NATO STANDARD

AMedP-4.9

REQUIREMENTS FOR WATER QUALITY DURING OPERATIONS

Edition B, version 1

OCTOBER 2022

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED MEDICAL PUBLICATION

Published by the
NATO STANDARDIZATION OFFICE (NSO)

INTENTIONALLY BLANK

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

19 October 2022

1. The enclosed Allied MEDICAL Publication AMedP-4.9, Edition B, Version 1, REQUIREMENTS FOR WATER QUALITY DURING OPERATIONS, which has been approved by the nations in the Military Committee Medical Standardization Board, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 2136.

2. AMedP-4.9, Edition B, version 1, is effective upon receipt and supersedes AMedP-4.9, Edition A, version 1, which shall be destroyed in accordance with the local procedure for the destruction of documents.

3. This NATO standardization document is issued by NATO. In case of reproduction, NATO is to be acknowledged. NATO does not charge any fee for its standardization documents at any stage, which are not intended to be sold. They can be retrieved from the NATO Standardization Document Database (https://nso.nato.int/nso/) or through your national standardization authorities.

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

Dimitrios SIGOULAKIS
Major General, GRC (A)
Director, NATO Standardization Office

INTENTIONALLY BLANK

RESERVED FOR NATIONAL LETTER OF PROMULGATION

INTENTIONALLY BLANK

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.

INTENTIONALLY BLANK

RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
BGR	The Bulgarian Armed Forces cannot fully implement Annex A & Annex B to AMedP-4.9, and the following points will be applied only: - Enterococcus, Escherichia coli (E. coli), Coliforms at 37°C, Number of revivable aerobic microorganisms at 22°C and 37°C, Sulfito-reducing bacteria, including spores (Clostridium spp). - Colour, Smell, Taste, Conductivity, Hardness, pH, Magnesium, Manganese, Nickel, Nitrates, Nitrites, Sulphates, Total Chlorine, Copper and Iron.
CAN	CAN does not routinely conduct direct-reading analyses for arsenic and cyanide. CAN does not normally monitor for enterococci, plate count, Clostridium perfringens, nor Legionella in water. Legionella is tested in air when warranted.
CZE	At presence CZE does not have needed technical equipment and trained personnel for testing entire parameters of portable water in the field in accordance with the requirements stated in AMedP-4.9 (B)1 RD 1, Annex A.
DEU	Due to European and national regulations DEU will not necessarily fulfill the limits for drinking water set out in Annex A and D in term of conductivity.
ESP	There are discrepancies between the standard consumption rate (5 l/pax) and sampling frecuencies established by the STANAG 2136 Ratification Draft and STANAG 2629 Water Production, Storage and Distribution (ATP-104) (15-30 l/pax).. Spain will comply with specifications from STANAG 2629 considered more compatible with reality when it comes to drinking water, water for food preparation and personal hygiene.
FRA	• Point 2.3 Personal sanitation water In cases where type II parameters exceed the LTS, the indicated 2.5 tolerance factor will not be applied and a risk analysis will be conducted in France to determine the required corrective actions and the possible restrictions for use. • Annex A Standards for routine situation In cases of exceedances of the LTS (Long Term Standards) and absence of STS (Short Term Standard), a hazard analysis will be conducted in France to determine the corrective actions to be taken. • Annex A Standards for routine situation : radioactivity

	For α or β activities, in cases of exceedances of the LTS (Long Term Standard), a risk assessment will be conducted in France based on the calculation of the total indicative dose. • Annex A Standards for routine situation In a routine situation and in the absence of a confirmed biological risk, France will not exceed the maximum threshold value of 1 mg/L of free available chlorine. • Annex A Standards for routine situation In a routine situation and in the absence of a confirmed specific risk, France will based itself on the maximum threshold values set out in the European Directive 2020/1984 for following parameters: antimony, chlorate, chloride, chlorite, mercury, nickel, nitrite, selenium, acrylamide, benzene, benzopyrene, dichloroethane, epichlorohydrin, trihalomethanes total.
GBR	Annex A – Long term standard.? UK aims to achieve these standards but reserves the right to adhere to national standards of domestic water quality legislation when appropriate. Annex D – MSES.? The UK does not currently have the capability to undertake analysis of all listed constituents/characteristics.
HRV	The medical support system in the Croatian Armed Forces shall meet the specified minimum requirements for field tests in operations. Other skills will not be developed in the Armed Forces, but will rely on the authorized civilian institution in the Republic of Croatia, as well as on the Allied capacities and capabilities of the host nation support in the area of operation.
LTU	The Lithuanian Armed Forces do not have the capability (taking into account the capabilities of civilian laboratories) to carry out analyses of Chlorate, Chlorite, Uranium, Epichlorohydrin, Vinyl chloride, Total α activity, Total β activity.
NLD	NLD has no field capabilities to analyze alpha and beta radiation [listed in Annex A]
NOR	2.2.3 Commercial Bottled Water (CBW): Norway will normally rely on approval given by the civilian national food/water safety authorities of the CBW producing facilities within the European Economic Area, both for own use and as a Host Nation. 3.2 The water supply chain 3: Disinfection: Garrisons connected to municipial water distribution systems frequently contains other hygienic barriers than chlorination. Thus additional chlorination according to this AMedP is performed when water is redistributed to field supply chains from municipial pipeline systems.

	3.3 Monitoring: Broader water analysis are performed by civilian, accredited laboratories. Analysis performed by military field laboratories are according to good laboratory practice (FAGLP). Annex A1: The colony count (22*C) concerning commercially bottled water shall be analysed no later than 12 hours postproduction. In this 12 hour period the water shall be stored at 3 to 5 *C and the results should not exceed 100 CFU/ml. If sampling and analysis of CBW are performed without these limitations higher values than the given limit often occurs. Annex D: During emergency situations where annex D is applicable, NOR will not be able to quantify the amount of all parameters given in annex D table using field methods.
SVK	The Armed Forces of the Slovak Republic shall apply - in addition to the limits specified in ANNEX A (A.1. Long Term Standard) also hydro-biological requirements for water intended for human consumption to the limits on living organisms, dead organisms and abioseston in accordance with the Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. Considering the range of the chemical parameters to be monitored, as set forth in Annex A (A.1. Long Term Standard), and required frequency of performing analyses of samples, as set forth in Annex B, it is concluded that the SVK Armed Forces' laboratories do not have the capacity to fully monitor said parameters. As for the free available chlorine, the SVK Armed Forces will only accept a maximum limit of 1 mg/l (Annex A; A.1. and A.2.). To date, the SVK Armed Forces' laboratories do not have the capability to diagnose radiological parameters set forth in the present standardization agreement. In the case of launching the acquisition procedure, the SVK Armed Forces will review the extent to which the present standardization agreement will be accepted.
SVN	Annex A, Standards for Routine Situation, A.1. Long Term Standard: Slovenian Armed Forces (SAF) cannot fulfill the requirements for the chemical and radiological testing.
TUR	Türkiye applies the criteria of EU drinking water directive (98/83/EC). Appendix A and B, Analytical parameter values may vary.
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.	

INTENTIONALLY BLANK

TABLE OF CONTENTS

INTENTIONALLY BLANK

CHAPTER 1 INTRODUCTION

1.1. GENERAL

This publication establishes the requirements for water quality during NATO operations. The main purpose with this document is to ensure interoperability within NATO concerning multinational water supply.
Water is required for numerous activities during operations. The most important is drinking. Drinking water must be readily available and consumed in adequate quantities to prevent dehydration. Drinking water should be potable, not contain any contaminants in concentrations that may result in adverse health effects and be safe from a medical point of view for human consumption, preparation of food and all domestic use, including personal hygiene and brushing teeth. Drinking water should also be palatable[1] so personnel will be willing to drink it in adequate quantities.

1.2. AIM

The purpose of the AMedP-4.9 is to:
- establish a standardised approach for ensuring the quality of water provided to troops during operations,
- establish minimum requirements and maximum levels of the constituents in water provided to troops during operations, and
- establish minimum water quality testing capabilities required in the field.

1.3. AGREEMENT

Participating nations agree:
- to follow the procedures of risk management described within this document,
- to notify other participating nations in a multinational water supply when the shared water does not meet the prescribed requirements, and
- that the minimum criteria for the quality of drinking water based on performance related risks will only be applied in emergency situations.

[1] Palatable water is cool, aerated, significantly free from objectionable colour, turbidity, taste, and odour and is generally pleasing to the senses. Palatable water is not necessarily potable and may contain disease-causing substances.

INTENTIONALLY BLANK

CHAPTER 2 WATER QUALITY STANDARDS

2.1. GENERAL

Water used for human consumption, food preparation, personal sanitation (including washing, showering, bathing), brushing teeth and medical treatment should have quality in line with the standards for potable water.
The quality of water for other purposes is not described in this AMedP.
Based on risk assessment with respect to the chemical constituents, a lower quality then potable can be applied for personal sanitation.

Potable water can be supplied as bulk (including supply by waterworks) or as packaged water.

2.2. DRINKING WATER STANDARDS

The goal is to provide potable water to deployed personnel that has a comparable quality as in their homeland and therefore is free of microbiological contaminants or substances in concentrations that can result in adverse health effects.

Three different types of standards are applicable:
Type I = health related parameter: non-compliance with the standard can result in a direct adverse health effect;
Type IIa = indicator parameter type a: non-compliance with the standard can result in an indirect adverse health effect (e.g. taste can limit consumption and result in dehydration),
Type IIb = indicator parameter type b: non-compliance with the standard indicates a possible technical problem and should be evaluated for any human health risk.
Type I and IIa standards are obligated for the risk assessment of the water quality; type IIb can be used for additional evaluation of the water supply chain.

Drinking water standards are based on a consumption of 5 liters per day. Higher consumption rates require additional risk assessment.
In some cases, as a result of the operational situation, reduced guarantees of the quality of the water supply may have to be accepted.

2.2.1. BULK WATER

Bulk water does not refer to a type of water but to the larger volume water in a storage or transportation unit. In the provision of bulk water, two situations are identified that determine the level of the water quality:

ROUTINE SITUATION

In routine situations the drinking water supply has to be secured by a water safety plan. This operational quality assurance system, based on HACCP[2] principles, is applicable for the whole supply chain from source of the raw water[3] to point of use. The quality of the water at the point of use should be in compliance with the Long Term Standards (LTS) of Annex A. This water can be used for long-term consumption and will not result in adverse health effects.

For the timeframe between water sampling and definitive analyses of all Annex A constituents/characteristics, a temporary decision for the release of the water based on field quality analyses is an operational necessity. Therefore, Short Term Standards (STS) are included in Annex A. STS can be applied for a limited period of 30 days and reflect the upper limit for potential performance degradation.

EMERGENCY SITUATION.

An emergency situation with regard to water supply is exceptional and applicable only in a situation when, due to hostile activity or other severe, unforeseeable conditions, water that meets the routine situation quality criteria cannot be produced or re-supplied in a timely manner. The quality of the emergency potable water should at least meet the Minimum Standards for Emergency Situations (MSES) listed in Annex D. The MSES are based on acceptable percentages (maximum of 10% of a group) of military personnel who may experience performance degradation within 7 days from the first moment of consumption[4].

For some constituents, Annex D gives adjusted guidelines for higher consumption rates up to 15 liters/day.

The health effects that may reduce some individuals performance are detailed in the Potential Health Effects column of Annex D.

The capability to examine the water quality during an emergency situation should be based on the standards in Annex D. Some standards in Annex D are marked because there are no simple field techniques currently available to measure the constituents at the relevant limits.

2.2.2. PACKAGED FIELD WATER

Packaged field water (PFW) is water that is treated to make it potable and sealed in plastic pouches or bottles by military units or contracted services for ultimate distribution to individual personnel for drinking. The water should have a free available chlorine (FAC) residual unless the applied packaging process makes the chlorination step unnecessary. The packaged water has to be approved by the appropriate competent authority.

---

[2] HACCP= Hazard Analysis Critical Care Points

[3] Raw water is fresh, brackish or sea water that has not been previously used, treated, or purified. Raw water must be approved by a competent national (military) authority, prior to use and will be treated if required to meet potable water standards.

[4] MSES are based on “Evaluation of Military Field-Water Quality” (Daniels, 1990).

The fielded military or contracted production plant must be approved by the competent national military authority based on the following criteria:

- an initially performed audit with extended sampling,
- production and distribution according to the HACCP principles, and
- written operating procedures including a product quality monitoring plan performed or controlled by a competent authority assuring that the quality of the produced water is in compliance with the Long Term Standards in Annex A of this AMedP.

2.2.3. COMMERCIAL BOTTLED WATER

Commercial Bottled Water (CBW) is water that is sealed in plastic or glass bottles by commercial businesses and produced for human consumption.
CBW can vary from bottled tap water to mineral and spring water, with a broad range of mineral content from < 50 mg/l up to >1500 mg/l. The commercial producing facility should be approved by the competent national military authority based on at least one of the following criteria:

- a performed audit (e.g. Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement), or
- presentation of accepted certificates (FSSC 22000, BRC, IFS, SQF, NSF)[5] or
- information received by a partner nation based on STANAG 2556.

2.3. PERSONAL SANITATION WATER

Water used for personal hygiene results in exposure by dermal contact, inhalation and incidental ingestion. The quality of water used for personal hygiene should comply with the LTS of Annex A.

For the assessment of dermal contact by the chemical constituents there is insufficient data to establish guidelines.
The toxicological relevant (type I) LTS from Annex A are protective for the risk by inhalation and incidental ingestion. For the risk assessment of this type of constituents 2,5 times the LTS can be used[6].
The type I microbiological parameters of the LTS of Annex A should be applied without an extra factor.
Type II parameters not compliant to the LTS should be assessed on possible adverse health effects.

Inhalation of aerosols with Legionella spp is a specific risk while showering.
Countermeasures specific for this risk are specified in Annex C.

[5] FSSC = Food Safety System Certification; BRC = British Retail Consortium; IFS = International Food Standard; SQF = Safe Quality Food; NSF = National Sanitation Foundation)
[6] Technical Guide 230, Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personell, 2013, U.S. Army Public Health Command.

INTENTIONALLY BLANK

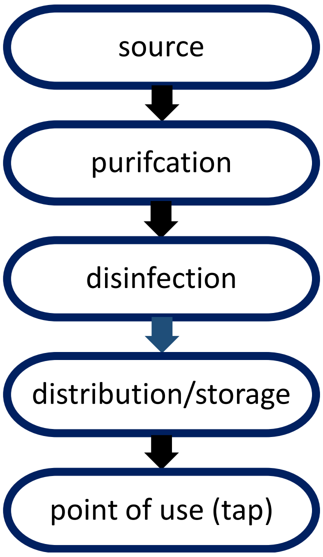
CHAPTER 3 RISK MANAGEMENT

3.1. GENERAL

The risk management procedures[7] to be used to maintain the quality of water in order to conserve performance and health should include:
– hazard identification,
– risk assessment,
– risk management (implementation of the controls) and
– evaluation (supervise implementation and evaluate effectiveness of the controls).

3.2. THE WATER SUPPLY CHAIN

The chain of water supply schematically divided in 5 steps:



The quality demands at the point of use (‘tap’) in relation to the quality (and its variations) of the source water determines the required treatment of the water. After purification countermeasures (e.g. disinfection) should be implemented to assure that quality loss during distribution/storage stays within the limits defined by quality demands at the point of use.
In the supply chain the major risks (Critical Control Point) and their countermeasures (treatment, process controls, monitoring) have to be identified.

[7] STANAG 2561 (AJMedP-4) - Allied joint medical force health protection doctrine.

1. Source

Deployed forces should make maximum use of local water supply systems. Where the quality or capacity of local systems is inadequate and cannot be quickly improved, alternative sources will have to be sought. The risk assessment starts with a characterization of the source based on map studies, available information and inspection. The assessment should describe the source character, its feeding area, relevant potential hazards, relevant potential threats and protection. The initial quality assessment (type I and IIa LTS of annex A) will reveal the direct risk of the source and determine the treatment method required for immediate use of the water source or for future development. Source water should be monitored periodically to identify trends.
The risk assessment starts with the (possible variations in) water quality of the source. The quality is determined by chemical, physical, microbiological and radiological parameters. The quality of the source should be monitored periodically to provide a timely indication of relevant decrease of quality.

2. Purification

Purification is the process of removing suspended solids, excessive dissolved solids, undesirable chemicals, and pathogenic micro-organisms including parasites, bacteria and viruses.
The source characteristics and the raw water quality determines the required purification step(s) to sufficiently reduce the level of contaminants in the source water. Multimedia and size-exclusion filters will remove suspended solids and some microbiological contaminants, but they will not remove dissolved solids or chemicals. If dissolved solids or chemicals must be removed from the raw water to meet the standards, technologies such as reverse osmosis, activated carbon and ion exchange must be used. Critical points in the individual step(s) should be monitored (preferably continuously) with process controls. The type of treatment will determine the process controls.
Frequently used combinations of purification step and process control are:

- reverse osmosis <> conductivity, and
- ultrafiltration <> turbidity.

3. Disinfection

Disinfection is the treatment of water to eliminate pathogenic micro-organisms. Directly after purification the water is disinfected, which is normally accomplished using chlorination or ultraviolet (UV) radiation. Chlorination is the preferred method because it leaves a measurable free available chlorine (FAC) residual. Produced water must contain a free available chlorine residual to make sure that the water is not re-contaminated during its transport and, or storage until the point of use/consumption.
Process controls for disinfection are:

- chlorination <> free available chlorine,
- UV disinfection <> inline detection of effective dose ($\geq$40 mJ/cm^2)[8].

[8] NSF/ANSI standard 55

At the point of production the FAC should be >0.5 mg/l, after a minimum of 30 minutes contact time. In case of increased risk of contamination of the supply chain, this concentration should be raised to 1 mg/l, but must not exceed 5 mg/l[9]. The above-mentioned concentrations should be maintained in bulk water. If water has a FAC < 0.2 mg/l anywhere during distribution it must be rechlorinated to > 0.5 mg/l after 30 minutes contact time.

4. Storage & transport
During storage and transport the quality of the water can deteriorate.
Main risk for field packaged and commercial bottled water is the migration of compounds from the bottle/package which can lead to reduced organoleptic acceptance of the water. High temperature during storage is a known factor for this risk of deterioration. PFW and CBW should be stored between 4°C and 30°C and out of direct sunlight.

For bulk water the deterioration of the quality can be caused by regrowth, migration (from water reservoirs, pipelines etc.) and contamination.

- To minimize risk of regrowth of opportunistic (pathogenic) bacteria and microbiological contamination the bulk water must have a free available chlorine concentration (FAC) ≥ 0.2 mg/l during all stages of storage and distribution until point/moment of use.
- Main risk by migration is caused by the use of Reverse Osmosis without remineralisation. This water can be aggressive, resulting in a significant increase of metal ions in the water from the internal lining of the pipelines, storage tanks, and water trucks.
- Deterioration of the water quality after purification is primarily determined by monitoring at point of production and point of use the parameters turbidity, colour, conductivity, colony count 22°C and coliform bacteria (see Annex B).
- FAC should be monitored as process control during storage/distribution in the supply chain directly after treatment until point of use.
- Generic countermeasures for contamination and regrowth are listed in Annex C

5. Point of use (tap)
The quality of the water at the point of use should be in compliance with the LTS of Annex A and monitored periodically (see Annex B) to verify the required water standards.
In case of a non-compliance the quality should be evaluated with the actual use of the water.

[9] WHO, Guidelines for drinking-water quality -4th ed., including the first addendum, 2017

3.3. MONITORING

Periodically or continuously monitoring of the water quality in the supply chain should be performed systematically to:

- specify the quality of the source,
- confirm the quality at the point of use,
- monitor possible deterioration after treatment, and
- monitor critical process-steps in the supply chain.

Annex B specifies the minimum sampling frequencies and sampling locations for monitoring of constituents. Deviation from this sampling strategy has to be documented in an operational analysis plan.

Analyses of the water quality should preferably be done by a laboratory accredited to ISO 17025 or working to equivalent procedures according to good laboratory practice (GLP). All test results (obtained both by field and by homeland facilities) and operational incidents with water quality aspects must be recorded and kept available for a minimum period of two years. Test results (and the underlying risk assessment) should be available in the theatre of supply.

3.4. MINIMUM FIELD TESTING CAPABILITIES

Field tests are performed under field conditions:

- for the safety assessment of drinking water,
- as indicators of water quality, and
- to confirm that equipment operates and processes perform appropriately.

For both routine and emergency situations, appropriate and adequate testing equipment should be available for field testing. The minimum capabilities for field testing are:

- E. coli
- Coliforms
- Turbidity
- Conductivity (or total dissolved solids)
- pH
- Free available chlorine (FAC)
- Colour
- Arsenic
- Cyanide

3.5. MULTINATIONAL WATER SUPPLY

Multinational water supply can be a responsibility of one nation or a group of nations. Contractors and third parties can be part of the multinational water supply.

The responsibilities for the supply of bulk water, PFW and CBW follow the same pattern. The producing nation is responsible for ensuring the quality of the (packaged) treated water, as is the purchasing nation for commercial bottled water. The producing, purchasing, and receiving nations are each responsible for maintaining the water quality during their national distribution, storage and transport.

The nation producing water to the benefit of other nations at a camp site with a stationary installation should perform the prescribed tests at the given frequencies (Annex B). The point of use in Annex B is the location where the receiving nation becomes responsible for the water quality.
For mobile facilities with frequently changing production/purification points, the producing nation should at least test for the STS that can be performed in the field (see pt. 3.4. Minimum field testing capabilities). When a mobile water production facility remains at the same location for longer than a month, the water supply should be monitored the same way as a stationary installation at a camp site.

Records of these control tests should be available for nations receiving the water in form of reports specifying at least the following information:
- Name of and contact information for the producing Nation/Organization/Unit,
- Time/date of sampling,
- Location of production operation,
- Description raw water source,
- Location(s) of sampling point(s),
- Purification techniques,
- Disinfection method,
- Intended use of the water by the producing nation (drinking and/or showering),
- Water quality: potable or non-potable,
- Test results for each constituent/parameter,
- Standards used to verify the quality,
- Statement of any non-compliant procedures and test results that don’t meet the standards,
- Unit/Organization/Laboratory responsible for sampling and analyses.

Nations receiving the water are in principle responsible for testing the water at their points of use to determine the water quality. Nations should at minimum test those parameters/constituents that can be negatively influenced during storage, distribution and transport.

CBW and PFW can be tested during storage, transport, and distribution, and should be tested in the event of a (suspected) problem with the water quality.

3.6. SUPPLY BY CONTRACTORS

Water provided by a contractor must comply with all the requirements specified for the routine situation. The contractor will provide a water supply plan (based on NEN-EN-ISO 9001 or equivalent) which describes at least the following aspects:
- Flow chart of the supply system,
- The capacity of the supply system,

- Quality of the raw water source,
- Specification (certificates if applicable) of the purification/disinfection system,
- Specification of local test equipment,
- Task (operating procedures), identity and qualifications (certificates if applicable) of operating personnel,
- Monitoring plan (constituents, sampling location, frequencies of testing, laboratory for testing, availability testing results),
- Procedures for corrective actions when quality is not in compliance.

Contractors using non-military water (treatment) equipment must use chemicals and materials that have been certified to the applicable NSF International (or equivalent standards like ACS (FRA), KIWA Water Mark (NLD), KTW (GER), WRAS (UK))[10]. The contracting entity must also ensure that the operators are trained and certified (if applicable) to operate the water treatment equipment and to test the quality of the water. The contracting entity must provide written copies of the test results LTS of Annex B) to all receiving nations. When the quality of the water does not meet the LTS at Annex A, the contracting entity will advise the other nations on the restriction for use and the initiated corrective action

[10] ACS = Attestation de Conformité Sanitaire; KIWA = Keurings Instituut voor Waterleiding Artikelen; KTW = Kunststoff-Trinkwasser; WRAS = Water Regulations Approval Scheme

ANNEX A STANDARDS FOR ROUTINE SITUATION

A.1. Long Term Standard

Constituent/characteristic[1]		Unit	Standard[2]	Type[3]	Remarks
Microbiological					
Coliform bacteria		CFU/100 ml	0	IIb	4
Escherichia coli (E. coli)		CFU/100 ml	0	I	4
Enterococci		CFU/100 ml	0	I	4
Colony count 22°C		CFU/ml	500	IIb	5
Clostridium perfringens		CFU/100 ml	0	IIb	4
Chlorine (free available)		mg/l	≥ 0.2 and ≤ 5	IIa	6, 7
Legionella spp		CFU/l	1000	IIb	4
Physical					
Colour		CU	15	IIa	8
Conductivity		µS/cm	1500	IIa	8, 9
Odour		-	Acceptable	IIa	4
pH		-	6.5 – 9.5	IIb	4, 10, 11
Taste		-	Acceptable	IIa	4
Turbidity		NTU	1	IIa	8
Chemical (inorganic)	**cas#**				
Aluminium	7429-90-5	mg/l	0.2	IIb	4
Ammonium	1336-21-6	mg/l	0.5	IIb	4
Antimony	7440-36-0	mg/l	0.02	I	
Arsenic	7440-38-2	mg/l	0.01	I	

[1] Selection of constituents/characteristics is based on Annex I of the European Directive 2020/2184 (December 2020); Additional constituents/characteristics added, are annotated.

[2] Standards are in principle copied from the Guidelines for Drinking-water Quality (4th edition including first addendum, 2017) of the World Health Organization (WHO). Standards based on another reference are annotated.

[3] Types are classified as:
I = health related parameter: non-compliance with the standard can result in a direct adverse health effect;
IIa = indicator parameter type a: non-compliance with the standard can result in an indirect adverse health effect (e.g. taste can limit consumption and result in dehydration)
IIb indicator parameter type b: non-compliance with the standard indicates a possible technical problem and should be evaluated for any human health risk.

[4] Standard is based on European Directive 2020/2184 (December 2020).

[5] EPA Guideline: above 500 CFU/ml heterotrophic bacteria can interfere with microbiological analyses of total coliforms and E. coli, and is an indicator for general regrowth after purification.

[6] Constituent/characteristic is not listed in Annex of the European Directive 2020/2184 (December 2020).

[7] Detailed information on preferred values for FAC is given in pt. 3.2. Disinfection.

[8] Standard is based on "Evaluation of Military Field-Water Quality" (Daniels, 1990).

[9] A minimum level of 200 uS/cm can be used as indicator for remineralization after reverse osmosis.

[10] When hypochlorite is used for disinfection an upper level of 8.5 is recommended.

[11] For water put into bottles or containers, the minimum value may be reduced to 4.5 pH units.

Constituent/characteristic		Unit	Standard	Type	Remarks
Chemical (inorganic)	**cas#**				
Boron (elemental)	7440-42-8	mg/l	2.4	I	
Bromate	-	mg/l	0.01	I	12
Cadmium	7440-43-9	mg/l	0.003	I	
Chlorate	-	mg/l	0.7	I	
Chloride	16887-00-6	mg/l	600	IIa	
Chlorite	-	mg/l	0.7	I	
Chromium	18540-29-9	mg/l	0.05	I	
Copper	7440-50-8	mg/l	2	I	
Cyanide	57-12-5	mg/l	0.05	I	13
Fluoride	7681-49-4	mg/l	1.5	I	
Iron	1309-38-2	mg/l	0.2	IIb	13
Lead	7439-92-1	mg/l	0.01	I	
Manganese	7439-96-5	mg/l	0.05	IIb	13
Magnesium	7439-95-4	mg/l	100	IIa	14, 15
Mercury (elemental)	7439-97-6	mg/l	0.006	I	
Nickel (elemental)	7440-02-0	mg/l	0.07	I	
Nitrate (as NO3 -)	14797-55-8	mg/l	50	I	
Nitrite (as NO2-)	14797-65-0	mg/l	3	I	
Selenium	7782-49-2	mg/l	0.04	I	
Sodium	7440-23-5	mg/l	200	IIb	13
Sulphate	14808-79-8	mg/l	300	IIa	15
Uranium	7440-61-1	mg/l	0.03	I	
Chemical (organic)	**cas#**				
Acrylamide	79-06-1	mg/l	0.0005	I	
Benzene	71-43-2	mg/l	0.01	I	
Benzo[*a*]pyrene	50-32-8	mg/l	0.0007	I	
Bromodichloromethane	75-27-4	mg/l	0.06	I	16
Bromoform	75-25-2	mg/l	0.1	I	16
Chloroform	67-66-3	mg/l	0.3	I	16
Dibromochloromethane	124-48-1	mg/l	0.1	I	16
Dichloroethane, 1,2-	107-06-2	mg/l	0.03	I	
Epichlorohydrin	106-89-8	mg/l	0.0004	I	
Tetrachloroethene (PERC)	127-18-4	mg/l	0.04	I	
Trichloroethene	79-01-6	mg/l	0.02	I	
Vinyl chloride	75-01-4	mg/l	0.0003	I	

[12] Only relevant when ozonation is used.
[13] Standard is based on European Directive 2020/2184 (December 2020).
[14] Constituent/characteristic is not listed in Annex of the European Directive 2020/2184 (December 2020).
[15] Standard is based on "Evaluation of Military Field-Water Quality" (Daniels, 1990).
[16] Trihalomethane: The sum of the ratio of the concentration of each to its respective guideline value should not exceed.

Constituent/characteristic	Unit	Standard	Type	Remarks
Chemical (pesticides)				
Individual	mg/l	0.0001	I	17, 18
Total	mg/l	0.0005	I	19
Radioactivity				
Total α activity	Bq/l	0.5		
Total β activity	Bq/l	1		

A.2. Short Term Standards

Constituents/characteristics		Unit	Standard	Type	Remarks
Microbiological					
Coliform bacteria		CFU/100 ml	0	IIb	
Escherichia coli (E. coli)		CFU/100 ml	0	I	
Chlorine (free available)		mg/L	detectable and ≤ 5	IIa	
Physical					
Colour		CU	15	IIa	
Conductivity		µS/cm	1500	IIa	
Odour		-	Acceptable	IIa	
pH		-	5 – 9.5	IIb	20
Taste		-	Acceptable	IIa	
Turbidity		NTU	1	IIa	
Chemical (inorganic)	**cas#**				
Arsenic	7440-38-2	mg/L	0.02	I	21
Cyanide	57-12-5	mg/L	2.0	I	21

[17] Standard of 0.0001 mg/l is a screening value originating from the European European Directive 2020/2184 (December 2020).In case of non-compliance Guidelines for Drinking-water Quality (4th edition including first addendum) of the World Health Organization (WHO) should be used to assess the specific individual pesticide(s). Pesticides without WHO guideline should be assessed by health-based standards (respectively maximum acceptable concentrations (MAC) and maximum contaminant levels (MCL)) from Health Canada and the US Environmental Protection Agency (EPA).

[18] In the case of aldrin and dieldrin the standard is 0.030 µg/l.

[19] Standard is based on European Directive 2020/2184 (December 2020).

[20] When hypochlorite is used for disinfection an upper level of 8.5 is recommended.

[21] Standard based on Technical Guide 230, Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personell, 2013, U.S. Army Public Health Command.

INTENTIONALLY BLANK

ANNEX B ANALYSES PROGRAM: PARAMETER, FREQUENCY AND SAMPLING LOCATION

Parameter/constituent	Sampling frequency/ year	Sampling location	
		production	point of use
Chlorine (free available)	365	x	x
Coliform bacteria	52	x	x
Colour	52	x	x
Conductivity	52	x	x
Escherichia coli (E. coli)	52	x	x
Odour	52	x	x
pH	52	x	x
Taste	52	x	x
Turbidity	52	x	x
Ammonia	12	x	x
Bromate[1]	12		x
Bromodichloromethane	12		x
Bromoform	12		x
Chlorate	12	x	x
Chlorite	12	x	X
Chloroform	12		x
Colony count 22°C	12		x
Dibromochloromethane	12		x
Enterococci	12	x	x
Nitrate (as NO3 -)	12	x	x
Nitrite (as NO2-)	12	x	x
Legionella spp	2	x	x
Clostridium perfringens	1	x	
Aluminum	1	x	
Antimony	1		x
Arsenic	1	x	x
Benzene	1		x
Boron (elemental)	1	x	
Cadmium	1	x	x
Chloride	1	x	

[1] Only relevant when ozonation is used.

Parameter/constituent	Sampling frequency/ year	Sampling location	
		production	point of use
Chromium	1	x	x
Copper	1	x	x
Cyanide	1	x	
Fluoride	1	x	
Iron	1	x	x
Lead	1	x	x
Magnesium	1	x	
Manganese	1	x	x
Mercury (elemental)	1	x	
Nickel (elemental)	1	x	x
Selenium	1	x	
Sodium	1	x	
Sulphate	1	x	
Uranium	1	x	
Acrylamide[2]	1		x
Benzo[a]pyrene	1	x	
Dichloroethane, 1,2-	1	x	
Epichlorohydrin[2]	1		x
Pesticides Individual/total	1	x	
Tetrachloroethene (PERC)	1	x	
Trichloroethene	1	x	
Vinyl chloride[2]	1		x
Total α activity	1	x	
Total β activity	1	x	

[2] Analyses of this constituent is only applicable when materials are used in the water supply system that can release this compound.

ANNEX C COUNTERMEASURES FOR CONTAMINATION & REGROWTH

1. A decrease in the quality of water during storage, transport and distribution can be caused by internal and external factors. Contamination and regrowth are the two major risks.

2. Contamination can occur:
   a. when treatment systems fail;
   b. when contaminated water surrounding the distribution system enters because of low internal pipe pressure or through the effect of a "pressure wave" within the system;
   c. when contaminated water is drawn into the distribution/storage system through back flow resulting from reduction of line pressure and a physical link between contaminated water and the distribution/storage system;
   d. through human error (illegal or unauthorised connections) resulting in unintentional cross-connection of waste/stormwater pipes into the distribution system;
   e. through intentional contamination by enemy/terrorist action;
   f. through open or unsecured storage of treated water, including, for bottled and packaged water, warehouses, field storage locations, and the bottles and packages themselves;
   g. when existing mains are repaired or when new mains are installed by the introduction of contamination (soil, debris) into the system;
   h. through leaching or dissolving of chemicals and metals from bottles and packaging materials, pipes, solders, jointing compounds, taps and chemicals used in cleaning and disinfection;
   i. through diffusion through pipes, bottles and packaging materials, of chemicals like petrol, oil and chemical war agents;
   j. if no or improper cleaning and disinfection procedures have been applied to storage tanks and water trucks.

3. The countermeasures for contamination include technological and security-based actions:
   a. performing adequate routine monitoring of physical, chemical, and biological indicators of possible contamination;
   b. maintaining adequate system pressure;
   c. having and periodically testing back-up power systems;
   d. installing prevention devices for cross-connection and back-flow;
   e. fully securing storage and distribution systems;
   f. implementing timely and effective repair procedures;
   g. following good practices in cleaning and disinfection procedures;
   h. establishing security precautions against sabotage;
   i. performing enhanced and more frequent surveillance and monitoring when the threat level rises.

4. Cleaning and disinfection procedures include the following:
   a. implement and apply adequate methods for cleaning and disinfecting containers, tubing, distribution system and connection pieces prior to use, and if required;
   b. Clean and disinfect containers and distribution system components after they are used to carry any non-potable water and when containers, tubing, or connection pieces have been contaminated;
   c. Clean, disinfect, and properly store empty containers, tubing, and connecting pieces;
   d. Keep records available for a minimum period of two years of all cleaning, disinfection, and any corrective actions

5. Regrowth of bacteria in stored and distributed water can be controlled by:
   a. aggressive cleaning, disinfecting, and inspecting all components of water supply storage, transport, and distribution systems prior to putting them into use;
   b. avoiding accidental contamination and maintaining a free available chlorine;
   c. examining the concentration of free available chlorine in bulk and packaged water periodically during storage and transport/distribution. This will give an indication of the integrity of the supply chain after purification and the potential for regrowth;
   d. maintaining sterile water packaging environments and the sterility of packaging material;
   e. storing bottled and packaged water out of direct sunlight and preferably in a conditioned location.

6. Legionella spp are a specific risk in the hot water part of distribution system of sanitary water and can be controlled by:
   a. Keeping the temperature of sanitary hot water permanently at or above +55°C at the output of the production/storage equipment. If the temperature is below +55°C the temperature should be increased at least weekly minimal:
      - five minutes if the water temperature reaches or exceeds +70°C;
      - 10 minutes if the water temperature reaches +65°C;
      - 20 minutes if the water temperature reaches +60°C.

      In order to limit the risk of burns:
      - the maximum temperature of the sanitary hot water must be set at +55°C at faucets of the washrooms;
      - in other rooms, the maximum temperature of the sanitary hot water must be limited to +60°C (+140°F) at faucets.
   b. Looping the sanitary hot water distribution system. The absence of looping is permitted if the volume of water contained in the pipe between point of production/storage of the hot water and the farthest point of use does not exceed three liters.

ANNEX D MINIMUM STANDARDS EMERGENCY SITUATIONS (MSES) FOR SHORT TERM (≤ 7 DAYS) WATER CONSUMPTION

Constituent or Characteristic[1]	Unit	Standard[2]		Potential Health Effect
		5 L/day	15 L/day	
Microbiological				
E.coli[3]	No/100 ml	0	0	Mostly gastro-intestinal effects due to presence of pathogenic micro-organisms, *E.coli* is indicative of the presence of pathogenic micro-organisms
Physical				
colour	CU[4]	50	50	Risk of dehydration due to reduced water consumption caused by decreased palatability; symptoms of dehydration include weariness apathy, impaired co-ordination, delirium, heat stroke
turbidity	NTU[5]	1	1	- Risk of dehydration due to reduced water consumption caused by decreased palatability, - Mostly gastro-intestinal effects due to presence of pathogenic micro-organisms, caused by decreased disinfection efficiency.

[1] Health related constituents and characteristics, other than those listed in the table, are to be maintained at levels which are as low as is reasonably practicable. This will require sufficient effort, depending on the circumstances, to ensure that health related risks will not be expected.

[2] Minimum Standards Emergency Situation are scientifically based levels at which some sensitive individuals might experience adverse short-term health reactions, but overall unit performance and mission accomplishment should not be jeopardized. [Daniels, .I.I, and G.M. Galledos eds., Evaluation of Military Field-Water Quality', Lawrence Livermore National Laboratories, 1990].

[3] Before testing for *E.coli*, sodiumthiosulphate shall be added to the sample to remove chlorine.

[4] CU = Colour Unit; one Colour Unit = 1 mg platinum per liter water (cobalt-platinum method).

[5] NTU = Nephelometric Turbidity Unit

Constituent or Characteristic	Unit	Standard		Potential Health Effect
		5 L/day	**15 L/day**	
Physical				
conductivity[6]	µS/cm	1500	1500	Risk of dehydration due to reduced water consumption caused by decreased palatability
pH	-	5-9.5	5-9.5	More corrosive activity on lower pH and decreased disinfection efficiency at higher pH
odour and taste	-	Acceptable	Acceptable	Risk of dehydration due to reduced water consumption caused by decreased palatability
Chemical				
arsenic (As- fraction)	mg/l	0.3	0.1	Facial swelling, vomiting, loss of appetite, abdominal pain, diarrhoea, shock, muscle cramps, headache, chill, cardiac abnormalities, anaemia, decreased white blood cell count, enlargement of liver, delayed effects including sensory and motor peripheral polyneuropathies
magnesium	mg/l	100	30	Laxative effect that can lead to symptoms of dehydration including weariness apathy, impaired co-ordination, delirium, heat stroke
chloride	mg/l	600	600	Risk of dehydration due to reduced water consumption caused by decreased palatability
cyanide	mg/l	6	2	Headache, breathlessness, weakness, palpitation, nausea, vomiting, giddiness, tremor, rapid heartbeat, dizziness, confusion, anxiety, agitation, cardiac arrhythmias, seizures, stupor, coma
inorganic mercuric compounds[7] (Hg-fraction)	mg/l	0.003	0.001	Mercury compounds mainly have health effects on the kidney and the central nervous system

[6] The measurement of the conductivity is an indicator for the total dissolved solids. The standard for total dissolved solids is 1000 mg/l (independent the consumption level and period of consumption. The conversion-factor depends on the nature of the water and varies for natural waters from 0.55 to 0.70 (mg*cm) /(*µS). The most conservative factor (0.7) is used for the conversion

[7] At the moment these constituents cannot be measured (with simple techniques in the field).

Constituent or Characteristic	Unit	Standard		Potential Health Effect
		5 L/day	15 L/day	
Chemical				
sulphate	mg/l	300	100	Laxative effect that can lead to symptoms of dehydration including weariness apathy, impaired co-ordination, delirium, heat stroke
total organic halogen[8], [9] (Lindane as reference),	mg/l	0.450	0.150	Variable depending on the specific halogenated hydrocarbon(s)
lewisite (arsenic fraction)	mg/l	0.080	0.027	Nausea, vomiting, diarrhoea, abdominal pain, intense thirst, weakness, hypotension, hypothermia
sulphur mustard	mg/l	0.140	0.047	Nausea, vomiting of blood, diarrhoea, abdominal pain, fever, headache, cardiac arrhythmias, dizziness, malaise, loss of appetite, lethargy, convulsion, leukopenia, anemia, immumosuppression
nerve agents	mg/l	0.012	0.004	Nausea, vomiting, diarrhea, abdominal cramps, headache, giddiness, dizziness, excessive salivation, tearing, miosis, blurred or dim vision, difficult breathing, cardiac arrhythmias, loss of muscle coordination, muscle twitching, random jerking movements, convulsions, coma
T-2 toxins	mg/l	0.026	0.0087	Nausea, vomiting, diarrhea, generalised, burning erythema, mental confusion

[8] At the moment these constituents cannot be measured (with simple techniques in the field).

[9] Total organic halogen (TOX) is measured as chloride: adsorption of the TOX on granular activated carbon and combustion of the carbon to form hydrogen halide, which is measured by microcoulometry. The toxicity for the wide range of halogenated hydrocarbons differs extremely. The TOX standard is based on the insecticide lindane; the emergency standards for lindane are for 0.6 mg/l at 5 l/day and 0.2 mg/l at 15 l/day.

Constituent or Characteristic	Unit	Standard		Potential Health Effect
		5 L/day	15 L/day	
Radiological				
alpha	Bq/l	28500	9500	Nausea, vomiting, diarrhea The standard of each type of radiation correspondents with an exposure of 250mSv.[10]
beta	Bq/l	255000	85000	
gamma	Bq/l	300000	100000	

---

[10] Even under emergency situations, every effort should be made to keep the dose "as low as reasonably achievable (ALARA)". In STANAG 2473 Edition 2 (Commanders guide to radiation exposure in non-article 5 crisis response operations) the following limits are specified for emergency situations:

- For priority tasks, i.e. tasks that contain the hazard, avert danger to persons or allow the mission to continue without major revisions in the operational plan, exposures of up to 100 mSv should not be exceeded.
- For critical tasks, i.e. tasks that save lives or allow continued support that is deemed essential by the Operational Commander to conduct the mission, 250 mSv are considered permissible.

The radiological standards at the exposure of 100 mSv can be derived by multiplication the standards at 250 mSv with a factor 0.4.

According to STANAG 2473 some critical tasks may be continued above 250 mSv. Moreover, in case of radiation exposure between 250 and 750 mSv, acute adverse health effects will develop, resulting in immediate performance degradation. At this level of exposure, STANAG 2461, AMedP-6(C) Nuclear, recommends expedited evacuation from the operational environment, i.e. personnel affected will not be able to continue their mission. The standards in the table do not take into account the possibility of external whole body irradiation. If external radiation has been confirmed by dosimetry or has to be expected, an adapted activity limit can be calculated using the following equation:

$$\text{Activity-Limit}_{[\,\text{Bq/l}\,]} = \frac{\text{Dose - Limit}_{[\,\text{Sv}\,]} - \text{External Dose}_{[\,\text{Sv}\,]}}{\text{dose coefficient}_{[\,\text{Sv/Bq}\,]} \cdot \text{expected consumption volume}}$$

The levels of the different types of radiation that corresponds with the exposure limit of 250mSv in the table are based on worst-case dose coefficients. The following radionuclide's which are released in significant quantities following a nuclear explosion or a nuclear accident were used for the estimation of the standards:

Radiation type		Nuclide	Dose coefficient (ICRP-72) [Sv/Bq]
Alpha		Pu-239	2.5E-07
Beta		Sr-90	2.8E-08
Gamma		I-131	2.2E-08

INTENTIONALLY BLANK

AMedP-4.9(B)(1)