shall undergo practical performance tests as specified in ISO 17420-1:2021, 5.8.

7.2 Requirements for supplied breathable gas CBRN RPD components

7.2.1 Connections

If more than one connector is present on a CBRN RPD, incorrect combinations shall be prevented, preferably by design solutions or by information on the right selection of combinations contained in the information supplied by the manufacturer.

Check in accordance with [Clause 13](#).

If more than one valved cylinder is used on one CBRN RPD they shall be regarded as a system and all connections shall be the same.

It shall not be possible to connect a cylinder of higher rated filling pressure to a CBRN RPD, which is designed to operate at a lower rated working pressure.

7.2.2 Resistance to permeation of breathable gas cylinders by liquid HD

7.2.2.1 General

A breathable gas cylinder permeation test is required for composite breathable gas cylinders with non-metallic liners.

The following breathing gas cylinders are not subject to this requirement:

- composite cylinders with a metallic liner
- cylinders with an all-metallic construction
- cylinders which are irremovably integrated into RPD and which are tested as a unit in [7.1.6](#) and [14.2](#).

7.2.2.2 Cylinder permeation requirement

Supplied breathable gas cylinders shall be resistant to permeation by HD liquid chemical agent.

Following testing in accordance with [14.3.2](#), the maximum permitted concentration of agent in the breathing gas (C_{HD}) predicted for any individual test sample when calculated in accordance with [14.3.3.2.2](#) shall be $3,0 \mu\text{g}/\text{m}^3$. This corresponds with the minimum reporting limit for the system permeation test.

Testing shall be performed in accordance with [7.2.2.2](#) and the test method in [14.3](#).

8 Escape CBRN supplied breathable gas RPD

8.1 General

Escape CBRN supplied breathable gas RPD shall conform to Class ES CBRN. RPD designated as ES CBRN (t) shall meet the requirements of ISO 17420-6:2021, Clauses 5, 6 and 7 and the requirements in [Table 3](#).

Escape CBRN supplied breathable gas RPD shall have a minimum protection class of PC4 and shall perform at the designated flow rate as specified in ISO 17420-6:2021, 7.2.9.1 for the class escape supplied breathable gas RPD.

The designated duration, t , in minutes follows the increments of:

- 5 min between 15 min and 30 min (15 min, 20 min, 25 min, 30 min);
- 10 min between 30 min and 60 min (40 min, 50 min, 60 min);
- 30 min between 60 min and 120 min (90 min, 120 min); and
- 60 min between 120 min and 240 min (180 min, 240 min).

The maximum designated duration for class ES CBRN shall be 240 min.

The minimum duration of air supply and times for chemical agent protection are defined according to the designated duration.

NOTE The minimum and maximum durations are not the same as for escape RPD in ISO 17420-6.

8.2 Requirements for Escape CBRN supplied breathable gas RPD

8.2.1 Determination of Escape CBRN supplied breathable gas RPD duration, t

The requirements of ISO 17420-6, 7.2.9.2 shall be met following sequential pre-conditioning in accordance with [Table 3](#).

8.2.2 Escape RPD performance requirements

The requirements of ISO 17420-6:2021, Clause 6 and [7.1.2](#), shall be met except that sequential pre-conditioning, where applicable, shall be according to [Table 3](#).

NOTE A wider temperature range can be offered by a manufacturer as an optional feature.

The requirements shall be as specified in:

- ISO 17420-6:2021, 7.2.10.1.2;
- ISO 17420-6:2021, 7.2.10.1.3;
- ISO 17420-6:2021, 7.2.10.1.4;
- ISO 17420-6:2021, 7.2.10.1.5;
- ISO 17420-6:2021, 7.2.10.1.6.

8.2.3 Protection class

Escape CBRN supplied breathable gas RPD shall be tested in accordance with ISO 17420-1:2021, 5.7, and shall achieve a minimum protection class PC4.

8.2.4 Chemical agent resistance for Escape CBRN supplied breathable gas RPD

8.2.4.1 General

ES CBRN RPD shall be resistant to the permeation and penetration effects of highly toxic chemical agents. Distilled sulphur mustard (HD) and sarin (GB) as the test agents shall be used.

8.2.4.2 Escape CBRN supplied breathable gas RPD chemical agent resistance

8.2.4.2.1 ES CBRN RPD chemical agent resistance test samples

Testing shall be carried out with the number of samples indicated in [Table 3](#) and shall demonstrate that the maximum levels of permeation in [Table 6](#) are not exceeded. The test duration shall be twice the minimum rated duration of the RPD.

For each agent, a minimum of one RPD without pre-conditioning shall be tested, and a minimum of two after sequential pre-conditioning as applicable in [Table 3](#).

The defined duration, t , in minutes controls the selection of test requirements.

Where the RI is designed so that there are barriers between different spaces of air management, the requirements of this clause apply in all spaces. For example, if the oro-nasal and eye spaces have separate breathable gas supplies, then both spaces shall be sampled.

8.2.4.2.2 Testing and pass/fail criteria

The maximum levels of permeation in [Table 6](#) shall not be exceeded.

The test requirements (see [Table 6](#), column 1) are chosen according to the defined duration of the ES CBRN RPD.

Either of the following criteria shall constitute a failure

- three consecutive sequential instantaneous concentration data points during execution of the test at or exceeding the value in [Table 6](#), or

- exceeding the maximum breakthrough dosage (concentration, integrated over test duration) as shown in [Table 6](#), calculated after completion of the test.

Testing shall be performed in accordance with [Clause 14](#).

Table 6 — Liquid and vapour test requirements for ES CBRN RPD

RPD Type	Agent	Challenge	Challenge duration min	Breathing machine airflow rate l/min ^b	Maximum peak excursion mg/m ³	Maximum breakthrough (concentration integrated over test duration) mg-min/m ³	Test duration h	Number of RPD tested
ES CBRN with $t \leq 30$ ^a	GB Vapour	210 mg/m ³	t	40	0,087	0,9	$2t$	3
	HD Vapour	50 mg/m ³	t	40	0,60	6,0	$2t$	3
	HD Liquid	$\geq 0,50$ ml ^c	$2t$	40	0,60	6,0	$2t$	
ES CBRN with $t \geq 40$ ^a	GB Vapour	210 mg/m ³	30	40	0,087	2,1	$2t$	3
	HD Vapour	50 mg/m ³	30	40	0,60	6,0	$2t$	3
	HD Liquid	$\geq 0,50$ ml ^c	$2t$	40	0,60	6,0	$2t$	

^a t = designated duration as specified in [8.1](#).

^b Sinusoidal flow. The setting of the breathing machine shall be $(36 \times 1,1)$ l/min.

^c This volume depends on the minimum number of droplets for this class specified in [14.2.5.3.3.1](#), but more droplets may be applied based on RPD design where necessary.

8.2.5 Breathable gas cylinder permeation

A breathable gas cylinder permeation test is required in accordance with [7.2.2](#) for composite breathable gas cylinders with non-metallic liners.

8.2.6 Practical performance testing

The RPD without pre-conditioning shall undergo practical performance tests as specified in ISO 17420-1:2021, 5.8. The requirements for donning/doffing in ISO 17420-1:2021, 5.8.2, are replaced by those given in ISO 17420-6:2021, 7.2.10.4.

9 Combined and multi-functional RPD

9.1 General

Combined RPD provide capabilities within both filtering and supplied breathable gas supply modes. These can include unassisted and assisted filtering RPD combined with supplied breathable gas configurations, and escape combined with non-escape RPD.

“Multi-functional” RPD provide capabilities to operate in different modes but which do not encompass both supplied breathable gas and filtering modes. Such types are:

- within the unassisted filtering mode and assisted filtering mode;
- within the class S and SY supplied air modes.

RPD which are both combined and multi-functional shall satisfy requirements of both [9.2](#) and [9.3](#).

Combined and multi-functional RPD shall meet the common requirements for all of their classifications according to [Clause 4](#).

There shall be clear indication to the wearer as to which mode the RPD is operating in.

Testing shall be in accordance with [7.1.7](#).

9.2 Combined RPD

Permitted configurations of combined RPD shall be:

- supplied breathable gas RPD class CBRN1 combined with filtering RPD class CBRN1;
- supplied breathable gas RPD class CBRN2 or CBRN3 combined with filtering RPD class CBRN2.

The full requirements of a designated class shall be met in each mode whichever mode of operation is selected.

Combined RPD shall function such that only one mode is operational at a time.

The minimum protection level for the designated class shall be maintained at all times including when transitioning between operating modes.

The operation of changing the mode from filtering mode to supplied breathable gas mode shall not result in a decrease of CBRN class below that of the CBRN class of the combined RPD.

Testing shall be in accordance with [7.1.7](#).

Other requirements of ISO 17420-4:2021, 6.15.1, apply.

9.3 Multi-functional RPD

Multi-Functional RPD shall be classified to a single CBRN class. The full requirements of the designated CBRN class shall be met for each method of operation.

Requirements of ISO 17420-4:2021, 6.15.2, apply.

9.4 Requirements – Escape CBRN combined with other RPD classes

RPD which combine ES CBRN with S or SY functionality shall meet the requirements of ISO 17420-6:2021, 7.1.2, and [Clauses 7](#) and [8](#) of this document noting that the highest requirements shall apply.

10 Optional features

10.1 General

In the absence or presence of optional features, the RPD shall comply with all requirements of this document appropriate to its classification.

Optional features shall conform to the requirements according to [Table 2](#) or [Table 3](#).

10.2 Optional connectors

The requirements of ISO 17420-4:2021, 6.16.2, shall be met and additionally, the design shall facilitate avoidance of contamination during the connection process as established through the failure modes effects analysis (FMEA).

10.3 Hydration

In addition to meeting requirements of ISO 17420-4:2021, 6.16.7, the following shall be met:

- the design shall facilitate avoidance of contamination during the connection process – as established through the FMEA;
- hydration systems shall be tested for agent permeation and penetration as part of the chemical resistance test specified in [7.1.6](#) or [8.2.4](#).

11 Training RPD and components

RPD and components for use in training which do not satisfy the requirements of this document shall:

- be physically representative of the related RPD or component including airflow resistance;
- be clearly identified as for training only, on the RPD, component, external packaging and carrier if used;
- incorporate a permanent and durable label identifying the RPD or component as only for training use;
- not incorporate lettering indicating CBRN capability.

Unless the component is designated for single-use, guidance shall be included in the information from the manufacturer for cleaning and preparation for re-use.

12 Reliability

The requirements of ISO 17420-4:2021, 6.10, shall be followed in preparation of the FMEA to demonstrate capability of specific features of RPD.

Additional considerations for CBRN RPD include (but are not limited to):

- chemicals which may damage RPD components or accelerate natural degradation;
- decontamination methods;
- effects of decontaminant materials on RPD function and components;
- performance of hydration systems;
- recommended storage conditions;
- storage life.

13 Inspection and practical performance testing

The inspection shall be made prior to laboratory or practical performance tests, or as specified in the specific clauses of this document. Inspection shall be conducted in accordance with ISO 17420-4:2021, 7.2.

Additional requirements for marking as specified in [Clauses 11](#) and [15](#) shall be assessed.

14 Test methods

14.1 General

This clause defines test methods which are not included in the ISO 16900-series.

Unless otherwise stated, testing shall be conducted in accordance with [5.1](#).

14.2 Chemical agent penetration and permeation tests

SAFETY PRECAUTIONS — The tests described in this clause involve use of highly toxic compounds. Appropriate safety precautions and sample disposal practices are required.

14.2.1 General

This test allows RPD to be challenged with highly toxic chemical agents and the permeation of agent into the inhaled air to be measured for an extended period.

This test method applies to filtering and supplied breathable gas devices.

RPD, including all components and accessories which form part of the breathing circuit, with the exception of gas cylinders (a separate permeation test is specified for cylinders, see [14.3](#)), shall be tested.

Three RPD shall be tested in an atmosphere containing GB vapour and three shall be tested in an atmosphere containing HD vapour. In each set of three, two RPD shall be pre-conditioned as specified in [Table 2](#) or [Table 3](#) and one tested without pre-conditioning.

Test requirements for each CBRN class are defined in [Table 5](#) and [Table 6](#).

Values of the maximum peak excursion and concentration integrated over test duration shall be recorded.

Other test equipment designs that are identical in principle but vary in detail to that described in this standard may be used, so long as the conditions described in [Table 5](#) or [Table 6](#) are maintained. Details of the test set up can vary according to the RPD type.

14.2.2 Materials

14.2.2.1 Distilled sulphur mustard (HD)

Liquid purity $\geq 95\%$ traceable to a nationally or internationally recognised standard, used within one year of analysis.

14.2.2.2 Sarin (GB)

Liquid purity $\geq 95\%$ traceable to a nationally or internationally recognised standard, used within one year of analysis.

14.2.2.3 Dilute HD

Used to test the calibration of the continuous air monitoring system, at a concentration chosen to be at the mid-point of the continuous air monitoring system calibration curve

14.2.2.4 Dilute GB

Used to the calibration of the continuous air monitoring system, at a concentration chosen to be at the mid-point of the continuous air monitoring system calibration curve.

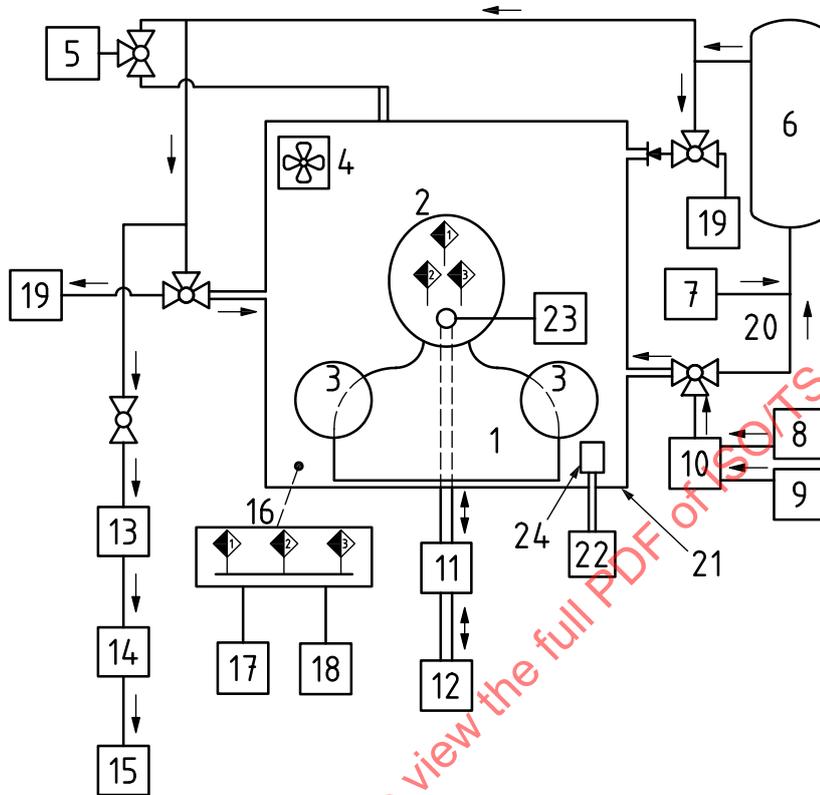
14.2.2.5 Breathing gas

A breathable gas supply that meets the water content requirements of ISO/TS 16975-1:2016 Table 12, shall be used. Oil, particle and condensate content shall be $\leq 0,5 \text{ mg/m}^3$.

14.2.3 Test equipment

14.2.3.1 General

Typical test equipment layout is shown in [Figure 1](#).



Key

1	manikin	13	sorbent tube
2	sample ports – Eye () and nostrils ()	14	mass flow controller
3	gloves – attached to face of exposure chamber (optional)	15	vacuum source
4	mixing fan	16	sample ports – linked to corresponding ports on head
5	chamber detector	17	detector 1
6	mixing chamber	18	detector 2
7	agent introduction	19	vent to hood
8	air supply	20	humid air tube
9	water supply	21	exposure chamber
10	flow-temperature-humidity controller	22	breathable gas supply system
11	safety filter	23	mouth opening
12	breathing machine	24	high pressure connector

Figure 1 — A typical test equipment layout for GB and HD permeation and penetration test

14.2.3.2 Manikin

An agent-resistant test manikin representative of a human torso. The manikin shall incorporate:

- an inflatable bladder (or similar device) which creates a seal with a RI

- fittings which enable connection to a breathing machine
- ports for sampling the breathing gas internal to the attached RI in the oro-nasal and ocular region.

The manikin shall be tested for leaks when new and in accordance with the laboratory and supplier's procedures for calibration.

14.2.3.3 Exposure chamber

The exposure chamber is constructed of chemically resistant materials with at least one front side constructed using a transparent, chemically resistant material. This forms an enclosure suitable for testing RPD, with:

- a floor capable of supporting the manikin;
- a removable front panel to allow access to the RPD on the manikin;
- an air filter or appropriate engineering control measure for removal of HD or GB vapour;
- ports to accommodate tubing for the challenge vapour and clean purge air;
- an electric fan, inside, near the top front, to achieve a well-mixed challenge vapour.

A 0,6 m-side cube has been found to be a suitable dimension although a larger chamber may be necessary to accommodate certain RPD, noting that increased agent supply rate may also be necessary to ensure rapid and uniform mixing to achieve target concentrations.

14.2.3.4 Detectors

14.2.3.4.1 Leak detector

A leak detector shall be used capable of detecting aerosol particles at a concentration of $\leq 0,001$ % of the challenge concentration (e.g. a challenge concentration of 100 mg/m^3 mineral oil needs a detector capable of detecting $0,001 \text{ mg/m}^3$).

14.2.3.4.2 Continuous detection systems

14.2.3.4.2.1 Challenge concentration monitoring system

A continuous air monitoring system shall be capable of detecting GB and HD at the levels required in the test chamber.

The measurement interval time shall be ≤ 5 min.

The continuous air monitoring system shall be calibrated over the applicable concentration range prior to testing and in accordance with manufacturer's instructions if applicable.

The following equipment has been found suitable for chamber concentration detection:

- an infrared absorption-based detector; or
- a gas chromatograph with a flame ionization detector (FID).

14.2.3.4.2.2 Breathing zone concentration monitoring system

A continuous monitoring system shall be capable of detecting GB and HD at the levels required in the nasal and eye region sampling ports of the manikin.

Sampling shall be from the oro-nasal region sampling port of the manikin. If the interface design incorporates a separate ocular air management zone, this shall be sampled also. If there are additional

air management zones, these shall be sampled. The configuration of the test manikin may need to be adjusted to enable this. The requirements of [Table 5](#) or [Table 6](#) shall apply in all cases.

The measurement interval time shall be ≤ 3 min for GB and ≤ 3 min for HD.

The breathing zone concentration monitoring system shall be calibrated over the applicable concentration range prior to testing and in accordance with manufacturer's instructions if applicable.

The following equipment has been found suitable for detection in the nasal and eye regions:

- a gas chromatograph with a flame photometric detector (FPD) and pre-concentrator tube.

14.2.3.4.2.3 Agent delivery system

The agent delivery system shall comprise:

- a means of delivering agent into an air stream at a controlled rate to create a challenge vapour at a specified concentration;
- a regulated airflow-temperature-humidity control system capable of supplying airflow according to [Table 7](#).

14.2.3.4.2.4 Breathing machine

A breathing machine shall be used to produce a sinusoidal breathing pattern as given in [Table 7](#).

14.2.3.4.2.5 Breathable gas supply system

For self-contained RPD (class Sxxxx); a supply system capable of providing the maximum and minimum supply pressures of the RPD and of cycling between them.

For airline supplied RPD (class SY); a supply system capable of providing breathable gas within the specified range for the RPD.

The cylinder valve and the joint to the high-pressure connector shall be subjected to agent permeation testing.

A high-pressure connector is used to connect the source of breathable gas to the cylinder valve and shall include a suitable sealing geometry according to the relevant connection standard. A source of supplied air replaces the compressed breathable gas cylinder of the RPD, which is not part of this test.

14.2.4 Preparation

14.2.4.1 RPD assembly/pre-check

The RPD shall be assembled and pre-use checks shall be performed following instructions in the information supplied by the RPD manufacturer.

The RPD shall be mounted on the manikin in the exposure chamber, following the donning instructions in the information supplied by the manufacturer.

The gas supply system shall be connected.

The assembled unit shall be photographed.

An operational check shall be conducted as applicable.

The breathing machine shall be turned on.

14.2.4.2 Pre-screening test

14.2.4.2.1 General

A pre-screening test with a non-toxic surrogate may be undertaken to establish correct connection of the test sample to the equipment. This avoids saturation of the detector in cases of excessive leakage.

The pre-screening test can be performed in the same chamber in which chemical agent exposure testing is performed or in a separate chamber.

The screening criteria and consequent actions are determined by the test laboratory.

14.2.4.2.2 Method

Using the RPD mounted on a manikin as described in [14.2.4.1](#), the leak detector shall be connected to a port into the exposure chamber.

The exposure chamber shall be closed.

The exposure chamber shall be filled with surrogate aerosol (oil aerosol or equivalent) in such a concentration that in combination with the level of detection, an inward leakage measurement of 0,001 % can be determined.

The sample line shall be connected to the manikin eye and/or nasal ports according to the air management of the RI to ensure that all zones are sampled.

The leak detector shall be connected to a sample line from the manikin and the leakage level shall be measured.

The inward leakage for the RPD mounted on the manikin shall be determined and recorded.

An inward leakage of less than 0,001 % has been found to demonstrate an adequate seal between the RPD and the manikin.

If a leakage level of less than 0,001 % cannot be achieved, the test shall be terminated or at the discretion of the test supervisor and in consultation with the manufacturer shall be continued with the live agent test.

14.2.4.3 Agent background test

Each agent shall have a maximum baseline value (background value) for detection by the continuous monitoring system.

An agent background characterization test shall be performed as follows.

The continuous monitoring system shall be connected to a sampling port of the manikin in the agent exposure chamber and the background level shall be monitored for ≥ 15 min.

The maximum acceptable measured background levels are:

- GB: 0,2 $\mu\text{g}/\text{m}^3$
- HD: 2,0 $\mu\text{g}/\text{m}^3$.

If the measured background levels exceed these values, methods of resolution can be:

- cleaning the chamber;
- decontaminating the chamber;
- changing the bladder on the test assembly;

- perform preventative maintenance on the continuous monitoring system, re-calibrate and verify with a calibration test.

14.2.4.4 Set-up

This procedure applies to test methods in [14.2.5.2](#), [14.2.5.3.2](#) and [14.2.5.3.3](#).

If applicable, the RPD shall be removed from the pre-screening test chamber and shall be installed on the manikin in the agent exposure chamber, following the manufacturer’s donning instructions. The system leakage test as specified in [14.2.4.2](#) can be repeated.

The sample line shall be connected to the manikin eye and/or nasal ports according to the air management of the RI to ensure that all zones are sampled.

Monitoring shall start.

14.2.5 Chemical agent tests

14.2.5.1 General

Tests with either Sarin (GB) or Distilled Sulphur Mustard (HD) shall be performed separately and on separate test samples.

The durations and conditions for each test according to the class of RPD are specified in [Table 5](#) or [Table 6](#). The timing of elements for each test is indicated in [Table 8](#).

If the challenge concentrations are measured in the mixing chamber (key 6 in [Figure 1](#)), then the effect of dilution by exhaled air in the chamber should be taken into account when calculating the required inlet challenge concentration and flow.

The test system shall be configured such that 80 % of the specified vapour concentration is reached within 20 % of the specified challenge duration.

General airflow conditions for chemical agent testing are given in [Table 7](#).

Table 7 — Airflow conditions for CBRN chemical agent test

Temperature °C	Relative humidity %	Airflow for GB and HD test (test chamber feed) l/min	Breathing pattern l/min
(25 ± 3)	(50 ± 5)	(60 ± 5)	(40 ± 0,8) l/min (36 strokes/min × 1,1 l/ stroke)

Minimum detection levels can vary between different types of detector, but the minimum reporting concentrations for continuous monitoring systems shall be:

- GB: 0,3 µg/m³
- HD: 3,0 µg/m³.

If the measured concentration is lower than this, it is set at zero.

14.2.5.2 Sarin (GB) vapour permeation test

The exposure sequence for the GB vapour permeation test is indicated in [Table 8](#) for CBRN RPD or [Table 9](#) for ES CBRN RPD.

Timing shall start at the first introduction of GB vapour.

The chamber shall be closed, the airflow-temperature-humidity control system and agent delivery system for the GB vapour challenge shall be set using the characteristics given in [Table 5](#) or [Table 6](#) and [Table 7](#).

The agent delivery system shall be allowed to run for the specified challenge duration.

The GB vapour challenge shall be turned off and flushing the chamber with clean air from the airflow-temperature-humidity control system shall be continued until the total test duration specified in [Table 5](#) and [Table 6](#) has been reached.

The GB concentrations shall be monitored throughout this period using the chamber continuous air monitoring system and the breathing zone continuous air monitoring system.

Three consecutive sequential test data points at or exceeding the value shown in [Table 5](#) and [Table 6](#) shall constitute a failure.

If a failure occurs, the test shall be terminated and the time recorded.

The breathing machine shall be turned off.

The accurate operation of the breathing zone continuous air monitoring system shall be verified by introducing a known concentration of test agent. If the measured value is within 10% of that expected the test is valid.

14.2.5.3 Mustard (HD) permeation test

14.2.5.3.1 Test timing

The time sequence of the test which may include droplet application is indicated diagrammatically in [Table 8](#).

Droplets are applied as specified in [14.2.5.3.3](#).

14.2.5.3.2 CBRN1 vapour permeation test

The chamber shall be closed, the airflow-temperature-humidity control system and agent delivery system for the HD vapour challenge shall be set using the characteristics given in [Table 5](#) and [Table 7](#).

The agent delivery system shall be allowed to run for the specified test duration.

The HD vapour challenge shall be turned off and flushing the chamber with clean air from the airflow-temperature-humidity control system shall be continued until the total test duration specified in [Table 5](#) and [Table 6](#) has been reached.

The HD concentrations shall be monitored throughout this period using the chamber continuous air monitoring system and the breathing zone continuous air monitoring system unless a failure occurs.

Three consecutive sequential test data points at or exceeding the value shown in [Table 5](#) shall constitute a failure.

If a failure occurs, the test shall be terminated and the time recorded.

The breathing machine shall be turned off.

The accurate operation of the breathing zone continuous air monitoring system shall be verified by introducing a known concentration of test agent. If the measured value is within 10 % of that expected the test is valid.

14.2.5.3.3 Liquid and vapour permeation test

14.2.5.3.3.1 Allocation of droplets

Where testing with liquid agent is called for in [Table 5](#) or [Table 6](#), HD droplets of 20 µl shall be applied using a syringe, or other metered dispensing instrument, on to the RPD.

RPD fitted to the manikin, in its as-worn state, shall be tested. The guidelines below shall be used to determine the position of the droplets.

Attachments to the RI (for example: a voice amplifier, hydration tube and connector) shall have droplets placed on them when known to be connected to the breathing gas supply chain.

If a hydration tube is connected to the RI via an isolating valve, then that valve shall be open during the test. The connector to the hydration reservoir shall be closed.

For the RI: 25 droplets including the connection to the rest of the RPD (if present) shall be applied as shown in [Figure 2](#) or [Figure 3](#) according to type T or L.

For the RPD extending beyond the RI, but excluding the RI, a minimum of 18 droplets shall be applied in accordance with the following generic guidance:

Working from top to bottom:

- 1 droplet for each component comprising non-metallic material exposed to the external environment;
- 1 droplet for each joint;
- with the remaining droplets distributed uniformly over the RPD excluding the RI.

Additional droplets beyond 18 shall be added if necessary so that each joint has 1 droplet applied.

14.2.5.3.3.2 Method for CBRN2

The exposure sequence for the mustard liquid and vapour permeation test is indicated in [Table 8](#).

The RPD test shall be set up in accordance with [14.2.4.4](#).

The chamber shall be closed, the airflow-temperature-humidity control system and agent delivery system for the HD vapour challenge shall be set using the characteristics given in [Table 5](#) and [Table 7](#).

The agent delivery system shall be allowed to run for the specified test duration.

The HD vapour challenge shall be turned off and flushing the chamber with clean air from the airflow-temperature-humidity control system shall be continued until the specified time for droplet application in [Table 8](#) has been reached.

The chamber shall be opened and droplets shall be applied in accordance with [14.2.5.3.3.1](#).

The initial location of the drops shall be marked on a photograph of the RPD.

The chamber shall be closed and flushing the chamber with clean air from the the airflow-temperature-humidity control system shall be continued until the total test duration specified in [Table 5](#) has been reached.

The HD concentration in the breathing zone shall be monitored throughout this period using the continuous air monitoring system and the breathing zone continuous air monitoring.

Three consecutive sequential test data points at or exceeding the value shown in [Table 5](#) shall constitute a failure.

If a failure occurs, the test shall be terminated and the time recorded.

The breathing machine shall be turned off.

The accurate operation of the breathing zone continuous air monitoring system shall be verified by introducing a known concentration of test agent. If the measured value is within 10 % of that expected the test is valid.

14.2.5.3.3.3 Method for CBRN3 and ES CBRN

The exposure sequence for the mustard liquid and vapour permeation test is indicated in [Table 8](#). The test comprises three phases: application of droplets, exposure to HD vapour and exposure to clean air.

The RPD test be set up in accordance with [14.2.4.4](#).

Droplets shall be applied in accordance with [14.2.5.3.3.1](#).

The initial location of the drops shall be marked on a photograph of the RPD.

The times when the first droplet and the last droplet is placed on the RPD shall be recorded. The test starts when the first droplet is applied. The vapour challenge starts at point *d*, when droplet addition is complete, as shown in [Table 8](#) or [Table 9](#). This is used in determining the termination of vapour application in accordance with [Table 5](#) or [Table 6](#).

The chamber shall be closed, the airflow-temperature-humidity control system and agent delivery system for the HD vapour challenge shall be set using the characteristics given in [Table 5](#) or [Table 6](#) and [Table 7](#).

The agent delivery system shall be allowed to run for the specified test duration.

The HD vapour challenge shall be turned off and flushing the chamber with clean air from the airflow-temperature-humidity control system shall be continued until the total test duration specified in [Table 5](#) or [Table 6](#) has been reached.

The HD concentration shall be monitored throughout this period using the continuous air monitoring system.

If a failure occurs, the test shall be terminated and the time recorded.

The breathing machine shall be turned off.

The accurate operation of the breathing zone continuous air monitoring system shall be verified by introducing a known concentration of test agent. If the measured value is within 10 % of that expected the test is valid.

Table 8 — Timing sequence for CBRN RPD and ES CBRN RPD permeation/penetration tests

RPD class	Agent	Application sequence
CBRN1	GB vapour	
	HD vapour	
CBRN2	GB vapour	
	HD liquid and vapour	
		<p> Period of vapour application Period of clean air application Period of presence of droplets </p> <p> $t_{(h)}$ time in hours d time taken to apply droplets </p> <p> A Vapour challenge on B Vapour challenge off/Clean air on C Test complete D Apply HD droplets E HD droplet application complete/Start vapour challenge </p>

Table 8 (continued)

RPD class	Agent	Application sequence
CBRN3	GB vapour	
	HD liquid and vapour	
<p> </p> <p> $t_{(h)}$ time in hours d time taken to apply droplets </p> <p> A Vapour challenge on B Vapour challenge off/Clean air on C Test complete D Apply HD droplets E HD droplet application complete/Start vapour challenge </p>		

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Table 9 — Timing sequence for ES CBRN RPD permeation/penetration tests

RPD Class	Agent	Application Sequence
ES CBRN $t_{esc} \leq 30$ min	GB vapour	
	HD liquid and vapour	
ES CBRN $t_{esc} > 30$ min	GB vapour	
	HD liquid and vapour	
<p> </p> <p> $t_{(min)}$ time in minutes d time taken to apply droplets t_{esc} designated duration of escape device </p> <p> A vapour challenge on B vapour challenge off/clean air on C test complete D apply HD droplets E HD droplet application complete/start vapour challenge </p>		