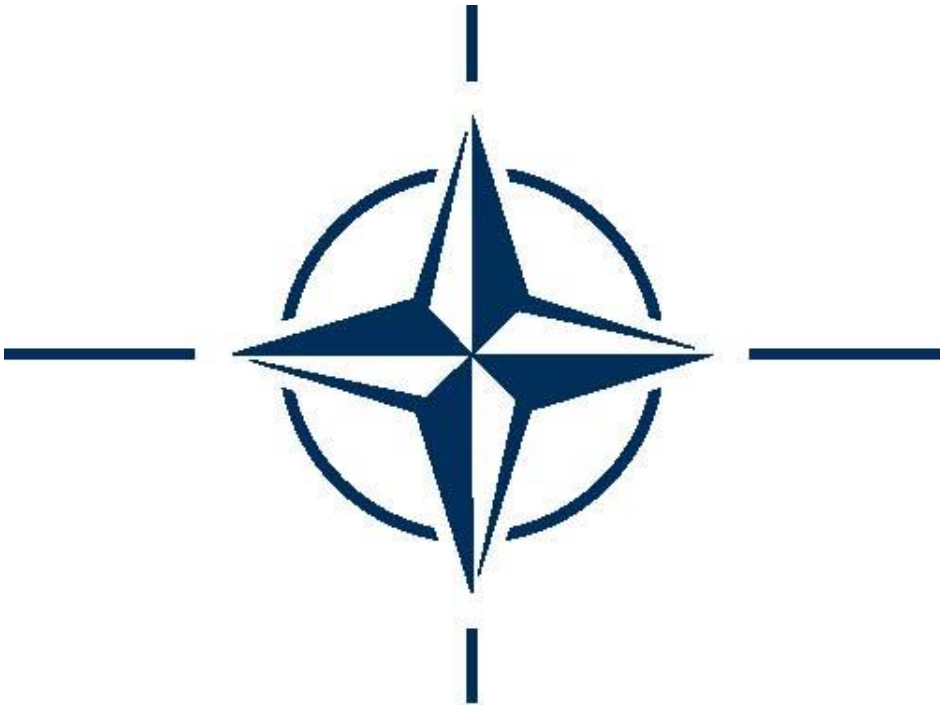
NATO STANDARD

AEP-73

COMBINED OPERATIONAL CHARACTERISTICS; TECHNICAL SPECIFICATIONS AND EVALUATION; TESTS AND CRITERIA FOR CBRN RESPIRATORY PROTECTIVE EQUIPMENT

Edition B Version 1

JUNE 2021



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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

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NATO LETTER OF PROMULGATION

4 June 2021

1. The enclosed Allied Engineering Publication AEP-73, Edition B, Version 1, COMBINED OPERATIONAL CHARACTERISTICS; TECHNICAL SPECIFICATIONS AND EVALUATION; TESTS AND CRITERIA FOR CBRN RESPIRATORY PROTECTIVE EQUIPMENT, which has been approved by the nations in the NAAG, is promulgated herewith. The recommendation of nations to use this publication is recorded in STANREC 4727.

2. AEP-73, Edition B, Version 1, is effective upon receipt and supersedes AEP-73, Edition A, Version 2, which shall be destroyed in accordance with the local procedure for the destruction of documents.

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4. This publication shall be handled in accordance with C-M(2002)60.

Zoltán GULYÁS
Brigadier General, HUNAF
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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CHAPTER 1 INTRODUCTION

1.1. PURPOSE

The multi-service operational guidelines for CBRN Defence of NATO forces (STANAG 2352/ATP-84 ed. B, version 1, Nuclear, Biological and Chemical (CBRN) Defence Equipment – Operational Guidelines) requires that each individual shall be provided with an individual protection system (protective uniform, hand and feet protection, prophylaxis/pre-treatment medications, decontamination kit). This system shall ensure the survival of military personnel under conditions of a CBRN incident and maintain their ability to carry out their duties. This document deals with respiratory protection, which is a key part of this system. The purpose of this Allied Engineering Publication (AEP) is to provide the materiel acquisition community with the operational requirements, technical specifications, test methodology and acceptance criteria to be applied during the acquisition and through-life management of chemical, biological, radiological, and nuclear (CBRN) protective respirators. It will also benefit those involved in setting requirements for personal protection, and in the research and development, testing and evaluation of CBRN protective respirators.

1.2. OTHER INFORMATION

The document also provides background information and guidance to the proper selection of these requirements, specifications, test methods and criteria for specific personal protection items.
This document sets out the requirements for the respiratory protection system. In Chapter 2 the requirements for such a system for general use are stated, whereas in Chapter 3 and 4 requirements for systems for special applications are given. These comprise respiratory protection for self-contained breathing apparatus (Chapter 3) and powered air purifying respirators (Chapter 4).
The format chosen for chapter 2 is that of a triptych, the first panel stating the operational characteristics, the second panel the corresponding technical specifications and the third panel the evaluation tests and test criteria. Chapter 5 of the document provides descriptions of test methods or the references to methods in existing documents to be used and is aimed at standardization within NATO.

1.3. INTEROPERABILITY

This document sets a minimum standard for nations, in order to enhance interoperability between North Atlantic Treaty Organization (NATO) forces. NATOTerm, the official NATO terminology database, defines “interoperability” as “The ability to act together coherently, effectively and efficiently to achieve Allied tactical, operational and

strategic objectives". Nations should provide at least one system that protects against the challenges defined in this Allied Engineering Publication (AEP).

1.4. APPLICABILITY

The requirements, specifications, test methods and criteria in this document are intended for use when designing and evaluating CBRN respiratory protective devices for general tasks. Specialised groups might have requirements not covered by this document but the selection of equipment for specialist requirements may benefit from the overall methodology defined in this document.

1.5. SCOPE AND LIMITATIONS

1.5.1. Respiratory Protection

Respiratory protective devices generally comprise a means to seal the eyes, respiratory tract, and gastro-intestinal tracts, and the head (or part of it) from the environment, so as to prevent ingress through the mouth or nose or contact with the eyes and skin of the head of all chemical and biological agents, or radioactive particles. Dermal protection requirements are addressed by STANAG 4548 OPERATIONAL REQUIREMENTS, TECHNICAL SPECIFICATIONS AND EVALUATION CRITERIA FOR CBRN PROTECTIVE CLOTHING - AEP-38 EDITION B. The dermal protection requirements of AEP-38 should be applied to the areas of skin covered by respirators and associated hood systems. The respiratory protective device is part of the individual protective ensemble and will usually be worn in association with CBRN dermal protective equipment and might also include other protective equipment like body armour, survival equipment, helmet, etc. At this point full compatibility and tight interfaces must be reached, demonstrated and evaluated in a dynamic environment.

1.5.2. Limitations

During the revision process the team of experts was limited in accessing current threat information. Protection requirements are therefore based on recommended challenge levels for protection as calculated by the CLP. Other limitations included the availability of toxicological criteria for certain challenges, and the status of scientific development.

1.6. STRATEGIC CONTEXT AND OPERATIONAL ENVIRONMENT

This Chapter provides a broad description of the chemical, biological, radiological and nuclear (CBRN) risks within the global security environment and the relationship between force protection principles and CBRN defence. It does not claim to be complete and is only aimed at assisting the requirements and acquisition communities in identifying the nature of the input needed from strategic analysts.

1.6.1. Strategic Context

1. Global Instability

Hostile state and non-state actors may seek access to, threaten, or use weapons of mass destruction (WMD). This could include the use of chemical, biological, radiological and nuclear (CBRN) weapons and devices and in the future, new classes of weapons based on emerging technologies and/or easier delivery methods.

At the same time, expanding urbanization and the global distribution of nuclear, biological and chemical industries and materials increases the possibilities of the release of toxic industrial material (TIM) into the environment as a result of neglect, natural or manmade disaster, deliberate action or collateral damage in the course of military operations.

2. NATO Operations

To accomplish the full range of the Alliance's military missions and to guarantee NATO's military effectiveness and freedom of action, the Alliance requires essential operational capabilities (EOCs). Whilst there are numerous capabilities which can contribute to the successful accomplishment of Alliance missions, EOCs are the required military capabilities necessary for Alliance forces and headquarters (HQ): ones which must be available at the right time and place, capable of conducting effective, sustained operations in the most austere environments and with the requisite force protection.

NATO operations need to be planned and conducted against a background of the risk of employment of CBRN substances. Additionally, across the whole spectrum of conflict, including peace support operations, there may be a risk of release of harmful substances from damaged industrial facilities or nuclear installations. Therefore, NATO forces need not only to be capable of defence against conventional attacks but also to be proficient in conducting operations over protracted periods in a CBRN environment.

3. Asymmetric Warfare

In the face of continuing NATO superiority in conventional military capabilities, adversaries may seek unconventional strategies and tactics, including the use of CBRN substances, to reduce this advantage. Adversaries are likely to focus on perceived NATO weaknesses and vulnerabilities such as the sensitivity of public opinion to casualties and other such cultural, legal and ethical constraints. Attempts may be made to employ the threat of CBRN use as part of an information campaign to constrain Alliance or Coalition rules of engagement and to detach wavering Alliance / Coalition members. Adversaries may have scant regard for international law and ethical standards, allowing them to engage in the deliberate targeting of civilian populations, including expatriates, or the deliberate positioning of military assets amongst civilian infrastructure or cultural sites.

4.

The NATO CBRN Defence Requirement

CBRN defence should not be an end but should permit operations to continue with the minimum of degradation and loss of tempo.
CBRN defence should be guided by the following overarching principles in support of a Joint Force:

i. Assessment of the threat
ii. Risk management
iii. Joint and multinational operations
iv. Prioritisation
v. Flexibility.

1.6.2. Operational Environment in AEP-73

This AEP has been revised to take into consideration not only conventional NATO operations but also operations conducted in environments characterised by fluid, non-linear battlefields and the use of unconventional force by irregular adversaries. Previously NATO doctrine had forces operating for extended periods of time in contaminated environments. However, with CBRN defence improvements in the areas of detection / identification / monitoring, knowledge management, physical protection, hazard management, and medical countermeasures, commanders have more options such as:

i. to continue the operation unmodified,

ii. to continue the operation but in a modified form to reduce exposure to identified hazards, and

iii. to cease the operation and withdraw forces, if hazards are too severe.

The wider range of options affects the nature of the CBRN protective equipment chosen.
Commanders need to reconcile the vulnerability of their forces to CBRN hazards with the concomitant restrictions imposed by the use of protective measures, and the need to pursue the mission. Threat, vulnerability, and risk analysis procedures, outlined in ATP-3.8.1 Volume 1, assist commanders in determining the defensive posture to be adopted, in order to reduce degradation while improving operational efficiency. All analysis will change with time and as the situation changes and will need to be reviewed regularly.

1.7. USER GROUPS AND TASKS

Although nations should provide at least one system / set of systems that protects against the challenges defined in this AEP, certain user groups might need special (extra) requirements for their protective equipment.

1.7.1. User Groups

The variety of tasks or the kind of missions undertaken by NATO personnel (AJP-3.8) is too varied to allow highly specific representative tasks or capabilities to be defined. However, generalised representative major user groups have been identified:

(1) combat soldier, dismounted

(2) combat soldier, mounted (vehicle)

(3) special operations

(4) amphibious / maritime personnel

(5) CBRN defence specialist personnel (e.g. decontamination, reconnaissance)

(6) logistics personnel

(7) medical personnel

(8) command/staff roles

(9) explosive ordnance disposal (EOD) and related tasks

It should be noted that this list does not encompass all the roles that are undertaken within NATO. Certain small specialist user groups will have requirements not covered specifically in this document for example aircrew user groups being covered by STANREC 4826 / AEP-4826 Aircrew Individual Protective Equipment.

1.7.2. External Conditions

When determining the requirements for individual protective equipment (IPE) for a user group, the conditions that are likely to be encountered by the specific user group have to be established. Conditions related to climate are generally common for all user groups but other factors that may vary include exposure to CBRN substances, flame/fire, water, high wind speeds (from transport in open vehicles or from rotors) and battlefield contaminants.

1.7.3. Analysis

If dedicated respiratory protection is needed, a detailed analysis is necessary to determine the magnitude of the challenges identified in the operational analysis, their mutual interaction and their impact on the requirements for the respiratory protection item.

1.7.4. Selection Parameters for IPE

Selection of any form of IPE and its required protection level must be balanced against the needs of the specific user group and will depend on numerous considerations such as:

(1) the duration of the task,

(2) the durability required,

(3) physical effort necessary to complete the task,

(4) acceptable heat stress levels,

(5) the need for specialised equipment such as self-contained breathing apparatus,

(6) the likelihood, duration, and challenge level of an expected CBRN incident,

(7) doctrine, which outlines the protective measures for soldiers at the moment of the CBRN incident,

(8) risk, vulnerability and threat analysis, and the acceptable risk a nation will take, and

(9) a nation's CBRN defence programme.

1.7.5. Tasks

1. Combat soldier, dismounted

Dismounted combat soldiers are likely to have the highest physiological stress and greatest exposure to the environment, and also require the greatest degree of flexibility when wearing IPE. Their IPE should integrate with a wide range of associated personal equipment, weapons, communications, optics and vehicles. Tasks will vary from low to high intensity operations in all types of climates. Therefore, the IPE should allow usage in a wide range of environments whilst offering protection against a wide threat range.

2. Combat soldier, mounted

The major differences in protective requirements between mounted personnel (e.g., armour, infantry, artillery, and logistics) and the dismounted soldier are driven by the constraints, hazards, and capabilities of the vehicle, and not by the operational CBRN environment. Within vehicles, mounted personnel face a reduced threat of being exposed to a liquid chemical hazard. However, the risk and threat rise when they exit their vehicle. By the nature of their surroundings, vehicles are subjected to severe fire

/ flame hazards, greater heat stress, and space constraints. However, mounted personnel may have chemical, biological, radiological and nuclear collective protection (CBRN COLPRO), supplied clean air and/or cooling systems which mitigate these constraints. Personnel in open vehicles might encounter CBRN challenges at elevated wind speeds which their IPE may not have been designed against.

3. Special operations

Special Forces may need to operate in a CBRN contaminated area. The need for high flexibility, mobility, and low thermal burden IPE may require specialized protective concepts.

4. Amphibious / maritime personnel

Naval personnel need most if not all the same considerations for respiratory protection as ground force personnel. Three distinct categories must be considered for shipboard personnel: personnel on weather decks or in harbours (potentially exposed to the full range of hazards), personnel within the vessels' structure but ex-citadel (potentially exposed to vapour/aerosol hazards only), and personnel within the citadel (no exposure when the citadel is activated). All maritime personnel are liable for action damage duties including fire-fighting, their systems must meet minimum standards of heat protection and flame retardance.

5. CBRN operational specialist personnel (e.g. decontamination, reconnaissance)

The decontamination process often involves intensive work applying decontamination solutions using high pressure sprays. Therefore, respiratory equipment must have excellent protection against high levels of toxic agents, water and decontamination solutions in vapour, liquid, and aerosol form. Total endurance time for the operators will depend on many factors such as weather and temperature, decontamination solutions and the level of decontamination required, as well as following work to rest tables. CBRN operational specialists not involved in decontamination tasks, e.g. sampling and identification of chemical, biological and radiological (SIBCRA) teams, reconnaissance teams, can be expected to need the same level of protection as the dismounted combat soldier or mission specific protection.

6. Logistic personnel

Because of the self-defence requirement that derives from operating on the non-linear battlefield, all support personnel require the same levels of protection as dismounted combat soldiers.

7. Medical personnel

Medical personnel will be active on and off the actual battlefield. They will require various levels of protection, up to the same level of protection as dismounted soldiers.

8. Command / staff roles

Command and staff personnel will require the same level of protection as dismounted soldiers.

9. EOD and related tasks

Gear intended to protect against explosion is burdensome and heavy. Respiratory protection for this application will likely be specialised.

1.8. EQUIPMENT

This paragraph gives a brief description of the examples of respiratory protection currently in use and a description of trends, both as of the end of 2016. This paragraph does not claim to be complete, nor does it give prescriptive design requirements. New materials and systems are continuously being developed.

1. Negative pressure air purifying device

A negative pressure, air purifying device with full face mask is designed and constructed to enable the wearer to breathe ambient air via a filter(s). The exhaled air passes without recirculation from the full-face mask via the exhalation valve(s) to the ambient atmosphere. These form the majority of respiratory protective devices in service within NATO nations.

2. Positive pressure air purifying respirator (PAPR)

A positive pressure, air purifying device is designed and constructed to pass ambient air via a filter(s) into the face mask or hood under positive pressure (generally provided by a fan blower unit) to enable the wearer to breathe. The filters shall be combined gas/vapour filters and particle filters. The exhaled air passes without recirculation from the full-face mask or hood via the exhalation valve(s) to the ambient atmosphere. A specialised sub chapter of the PAPR is that used to protect armoured vehicle crews, which commonly links several respirators to one filtration unit.

3. Self-contained, open circuit breathing apparatus

Positive or negative pressure, self-contained, open-circuit compressed air breathing apparatus are designed and constructed to enable the wearer to breathe air on demand from pressure vessel(s), carried by the wearer, via a pressure reducer and/or a lung governed demand valve connected to the face-piece. The exhaled air passes without re-circulation from the face-piece via the exhalation valve to the ambient atmosphere.

4. Positive pressure, self-contained, closed-circuit breathing apparatus

Positive pressure, self-contained, closed-circuit breathing apparatus are designed and constructed to enable the wearer to breathe air on demand from pressure vessel(s), carried by the wearer, via a pressure reducer and/or a lung governed demand valve

connected to the face-piece. The exhaled air passes through a CO_2 scrubber and O_2 replenisher and re-circulates via the face-piece around a closed system.

5. Hybrid systems

To maximise the operational capability of respiratory protective systems combination systems based on a mixture of the devices listed above mounted on the same face-plate are currently available. Combined systems can switch between air-purifying and air/gas-supplied modes (e.g. combined PAPR/SCBA), whereas multifunctional systems can switch between two different modes, both of which are either air-purifying (e.g. air purifying respirator (APR)/PAPR), or are air/gas supplied (e.g. SCBA/air-line).

6. Escape hoods

These are a specific class of system that are designed to afford only very limited protection (in terms of minutes and not hours) so as to afford a safe escape from a contaminated area. This Allied Engineering Publication does not cover these systems.

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CHAPTER 2 CBRN AIR PURIFYING RESPIRATOR FOR GENERAL USE: COMBINED OPERATIONAL CHARACTERISTICS; TECHNICAL SPECIFICATIONS AND EVALUATION CRITERIA

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
2.1. PROTECTION CHARACTERISTICS		
Protection against CBRN hazards The protective mask must provide efficient and durable protection to the face, the eyes, and respiratory and gastro-intestinal tracts of the wearer against field concentrations of chemical, biological and radiological agents and radioactive fallout particles. This protection must be ensured under all climatological conditions to be met in the relevant parts of the NATO theatre of operations. Additional protection may be derived from the use of prophylactic measures. Face-seal must not be affected by the vision corrective systems to be used with the mask. For male users, the use of the mask requires shaving at least once every 24 hours which is compulsory in order to avoid the face-seal leakage affected by a stubble beard. Technical details given are for standard (i.e. outdoor) military operations. CBR-challenge in a confined space (indoor scenarios) may lead to	Protection against CBRN hazards Protection is required against all chemical compounds, biological organisms and radioactive particulate matters that are liable to be used as CBRN-warfare agents. For specific chemical and biological substances and types of attack reference is made to the official documents concerning the threat [STANREC 4726 / AEP-72]. The level of protection provided by a protective mask is indicated by the masks' protection factor (PF). This number, which is determined experimentally by measuring face piece seal and filter and exhalation valve leakage, is defined as the ratio of concentration of test substance outside the mask to the concentration of test substance inside the mask face piece. Leakage is defined as the reciprocal of PF and is expressed as a percentage. The adequate and appropriate qualification methods in determining protection factor of protective mask must include the three challenges (chemical, biological and radiological), and applied on all components (face seal, outlet valve and filter) of the mask. Most desirable would be a simultaneous test of all components at the same time, the Total Inward Leakage (TIL) test	Protection against CBRN hazards The tests for evaluating the CBRN-protective level of the protective mask consist of instrumental tests on each individual component (filter, face seal, outlet valve) on the mask, and combined tests employing human volunteers (man tests) to measure the leakage of the components on the mask (face seal and outlet valve) and the filter. Thus, there are three approaches to meet the requirement 1. Individual component testing (face seal, outlet valve, filter penetration) 2. Face seal and outlet valve (remaining components) and filter penetration separately 3. TIL (face seal, outlet valve leakage and filter penetration all measured in one test) In all cases, a dust test of the outlet valve as described under d) is recommended – but not mandatory. The tests are listed below:

<table>
<tr><th>OPERATIONAL CHARACTERISTICS</th><th>TECHNICAL SPECIFICATIONS</th><th>EVALUATION AND TEST CRITERIA</th></tr>
<tr>
<td>such high concentrations the use of SCBA is indicated.</td>
<td>(EN 13274-1 or AEP-71) and using the challenge the protective mask must protect against.

The following table provides an overview on test methods that are available for qualification of the protective mask and how they can be applied for the desired purpose.

The detailed test conditions are described in Evaluation and Test Criteria column.

Table on possible PF qualification methods
<table>
<tr><th>Respirator Element</th><th colspan="3">Type of PF Qualification</th></tr>
<tr><th></th><th>Chemical</th><th>Biological</th><th>Radiological</th></tr>
<tr><td>Face seal</td><td>SF_6, helium[1.2], aerosol < 0.6 µm</td><td>physical aerosol[3] < 2.5 µm, living simulant</td><td>aerosol 0.6 µm</td></tr>
<tr><td>Outlet valve</td><td>SF_6,helium[1.2], aerosol < 0.6 µm</td><td>physical aerosol[3] < 2.5 µm, living simulant</td><td>- aerosol 0.6 µm</td></tr>
<tr><td>Filter</td><td>aerosol covering most penetrating particle size range (0.1-0.5 µm)</td><td>dry or liquid aerosol[2], < 1 µm NMD[4], living simulant</td><td>aerosol covering most penetrating particle size range (0.1-0.5 µm)</td></tr>
</table>
[1] Can also be used for B-qualification
[2] Can also be used for R-qualification
[3] Can also be used for R-qualification if particle size is selected adequately
[4] Filter qualification against B-agents needs to be performed using particle counting methods</td>
<td>(a) Instrumental tests of individual components

These tests are further elaborated below in Paragraph 2.1.2.2.

(b) Man test for face seal leakage, TIL and face seal leakage with outlet valve.

A test subject who is properly fitted with a well-maintained mask is exposed to an atmosphere with a test agent (see below). The leakage, defined as 1/PF, is expressed as the ratio of the concentration of test agent inside the mask to the challenge concentration of test agent.

In the case of face seal leakage and face seal leakage with outlet valve, other sources of leakage are to be excluded (artificially plugged-up). Suitable test agents must meet the following requirements:
- non-toxic in the amount and concentration that may occur in the inhaled air;
- measurable in the range of relevant concentrations;
- have a known lung retention (preferentially zero); and
- have no tendency to be adsorbed or deposited on solid surfaces whether humid or dry.

Leakage tests for face seals and outlet valves with subjects are preferably done in test chambers. It is easier to generate high concentrations of test substances in confined spaces. Fixed installations are possible as well as flexible ones (e.g. tents). Design aspects to be considered:</td>
</tr>
</table>

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		- Generation of test substances in high and homogenous concentrations to make high PF obtainable; - Sufficient in size allowing the use of treadmill or bicycle ergometer; - Camera monitoring during PF-testing recommended; - Optional use of supply hoses for fresh air from outside to the subject, protected against ingress of the test substance; - Supply hose, if applied, and connector should not affect the fit of the respirator during PF-test. Face seal leakage is determined at least 3 times for each test subject with repeat donning and doffing of the protective mask, while performing the following exercise protocol. Exercise protocol (ref. AEP-71): Subject should remain at rest while wearing a protective mask for at least 5 minutes prior to the measurement. The following activities can be performed standing still/treadmill walking/cycling for a minimum of 1 minute each: - Normal breathing - Deep breathing - Head movement side to side, repeatedly - Head movement up and down, repeatedly - Bend over and reach for the floor, repeatedly

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		- Facial Expressions: yawning, smiling, frowning, chewing (rotating the jaw) - Speaking or mouthing For statistically significant measurements of leakage or PF, a test panel consisting of at least 25 persons (female and male), or at least 12 persons when the entire population is male, is considered adequate. Selection of test subject should follow closely to anthropometric survey of troops from each NATO country based on Menton-Sellion and bizygometric measurements. The overall value of leakage is the geometric means of leakage from each of the different exercises. The tests must be performed at (20 ± 5) °C (room temperature). It is desirable to maintain the same level of PF at (-20 ± 2) °C and (40 ± 2) °C. (c) Leakage of the outlet valve This test is performed dynamically using a mannequin head and a sinusoidal breath simulator under realistically humid conditions. The outlet valve assembly is surrounded by air flowing at a speed of about 1.6 m/s perpendicular to the valve assembly and containing a suitable test agent. Suitable agents are insoluble in water and are not adsorbed or deposited on solid surface whether wet or dry. The ratio of the "inhaled" concentration to the challenge concentration of the test agent is a measure of the dynamic leakage. It is measured at breathing rates of 15 strokes/min x 0.67 L (=10 L/min), 20 strokes/min

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		x 1.5 L (=30 L/min) and 30 strokes/min x 2.7 L (=80 L/min). (d) Dust test of the outlet valve (optional) The dust-proofness of the outlet valve is tested with the type of sand or dust that is encountered in the area where the mask is to be used (US MIL-STD-810). One gram of sand or dust is dispersed inside of the outlet valve assembly. A possible leak is determined either by measuring the TIL or the dynamic leakage of the outlet valve. (e) Filter aerosol penetration test Test descriptions for particle filter elements are given under 2.1.2.1 and 2.1.3.(a).
2.1.1. Protection against airborne chemical hazards		
	The protective mask constitutes a barrier between the wearer's face (or head) and the contaminated atmosphere. Inhalation occurs through a filter and exhalation through an outlet valve. Absolute purification of the inhaled air being not feasible, a maximum penetration of 10^{-4} regarding chemical vapours is considered acceptable, while the separate contribution of the two inevitable leak sources are each bound to a maximum: **2.1.1.1. Filter element**: 3.0×10^{-5} **2.1.1.2. Remaining components**: 7.0×10^{-5} (face seal and outlet valve)	Leakage evaluation tests consist of the use of various dosages of several agents and simulants. Methods, challenge levels, breakthrough thresholds and detection procedures depend on the challenge test substance used. **2.1.1.1. Filter element** tests are described separately in paragraph 2.1.3. **2.1.1.2. Remaining components**: Test challenge: SF_6 or Helium or < 0.6 µm MMD test aerosol

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		Generation method: Pressurised gas cylinder and suitable aerosol generators Challenge concentration: Depends on analytical method used. The concentration should be high enough to enable PF determination with sufficient statistical confidence. National established exposure limits should be applied. The challenge concentration should be kept stable. Sampling procedures: In-mask sampling usually carried out at the drinking tube assembly. In case of high challenge concentration, sample dilution may be carried out with suitable devices such as Venturi dilutor. Measurement instrumentation / analytical methods: e.g. FTIR-Spectrophotometer, Flame photometer, (optical) particle counter Detection limit (min. PF): ≥ 100,000. Definition of PF: challenge concentration / in mask concentration

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
2.1.2. Protection against airborne biological hazards		
	Regarding biological aerosol a leakage of 10^{-5} essential (10^{-6} desirable) is considered acceptable when tested with particles not larger than 2.5 µm (1 µm for filters), while the separate contribution from the two inevitable leak sources (filter and the remaining components) are each bound to a maximum:	Using various dosages of several agents and simulants. Test methods, challenge levels, breakthrough thresholds and detection procedures depend on the challenge substance used.
	2.1.2.1. Filter element: 3.0 x 10^{-6} essential (3.0 x 10^{-7} desirable)	**2.1.2.1. Tests for filter element** Test medium: Living simulants (American Conference of Governmental Industrial Hygienists: Bioaerosol Assessment and Control, J. Macher (ed.), Cincinnati, OH, USA, ACGIH)) or physically equivalent-aerosol for bacteria/spores with an aerodynamic particle size of not larger than 1 µm NMD; or using suitable aerosols, e.g. DEHS (diethylhexylsebacate), DOP (dioctylphthalate), poly-alpha-olefin (PAO), sodium chloride or polystyrene latex spheres (PSL). Generation method: - preferably: condensation monodispersed aerosol generator; or - poly-dispersed aerosol generator Challenge concentration: dependent on analytical instrumentation but enough to determine required PF. Test Flow:

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		80 L/min steady state air flow rate Sampling procedures: - Representative sampling upstream/downstream (tubes as short and straight as possible and made of material that minimises electrostatic deposition) - Aerosol measurement up and downstream in parallel, and in cases of only one aerosol detector is available, experimenter has to ensure stability of particle concentration - Usage of diluter if coincidence failure above 10% - Sampling time: as long as it needs to gain statistical confidence. Measurement instrumentation/Analytical methods: - For monodisperse generation: Condensation Nucleus Counter (CNC) - For poly-disperse generation: Aerodynamic Particle Spectrometer or Aerosol Spectrometer Detection limit (min. PF): ≥ 1,000,000. The filters are to be tested after simulated rough handling (2.3.4.4).

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
	2.1.2.2. Remaining components: 7.0 x 10^{-6} essential (7.0 x 10^{-7} desirable)	**2.1.2.2. Tests for the Remaining Components** Test challenge: corn oil, poly-alpha-olefin (PAO), DEHS, sodium chloride Generation method: Poly-dispersed aerosol generator, e.g. Collison Nebulizer, Laskin aerosol generator or monodis-persed aerosol generator, e.g. Sinclair-La Mer. Particle size distribution: mono- or poly-disperse generated aerosol, mass median diameter (MMD) < 2,5 µm Challenge concentration: depending on analytical method but should en-sure a stable concentration with adequate parti-cles in the sampled air to determine required PF with sufficient statistical confidence. Sampling procedures: sampling via drinking tube, sampling flow 100 mL/min – 3 L/min, chamber concentration with dilution (1:100). Measurement instrumentation / analytical meth-ods: Aerodynamic Particle Spectrometer (APS)

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2.1.3. Testing of Individual Components		
	The protective respirator system must protect against the highest (desired) vapour dosage given in AEP-72 Volume II, Table 4.1. This will assure adequate protection for multiple symmetric attacks with chemical agents. The protective respirator system must also protect against the CSG recommended essential challenge levels against single TIC attacks / accidental releases as cited in AEP-72 Volume III, Table 4.2 with the exception of those TIC known to difficult adsorb on activated carbon (e.g. NOx, CO…) or which may generate highest vapour dosages due to giant release sizes (e.g. chlorine, as per table 4.2 of AEP-72 Volume III). In those cases, SCBA would be the method of choice for breathing protection. The penetration of the filter by aerosol must remain below 3 x 10^{-5} at flow rates up to 80 L/min until 250 mg of aerosol has collected on the filter. The increase in pressure drop must not cause undue breathing resistance or inward leakage. Exposed mask components must provide protection against vapour permeation to the extent of 24 hours minimum penetration-resistance following exposure to liquid mustard (HD) and at least one of the nerve agents GA, GB, GD or VX.	Test of the protection against chemical agents comprises tests of the filter canister against airborne contamination and of mask materials against droplets. In order to detect leakage in the canister housing, the experimental set-up must assure that the canister is entirely surrounded by the challenging atmosphere. (a) Particulate filtration Particulate filtration by the aerosol filter is tested both with a liquid and a solid aerosol in accordance with EN 143 with deviations as described below. The liquid aerosol may be either paraffin oil, PAO, DEHS or a dioctylphthalate (DOP) aerosol. The solid aerosol may be either a sodium chloride or an equivalent aerosol. Initial penetrations are measured at a continuous flow of 80 L/min; temperature is 23 ± 3°C and relative humidity is 80% or lower for the liquid and 50% or lower for the solid aerosol. For the oil aerosol the measurement at 80 L/min is continued until a total load of 250 mg. In no case must penetration exceed 3.0 x 10^{-5}. The canisters are to be tested after simulated rough handling (2.3.4.4).

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		(b) Vapour filtration The vapour filtering properties of filters for negative pressure air purifying devices are evaluated in a series of breakthrough and efficiency tests, specified under 2.1.3.1 and 2.1.3.2. In each test at least three canisters are tested. In all tests the filters are preconditioned at the nominal air flow rate – a constant flow may be applied – until equilibrium; usually for a duration of 16 hrs (minimum) but not exceeding 24 hrs (maximum) at (23 ± 1) °C and (80 ± 2) % RH. These conditions hold also throughout the filtration tests properly. The air flow pattern for filter testing must be pulsating – unless evidence has been demonstrated that a steady state air flow rate will produce equivalent results In all cases a filter is taken up in an air flow line, whilst it is orientated with respect to gravity in such a way that channelling of air due to possible setting of the adsorbent material, is most probable to come apparent. No channelling must occur, i.e. the detector in use must not indicate an offset from the zero line immediately after the gas challenge has been started. Provided that channelling issues were effectively avoided, the following tests (2.1.3.1. and 2.1.3.2.), all or part, may also be performed in a model scale sorbent tube if the scale-down calculation is based on equivalent values for air flow velocity, carbon layer height in flow direction and packing density of the adsorbent. In accordance with ASTM D5160-95 (ed. 2015) the sample tube

<table>
<tr><th>OPERATIONAL CHARACTERISTICS</th><th>TECHNICAL SPECIFICATIONS</th><th>EVALUATION AND TEST CRITERIA</th></tr>
<tr><td></td><td></td><td>diameter should be at least twelve times the diameter of the largest carbon particles present or 16 times the mean diameter.</td></tr>
<tr><td></td><td>2.1.3.1. Filter breakthrough tests with chemical warfare agents (CWA)

Each filter under test must meet the stated requirements; averaged breakthrough times are disregarded for evaluation. It is desirable to maintain the same level of filter performance at (0 ± 2) °C and (40 ± 2) °C under otherwise the same conditions.

The required performance in terms of breakthrough times of the canisters must still be met after the ageing test specified sub 2.4.1. and 2.4.2.</td><td>2.1.3.1. Filter breakthrough tests with CWA

Table on filter performance requirements for negative pressure air purifying devices

<table>
<tr><th>CWA</th><th>PS [1]</th><th>CK [2]</th><th>AC [3]</th></tr>
<tr><td>Air flow rate</td><td colspan="3">pulsating 24 half sine waves/min * 2.08 L (= 50 L/min average flow) [4] or constant 50 L/min if equivalent results demonstrated.</td></tr>
<tr><td>challenge concentr.</td><td colspan="3">2,000 mg/m³</td></tr>
<tr><td>Breakthr. criterion</td><td colspan="3">5 mg/m³</td></tr>
<tr><td>Breakthr. time</td><td>37.5 min</td><td>15 min</td><td>15 min [5]</td></tr>
</table>
1 Chloropicrin
2 Cyanogen Chloride
3 Hydrogen Cyanide
4 each wave is followed by an equal period of standstill
5 C2N2 can sometimes be present in the effluent air. The breakthrough applies to the total concentration of (C2N2 + HCN)</td></tr>
<tr><td></td><td></td><td>2.1.3.2. Filter efficiency test with sarin

The filter is challenged with sarin in a concentration of 500 mg/m³ during 20 min. The air flow of 80 L/min is pulsating with a pattern of 36 half sine waves per minute of 2.22 L each; each</td></tr>
</table>

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		wave is followed by an equal period of stand still. The total amount of sarin that penetrates through in the period of 20 min must not exceed 40 µg. If it is demonstrated that DMMP is a suitable simulant for sarin for the adsorbent under test, the efficiency test may be assessed by using DMMP at a concentration of 1,000 mg/m³ up to the same ct-value of 10,000 mg*min/m³ under otherwise the same conditions.
		2.1.3.3. Liquid CWA protection of face piece material and eyepieces The CWA resistance of face piece and eyepiece materials is to be tested with liquid HD and at least one of the nerve agents GA, GB, GD or VX, according to the procedure defined by AEP-38, Volume 1, Section F.6 “CWA liquid swatch test – qualitative methods”. Material samples are contaminated in accordance with AEP-72 Volume I, table 5.1 (CWA liquid challenge levels). During 24 hours the permeated agent is monitored by means of specific detection papers, specified in AEP-38, Volume 1, Section F.6. The tests are to be performed in closed top configuration and at a preferred test temperature of 37 °C (± 2 °C). The breakthrough time of CWAs should be at least 24 hours. Alternative detection methods (e.g. ODA-method: based on a reaction between an orthodianisidine-dihydrochloride solution (ODA reagent) and the permeated G-agent) may be applied by nations as considered appropriate.

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2.1.4. Protection against radiological agents and nuclear fall-out		
This paragraph refers exclusively to the challenge posed by inhalation of radioactive material, not external radiological threats (see for that STANAG 2521 / ATP- 3.8.1). Three types of scenarios can be identified: 1) radiological weapons (“dirty bombs”), 2) nuclear reactor incidents and 3) nuclear strike scenarios. Radiological weapons constitute the major challenge for respiratory protection. They are characterized by the generation of radioactive aerosols in the respirable range (smaller than 10 µm). The external radiation hazard from radioactive particles collected in the canister is negligible. The generation of radioactive gas is also of negligible importance. In a nuclear reactor incident inhalation hazard from radioactive aerosols is generally of the same order as the external radiation hazard and inhalation hazard of radioactive iodine. Prior intake of thyroid blocking agents such as stable potassium iodine is advised to reduce the internal radiation dose due to this iodine. The inhalation risk due to radiological aerosols from nuclear weapon strikes will be relevant but minor compared to the external radiation risk generated by the fall-out. Respirator use is required and relevant. External radiation hazard	Radiological hazards for inhalation arise from - radioactive aerosols and - radioactive gases which can be caused by a variety of radiological and nuclear incidents. For radiation protection the effective dose equivalent is the limiting factor which can be divided in the external and the internal dose. For the internal dose (inhalation and ingestion) the 50-year-commited dose governs the criteria. Only respirable particles are considered relevant for mask requirements. The protection factor for individual breathing protection must be chosen so that a balanced protection – in respect to the external dose – is achieved. Investigations showed, that in military scenarios generally the radioactive gases are of minor internal dose relevance. The dose is determined by inhaled aerosol. For the duration of a mission the filter element must stop radioactive fall-out particles liable to be encountered on the battlefield to an equal or greater extent than chemical aerosols. Regarding radiological aerosol a TIL of 10^{-4} essential (10^{-5} desirable) is considered acceptable for particles larger than 0.5 µm and 10^{-3} for particles smaller than 0.5 µm which is less stringent than the allowance for chemical aerosol protection.	Fulfilment of the requirements for fine aerosols defined in 2.1.3 (a) ensures adequate filtration of radioactive aerosols. Measurement of the external dose rate due to the radiation of radioactive particles captured on the filter should be determined by holding an appropriate probe (gamma/beta) as close as possible to the canister without actually touching it.

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from radioactive particles collected in the canister may be relevant, warranting regular change of canisters.		
	2.1.4.1. Filter element: 3.0 x 10^{-6} essential (3.0 x 10^{-7} desirable)	These criteria are already covered by the tests for chemical and biological aerosol protection.
2.1.5. Protection against the effects of conventional weapons		
It is essential that damage to the eyepiece(s) of the mask by small fragments of projectiles or other causes does not result in eye injury.	The eyepiece(s) must provide protection against a simulated fragment of 325 mg that hits perpendicularly at a speed of 215 m/s.	The test is performed according to STANAG 4296. Eye pieces in a mask mounted on a dummy head are hit perpendicularly in the centre with a fragment simulating projectile of 325 mg weight at varying impact rates. The rate at which no spalling, shattering chips or fractures are observed must be at least 215 m/s. The effect of wearing vision correction inserts should also be considered, as the impact of a projectile may cause sufficient deformation for the insert to contact the eyes.
2.1.6. Protection against nuclear light flashes and against laser beams		
The mask, excluding the eyepiece(s) must protect against thermal radiation to the same extent as the reminder of the serviceman's clothing.	When a mask wearer is exposed to a heat flash of 60 J/cm² essential or 120 J/cm² desirable (corresponding to a standard fission 30 kT nuclear explosion at a distance of 1.6 or 2.2 km under clear weather conditions), the pain limit according to Stoll-Chianta for the skin in contact with the mask material	The assembled mask and canister shall be exposed in different orientations to fluencies of 60 and 120 J/cm² in 1 s to a heat source with a spectrum similar to that of the fireball originating from a nuclear explosion (6000 K). The heat

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Protection of the eyes against the blinding effects of nuclear explosions as well as of lasers is a desirable characteristic.	must not or hardly be exceeded. This implies that the amount of heat transmitted during periods of 4 and 15 seconds after the heat starts to penetrate the material must not exceed 6 and 9 J/cm² respectively. If the concerned part of the mask is covered by e.g. a hood, then the combination should meet the requirement. Protection of the eyes against heat flash as well as against light flash and laser radiation may be obtained from separate devices. It is essential to provide protection against laser beams of wave lengths in the 1.06 and 0.694 µm range; the attenuation must be at least equivalent to the effect of frequency specific filters in the 3.5 to 4.0 optical density (OD) range. Such devices must be capable of withstanding in very rapid energy and heat build-up associated with laser illumination. Nuclear flash protection requires attenuation by broad band filters of an OD in the 3.5 to 4.0 range.	flow behind the complete mask material is measured throughout the time during which heat is penetrating. For 4 and 15 s periods starting during this time, the amount of heat is calculated and compared with the cited values of 6 and 9 J/cm² respectively; the starting point is scanned over the entire time of penetration.
2.2. USE CHARACTERISTICS		
2.2.1. Use of the mask as such		
2.2.1.1. Wearability and comfort (a) The protective mask carried by the wearer must be readily accessible to him regardless of his posture so that after some training he can	**2.2.1.1. Wearability and comfort** (a) Proper donning of the mask must be simple without possibilities of misusage. Total donning time, including time to take the mask from the carrying bag must be shorter than 9 seconds for trained personnel.	**2.2.1.1. Wearability and comfort** (a) Donning time is tested in a troop trial where properly trained soldiers are ordered to don their masks. Different body postures are taken into account: standing upright, sitting and lying on

<table>
<tr><th>OPERATIONAL CHARACTERISTICS</th><th>TECHNICAL SPECIFICATIONS</th><th>EVALUATION AND TEST CRITERIA</th></tr>
<tr><td>place it in the protective position sufficiently rapidly to provide protection under all operational conditions.</td><td></td><td>the ground. The criterion of 9 seconds must be met by 95% of the subjects.</td></tr>
<tr><td>(b) The protective mask must interfere as little as possible with the wearer's respiratory function.</td><td>(b) i. The breathing resistances as experienced by the mask wearer are bound to the maximum values as stated in the table below. Inhalation resistance comprises the combined contributions of the canister, air guides and inlet valves. Maximum allowed inhalation resistances at continuous air flow are as follows:
<table>
<tr><td colspan="2">Air flow (constant)</td><td colspan="2">Max. press. drop (Pa)</td><td colspan="2">Max. resistance (Pa*s/dm³)</td></tr>
<tr><td>(dm³/s)</td><td>(L/min)</td><td>Initial</td><td>After clogging</td><td>Initial</td><td>After clogging</td></tr>
<tr><td>0.50</td><td>30</td><td>150</td><td>225</td><td>300</td><td>450</td></tr>
<tr><td>0.83</td><td>50</td><td>275</td><td>412</td><td>330</td><td>465</td></tr>
<tr><td>1.33</td><td>80</td><td>500</td><td>750</td><td>375</td><td>562</td></tr>
<tr><td>4.00</td><td>240</td><td>1600</td><td>2400</td><td>400</td><td>600</td></tr>
</table>
At each air flow the exhalation resistance must be less than half the inhalation resistance. The mask must not collapse at the under pressure that occurs at an inhalation flow rate of 350 L/min.
ii. Clogging effects in the aerosol filter must not exceed the values provided in table 2.2.1.1 b above. The test is to be</td><td>(b) Influence on breathing
i. Breathing resistance of the mask. The mask is put on a dummy head provided with an air pipe; a continuous flow, simulating either an inhalation or an exhalation air space velocity is created. The pressure drop over the mask is measured as a function of flow at 30, 80 and 240 L/min. The cited values for pressure drop must not be exceeded. At a simulated constant inhalation air flow of 350 L/min it is observed whether the mask collapses.
ii. Increase of breathing resistance of the aerosol filter due to clogging is measured with dolomite dust as test aerosol (Mass median Stokes diameter is 6.0 µm) according to the method described in European Norm (EN) 143. An equivalent coarse dust may be applied as well. The filter is loaded up to 1.5 g.
iii. The volume-averaged carbon dioxide content of inhaled air is measured with a mask placed on a dummy head according to the method described in EN 136. Volume-averaging is achieved instrumentally; the mean value for the carbon dioxide content must be smaller than 1% by volume.</td></tr>
</table>

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
	performed for example in accordance to the method described in EN 143 with a coarse aerosol (Dolomite dust or equivalent) up to 1.5 g. iii. Exhaled carbon dioxide must be re-inhaled as little as possible. The inhaled volume-averaged carbon dioxide content must be less than 1% by volume.	
(c) Trained personnel, not suffering from head injuries, shall be capable of wearing the mask for a minimum of 24 hours while performing their mission under conditions of moderate work rate and temperate climatic conditions. The mask must present no health hazard to the wearer. Component parts likely to come into contact with the skin must be non-dermatitic. Materials used should be free of odours, which may be undesirable to the wearer.	(c) Under moderately warm climatic conditions (defined as A2, B2, and C1 in AECTP-200 it must be possible for trained personnel to wear the mask for 24 hours while continuing to perform their mission; prolonged high work rates are excluded.	(c) Wearing time of the mask. i. Materials that come into contact with the wearer's skin must not have any short- or long-term adverse effect, either irritating or toxic. No toxic or offensive vapours must be released from any part of the mask. When designing the respirator materials that come into contact with the skin should be checked for dermatitic responses, e .g. using the Modified Draize Test. Personnel having participated in practical tests with the mask will be examined and questioned on this point, and monitored for a period of 48 hours after the test. ii. Users trials with trained personnel are undertaken to determine whether military missions can be satisfactorily performed during 24 hours, while the involved individuals are wearing their masks. The individuals are interviewed on their subjective impressions concerning the effectiveness of the mask.
(d) It must be possible to sleep while being protected by the mask.	(d) It must be possible for a mask-wearer to sleep, while his mask continues to provide protection. In applicable cases	(d) In a user's trial it must be determined whether a masked subject is capable of sleeping for a reasonable period while maintaining

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The mask must permit both left and right-handed personnel to perform their task (e.g. weapon firing) without a decrement in performance. In case the filter element is mounted on the side of the mask then it must be possible to fit the filter to the left- and right-hand side of the face piece using simple tools. (e) The number of sizes required to obtain a positive fit should be as small as possible. (I) The mask must be light and small, consistent with overall performance requirements.	changing the position of the filter canister must be possible; the use of simple tools is allowed.	protection against CB agents. The test subjects will be observed to see whether their masks continue to fit properly during sleep. If applicable the changing procedure of the canister is checked for its' security and simplicity.
2.2.1.2. Vision The protective mask shall interfere as little as possible with vision under all weather conditions and when worn for prolonged periods. It shall accommodate or provide a means for vision correction.	**2.2.1.2. Vision** (a) Optical properties of the eye pieces i. Light transmission must be at least 84%. ii. Haze is required to be smaller than 3% (essential) or 2% (desirable). iii. Optical distortion must be acceptable on the basis of comparison with Figure 1 of the US standard MIL-DTL-43511D.	**2.2.1.2. Vision** (a) Optical properties of the eye pieces i. Light transmission is measured according to the procedure of EN 167 or ASTM D1003-13. Transmission must be assessed to be at least 84%. ii. Haze is measured following the same standards as mentioned sub 1; the criterion is 3% at most (required) and 2% at most (desired). iii. The optical distortion is assessed according to the procedure described in the EN 167. A detailed specification is given in the US standard MIL-DTL-43511D. The criterion is found in a comparison between the obtained pattern of distorted parallel lines and a few specifically presented patterns that are considered to be critical.

<table>
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<tr><td></td><td>iv. Prismatic deviation must not exceed the following values:
vertical: algebraic difference: < 0.25 dioptres
Prismatic: < 0.25 dioptres
Horizontal: algebraic sum: < 0.5 dioptres
Algebraic difference: < 0.25 dioptres

v. Refractive power of curved lenses must not exceed the following values:
spherical ± 0.125 dioptres
cylindrical ± 0.125 dioptres
(absolute values)</td><td>iv. Prismatic deviation is assessed according to the procedure described in the EN 167. A detailed specification is given in the US standard MIL-DTL-43511D. The criteria for the measured deviations are given under the Technical Specifications.

v. Refractive power is assessed according to the procedure described in the EN 167. A detailed specification is given in the US standard MIL-DTL-43511D. The criteria for the measured refractive power are given under the Technical Specifications.</td></tr>
<tr><td></td><td>(b) Field of vision

The protective mask must reduce the natural field of vision as little as possible. Visual observation by the wearer and his general awareness must be ensured to a satisfactory extent. They are expressed in three visual efficiency indices, which are defined as the quotient of the fields of vision with and without mask for three stipulated ranges of directions. For the right eye the indices correspond to the ranges in the table (see also Chapter 5), which also presents the visual efficiency index (for the right eye).

<table><tr><th></th><th>range (°)</th><th>min. required value (%)</th></tr><tr><td>lateral</td><td>70 - 135</td><td>80</td></tr><tr><td>downward</td><td>135 - 180</td><td>50</td></tr><tr><td>binocular</td><td>250 - 315</td><td>20</td></tr></table></td><td>(b) Field of vision

i. The reduction in field of vision by wearing the mask is determined using an instrumental method to determine the limiting influence of the mask expressed in the efficiency indices (see chapter 5). The values for the lateral, downward and binocular visual efficiency indices must have minimum values of 80, 50 and 20 % respectively.

ii. Visual observation and general awareness are also tested functionally in a troop trial including a run on the assault-course.</td></tr>
</table>

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
	(c) Clarity of vision The protective mask must provide good visual clarity, also when worn for a long time at temperatures ranging from -25 °C to 50 °C (desirably -40°C to 50°C).	
	(d) Corrective lenses The mask must allow for use of corrective lenses; these may be either an integral part of the mask or a separate device. The combination must meet the requirements for vision and clarity and CBRN-protection must not be affected.	(d) The suitability of the corrective lenses is tested functionally in a user trial. Where appropriate the influence on face seal leakage is tested (See paragraph 2.1.1(a)).
2.2.1.3. Speech The protective mask shall interfere as little as possible with normal voice transmission and hearing. It shall permit intelligible voice transmission to at least half the distance at which it is possible to communicate without a mask.	**2.2.1.3. Speech attenuation and hearing** (a) Speech attenuation The mask must interfere as little as possible with direct speech and must permit intelligible voice transmission to at least half the distance at which it is possible to communicate without a mask. An attenuation of 6 dB corresponds to a distance factor of 2. The attenuation of the sound for speech intelligibility must not be reduced by more than 6 dB and 18 dB for direct and telephone communications, respectively. Speech intelligibility must not be affected otherwise e.g. by movements of the outlet valve.	**2.2.1.3. Speech attenuation** (a) Attenuation of speech intelligibility is measured according to a method based on the one-third octave band approach according to NIOSH TEB-CBRN-APR-STP-0313. In these tests attenuations of 6 and 18 dB for direct and telephone communications respectively are permissible. Speech intelligibility may be checked by the method described in NIOSH TEB-CBRN-APR-STP-0313 known as the "modified rhyme test" (adapted for non-English-speaking nations).
	(b) Hearing If hearing may be supposed to be impaired by a significant extent by the respirator system (e.g. in case a hood is part of the system) an assessment of the degradation is required. Since an instrumental test is not available, a test procedure involving a panel of test persons is to be preferred	(b) Hearing The procedure, known as the Modified Rhyme Test, described in NIOSH TEB-CBRN-APR-STP-0313, is directly applicable for English speaking nations. After adaptation of the test according to specific language characteristics it may be useful for other nations. Criteria are to be defined on a national level.

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2.2.1.4. Intake of water and liquid food The protective mask must allow the wearer to drink and have liquid food while continuing to provide protection.	**2.2.1.4. Intake of water and liquid food** A provision must allow the wearer to take water and liquid nourishment without breaching the CBRN protection and without a risk of contaminating the liquid. Intake of water must be possible at a rate of at least 0.2 L/min and the preparation of the device must take no more than two minutes. The method of intake of liquid food must not cause nausea and be possible at a satisfactory rate. Mask leakage must not exceed 0.01% during preparation and operation of the device.	**2.2.1.4. Intake of water and liquid food** The device is checked for its safety against CW-agents apart from the material's test of paragraph 2.1.1.1 (c). In a laboratory test the attainable drinking rate is measured using test persons. It must be possible to consume at least 100 cm^3 of water in half a minute. In a user trial it is checked whether water and liquid nourishment can be consumed without problems.
2.2.1.5. Care and maintenance The protective mask must only require simple maintenance and must be cleanable with normally available means.	**2.2.1.5. Care and maintenance** The protective mask must be easily cleaned using field available means without damage or deterioration of the mask materials. The construction of the mask must be such that maintenance and replacement of essential parts can be carried out at low level and with simple tools.	**2.2.1.5. Care and maintenance** The requirements for simple maintenance and care are tested in a user trial. The integrity of the protective mask is checked after a number of cleanings.
2.2.1.6. Indication for gas filter exhaustion It is desirable that a means be provided that indicates that the filter element must be replaced.	**2.2.1.6. Indication for gas filter exhaustion** The means for indication of the imminent exhaustion of the gas filter must give an unequivocal warning signal to the wearer. This signal must be sufficiently in time for him to change his canister.	**2.2.1.6. Indication for gas filter exhaustion** A suitable method would depend on the nature of the device; to be defined as soon as a device is available.
2.2.1.7. Resuscitator In certain cases, artificial respiration after intoxication by CW agents may be lifesaving. A resuscitation device for buddy help in the field is therefore a desirable piece of equipment. If the resuscitator is used in connection with the mask and/or requires special provisions in the mask then those provisions should not degrade the	**2.2.1.7. Resuscitator** The leakage of the mask due to application of the resuscitator must not exceed the values stated sub 2.1.1.	**2.2.1.7. Resuscitator** The use of the resuscitator is introduced as part of the exercise protocol for face seal leakage. (See 2.1.1.1 (a)).

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performance of the mask. The preparation of the resuscitation device must be rapid and easy and its use must not increase the wearer's mask inward leakage.		
2.2.2. Compatibility		
Compatibility with other equipment is only required in relation to those items already in service or/due to enter service before the mask. Once the mask has been introduced the onus of achieving compatibility will rest with any future equipment.	The mask must be compatible with all items of combat clothing, and with as many items of equipment, weapons and instruments as possible.	
2.2.2.1. Compatibility with optical devices The protective mask should not impede the satisfactory use of optical devices, such as binoculars, night vision instruments and aiming devices. Compatibility may also be achieved by adaptations of the optical devices.	**2.2.2.1. Optical devices** The protective mask should not hamper the use of any type of optical instrument employed or about to enter service; if this is not possible an adaptor between the optical instrument and the protective mask is allowed.	**2.2.2.1. Optical devices** Compatibility with optical means is evaluated for each separate instrument in a user trial.
2.2.2.2. Compatibility with Communications equipment The protective mask should not impede the satisfactory use of receiving and transmitting communication devices without recourse to special devices which are not integral part of the mask or the communication equipment itself.	**2.2.2.2. Communications equipment** The protective mask should allow the use of all communications equipment by all operators (either right or left-handed) without recourse to special devices.	**2.2.2.2. Communications equipment** Compatibility with telephone and microphones is evaluated in a user trial.
2.2.2.3. Compatibility with other personal equipment	**2.2.2.3. Other (personal) gear**	**2.2.2.3. Other (personal) gear** Compatibility with other personal gear is evaluated in a user trial. Attention is specifically paid

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
The protective mask, carrier and accessories shall be designed so as to cause a minimum of compatibility problems with environmental and CBRN clothing, protective head gear, load bearing equipment, aural protectors, communication headgear.	(a) The protective mask and carrier must be capable of being used and worn in conjunction with other personal gear without seriously affecting combat efficiency. (b) When not in the use position, the mask must be kept in a container or haversack, enabling it to be carried in convenient positions without hampering the soldier in his movements and allowing it to be donned within the required time (see 2.2.1.1. (a)).	to the aspects mentioned under (a) and (b) of the Technical Specifications.
2.2.2.4. Compatibility with compass Materials used in the manufacture of the mask and its components must be non-magnetic.	**2.2.2.4. Compatibility with Compass** The materials used in manufacturing of the protective system must be non-magnetic.	**2.2.2.4. Compatibility with Compass** The mask is checked for its magnetic properties in a practical test. The presence of a mask must be checked not to influence the reading of a compass regardless the orientation of the compass.
2.2.2.5. Compatibility with weaponry The mask should not impede the satisfactory use of all individual and crew severed weapons.	**2.2.2.5. Compatibility with weaponry** When weapons are fired by individuals that are wearing their masks the score of hits must not be significantly lower than in case no masks are worn; firing time must not increase by more than 25%.	**2.2.2.5. Compatibility with Weaponry** In a field test it is measured whether the score of hits is affected by wearing the mask; the required firing time is measured also and must not increase by more than 25%.
2.2.3. Filter element replacement		
It must be possible for the individual to replace detachable filter elements in a correct and safe way without special tools when he is wearing CB or environmental gloves.	The construction and positioning of filter elements must allow an easy and secure replacement by the wearer himself, whether or not wearing CBRN-gloves. The replacement must not take more than 45 seconds. If the connection is by screw thread this must conform to AEP-4155.	In a user trial it is checked whether trained personnel, wearing the mask and CBRN gloves is able to safely change the filter element(s) within 45 seconds. It is checked whether the screw thread (when applied) conforms to AEP-4155.

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
2.3. SURVIVABILITY		
2.3.1. Resistance to CB agents, field contaminants and decontaminants		
Proper functioning of the protective mask must be ensured and no deterioration of materials (in particular no loss of optical properties of eye-piece(s)) may occur after prolonged contact with CB agents, with other contaminants likely to be encountered and after contact with the decon-taminants in use or about to enter service. It must be possible to decontaminate the mask sufficiently using existing decontaminants and procedures.	The respirator must be resistant against CB agents, normal field contaminants (POL and solvents), and decontaminants for skin and personal equipment. Materials must not deterio-rate chemically and the proper functioning of the respirator (notably vision and operation of the valves) must not be af-fected.	The influence of liquid CB agents on the eye piece(s) is assessed by applying 1 µl droplets of liquid agents and evaluating the optical proper-ties. The agents are mustard, VX and GD. The resistance against POL, solvents, and de-contaminants is measured simulating a worst-case situation; a high degree of contamination and a delayed decontamination are taken into account. The Method described in AEP-38 Vol-ume I F105 (pre-treatments) is used for the con-tamination. In all cases the properties of the ma-terials must remain acceptable. After application of (de)contaminants to accessi-ble parts of the entire respirator, it must continue to function properly, notably the outlet valve.
2.3.2. Resistance to thermal radiation		
At distances from a nuclear explosion where in-capacitation of personnel due to radiation and blast are minimal, any damage to the mask caused by thermal radiation must be such that protection against one attack with Band C agents is still provided. Such protection should	**2.3.2.1. Thermal radiation from flames** Under the conditions of BS 5438 or EN 136 the protective mask must be fire resistant, not melt and not release toxic vapours that might be inhaled or act on eyes or skin. Burning time must not exceed 3 seconds; no afterglow is allowed to occur.	**2.3.2.1. Thermal radiation from flames** The flame resistance of the applied materials is tested according to BS 5438 or EN 136. Criteria: burning time 3 seconds at most and afterglow 0 seconds. No holes may form.

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
also be provided if the mask is exposed to flames and fires under conditions where a human would survive.	It is remarked that the resistance to flames of the mask need not be higher than that of the protective clothing to be worn in conjunction with the mask.	Alternatively, the flammability of the entire mask is checked according to the flammability test described in EN 136. Criterion: the face piece must not continue to burn after removal from the flames.
	2.3.2.2. Thermal radiation from nuclear explosions The exposed parts of the protective mask must not burst into flame, bum or melt when subjected to a heat flash of 60 J/cm^2 (essential) or 120 J/cm^2 (desirable) corresponding to a nuclear standard fission explosion of 30 kT in the air at a distance of 1.6 km or 2.2 km in clear weather conditions.	**2.3.2.2. Thermal radiation from nuclear explosions** The aspect of resistance against thermal radiation originating from a nuclear explosion is evaluated in the test described under 2.1.6. After the test the mask must still function properly. After checking speech transmitter, outlet valves and canister for leakage the mask is inspected visually and, if necessary, checked more thoroughly.
2.3.3. Resistance to blast		
The mask must continue to provide protection to personnel under adverse conditions normally encountered as part of the operational environment such as nuclear blast effects up to prescribed levels, blast of friendly artillery, high velocity airstream from rotor downwash or ground running aircraft.	The mask must be capable to withstand the blast effects which are experienced when the wearer fires weapons. It must also resist the blast effect experienced from the nuclear explosion mentioned in paragraph 2.1.6, i.e. a dynamic pressure of 0.2 kg/cm^2 (= 20 kPa), must not affect the functioning of the mask.	Blast tests simulating the shock waves that are experienced both by a mask wearer when firing weapons in use and by those that are in proximity of the fired weapon, are performed with the respirator, donned on a dummy head. Different orientations of the respirator with respect to the shock wave are applied. Tests are also performed with masks in their carrier bags. Actual values for the positive pressure and its duration depend on the type of weapon and must therefore be decided at national level. A dynamic pressure of 20 kPa exerted on the mask in any orientation, must not affect the

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		functioning of the mask. The proper operation of valves, the tightness of the eye-glasses and voice transmitter are to be checked notably.
2.3.4. Ruggedness		
The protective mask, carrier and accessories, must be capable of withstanding normal wear and tear caused by combat operations, including amphibious.	**2.3.4.1. General** The mask and its carrier must be robust enough not to be damaged during military activities in time of peace and war. Construction and materials must reduce the risk that the mask is disabled by normal wear and tear to a minimum. The mask and its carrier shall be sufficiently rugged to withstand all forms of transportation.	**2.3.4.1. General** A troop trial which includes all relevant military situations must prove whether the entire mask is sufficiently rugged.
	2.3.4.2. Ruggedness of eye lenses The optical properties of the eye lenses must not deteriorate during normal use of the protective mask. The eye lens must be shatter and scratch resistant. Notably they must not be scratched by materials with which they are liable to be brought into contact. The eye lens must not show spalling, shatter, fractures or chips at a low velocity (5 m/s) perpendicular impact of a 22 mm diameter steel ball.	**2.3.4.2. Ruggedness of eye lenses** A steel ball of 22 mm diameter is dropped from a height of 130 cm above the centre of the eye lens according to the method indicated in EN 168. The eye lens must not show spalling, shatter, fractures or chips. The scratch resistance of the eye lenses is tested according to the tumbling abrasion test with sand as per EN 168. The haze must not increase by more than 3%.
	2.3.4.3. Specific mechanical properties Separate parts of the mask must stand up to the mechanical strength tests defined in EN 136. The involved parts are: head harness and separate straps, the connection between the face blank and the filter canister, the connection between the exhalation valve housing and face blank.	**2.3.4.3. Specific mechanical properties** Parts of the mask are tested to check their robustness e.g.: Head harness and separate straps, connection between face blank and the connection for the filter canister, connection between exhalation valve housing and face blank are tested according to suitable methods e.g.,

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		those described in EN 136 (paragraphs 4.3.2, 4.11.3, 4.11.4, 4.12.3, and 4.14.3).
	2.3.4.4. Ruggedness of the filter element (a) Influence of rough handling The filter element must retain its protection properties after simulated rough usage according to the method described in EN 14387. (b) The release of carbon dust after rough handling according to EN 14387 must be below given levels, acceptable from a point of view of toxicity. A dust collecting filter sheet is recommended on the effluent side of the gas filter element to avoid pestering or detrimental abrasion entering the respiratory organs and eyes of the user.	**2.3.4.4. Ruggedness of the filter element** (a) Mechanical strength test (simulated rough handling) Each filter shall be subjected to 2,000 revolutions at 100 RPM on the test apparatus described in EN 14387. Subsequently the filter elements must not be damaged nor display any rattling sounds when being shaken - which might point to a loose or displaced carbon bed - nor shall there be any discharge of loose materials. (b) Carbon release test After being subjected to the simulated rough handling test (a) a steady state air flow rate of 50 L/min (3 m^3/h) shall be drawn through the filter under test and the released carbon dust be measured by appropriate means for 15 minutes. The inhalable dust concentration may not exceed 4 mg/m^3. A dust monitor – or optical particle counter running in mass concentration modus for inhalable dust fractions – is recommended but gravimetric determination may also be feasible. In the latter case the total emission of dust collected on a filter medium in 15 minutes must be less than 3 mg.
	(c) Water repellency	(c) Water repellency Either the filter canister or the aerosol filtering material that has been applied is submitted to

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
	The filter canister must not be penetrated by liquid water if it is exposed from the air entry side to water of a pressure up to 3.0 kPa.	the procedure described with ISO 811. At pressures up to 3.0 kPa, no liquid water must be visually observed to penetrate.
2.3.5. Carrier		
The mask is to be provided with a carrying pouch / haversack or the like with facilities to carry the mask's accessories (individual detection and decontamination equipment and self-aid drugs), which protects the mask and its accessories from all hazards likely to be encountered in operational situations (excluding high velocity projectiles). Provision will be made to permit the mask in its carrier to be immersed in water without damaging its protective properties. Separate means of protecting the filter element are acceptable provided they do not hinder the rapid use of the mask.	After the carrier with its contents has been immersed in water for 10 minutes, the mask must still function properly. The carrier must protect the respirator against liquid CB-agents and normal liquid field contaminants. To this end it must not be penetrable for liquids and agents in liquid form. Protection of the filter element against penetration of water may be obtained from a special device. Such protection may be obtained by the use of a water-tight container for the mask or other appropriate means which do not hinder the rapid use of the mask.	The carrier with mask is immersed in water at a depth of 0.5 m during 10 minutes; its orientation is varied in this time. The mask, including the filter element, must function properly after this treatment.
2.4. STORAGE LIFE AND SERVICE		
The mask has to maintain its protective properties against CBRN threats throughout its required storage and service life. It is recommended that the protection against CBRN agents is investigated at different stages of the respirator life cycle.	The minimum protection level provided by the respirator should not be affected by the storage and service life. Ageing of the materials used for different components may influence the protection provided by the respirator and filter canisters. In addition to material component testing, it is recommended that the whole system approach is applied by testing the Protection Factor of the respirator (see section 2.1. for details) at different stages of its life cycle to ensure the eventual changes does not reduce its performance.	The vast majority of respirators are designed to require fit testing, and all respirator styles benefit from an assessment of whether they deliver adequate performance in use. This assessment can be quantitative or qualitative, and different T&E procedures are described in AEP-71. The effectiveness of the respirator/human interface is to be assessed at various stages in the respirator life cycle, such as development, selection,

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
	Table 1 below outlines the significant phases in the development, selection, and use of a respirator, and how they relate to the requirement to assess protection of the respirator.	user issue, and prior to field use. The various types of FF and PF measurements as given in the definitions have different application throughout the life cycle. The minimum value of PF as given in section 2.1. should be achievable throughout the required storage and service life periods.

	Life cycle phase						
				service			
Test type as per AEP-71	**Selection/ qualification**	**Maintenance**	**Storage**	**Individual issue and recertification**	**Training**	**Prior to deployment**	**Field use**
Seal check	x			x	x	x	x
Qualitative fit test (QLFT)				x	x		x
Headform inward leakage test (HIL)	x	x	x				
Quantitative fit test (QNFT)	x	x	x	x	x	x	x
Simulated workplace protection factor (SWPF)	x	x					

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
2.4.1. Storage life		
The shelf life of the packaged mask shall not be less than 10 years if stored under relatively controlled conditions (shielded from direct sunlight and rain, temperatures between -10 to +40 °C, all relative humidities) and in its original packing and provided with the prescribed means of preservation. The shelf life of packaged filter canisters may vary significantly as a function of the employed adsorption material and residual moisture content within the canister. However, the shelf life of packaged canisters shall not be less than 5 years under relatively controlled conditions as described above for masks. If moved to an uncontrolled environment* the packaged material must still provide the required level of protection after periods up to 4 months in those uncontrolled conditions. It is accepted that protection against excess humidity and fungal growth during storage may be achieved by suitable packaging materials. * induced air temperatures may be between the extremes of -46 and +71 °C (MIL-STD-810G)	The packaged mask must remain serviceable and the protective capacity of the packaged filter must not degrade below the requirements for a minimum of ten years (mask) respectively 5 years (canister) of storage under stated conditions. Preferably materials should have well-known ageing properties. They must not be bio-degradable. Long term oxidative degradation properties of the mask materials are determined in accelerated ageing tests simulating 10 years of storage at different temperatures. After these tests, the materials must not have lost their mechanical properties to a degree that casts doubt on the utility of the packaged mask when checked functionally. When properly packaged, the effects of ozone and UV radiation may be excluded from this test. (Referred is to paragraph 2.4.2). The effects of long-term storage in the cold on harness should be examined on rubber materials. It is allowed that a priori specified parts of the mask are replaced within the period of the stated storage life. These parts must be clearly marked with their date of manufacture.	Accelerated ageing tests are performed on all mask materials prone to show degradation in relevant properties. The ageing must simulate a 10 years period of storage under the severest conditions to be expected. Ageing or other procedures may be based on ASTM D573, ASTM D865 or other standards. To take into account long term oxidative degradation, the procedure described in ISO 188 may be followed. A period of 10 years must be simulated. In the absence of reliable accelerated ageing tests for filter canisters a low/high temperature test in accordance with MIL-STD-810G, method 502.5 (low T) and 501.5 (high T) is recommended to simulate extreme storage and transit conditions and to check the integrity of the packaging material. The extreme temperatures for induced storage and transit conditions are – 46 °C and + 71 °C as per MIL-STD-810G. Humidity control is not necessary as the canisters under test shall be stored within a protective packaging (e.g. laminated foil). A 5 hrs storage in the cold and a 7 days storage in the heat is recommended. In between the two extreme conditions filters should be taken out of the chamber and return to standard ambient conditions (20 ± 5) °C.

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
		All protective and mechanical properties as described in this document must continue to meet the stated requirements.
2.4.2. Service life		
The normal service life of the mask, excluding the filter element, shall not be less than seven years, provided that the mask has not suffered unusually rough usage or abuse. If replacement of components is necessary to achieve this service life, it is required that: - the number and frequency of replacements of those components should be as small as possible. - the components which are identified as having an in-service life of less than seven years should be clearly marked during manufacture with year of manufacture. - the replacement of those components should be capable of being carried out using simple tools. All the measures should be accompanied by leakage test followed by a full respirator FF testing in accordance to AEP-71 and the measured PF should remain unchanged. The service life of the canister depends on the operational conditions the filter is intended to be	Leaving a side unusually rough usage, the service life of the protective mask (filter elements excluded) must be 7 years minimal, provided it is appropriately maintained. Preferably materials used should have well known ageing and weatherability properties in the context of their usage in the open air. Relevant weathering trials should be performed simulating the most extreme climatic conditions which may be encountered. After these trials the mask should be examined visually, its performance checked and the mechanical properties (tensile strength, elongation, modulus, hardness) compared with those of the original material. The degradation of these properties should not be such as to affect the utility on these climates. To take into account long term oxidative degradation, accelerated ageing tests simulating a 7 years period should be performed. After these tests the mechanical properties should be adequate as to ensure a good performance of the mask. Alternatively, for rubber materials, stress relaxation tests (continuous or intermittent) may be used to predict long term mechanical behaviour. Ultraviolet radiation resistance of possibly exposed materials must be high enough not to endanger the proper functioning of the mask.	Storage conditions must be followed to check the service life of the mask, on the understanding that the ageing conditions are different in a few aspects: 1. Rubber materials must be checked on ozone cracking resistance on the basis of ISO 1431 using 50 ppm ozone, 40 °C and 20% stress, for 24 h. 2. Ultraviolet radiation resistance may be tested according to EN ISO 4892-2. 3. In weathering trials, the most extreme conditions that are simulated to be encountered are: cold dry, hot wet and hot dry. The exact choice of conditions is dependent on the specific site where the mask is to be used. Filter elements should be tested in a suitable climatic chamber in accordance with MIL-STD-810G, method 507.5. The recommended cycle for most demanding conditions is B2; but other cycles may be tested additionally. The chosen 24 hrs climatic cycle should be programmed in an infinite loop and the filter under test shall be stored in the chamber unsealed and open to the test atmosphere. An air flow must not be applied

OPERATIONAL CHARACTERISTICS	TECHNICAL SPECIFICATIONS	EVALUATION AND TEST CRITERIA
used in. Most demanding conditions in terms of the filtration performance are warm and humid climates as described in MIL-STD-810G. Under those climates the material properties, especially the gas filter performance, will suffer significantly by the ageing effect.	Rubber materials should be checked on ozone cracking resistance. The protective and mechanical properties must continue to respond to the requirements. The performance of the canisters after simulated ageing must not decrease below the required values.	through the filter elements. Note: for chamber control purpose, 100 % RH implies as close to 100 % RH as possible, but not less than 95 % RH. The filter performance must still meet the requirements*, after simulated use of the canister during the maximum period of the designated service life prior to a possible chemical attack. This period may differ between filter types. This test may also be applied to obtain service life information if no requirements were defined for the service life under different weather conditions. * The adsorption of normally occurring atmospheric pollutants (e.g. POL) must be taken into account. Since no test can be formulated for such additional challenges, the method of choice can be the usage of a safety factor. This means that the required breakthrough time shall be multiplied by this safety factor (recommended factor = 1.3) in order to consider pollutant.

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CHAPTER 3 SELF-CONTAINED BREATHING APPARATUS (SCBA)

3.1. INTRODUCTION

A self-contained breathing apparatus (SCBA) is a device to provide breathable air, independently of the surrounding atmosphere. It may fall into one of two categories: open-circuit or closed-circuit SCBA.

(1) An open circuit SCBA provides a portable supply of compressed breathing air and is independent of the ambient atmosphere. The exhaled air passes without recirculation to the ambient atmosphere.

(2) A closed-circuit SCBA (rebreather device) removes carbon dioxide from the exhaled air and adds oxygen or oxygen/nitrogen to the inhaled air for breathing by the wearer and is independent of the ambient atmosphere. The use of closed-circuit systems is primarily restricted to homeland defence missions where longer wear times are necessary. For these missions there is no need to define measures of interoperability.

This chapter will describe only the type of open circuit SCBA (1), and operational characteristics, appropriate international qualification standards for the protection of the respiratory tract, the eyes and the upper part of the head (not covered by the protective clothing) by SCBA against the effects of CBRN substances and TIM releases, where they are additional or deviate from those in chapter 2. The needs for firefighting missions are not covered.

A SCBA generally consists of:

(1) Pressure vessel

(2) Body harness

(3) Air supply hoses

(4) Connectors and couplings

(5) Demand valve

(6) Pressure reducers

(7) Face mask

(8) Warning devices

The requirements for CBRN SCBA are defined in BS 8468-1 and NIOSH Statement of Standard (www.cdc.gov/niosh).

SCBA are used with or without positive pressure to the mask. Positive pressure systems usually provide the highest level of protection.

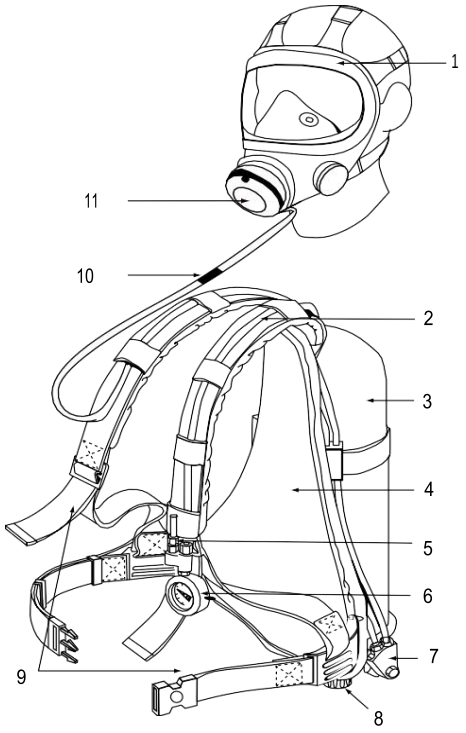

FIGURE 1: open-circuit self-contained breathing apparatus with full face mask

1- full face mask, 2- manometer connection, 3- compressed gas cylinder, 4- supporting carriage, 5- warning device, 6- pressure gauge, 7- pressure reducer, 8- cylinder valve, 9- carrying strap, 10- air supply hose, 11- regulator / demand valve

Currently fielded protective equipment for protection against chemical, biological and radiological agents is specifically designed for these purposes. Self-Contained Breathing Apparatus (SCBA), i.e., the breathing supply is carried by the wearer, is required if the environmental conditions exceed the defined CBRN scenarios in which air-purifying respirators are designed to function (reference EN 132).
These conditions could be the exposure to combustion products (e.g. firefighting scenarios), immediately dangerous to life and health (IDLH) atmospheres, or oxygen deficient atmospheres most probable for indoor scenarios (e.g. on ships). Situations such as rescue missions and other special use applications in CBRN release scenarios also necessitate the use of SCBA if sufficient detection and identification of a potential hazardous release is not possible.
SCBA could be used with different kind of clothing, e.g. with fire fighter suits, permeable CBRN protective suits and impermeable suits. For the impermeable suits there are different kinds and different ways of SCBA use possible. The SCBA could be worn

completely inside the suit or it could be mounted outside. The kinds of suits and how to combine them with SCBA will have major impact on the overall protection.
As the criteria for CBRN clothing are addressed in STANAG 4548 (AEP 38), this chapter concerning breathing protection will mention that there are impacts to protection caused by the combination of SCBA with clothing, but not describe them in detail.

This chapter does not apply to escape SCBAs including hybrid systems equipped with an air-purifying respirator. Escape SCBAs are designed for egress from IDLH atmospheres and are intended for short term use (e.g. less than 30 min). Hybrid systems consist of respiratory protection devices that can be operated in either air-purifying or SCBA mode and are designed for short- or long-term use under IDLH conditions. The air-purifying component can consist of either a powered or non-powered filtering respirator. Long term use hybrid systems should meet their respective standards for each mode of operation and during change-over.

3.2. QUALIFICATION OF SCBA

This chapter applies only to respiratory protection in a CBRN environment and may include scenarios where oxygen deficiency exists. SCBAs may be worn with permeable or gas-tight impermeable suits.

3.2.1. Protection Factors (PF) Qualification Test Methodologies – System Test

SCBAs must reach the PF values provided in paragraph 1 chapter 2 of this document when tested against CBRN agents in terms of face seal and outlet valve leakage.
The methods used for qualification must follow national or international standards, e.g.,

(1) the corn oil test per NIOSH document RCT-CBRN-STP-0001 or

(2) the salt test per EN 137

(3) the respiratory SWPF tests as described in CAN/CSA/Z1610-11(R16) C.5.

These test methods have to be adapted to the specific features of the SCBA (systems operating at overpressure, interfaces for testing hoses, removal of spurious particulate from the supplied breathable gas, etc). Particularly, the face piece of SCBAs must have, or be modified to provide, connectors that give the ability to sample within the facepiece such that protection factor can be measured.

3.2.2. Ergonomic Aspects

Due consideration should be taken to human-engineering of the equipment since ergonomic aspects will directly affect the operational readiness and effectiveness of the user. In terms of total weight, volume, operability and handling, comfort, noise emission etc. the user's burden should be reduced as much as possible. However, as the operational requirements for the numerous user groups defined in chapter 1 of the AEP-73 may vary significantly, the right balance between ergonomic and operational demands has to be derived from the ATP-65 on a case by case basis.

3.2.3. Resistance to CBRN Agents

The face piece, air cylinder and all connecting peripherals of the SCBA should be tested against CBRN agents according to international standards, e.g.

(1) BS 8468-1

(2) NIOSH test methods for SCBA, RCT-CBRN-STP-0002

(3) FINABEL O.7.C.

(4) STANREC 4548/AEP-38

(5) STANAG 4521/AEP-7

(6) CAN/CGSB/CSA Z1610.

3.2.4. Interoperability of SCBAs

SCBA is produced mainly for industrial applications and European and North American SCBAs are currently being manufactured following different specifications, in terms of the time of use, volume, pressure of air cylinders, the designation and the connectors at the pressure reducer valve, etc. Therefore, interoperability of components between different CBRN qualified SCBA-systems (as normally desired in NATO-documents) is not possible, nor advisable due to safety concerns.

3.2.5. Survivability

Survivability requirements mentioned in paragraph 3 of chapter 2, e.g. thermal radiation, ruggedness, resistance to blast etc., also apply to SCBAs as required by the mission and may be achieved in conjunction with additional protective clothing and equipment.

The general durability of all system components, i.e. gas cylinder, pressure reducer, cylinder valve, regulator, connectors, hoses etc. after ageing and in realistic use should be assessed, as they can split and crack; regular inspection and maintenance is critical.

3.2.6. Safe Doffing

When SCBA is worn, due consideration must be given to safe doffing of the potentially contaminated equipment, minimizing the potential for transfer of contamination. This is of particular importance if the SCBA is worn outside the clothing. The time needed to decontaminate the personal protective equipment and SCBA before safely removing the face piece will limit the time of use and needs to be considered. Some nations may adopt a second respirator (usually a negative pressure respirator) with a carbon-based canister for interim use after the face piece of the SCBA is removed. The SCBA should be designed to facilitate decontamination and replacement of components.

3.2.7. Reusability

The SCBA should be designed for repeated usage. Hence, it should either facilitate decontamination and replacement of components (see AEP-07: Chemical, Biological, Radiological and Nuclear (CBRN) Contamination Survivability Factors in the Design, Testing and Acceptance of Military Equipment) or be positioned underneath the protective clothing.

3.2.8. Duration of Use

SCBA provides the user with a limited time of fresh breathing air which usually varies from 15 min (escape apparatus) up to 90 min, independent of the surrounding atmosphere. It is important to note that under moderate to high working levels, the effective duration of use can be significantly lower than the rated service time of the SCBA.
However, the pressurized gas cylinder(s) shall be dimensioned for one mission duration according to the specific operational requirements. If the capacity of breathing air in the gas cylinder(s) does not suffice for one mission duration, spare gas cylinders should be immediately accessible; and be quickly and easily exchangeable by the SCBA user during the mission.
Tactics, Techniques and Procedures (TTP) have to take into account the loss in protection that might occur when the gas cylinders are exchanged.
A warning device indicating low pressure in the gas cylinder(s) shall be included. An optoacoustic alarm for low gas pressure is recommended. The alarm should be easy to switch off by the user.
The other components of the SCBA system e.g. face piece, hoses etc. must as a minimum provide protection for the same mission duration.

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CHAPTER 4 POWERED AIR PURIFYING RESPIRATORS (PAPR)

4.1. INTRODUCTION

Powered Air-Purifying Respirators (PAPR) are a type of Positive Pressure Air Purifying Device (PAPD). They typically consist of

(1) a power assisted blower unit mounted via a breathing hose of a sufficient length (or sometimes directly) to the face piece

(2) one or several filters for the filtration of the ambient air

(3) an accumulator or battery pack

(4) a respirator mask (figure 1), or hood, with one or more exhalation valves or other outlet ports

(5) a carrying strap or other device to attach the blower unit on the person

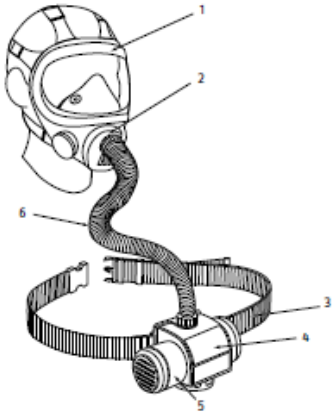

FIGURE 1 Powered air-purifying respirator with full face mask

1- full face mask, 2- hose-connecting point, 3- carrying strap, 4- blower, 5- filter with protection cover, 6- breathing hose

Power assisted filtering devices may be worn in conjunction with protective suits as well (figure 2) – with or without full face mask. Although these suits are outside the scope of this paper, they must be considered as part of the equipment capability.

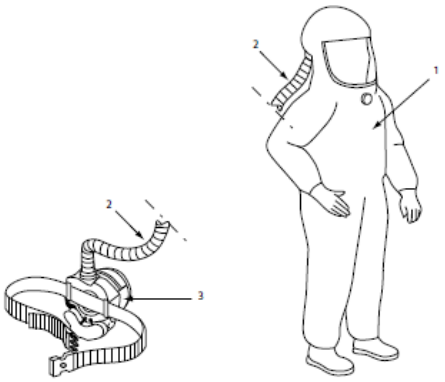

FIGURE 2 Powered air-purifying respirator with protective suit

1- protective suit, 2- breathing hose, 3- blower and filter

PAPR may be used under all conditions where negative pressure air-purifying devices (non-ventilated respirator masks) can be used. In terms of design changes from a comparable negative pressure APR, in addition to the blower unit, they will use one or more filters qualified for the higher flow rates, and should have a pressure compensating outlet valve in order to maintain positive pressure within the facepiece.

Under the best possible design and professional execution, they may significantly reduce the breathing resistance and contribute to the stress reduction of the user. It should be noted that the exhalation resistance can be even higher if no breath-responsive system is used. Depending on ambient conditions wearer physiological burden may be reduced with a resulting increase in operational effectiveness although the bulk of the system must be taken into account.

Depending on design, they may also reduce inward leakage significantly over other devices; however, such should not be assumed without specific qualification of the PAPR under realistic conditions of use.

Power assisted filtering devices are often used by specialized user groups. The scope and level of protection is usually defined by the operational requirements for the specific user groups (chapter 1: Strategic Concept and Operational Environment; User Groups and Tasks).

Note also that such user groups may have interest in using relevant combined devices, i.e. devices that combine both supplied air and powered air purification, since such devices potentially provide greater flexibility and duration of use. Nevertheless, there are no standards or guidance documents that currently address various issues associated with the performance requirements of such devices or their concept of use. Unresolved issues include: (i) safe switching between modes (including how to evaluate, and how to decide when it is appropriate to switch) and (ii) the requirements to be placed upon each part of the device considering that the entirety of the device will be exposed over the course of its wear even if parts are not necessarily used. Currently many such devices are only certified against civilian standards individually (as either PAPR or SCBA).

As a basis for testing and evaluating of PAPR systems the following standards may be applied:

(1) European Standard EN 12941: “Respiratory Protective Devices – Powered Filtering Devices Incorporating a Helmet or a Hood – Requirements, Testing, Marking”
(2) European Standard EN 12942: “Respiratory Protective Devices – Power Assisted Filtering Devices Incorporating Full Face Masks, Half Masks or Quarter Masks – Requirements, Testing, Marking”
(3) US standard NIOSH 2006 “Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Powered Air-Purifying Respirators (PAPR)”
(4) BS 8468-4: “Respiratory Equipment for use against CBRN Agents. Powered Air-Purifying Respirators. Specification”.

However, as commercial of-the-shelf products normally do not address specific military requirements, the following paragraphs shall provide guidance for the acquisition community, those involved in setting requirements for personal protection and for test and evaluation laboratories.

4.2. QUALIFICATION OF PAPR

This chapter applies only to respiratory protection in a CBRN environment. It does not include scenarios where oxygen deficiency exists, in which case a PAPR cannot be chosen.
Self-contained breathing apparatus (SCBA; see chapter 3) may be required instead if the environmental conditions exceed the defined CBRN scenarios (generally as a result of limited filter capacity or oxygen deficient environments, as a PAPR system is usually capable of providing comparable inward leakage protection to that of an SCBA). See the previous sections for caveats regarding the qualification and use of combined PAPR/SCBA devices.
The combination of air permeable or air impermeable protective suits and PAPR requires a system approach (AEP-38 Annex F chapter F.2) and might need a certification through national authorities depending on national regulations, e.g. as in the

(1) European Council Directive for PPE (89/686/EEC)

(2) ASTM F2588-07

(3) CAN/CGSB/CSA Z1610-11(R2016).

Requirements and testing of properties not directly related to CBRN protection like breathing resistance, noise level, carbon dioxide content of the inhalation air, resistance to flame etc. – are specified in national or international standards, e.g.

(1) NF S76-020-1

(2) NF ISO 16900

(3) CSA Z1610

(4) US CFR Part 84.

4.2.1. Power Supply Management

The power source of the blower system has to ensure functionality throughout one mission duration according to the specific operational requirements. The manufacturer will certify a minimum battery time.
In the case of a power failure, a spare battery or accumulator pack should be immediately accessible. Batteries as well as accumulators should be fast and easily exchangeable by the PAPR user during the mission (i.e. with full IPE worn) and should be air-transportable. Tactics, Techniques and Procedures (TTP) have to take into account the loss in protection that might occur when the blower is not operating and the performance of the system when the blower is not powered should be ascertained.
If the power supply is provided by accumulators, a charging device shall be part of the power supply equipment. Accumulator charging should be possible either when connected to low voltage supply (e.g. in vehicles) or when connected to the mains voltage of any infrastructure (e.g. in barracks, garage).
A regular inspection of the accumulator status is strongly recommended.
A facility to check the remaining run-time shall be included (EN 12942). An optoacoustic alarm for low battery status is recommended. The battery life indicator shall be visible to the user. The alarm should be easy to switch off by the user.

4.2.2. Blower Unit

The blower unit normally supplies the face piece with continuous excess air and should maintain overpressure in the mask when an appropriate pressure compensation outlet valve is used. An exception regarding continuous air supply exists in blower units which only provide an air flow on demand, i.e. when the user is breathing in; thus, reducing energy consumption.
It should be noted that the ventilator of the blower unit can generate particles itself by abrasion when running, thus falsifying the test results obtained by aerosol applying test methods (and such particles should also not pose a hazard for the users' health). One option to overcome this issue is to incorporate an additional particle filter with low pressure drop in the hose line between the blower and the face piece. Another option could be to avoid generic particle detection or to use a gas detection method.
The effect of low temperature on the operation of the blower should be considered, as applicable, since low temperature can have a significant adverse effect on power supply output.
If an exchange of filters is required during the mission, provisions should be made to isolate the air intake from the contaminated environment.

4.2.3. Ergonomic Aspects

Due consideration should be taken to human-engineering of the equipment since ergonomic aspects will directly affect the operational readiness and effectiveness of the user. In terms of total weight, volume, operability and handling, comfort, noise emission etc. the user's burden should be reduced as much as possible. However, as the operational requirements for the numerous user groups defined in chapter 1 of the AEP-73 may vary significantly, the right balance between ergonomic and operational demands has to be derived from the ATP-65 on a case by case basis.

4.2.4. Protection Factors (PF) Qualification Test Methodologies – System Test

PAPR must reach the PF values provided in paragraph 1 chapter 2 of this document when tested against CBRN agents in terms of face seal and outlet valve leakage.
The methods used for qualification must follow national or international standards, e.g.,

(1) the corn oil test per NIOSH document TEB-CBRN-APR-STP-0552,

(2) SWPF test per CSA Z1610

(3) salt test or SF_6 test per EN 136

These test methods have to be adapted to the specific features of the PAPR (systems operating at overpressure, interfaces for testing hoses, blower off, etc.).

4.2.5. Resistance to CBRN Agents

The face piece, blower unit and all connecting peripherals of the PAPR should be tested against CBRN agents according to international standards, e.g.

(1) BS 8468-4

(2) NIOSH test methods for PAPR, RCT-CBRN-STP-0002

(3) FINABEL O.7.C.

(4) STANREC 4548/AEP-38

(5) STANAG 4521/AEP-7

(6) CSA Z1610

4.2.6. Interoperability of PAPR

Interoperability of components between different PAPR systems (as normally desired in NATO documents) is generally not possible nor advisable due to safety concerns, as PAPR are normally approved for specified/licensed combinations of blowers, filters, masks and in special cases impermeable protection suits.

4.2.7. Survivability

Survivability requirements mentioned in chapter 2, paragraph 3 of this document, e.g. thermal radiation, ruggedness, resistance to blast, etc., also apply to PAPR as required by the mission and may be achieved in conjunction with additional protective clothing and equipment.
If the user is exposed to open flame or ignition sources, preventive measures should be taken to avoid flashback through the filter pack (e.g. flame arrester) since the air supply is continuously feeding oxygen through the filters. Protection against explosion, and flame-retardant provisions, should be considered as well in these cases.
The general durability of blowers and hoses after ageing and in realistic use should be assessed, as connectors, hoses and blower units can split and crack; regular inspection and maintenance is critical.

4.2.8. Safe Doffing

When PAPR is worn, due consideration must be given to safe doffing of the potentially contaminated equipment, minimizing the potential for transfer of contamination.
This is of particular importance if the PAPR is worn outside the clothing. The time needed to decontaminate the personal protective equipment and PAPR before safely removing the face piece will limit the time of use and needs to be considered.
It should be possible to convert the PAPR-protection mode into a negative pressure air-purifying mode during the doffing time of the suit (e.g. plug in a canister into the mask) which will facilitate doffing the dermal protective equipment without removing the mask.

4.2.9. Reusability

The PAPR should be designed for repeated usage. Hence, it should either facilitate decontamination and replacement of components (see AEP-07: Chemical, Biological, Radiological and Nuclear (CBRN) Contamination Survivability Factors in the Design, Testing and Acceptance of Military Equipment) or be positioned underneath the protective clothing.

4.2.10. Filter Performance

All filter tests have to be performed under air flow conditions specified for the PAPR blower system. The breathing rate and the blower flow rate need to be taken into consideration. It is recommended to limit the number of filters in order to minimize mass and volume of the PAPR system. However, increasing the number of filters improves filtration capacity.

If more than one filter is applied the difference in pressure drop between the filters should be minimized so that the difference in air flow rate through each filter is less than 20 % (EN 12942).
As a preventive measure, e.g. in case of filter fatigue, a set of spare filters should be immediately accessible and exchangeable with full IPE worn.

Usually, the required filter capacity is defined by the operational need derived from the threat scenario. However, as power assisted filtering devices are often used by specialized user groups, there may be neither threat scenarios nor performance requirements readily defined and applicable for testing purposes.
Provided that the environmental conditions do not exceed the defined CBRN scenarios in which air purifying respirators are designed to function, the technical specifications, evaluation and test criteria given under 2.1.3.1 of this AEP may be used with the exception of the test air flow rate which deviates from that paragraph (see following table).

Table on filter performance requirements for positive pressure air purifying devices

CWA	PS [1]	CK [2]	AC [3]
Air flow rate	Constant: nominal air flow rate divided by number of filters of the PAPR.		
challenge concentration	2,000 mg/m³		
Breakthrough criterion	5 mg/m³		
Breakthrough time	37.5 min	15 min	15 min [4]

1 Chloropicrin
2 Cyanogen Chloride
3 Hydrogen Cyanide
4 C2N2 can sometimes be present in the effluent air. The breakthrough applies to the total concentration of (C2N2 + HCN)

The required performance in terms of breakthrough times of the canisters must still be met after the ageing test specified sub 2.4.1. and 2.4.2.

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CHAPTER 5 DESCRIPTION OF TEST METHODS

5.1. INTRODUCTION

Most evaluation methods are described in detail in available existing documents. References to these documents are given in Annex A. The methods not described in detail in the referenced documents are given below.
This chapter contains a description of the following methods:

- Determination of field of vision
- Determination of Clarity of vision

5.2. METHOD FOR DETERMINATION OF FIELD OF VISION

The field of vision test is designed to determine the extent of vision of the protective mask with respect to:

(1) horizontal field

(2) vertical field

(3) binocular field

The equipment consists of a hemispherical dome (figure 1) of 1 m radius mounted with its pole to centre line horizontal. The internal surface of the dome is white painted and divided into a polar co-ordinate grid by 6nes subtending increments of 10° at the centre, and by great circle clock lines radiating at 10° intervals from the vertical through the pole. The protective mask is clamped in place at the centre of the hemisphere on the dummy head (see figure 2), facing into the dome. Small flash lamp bulbs are placed at the eyes. and when individually lit, define the field of vision of one eye. The interchapter of the periphery of the field of vision with the grid lines may be read and recorded on a standard projection of vision chart (figure 3). The areas thus delineated are now expressed as a percentage of the corresponding unmasked field of vision, with the aid of visual efficiency indexes.

Lateral visual efficiency index =

$$\frac{\text{Actual field from } 70-135^\circ}{\text{Full visual field from } 70-135^\circ} \text{ X } 100\,\%$$

Downward visual efficiency index =

$$\frac{\text{Actual field from } 135 - 180^\circ}{\text{Full visual field from } 135 - 180^\circ} \quad X \quad 100\,\%$$

Binocular visual efficiency index =

$$\frac{\text{Actual field from } 250 - 315^\circ}{\text{Full visual field from } 250 - 315^\circ} \quad X \quad 100\,\%$$

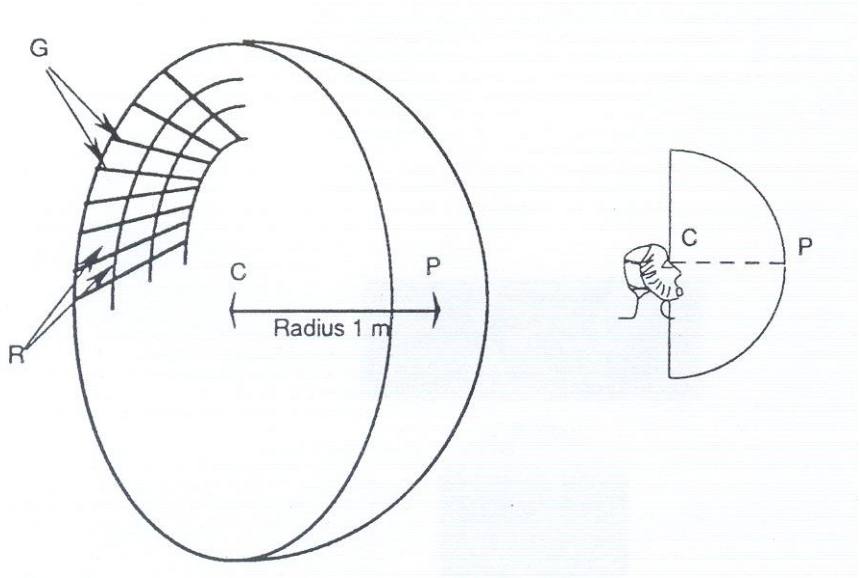

FIGURE 1
HEMISPHERICAL FIELD OF VISION DOME

FIGURE 2
DUMMY HEAD AT CENTRE OF DOME

P = Pole of hemisphere

C = Centre of hemisphere (coincides with the sellion of the dummy head)

G = Great circle lines

R = Lines subtending 10° increments at C

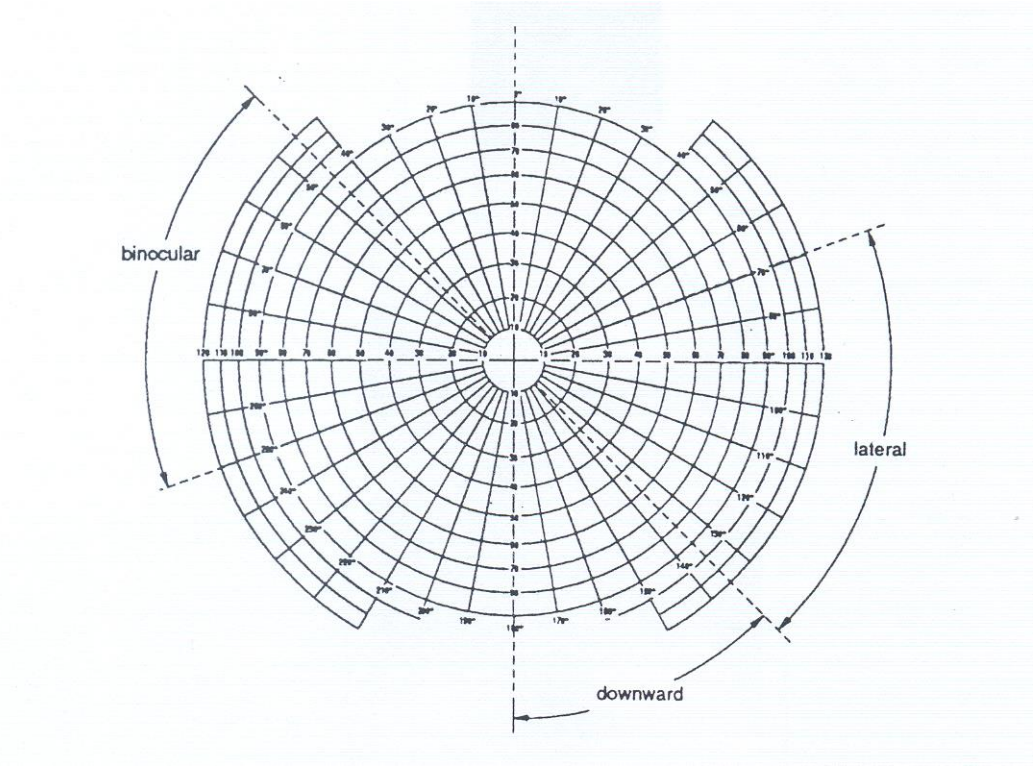

FIGURE 3 Vision chart for the right eye of the standard dummy head, with the sectors related to the three visual indices

5.3. DETERMINATION OF CLARITY OF VISION

The trial is carried out under the following conditions:

(1) Temperature: -25º C
(2) Wind speed: 5 m/s
(3) Relative Humidity: tending to saturation

All observations are timed from the initial donning time for a period of 30 minutes minimum and should be compared with similar tests made at room temperature.
The conduct of the test is as follows:

- Preliminary-outside the cold chamber

1. Prepare and fit the protective mask in accordance with the instructions provided and adjust, if necessary, to archive a good fit.
2. Remove, dry and comply with anti-dimming instructions.
3. Place the protective mask in the cold chamber for one hour with the interior uppermost.

- Test

1. Enter the cold chamber, remain 15 minutes, face into the wind and don the protective mask whilst holding the breath
2. Observe the extent of misting up and ice formation on the eye pieces. At 5-minute intervals during the test an optical sight card is read under an illumination of 500 lux. The sight card must be kept vertical and on a level with the eyes at a distance of 30 cm.
3. After about 30 minutes, take off the mask. Wait 5 minutes and put it on again. Then observe as described in paragraph 2.
4. Take note of physical discomfort.

**ANNEX A TO
AEP-73**

ANNEX A REFERENCES

The table below identifies the source documents like STANAGs, civilian standards and other references used in the main text. In all cases, the most recent version of the standard should be used, and test results should cite the edition/date.

Ref. no.	Page/Link	Document	Title
1	2-2; 2-3; 2-30; 2-29; 2-32	AEP-71 (UNCLASSIFIED) covered by STANREC 4725 (UNCLASSIFIED)	Fit and Protection Testing Methods for Negative-Pressure Respirators.
2	2-18	AECTP-200 (UNCLASSIFIED) covered by STANAG 4370 (AECTP-100 – 600) (UNCLASSIFIED)	Environmental Conditions.
3	**Error! Bookmark not defined.**; 1-2; 2-13; 2-13; 3-4; 4-3; 4-5	AEP-38, Ed. B, Vol. 1 covered by STANAG 4548	Operational Requirements, Technical Specifications and Evaluation Criteria for CBRN Protective Clothing.
4	**Error! Bookmark not defined.**	ANSI-S 3.35	Hearing Aids Under Simulated Real-Ear Working Conditions.
5	2-13	AEP-72 Volume I (UNCLASSIFIED) covered by STANREC 4726 (UNCLASSIFIED)	Recommended chemical, biological and TIC challenge levels.
6	2-10	AEP-72 Volume II (CLASSIFIED) covered by STANREC 4741 (UNCLASSIFIED)	Chemical agent challenge levels.
7	2-10; 2-10	AEP-72 Volume III (CLASSIFIED) covered by STANREC 4742 (UNCLASSIFIED)	Toxic Industrial Chemical challenge levels.
8	2-1	AEP-72 Volume IV (CLASSIFIED) covered by STANREC 4743 (UNCLASSIFIED)	Biological warfare agent challenge levels.
9	2-1	AEP-72 Volume V (UNCLASSIFIED) covered by STANREC 4790 (UNCLASSIFIED)	Radiological challenge levels.

Ref. no.	Page/Link	Document	Title
10	1-5	AEP-4826 covered by STANREC 4826	Aircrew CBRN Individual Protective Equipment (RD to be expected in 2021).
11	2-24; 2-24	AEP-4155 covered by STANAG 4155	CBRN Protective Mask and Filter Canister Screw Threads.
12	3-4; 3-5; 4-5; 4-6	AEP-07 covered by STANAG 4521	CBRN Contamination Survivability Factors in the Design, Testing and Acceptance of Military Equipment.
13	4-3	ASTM F2588-07	Standard Test Method for Man-In-Simulant Test (MIST) for Protective Ensembles.
14	2-19	ASTM D1003-13	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.
15	2-11	ASTM D5160-95	Standard Guide for Gas-Phase Adsorption Testing of Activated Carbon.
16	2-31	ASTM D573	Standard Test Method for Rubber – Deterioration in an Air Oven.
17	2-31	ASTM D865	Standard Test Method for Rubber—Deterioration by Heating in Air (Test Tube Enclosure).
18	1-5	AJP-3.8 (UNCLASSIFIED) covered by STANAG 2451 (UNCLASSIFIED)	Allied Joint Doctrine for Comprehensive CBRN Defence.
19	2-7	American Conference of Governmental Industrial Hygienists (ACGIH)	Bioaerosol assessment and control, J. Machen (ed.), Cincinnati, OH, USA.
20	1-1	ATP-84 ed. B, version 1 covered by STANAG 2352	Nuclear, Biological and Chemical (CBRN) Defence Equipment – Operational Guidelines
21	1-4	ATP-3.8.1, Volume 1 (UNCLASSIFIED) covered by STANAG 2521 (UNCLASSIFIED)	Allied Joint Tactical Doctrine for CBRN Defence on Operations
22	3-4; 4-5	ATP-65 (UNCLASSIFIED) covered by STANAG 2499 (UNCLASSIFIED)	The effect of wearing CBRN individual protection equipment on individual and unit performance during military operations.
23	2-25; 2-25	BS 5438	Methods of test for flammability of textile fabrics when subjected to a small

Ref. no.	Page/Link	Document	Title
			igniting flame applied to the face or bottom edge of vertically oriented specimens.
24	3-1; 3-4	BS 8468-1	Respiratory equipment for use against chemical, biological, radiological and nuclear (CBRN) agents. Positive pressure, self-contained, open-circuit breathing apparatus. Specification.
25	4-3; 4-5	BS 8468-4	Respiratory protective devices for use against chemical, biological, radiological and nuclear (CBRN) agents. Powered air-purifying respirators. Specification.
26	4-3; 4-4; 4-5	CSA Z1610	Protection of first responders from chemical, biological, radiological, and nuclear (CBRN) events.
27	4-4	CFR Part 84	Approval of Respiratory Protective Devices.
28	3-2	EN 132	Respiratory protective devices — Definitions of terms and pictograms.
29	2-17; 2-25; 2-25; 2-26; 2-27; 2-28; 4-5	EN 136	Respiratory protective devices. Full face masks. Requirements, testing, marking.
30	3-3	EN 137	Respiratory protective devices – Self-contained open-circuit compressed air breathing apparatus with full face mask – Requirements, testing, marking.
31	2-10; 2-18	EN 143	Respiratory protective devices – Particle filters – Requirements, testing, marking.
32	2-19; 2-19; 2-20; 2-20	EN 167	Personal Eye Protection –optical test methods
33	2-27; 2-27	EN 168	Personal Eye Protection – Non-optical test methods
34	4-3	EN 12941	Respiratory protective devices – Powered filtering devices incorporating a helmet or a hood – Requirements, testing, marking.
35	4-3; 4-4; 4-7	EN 12942	Respiratory Protective Devices – Power Assisted Filtering Devices Incorporating Full Face Masks, Half Masks or Quarter

Ref. no.	Page/Link	Document	Title
			Masks – Requirements, Testing, Marking.
36	2-2	EN 13274-1	Respiratory Protective Devices - Methods of Test - Part 1: Determination of Inward Leakage and Total Inward Leakage.
37	2-28; 2-28; 2-28	EN 14387	Respiratory protective devices – Gas filter(s) and combined filter(s) – Requirements, testing, marking.
38	4-3	European Council Directive 89/686/EEC	Personal Protective Equipment.
39	3-4; 4-5	Finabel Convention O.7.C	Méthodes de mesure de la résistance des matériaux imperméables et perméables au passage des agents toxiques.
40	2-31	ISO 188	Rubber, vulcanized or thermoplastic - Accelerated ageing and heat resistance tests.
41	2-29	ISO 811	Textiles – Determination of resistance to water penetration – Hydrostatic pressure test.
42	2-32	ISO 1431	Rubber, vulcanized or thermoplastic – Resistance to ozone cracking. Part 1: Static and dynamic strain testing Part 3: Reference and alternative methods for determining the ozone concentration in laboratory test chambers
43	2-32	ISO 4892-2	Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon arc lamps.
44	2-19; 2-19; 2-20; 2-20	MIL-DTL-43511D	Detail Specification: Visors, Flyer's Helmet, Polycarbonate.
45	2-31; 2-31; 2-31; 2-33; 2-32	MIL-STD-810G	US Department of Defense Test Methods Standard: Environmental Engineering Considerations and Laboratory Tests.
46	2-18	Modified Draize sensitization test	Modified Draize sensitization test with D & C yellow no.10 in combination dye systems.

Ref. no.	Page/Link	Document	Title
47	4-4	NF S76-020-1 / NF ISO 16900-1	Respiratory protective devices - Methods of test and test equipment - Part 1: Determination of inward leakage.
48	3-3	NIOSH RCT-CBRN-STP-0001	Laboratory Respirator Protection Level Test, Quantitative (High Flow Deep Probe Corn Oil) for Self-Contained Breathing Apparatus with Full Facepieces, Standard Testing Procedure (STP).
49	3-4; 4-5	NIOSH RCT-CBRN-STP-0002	Determination of Open Circuit, Self-Contained Breathing Apparatus (SCBA) Performance During Dynamic Testing Against Chemical Agents of Sarin (GB) Vapor and Distilled Sulfur Mustard (HD) Vapor and Liquid Standard Testing Procedure (STP).
50	4-5	NIOSH TEB-CBRN-APR-STP-0552	Determination of Laboratory Respirator Protection Level (LRPL) Values for CBRN Tight-Fitting Powered Air-Purifying Respirator (PAPR), Standard Testing Procedure (STP).
51	2-21	NIOSH TEB-CBRN-APR-STP-0313	Determination of Communication Performance Test for Speech Conveyance and Intelligibility of CBRN Full-Facepiece Air Purifying Respirator (APR) Standard Testing Procedure
52	2-15	STANAG 4296	Eye protection for the individual soldier – Ballistic Protection ; (1997).
53	4-3	US standard NIOSH 2006	Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Powered Air-Purifying Respirators (PAPR).

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ANNEX B ENVIRONMENTAL COMPATIBILITY AND HAZARDOUS SUBSTANCES

The following statement applies to all material/equipment described in this document:
The national laws, statutory orders, administrative directives as well as the technical regulations and standards pertaining to the environmental and hazardous materials legislation shall be observed during manufacture and operation. This particularly applies to the adherence of legal limits and to the prohibition of production and use.
Like technical safety, environmental compatibility is a quality characteristic with the minimum requirement being that the existing directives/laws are observed.
Substances and preparations, which are prohibited to be produced, used or marketed shall not be contained in the equipment. The equipment material must not contain any substances and preparations which are classified as carcinogenic, mutagenic or reproduction toxic. This also applies to hazardous substances which are not listed in Annex I of Directive 67/548/EEC but are, nevertheless, classified as carcinogenic, mutagenic or reproductive toxic. These requirements apply to all carcinogenic or mutagenic substances/preparations or reproductive toxins, categories 1, 2 and 3.
Products with increased susceptibility to micro-organisms shall be avoided or protected by suitable biocides.
All substances/preparations used (e.g. finishing materials, dyestuffs, activated carbon etc.) shall be physiologically and toxicologically safe.

AEP-73(B)(1)