NATO STANDARD

AAMedP-1.3

FUNCTIONAL REQUIREMENTS OF AIRCRAFT OXYGEN EQUIPMENT AND PRESSURE SUITS

Edition A Version 1

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NORTH ATLANTIC TREATY ORGANIZATION

ALLIED AEROMEDICAL PUBLICATION

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

16 January 2017

1. The enclosed Allied Aeromedical Publication AAMedP-1.3, Edition A, Version 1 FUNCTIONAL REQUIREMENTS OF AIRCRAFT OXYGEN EQUIPMENT AND PRESSURE SUITS, which has been approved by the nations in the MCASB, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 3198.

2. AAMedP-1.3, Edition A, Version 1, is effective upon receipt.

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

Edvardas MAŽEIKIS
Major General, LTUAF
Director, NATO Standardization Office

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RESERVED FOR NATIONAL LETTER OF PROMULGATION

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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]
BGR	The standard will not be implemented for aircraft Su-25 and helicopters AS 532 AL "Cougar", "Bell-206, Mi-17 and Mi-24".
FRA	While the merits of lowering the threshold for supplemental oxygen supply to 10,000 feet cabin altitude (paragraph 1.3.2) is recognized, it is currently impossible for the French Navy and Air Forces to implement this point. This would imply revising doctrines and frameworks of the use of unpressurized aircrafts as well as providing aircrafts with oxygen systems, which is not feasible at present.
NLD	The NLD reserves the right not to implement paragraphs 1.3, 2.2 to 2.6, 2.9, 2.10, 2.14 and 2.15 of AAMedP-1.3. Rationale: For passenger transport the MAA-NLD follows EASA and FAA regulations concerning supplemental oxygen where possible. For other missions the MAA-NLD sees no need to change current aircraft systems or operations. For future applications, including modifications to current systems, the use of AAMedP-1.3 shall be considered. Furthermore the NLD SOP differs from the STANAG on two points: Paragraph 1.2 Unpressurized Aircraft: a: below 13,000 ft: max 30 mins b. Not applicable Paragraph 2.5: Diluent Gas: Above 25,000 ft regulator not automatically switch to 100% oxygen.
SVK	The Slovak Republic reserves the right to apply this STANAG only to aircraft and equipment procured in the future.
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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TABLE OF CONTENTS

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CHAPTER 1 HYPOXIA PROTECTION

1.1 INTRODUCTION

It shall be the responsibility of each nation to ensure that its aircraft are fitted with appropriate oxygen equipment capable of affording the aircrew adequate protection against hypoxia throughout the operational envelope of the aircraft.

1.2 UNPRESSURIZED AIRCRAFT

If flight altitude exceeds 10,000 ft (3,048 m), unpressurized aircraft must be provided with an oxygen system with the capability of maintaining physiological protection for all aircrew members. While the maximum recommended altitude for unpressurized aircraft without oxygen is 10,000 ft (3,048 m), it is recognised that at times aircraft without oxygen systems may exceed this altitude limitation due to operational imperatives. This activity creates a risk to flight safety and should only be undertaken exceptionally and with due regard to aeromedical advice limiting altitudes and exposure times of excursions as follows:

a. Below 14,000 ft (4,267 m): max 30 mins.

b. Below altitudes of 12,500 ft (3,810 m): max one hour.

1.3 PRESSURIZED AIRCRAFT

1.3.1 Cabin Altitude Less than 10,000 ft (in Normal Flight Conditions)

All pressurized aircraft must be fitted with an oxygen system capable of providing physiological protection for all personnel in the event of decompression under the following conditions:

a. **Personnel Flying Aircraft**. If the aircraft flight altitude exceeds 25,000 ft (7,620m)[1], pilots require an oronasal mask of a type that can be positioned, fixed, sealed and made operational with one hand in less than 5 seconds. The oxygen system shall be compatible with other aircrew protection devices worn by the crewmember and its donning/doffing shall not delay or prevent performance tasks assigned to the aircrew member. If the aircraft flight altitude exceeds 40,000 ft (12,200 m), at least one pilot must don and use his oronasal mask routinely as reactive delay to

[1] Corresponding to the upper limit at which a ‘constant flow system’ can provide protection.

mask application and oxygen delivery would result in significant transient impairment.

b. **Operational Personnel**. The oxygen supply system shall be positionable and made operational in a time compatible with personnel safety. The system shall be compatible with the other aircrew protection devices worn by the crewmember and shall not delay or prevent performance tasks assigned to him.

c. **Transported Personnel**. An oxygen supply system shall be provided if the aircraft altitude exceeds 25,000 ft (7,620 m) or if it cannot be guaranteed, regardless of flight altitude, that the aircraft can descend to an altitude not exceeding 10,000 ft (3,048 m) in less than 4 minutes after accidental cabin decompression.

1.3.2 Cabin Altitude Greater than 10,000 ft (in Normal Flight Conditions)

All personnel must have an oxygen supply system available for inflight use.

CHAPTER 2 MINIMUM FUNCTIONAL REQUIREMENTS

2.1 OXYGEN SOURCES

2.1.1 Aircraft Oxygen Sources

Aircraft oxygen sources may be described as either ‘primary oxygen systems’, or as ‘backup oxygen systems’. Oxygen for these systems may be from a pure oxygen source produced by a reserve of liquid, gaseous or chemical oxygen, or from a Molecular Sieve Oxygen Generating System (MSOGS), a form of On Board Oxygen Generating System (OBOGS).[2]

2.1.2 Ejection Oxygen Source

The aircraft ejection system shall be fitted with an emergency oxygen system where ejection occurs >25,000 ft (7,620 m). This system will be activated automatically as the crewmember is disconnected from the aircraft.

2.2 OXYGEN CHARACTERISTICS AND REQUIREMENTS

1. Sources of pure oxygen shall guarantee a supply of gas containing at least 99.5% oxygen. However, oxygen provided from MSOGS is derived from engine ‘bleed air’ and is at the most 94% (the remainder being mostly argon).[3]

2. The minimum concentration of oxygen within mixed inspired gas (containing a partial pressure of water vapor of 47mmHg (63 kPa)) in pressurized cabins shall be sufficient to:

   a. Maintain an alveolar oxygen tension of at least 100 mmHg.

   b. Prevent the alveolar oxygen tension from falling below 30 mmHg on rapid cabin decompression when at least 94% oxygen is delivered to the mask immediately after decompression.

These criteria are designed to assure the quality of breathing gas delivered to aircrew during normal flight operations and are applicable to all types of OBOGS.

[2] An MSOGS cannot, by design, deliver pure oxygen.
[3] The variation in MSOGS concentration output being explained by efficiency changes with altitude, being most efficient at higher altitudes.

2.3 LEVEL OF ACCEPTABLE HYPOXIA

Oxygen concentration and pressure breathing for altitude (PBA) for a typical fighter aircraft with a ceiling of 50,000 feet and a standard 5 psi (34.5 kPa or 259 mmHg) cabin pressurization schedule shall conform to Figure 1. The step in the minimum oxygen concentration curve is referred to as the "Ernsting notch" and it ensures 30 mm Hg alveolar oxygen tension is maintained after a rapid decompression. BOS is the Back-up Oxygen Supply providing 100% gaseous emergency oxygen and which is normally part of the ejection seat assembly in order to provide oxygen following ejection at high altitudes. Consideration should also be given to automatic BOS supply where cabin altitudes exceed 25,000 ft or where OBOGS failure occurs.

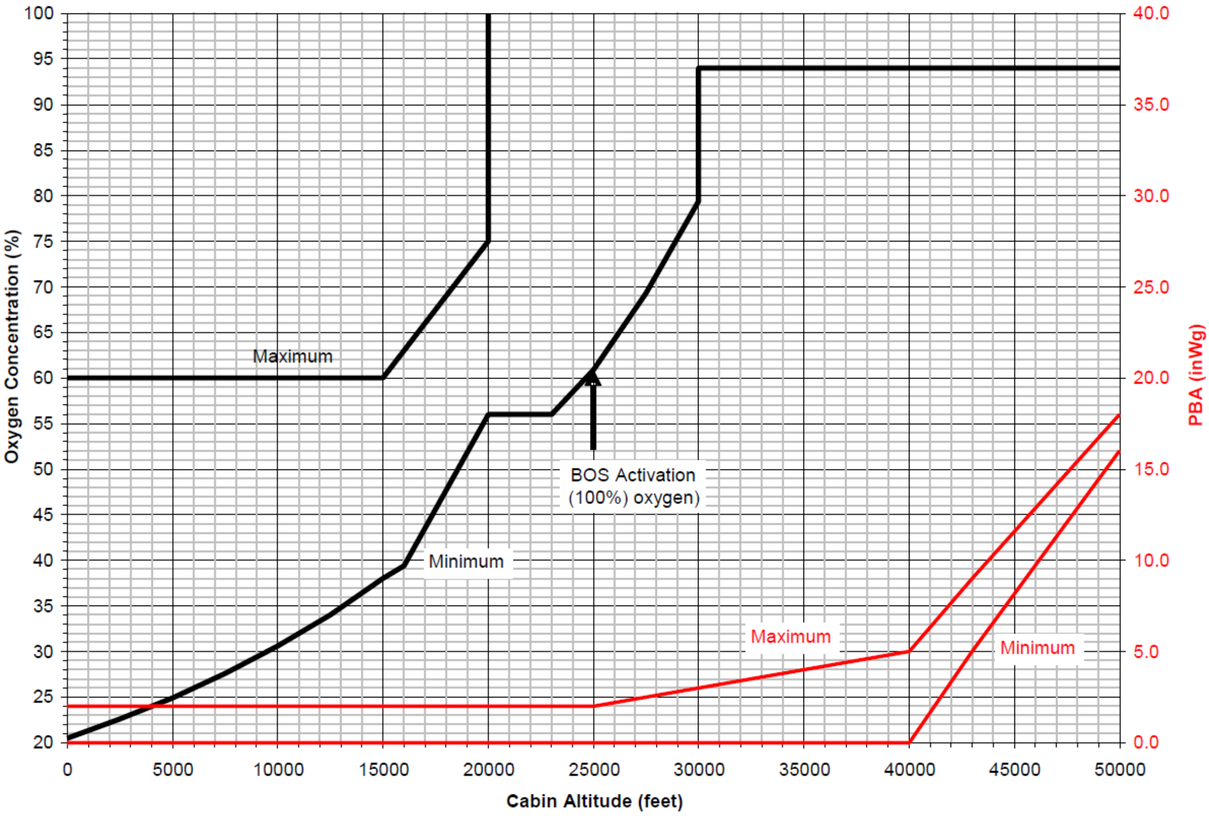

Figure 1: Recommended Minimum and Maximum Oxygen Concentrations for an OBOGS on a Military Aircraft with a Maximum Aircraft Altitude of 50,000 ft (15,240 m)

2.4 CONCENTRATION OF OXYGEN IN THE INSPIRED GAS FOLLOWING DECOMPRESSION OF THE CABIN

1. On decompression of the cabin (time of decompression between 0.1 s and 90 s) and the cabin altitude exceeding 30,000 feet, the concentration of oxygen in the gas delivered to the mask cavity must rise to above 94% when no more than 0.7 liters (ATPD) of gas has been inspired. The concentration of oxygen in the inspired gas shall be at least 94% for as long as the cabin altitude exceeds 30,000 feet. Automatic

BOS activation is recommended above 25,000 ft given increased likelihood of spurious warnings from OBOGS control at these altitudes.

2. In order to reduce the incidence of acceleration atelectasis and/or delayed otitic barotrauma, the concentration of oxygen in the inspired gas shall not exceed 60% at cabin altitudes between 0 and 15,000 feet, or 75% at a cabin altitude of 20,000 feet.

2.5 DILUENT GAS

Above 25,000 ft cabin pressure, 100% oxygen must be supplied, however, below this level, the oxygen equipment shall be able to supply the user with a diluted mixture of gas where major acceptable gases in the breathing mixture supplied to the aircrew are nitrogen, argon or a mixture of the two, in addition to oxygen. The concentration of argon shall not exceed 5% by volume of the total gas mixture.

2.5.1 Minimum Dilution Requirements

Oxygen delivery shall be sufficient to maintain a mean alveolar pressure of oxygen of at least 13.3 kPa (100 mmHg) up to a cabin altitude of 30,000 ft (9,150 m). Above this altitude, the mean alveolar pressure of oxygen may transiently fall below 13.3 kPa (100 mm Hg) but shall be at least 8 kPa (60 mm Hg) for all personnel flying aircraft, operational and transported personnel and 7 kPa (53 mm Hg) for passengers. In such circumstances, the aircraft must descend to 18,000 ft (5,486 m) if oxygen is available and to 10,000 ft (3,048 m) if oxygen supply is limited.

2.5.2 Closure of the Dilution Orifice by the User

Independently of the requirement specified in paragraph 2.5.1. above, the oxygen system must allow all aircrew personnel to close the dilution orifice and to select 100% of the gas provided by the breathable gas source or additional source when OBOGS is used as the primary source.

2.5.3 CBRN Protection

Protection against the risk of CBRN contamination of inhaled gas is the subject of a special agreement.

2.6 RESPIRATORY DEMAND

The operation of the oxygen system shall meet the requirements of this specification at pulmonary ventilations between 5 and 100L/min (ATPD) and peak inspiratory and expiratory flow of up to 3.3 L/s, with maximum rates of change of 10 L/s2 at peak flows of 1.5 L/s and 20 L/s2 at peak flows of 3.3 L/s.

2.7 SAFETY PRESSURE

When pressure demand oxygen regulators are used, they shall deliver a positive safety pressure sufficient for preventing the admixture of inboard leaks during the respiratory cycle. Safety pressure shall be selectable by the crewmember at any altitude. When the inspiratory flows do not exceed 1.4 L/s, the safety pressure delivered to the crewmember must be sufficient to maintain a positive pressure in the oronasal mask cavity.

2.8 MASK CAVITY PRESSURE AT ALTITUDES LOWER THAN OR EQUAL TO 38,000 FT (11,600 M)

The minimum pressure, maximum pressure and total pressure variation (swing) in the mask cavity, during a ventilation cycle at altitudes lower than or equal to 38,000 ft (11,600 m) shall not exceed the values given in Tables I and II below. The altitude of 38000ft is utilized to provide a margin of safety over the required figure of 39,000ft for protection against hypoxia.

Flow (L/s)	Mask Cavity Pressure kPa (inch H2O gauge)		
	Lower Limit	Upper Limit	Max Permissible Swing
0.5	-0.38 (-1.5)	+0.38 (+1.5)	0.50 (2.0)
1.5	-0.55 (-2.2)	+0.65 (+2.6)	0.85 (3.4)
2.5	-1.12 (-4.5)	+1.00 (+4.0)	1.75 (7.0)
3.3	-1.90 (-7.6)	+1.50 (+6.0)	3.00 (12.0)

Table 1: Without Safety Pressure
Peak Inspiratory and Expiratory Flow Limits and Mask Cavity Pressures at altitudes between 0 and 38,000 ft (11,600 m)

Flow (L/s)	Mask Cavity Pressure kPa (inch H2O gauge)		
	Lower Limit	Upper Limit	Max Permissible Swing
0.5	+0.02 (+0.1)	+0.75 (+3.0)	0.50 (2.0)
1.5	-0.20 (-0.8)	+0.95 (+3.8)	0.85 (3.4)
2.5	-0.90 (-3.6)	+1.25 (+5.0)	1.75 (7.0)
3.3	-1.75 (-7.0)	+1.65 (+6.6)	3.00 (12.0)

Table 2: With Safety Pressure
Peak Inspiratory and Expiratory Flow Limits and Mask Cavity Pressures at altitudes between 0 and 38,000 ft (11,600 m)

2.9 POSITIVE PRESSURE BREATHING FOR ALTITUDE (PBA)

Above 38,000 ft (11,582 m) cabin altitude, the breathable gas shall be supplied at a sufficient positive pressure in order to mitigate the level of hypoxia to an acceptable level to maintain consciousness and permit emergency descent actions by the pilot. When the breathable gas is supplied by a pure oxygen source, altitude positive pressure shall begin at a cabin altitude of 38,000 ft (11,582 m). When the breathable gas is supplied by a MSOGS, altitude positive pressure shall begin at a lower cabin altitude than the aforementioned value so that an equivalent mean alveolar pressure of oxygen may be guaranteed. The altitude safety pressure should be 0.5 kPa (2 in water gauge) at cabin altitudes greater than 30,000 ft (9,144 m).

2.10 MASK CAVITY POSITIVE PRESSURE BETWEEN 38,000 FT (11,600 M) AND 50,000 FT (15,240 M) IN THE ABSENCE OF COUNTER PRESSURE EQUIPMENT

1. Above 38,000 ft (11,580 m) and in the absence of counter pressure equipment, the mask cavity pressure is to increase linearly with fall of environmental pressure up to 50,000 ft (11,580 and 15,240 m). The mean mask cavity pressure (averaged over the ventilatory cycle) is to lie within the limits +0.1 to +1.0 kPa (0.4 to 4.0 inch water gauge) at 40,000 ft (12,200 m) and 4.0 to 4.5 kPa (16 to 18 inch water gauge) at 50,000 ft (15,240 m). At altitudes between 38,000 ft and 50,000 ft the total change of mask cavity pressure during a ventilator cycle is not to exceed 0.5 kPa (2.0 inch water gauge) with peak ventilator flow of 0.5 L.sec-1 and 1.0 kPa (4.0 inch water gauge) at peak ventilator flow of 1.8 L.sec-1.

2. These values are applicable only where breathing gas supplied exceeds 94% oxygen purity. If a crewmember receives oxygen through a molecular sieve oxygen concentrating system, it must be capable of maintaining a mean alveolar pressure

appropriate to the level required to maintain protection at the cabin altitude without the use of counter pressure equipment.

2.11 OPERATION OF THE ALTITUDE POSITIVE PRESSURE PRESS-TO-TEST FUNCTION IN THE ABSENCE OF COUNTER PRESSURE EQUIPMENT

Operation of the altitude positive pressure press-to-test function shall raise the mask cavity pressure to between 3.5 kPa (14.0 in water gauge) and 4.5 kPa (18.0 in water gauge). The total change of pressure during the respiratory cycle shall not exceed 0.75 kPa (3.0 in water gauge) when the peak inspiratory and expiratory flows are 0.5 L/sec.

2.12 ALLOWABLE INCREASES OF MASK CAVITY PRESSURE

When the crewmember must continually wear the oxygen mask, the rise of mask cavity pressure induced by realistic head movements or throughout the maximum rate of climb of an aircraft shall not exceed 0.25 kPa (1.0 in water gauge). The rise of mask cavity pressure produced by either the oxygen regulator failing in the open position, or rapid or explosive decompression, up to an altitude of 50,000 ft (15,240 m), shall not exceed 5.5 kPa (22.1 in water gauge).

2.13 OSCILLATORY ACTIVITY

There shall be minimal oscillatory activity when the oxygen system is used by the crewmember. The double amplitude of any oscillation of pressure in the mask cavity which lasts 0.25 s or longer shall not exceed 0.06 kPa (0.24 in water gauge).

2.14 ALARMS

Aircrew oxygen equipment shall be fitted with a device to warn the crewmember when a component of his oxygen system is defective or inoperative and BOS activation / use must be shown visually.

2.15 COUNTER PRESSURE SUITS

2.15.1 Definitions

1. Pressure suits are categorized:

    a. **Full Pressure Suit**. A full body garment that pneumatically pressurizes the whole of the body surface, to include the head.

b. **Partial Pressure Suit**. A pressure garment which mechanically pressurizes only part of the body surface, eg chest or lower body counter-pressure.

2.15.2 Scope of use

1. The use of pressure suits at altitudes exceeding:

   a. 45,000 ft (13,720 m): partial suit strongly recommended.

   b. 50,000 ft (15,240 m): partial suit mandatory.

   c. 60,000 ft (18,288 m): full suit recommended.

   d. Prolonged exposure: full suit recommended.

2.15.3 Mode of Operation

1. Partial pressure and full pressure suits should conform to the following modes of operation:

   a. **Respiratory counter-pressure**. To balance onset of PBA, an automatically pressurized respiratory (chest) counter pressure garment must be used above 50,000 ft (15,240 m) or if PBA pressure is greater than 4 kPa gauge (30 mmHg). Respiratory counter pressure provided by the garment should be no less than 0.86 times the breathing pressure. This difference isolates the garment from safety pressure and allows inflation only during periods of PBA or PBG.

   b. **Lower body counter-pressure**. Automatically pressurized lower limb and abdominal counter-pressure should be used when PBA pressure is greater than 4 kPa gauge (30 mmHg) or with prolonged PBA. This function can be provided by an anti-G garment or similar suit which applies lower body counter-pressure : breathing gas pressure at a ratio of between 1:1 and 1.5:1.

   c. **Full body counter-pressure**. If a full pressure suit is used, it should maintain the pressure altitude inside the suit at 38,000 ft (11,600 m) or lower. This provision is for emergency use only; requirements for prolonged pressure suit use are outside the scope of this agreement.

2.15.4 Breathable Gas Supply

Under all operational conditions, the main and/or emergency gaseous supplies to a pressure suit must ensure that the pressure and breathing gas composition delivered to the aircrew are sufficient to meet the provision of paragraphs 2.3 and 2.9.

2.15.5 Compatibility

1. The use of counter pressure garments must not adversely affect operational performance and shall not compromise:

a. Vision.

b. Hearing.

c. Speech.

d. Mobility (including the ability to check the 6 o'clock position).

e. Thermal comfort.

f. Emergency egress.

ANNEX A DEFINITIONS

The following definitions shall be employed when implementing the provisions of this document:

Ambient Temperature and Pressure Dry Gas (ATPD)	Volume of gas expressed as dry gas at the prevailing atmospheric pressure and temperature. The ambient pressure is the absolute pressure of the gas within the cavity of the mask and the temperature is constant at 15°C. In this document, all the volumes and gas flows are expressed in ATPD conditions.
Operational Personnel	Crewmembers not in primary control of the aircraft.
Personnel Flying Aircraft	Crewmembers in primary control of the aircraft.
Transported Personnel	All personnel on board an aircraft, but having no role for the performance or the safety of the aircraft itself.

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ANNEX B ACRONYMS

ATPD	Ambient Temperature and Pressure Dry Gas
MSOGS	Molecular Sieve Oxygen Generating System
OBOGS	On Board Oxygen Generating System
PBA	Positive Pressure Breathing for Altitude

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