NATO STANDARD

AEP-4784

CLEARANCE DECONTAMINATION

Edition A, Version 1

FEBRUARY 2022

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED ENGINEERING PUBLICATION

Published by the
NATO STANDARDIZATION OFFICE (NSO)

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

18 February 2022

1. The enclosed ALLIED ENGINEERING PUBLICATION AEP-4784, Edition A, Version 1, CLEARANCE DECONTAMINATION, which has been approved by the nations in the NATO ARMY ARMAMENTS GROUP (NAAG), is promulgated herewith. The recommendation of nations to use this publication is recorded in STANREC 4784.

2. AEP-4784, Edition A, Version 1, is effective upon receipt.

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

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Major General, GRC (A)
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]
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EXECUTIVE SUMMARY

NATO doctrine defines four levels of CBRN decontamination: Immediate, Operational, Thorough and Clearance decontamination. The most challenging of these is Clearance decontamination. Clearance decontamination is defined as: “decontamination of materiel to a standard sufficient to allow unrestricted transportation, maintenance, employment or disposal.”[1]. This AEP provides guidance on clearance decontamination for individual nations. It provides a decision-making process for clearance decontamination and the factors that need to be considered a case by case basis by operational planning staffs. It also provides guidance on the levels of ‘cleanliness’, or acceptable residual contamination levels, that need to be achieved for clearance decontamination.

[1] NATO Terminology Database

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CHAPTER 1 INTRODUCTION

1.1 Introduction

The use of CBRN weapon or devices by an adversary or any other situation (accidental or natural release such as epidemics) is a threat against which NATO Forces must be prepared. Current Doctrine[2] defines several different levels of decontamination. These are Immediate, Operational, Thorough and Clearance. Clearance decontamination is likely to be carried out at the end of a mission or when regenerating forces for a new mission. It is the most technically challenging of all the decontamination levels and may not be achievable.

1.2 Aim

The aim of this discussion paper is to define the NATO process for achieving CBRN Clearance decontamination of Allied Forces materiel, infrastructure and platforms. This process excludes CBRN contaminated human remains[3], waste and casualties, which are all covered by differing advice.

1.3 Definition

Clearance decontamination is defined as: “Decontamination of materiel to a standard sufficient to allow unrestricted transportation, maintenance, employment or disposal [4]. National policies will dictate the level of cleanliness required upon completion of the decontamination. This paper outlines a decision-making methodology to support national clearance decontamination planning as well as providing guidance on levels of cleanliness. In some circumstances it may be decided that clearance decontamination may be too difficult or too expensive and so would not be attempted. In these cases, the focus is on waste management and disposal. Further definitions are given in Annex C.

[2] STANAG 2451 – AJP-3.8 Allied Joint Doctrine for Comprehensive CBRN Defence, Oct. 2018
[3] (U) NATO Guidance for the Handling of Contaminated Human Remains on NATO-led Operations, Senior Defence Group on Proliferation, (12 Jun 2008).
[4]NATO Terminology Database

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CHAPTER 2 PRINCIPLES

2.1 Overall Principles for Decontamination

Due to the number of possible substances involved in a CBRN incident and the different approaches that will be required to achieve, clearance decontamination should be dealt with on a case-by-case basis. This direction therefore acknowledges that achieving clearance decontamination is bound by national laws, is threat specific and reliant on the available sampling and decontamination technologies. The process in this document and the flow chart in Annex A therefore focuses on establishing the decision-making process for clearance decontamination and the factors that will need to be considered, rather than trying to prescribe solutions for every possible eventuality. Annex B provides guidance on the levels for clearance decontamination from open sources. It is to be used as guidance only as part of the planning process. Each clearance decontamination will have to be planned on a case by case basis dependent upon a wide range of factors.

In an ideal world, the risk from CBRN substances would be eliminated by clearance decontamination completely. However, it is highly unlikely that equipment can be made free of all traces of contaminant. The levels given in Annex B provide guidance on cleanliness levels that may be acceptable. In most cases rather than risk elimination, clearance decontamination involves a process of evaluating the ability to meet a nationally accepted Clearance Level and should be conducted to be as low as reasonably achievable (ALARA)/as low as reasonably practicable (ALARP)[5] principle where possible. ALARP involves weighing a threshold against the trouble, time and money needed to reach it. Clearance decontamination should in all cases seek to "clean" the equipment/platform to a nationally acceptable Clearance Level as a minimum, keeping within applicable national military and civil legislation. In the cases where the ALARP risk does not meet the nationally accepted Clearance level then containment or quarantine activities may need to be carried out in preparation for future decontamination efforts or the evaluation of the equipment/platform as waste.

2.2 Strategy

Any clearance decontamination strategy should consider:

[5] What is "practicable" may depend on operational considerations and wider national and international considerations. "'Reasonably practicable' is a narrower term than 'physically possible' … a computation must be made by the owner in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them – the risk being insignificant in relation to the sacrifice – the defendants discharge the onus on them." UK Court of Appeal (in its judgment in Edwards v. National Coal Board, [1949] 1 All ER 743)

- The options available for sampling to clearance levels**.**

    i. The associated limitations of available detection, identification and monitoring equipment, field analytical equipment and laboratory analytical equipment. Many equipment specific limits of detection will be insufficient to detect down to required residual contamination levels.

    ii. Appropriate sampling techniques and equipment will need to be selected to appropriately assess both vapour and surface contamination to the require levels.

    iii. Sampling will need to include areas which might routinely be inaccessible, but nonetheless could become exposed during maintenance, equipment disassembly, servicing etc. This includes capillaries between panels, within screw threads, and voids.

- The potential health effects from exposure to the residual contamination.

- Access to verifiable clearance decontamination equipment and processes, to provide robust evidence that clearance levels have been met.

- Legal and safety requirements, which includes each nation's respective duty of care toward their personnel and compliance with their national legislation.

- Political acceptability.

- The ability to control the impact of the effects of decontamination on the local environment.

2.3 Critical Equipment

The strategy must address whether it is necessary to carry out the clearance decontamination of the equipment/platform to help regenerate military capability. It must address:

- **Criticality of equipment**. The effects of losing critical equipment or a whole platform to CBRN contamination can have wide ranging consequences if the equipment is unable to be replaced after operations.

- **Cost**. The financial cost of decontaminating a piece of equipment versus the operational impact and financial cost of losing a piece of equipment/platform; including the associated cost of disposing of that contaminated piece of equipment.

- **Risk**. The risk to the supply chain if any transportation is required prior to undertaking clearance decontamination. Movement of contaminated equipment must use containment to ensure unprotected personnel are not exposed to CBRN hazards and be in accordance with international laws.

- **Political/Reputational Issues.** In some cases, the operationally prudent option may be disposal of contaminated equipment in the operational theatre. Such an option of knowingly leaving contaminated equipment in a host nation may have long term political and reputational issues for NATO. In accordance with international law, the management & disposal of this equipment is likely to remain the responsibility of the NATO nation regardless.

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CHAPTER 3 PROCEDURES

3.1 Risk based Approach

NATO doctrine considers clearance decontamination to be applicable after the termination of conflict. Conduct of clearance decontamination to be a civilian, or a military, capability. The adoption of an ALARA/ALARP approach aimed at returning equipment and platforms to a tolerable level for interaction with civilian personnel; for whatever purpose this may be (e.g. deep maintenance). Each nation must nominate a lead authority responsible for the decontamination tactics, techniques and procedures (TTP) and will provide technical oversight and auditing of any monitoring and decontamination work carried out. A flowchart which outlines how clearance decontamination should be conducted is at Annex A.

3.2 Cleanliness Levels

Clearance decontamination procedures are such that the process is verified as being achieved by determining the residual contamination levels on every part of the equipment and demonstrating that those levels are below those determined, on a case-by-case basis, by the appropriate civilian authorities responsible for the health and safety of the civilian population from the member state in question. Guidance on levels is given in Annex B.

3.3 Containment and Transportation of Contaminated Materiel

Transportation of previously contaminated materiel, where residual contamination is at such a level that access must be restricted, must be subject to suitable precautions and containment to meet any applicable national legislation, regulations and policy. Where cross-border movement is required these precautions must also adhere to the legislation of those nations involved and relevant international organisations. In all cases, the respective member national legal service and transportation laws are applicable.

If it is necessary to send contaminated equipment back to a manufacturer for work of any kind, the member nations' respective design and support authorities must always be informed of the prior exposure of that equipment. The equipment should only be transferred when these authorities have reached agreement with the contractor on the health and safety implications of any work and what precautions must be taken.

Decontamination and transportation/repatriation activities require health and safety management TTP. It is the responsibility of the relevant national authorities to ensure

that health and safety management is in place for clearance decontamination activities and transportation/repatriation following an incident. An over-arching and endorsed health and safety case may be beneficial if prepared in advance of a CBRN incident. In some case repatriation might require political approval.

3.4 Records

Materiel/platforms that have been contaminated and subsequently decontaminated should have been marked as such and have records kept of the CBRN substance decontaminants used, and means used (equipment/samples) to determine the level of decontamination or residual levels This information will be of use when managing fleets of materiel/platforms as well as when new scientific information/data comes to light.

3.5 Clearance decontamination of ships

Clearance decontamination is performed on a ship to reduce contamination to below clearance levels. Clearance decontamination procedures for ships provides for the decontamination of equipment and personnel to a level that allows unrestricted transportation, maintenance, employment, and disposal. For a ship, this level of decontamination may only be possible using fixed facilities such as a shipyard or other such industrial facilities, depending upon the type and concentration of the agent(s) encountered. For a ship, it is typically conducted after termination of conflict and return to a homeport or a shipyard maintenance facility, when the commander determines it is in the unit's best interest, or when directed by higher authority. For additional information on shipboard decontamination procedures, see ANEP-57.

**Annex A to
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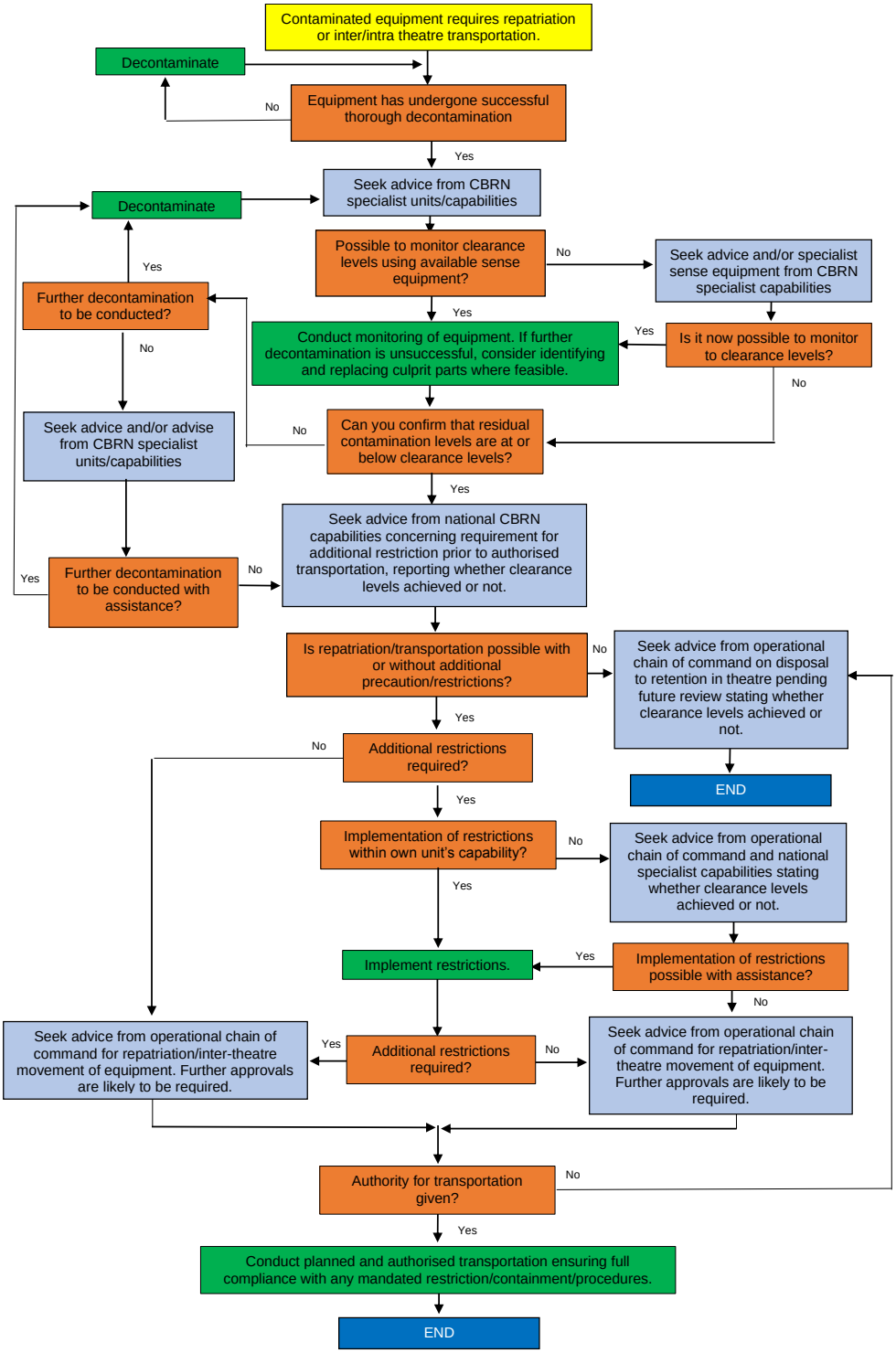
ANNEX A - FLOWCHART FOR THE POST CBRN CONTAMINATION RETURN OF PLATFORMS/EQUIPMENT BACK TO THE MEMBER STATE



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ANNEX B – GUIDANCE ON CBRN CLEARANCE DECONTAMINATION LEVELS

The toxicological information contained in this Annex is taken from open source data (see appendix 4) and is for guidance to aid planning. References may also be used to help generate requirements for clearance decontamination capabilities, and more importantly sensor equipment to verify the level of decontamination achieved.[6]

Current doctrine does not specify the levels to be achieved by clearance decontamination it only details some of the issues relating to it.[7] The Appendices to this Annex list the clearance levels for Chemical, Biological and Radiological contamination.

The terminology used in this Annex is listed at Annex D.

Appendices:

B-1. Chemical Hazards

B-2. Biological Hazards

B-3. Radiological Hazards

B-4. List of References

[6] Many of the levels recommended here may be beyond the detection capabilities of generalist military CBRN sensor equipment.
[7] ATP-3.8.1 VOL 1.

APPENDIX 1 TO ANNEX B – CHEMICAL HAZARDS

Both vapour and surface contamination levels must be evaluated separately when assessing levels of contamination. In the below table, the General population (GPL) column states a suggested vapour concentration limit for clearance levels. Surface contamination level guidance has not been provided, but a limit for clearance levels must be established & evaluated against before clearance decontamination can be considered to have been achieved.

The vapour relates to the hazard posed by the “off gassing” of the agent to the individual. This vapour hazard may build up to dangerous levels if the item/system is contained in any way.

The rate of “off-gassing” will depend on factors such as:

a. The physical properties of the CWA.

b. The temperature and other environmental factors.

c. The nature and shape of the surface that has been contaminated.

d. The exposure time that could emphasis the concentration of the product.

The surface contamination relates to the hazard posed by the contact between the surface and the individual. The required maximum residual surface contamination levels for Chemical Warfare Agents will be particularly challenging and may be beyond current technologies. They should be determined based on national assessment. This assessment should be based on an exposure limit which poses negligible risk of health effects, but should consider appropriate daily exposure limits, the likely number of touches within a day and the amount of surface area being contacted. As clearance decontamination is for unrestricted use, possible exposure during any and all maintenance/disassembly tasks must also be considered, including the risk of entrapped agent.

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Chemical Hazards	Percutaneous	Lethal	Immediately	Occupational	General population	Worker Population Limit	General population
	Toxicity	Concentration Time Ratio (10 min)	Dangerous to Life & Health (IDLH)	TWA - Short term exposure limit (STEL)	Acute Exposure Guideline (GPL) (AEG Level 1)	(WPL)	(GPL)
	LD_{50}	LCt_{50}		15min x 4 times per day	10 min	8hrs daily/multi yr time weighted average	24hrs x 7days per week
Agent	(mg/kg)	(mg-min/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)
Tabun	21.4 [1]	120[1]	0.1[2]	0.0001[2]	0.0069[2]	0.00003[2]	0.000001[2]
Sarin	24.3[1]	60[1]	0.1[2]	0.0001[2]	0.0069[2]	0.00003[2]	0.000001[2]
Soman	5[1]	60[1]	0.05[2]	0.00005[2]	0.0035[2]	0.00003[2]	0.000001[2]
Cyclosarin	5[1]	60[1]	0.05[2]	0.00005[2]	0.0035[2]	0.00003[2]	0.000001[2]
VX	0.07[1]	15[1]	0.003[2]	0.00001[2] [9]	0.00057[2]	0.000001[2]	0.0000006[2]
Mustard	20[1]	1710[1]	0.7	0.003[2]	0.4[2]	0.0004	0.00002[2]
Phosgene	Not Available	3200[4]	8 (3)	0.4 (VLE) 0.8 [C]	Not Available	0.4	Not Available

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Chemical Hazards	Percutaneous	Lethal	Immediately	Occupational	General population	Worker Population Limit	General population
	Toxicity	Concentration Time Ratio (10 min)	Dangerous to Life & Health (IDLH)	TWA - Short term exposure limit (STEL)	Acute Exposure Guideline (GPL) (AEG Level 1)	(WPL)	(GPL)
	LD_{50}	LCt_{50}		15min x 4 times per day	10 min	8hrs daily/multi yr time weighted average	24hrs x 7days per week
Agent	(mg/kg)	(mg-min/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)	(mg/m^3)
Lewisite	8 – 30[6]	1200 – 1500	0.7	0.003[4]	Not Available	0.0004 or 0.003[12]	Not Available
Cyanogen Chloride	Not Available	11000[4]	Not Available	0.75 [C] 0.77[8]	Not Available	0.6[3]	Not Available
Chlorine	Not Available	6000 – 19000	Not Available	2.9[8]	2.9	1.5[8]	Not Available
Arsenic	Not Available	Not Available	5	*0.002 (inorg) 0.5 (org)*	Not Available	0.01[8]	Not Available

APPENDIX 2 TO ANNEX B – BIOLOGICAL HAZARDS

This section provides a process for developing hazard clearance level by establishing specific guidance for the reinstatement for platforms and material contaminated with a biological hazard. Commanders should evaluate the overall risk to personnel and mission objective when implementing this guidance. The processes used to achieve biological hazard clearance levels should be health protective for unrestricted use. This means that a clearance level is achieved when residual biological hazard is at or below health-based exposure level protective of public health following biological decontamination. Adherence to the procedures provides for a general level of protection. Although this guidance does not set an upper bound limit, such as 10-6 log kill (reduction of viable organisms by a factor of 10^6), it does establish a process for clearance certification decisions while identifying an acceptable level of protection. The general CBR hazard clearance process for CBR hazard contaminated platforms and material involves planning considerations related to the clearance process of any CBR hazard. However, there are several additional planning factors for biological agent clearance decontamination. Health-based biological agent exposure guidelines informing clearance decontamination levels for biologically contaminated platforms and materiel are still under development at the time of this issuance's writing and will be incorporated into updated guidance policy or this issuance.

Clearance decontamination strategies require not only identifying the biological hazard and verifying its presence, but also obtaining information about that hazard. Characteristics of a biological hazard that are critical to the decontamination effort include the environmental persistence, viability or biological activity, and concentration of the biological hazard and its susceptibility to inactivation. Biological agent decontamination requires the use of decontamination products, technologies, and methods that have demonstrated biocidal activity or similar destructive influence against a specific biological hazard. The biological agent decontamination strategy should be relevant to the specific biological hazard posed, the amount of biological agent-contamination, its physical form, environmental conditions, and interfering materials (such as oil, grease, soil, and vegetation) that could reduce decontamination effectiveness.

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Biological Hazard **AGENTS**	**Incubation Period** **Hours (h) Days (d) Weeks (w)**	**Infectious Dosage (ID_{50})** **Particles, (CFU or PFU)**	**Fatality Rate** (if untreated) **%**
Bacillus anthracis (Inhaled)	1-7d	8000-10000	90%
Bacillus anthracis (Cutaneous)	1-7d	600-2000	20%
*Brucella** (Inhaled, small animal)	1-60d	10-500	2-6%
*Brucella** (Inhaled, human)	1-60d	Not available**	2%***
Brucella (Ingested)	Not Available	Not Available	<1%
Burkholderia mallei	10-60d	1000?	95%
dicBurkholderia	2d->4w	10-10000	70%
Coccidiodes immitis	1-4 w	?	?
Coxiella burnetii	2-3 w	1-10	< 1% (rare)
Ebola (contact/aerosol)	2-21 d	10-50	50-90%
Franciella tularensis (Inhalation)	2-10d	10-50	30-60%
Franciella tularensis (cutaneous)	2-10d	10-400	10%
Marburg Virus	2-14d	100	25-80%
SARS-CoV-2	5-7d	10-1000 (est)	0.1-14.1% (age dependent)
Variola Virus	7-19 d	10-100	30% (variola major) [13] <1% (variola minor) [13]
Venezuelan equine encephalitis virus (VEEV)	5-15 d	10-100	<1% (rare)
Yersinia pestis (sub-cutaneous)	1-10d	<100	50%-90%
Yersinia pestis (aerosol)	1-4d	100-10000	100%

*species from the *Brucella melitensis* group, i.e. *Brucella melintensis*, *Brucella abortus*, *Brucella suis.*
**Many published articles have reported without citation that the minimal infectious dose for brucella is between 10 to 100 cfu. Primate infection assays show that the ID_{50} ranges between 1000-100000 ufc (for a review, Olsen et *al.* 2018, vol. 23(2) 77-90, DOI: 10.1177/1535676018771983).
*** Fatality rate of 80% in case of acute endocarditis (6% occurrence).

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Biological Hazard	**Time to Onset of Symptoms**	**Fatality Rate**	**LD_{50}**
		%	**ug/kg**
Anatoxin A (VFDF) neurotoxin	Mins	Unknown	170-250 50 Anatoxin A (s)
Conotoxin	Mins	Unknown	5-20 (type dep.) s.c mice or 3-6
Palytoxin		Unknown	0.03 – 0.45 i.v mice or 0.08 (human)
Batrachotoxin	Mins	Unknown	2 s.c mice; 1-2 human est. or 0.1-2.0
Diptheria Toxin	Delayed	Unknown	0.03 - 0.1 human i.m
Saxitoxin	10 mins - 4hrs (dose dep)	Unknown	3 i.v mice 8-9 i.p mice or 1-2
Tetrodotoxin	30 mins - 4hrs (dose dep)	Unknown	10 i.p mice; 30 human
Botulinum toxin type A	12 – 72hrs	50- 60%	0.0002-0.0012 i.p mice or 0.01 inh human
Clostridium perfringens Epsilon toxin	Delayed	Unknown	0.1-5 or 7.7 i.p rat 0.07-0.2 inh human
Ricin (E-D)	18 – 24hrs	~6%	2-5 i.p mice 3.7-14 inh rat 1-10 inh human

Staphylococcal enterotoxin B	3 – 12hrs	Unkn own	0.02 – 1.7 human 1-15 i.v mice 20 i.v monkey 20-40 inh monkey
Trichothecene (e.g. T2)	30mins – 12hrs (dose dep)	Unknown	25-50 human or 0.0052 i.p mice

APPENDIX 3 TO ANNEX B – RADIOLOGICAL HAZARDS

Guidelines for clearance decontamination of radiologically contaminated materiel/platforms will be primarily focused on the containment of radiological content and the control of external radiation levels. For containment of radiological content, the materiel/platforms must be assessed for removable contamination and fixed contamination. Removable contamination is contamination that is easily transferred from one location to another by normal means such as touching the area. Fixed contamination is contamination that is not easily transferable without mechanical deformation of the material such as sanding or grinding the area. For control of external radiation levels, acceptable radiological doses are based upon avoiding exposures to radiation that would cause immediate injuries deterministic effects (hours to weeks) and limiting long-term delayed effects of exposure (years to lifetime), such as cancer, called stochastic effects. For clearance decontamination, it is likely that the potential for stochastic effects will be the principal concern due to expected low levels of radiological exposure after initial decontamination efforts. It is currently accepted that the risk of a stochastic effect is proportional to the dose received and that there is no threshold below which the risk is zero, i.e. no matter how small a radiation dose is received, there will still be some risk associated with it. For radiologically contaminated items clearance levels are chosen in order to be protective of public health, promote consistency with International Atomic Energy Agency guidance, and ensure freedom of transit of material/ platforms across international borders

Radiation doses are measured in Sieverts (Sv). In effect, this is a measure of the risk of stochastic radiation effects associated with a radiation exposure. However, the Sievert is a large unit, so more realistic exposures are likely to be within the milliSievert (mSv) or microSievert (μSv) ranges.

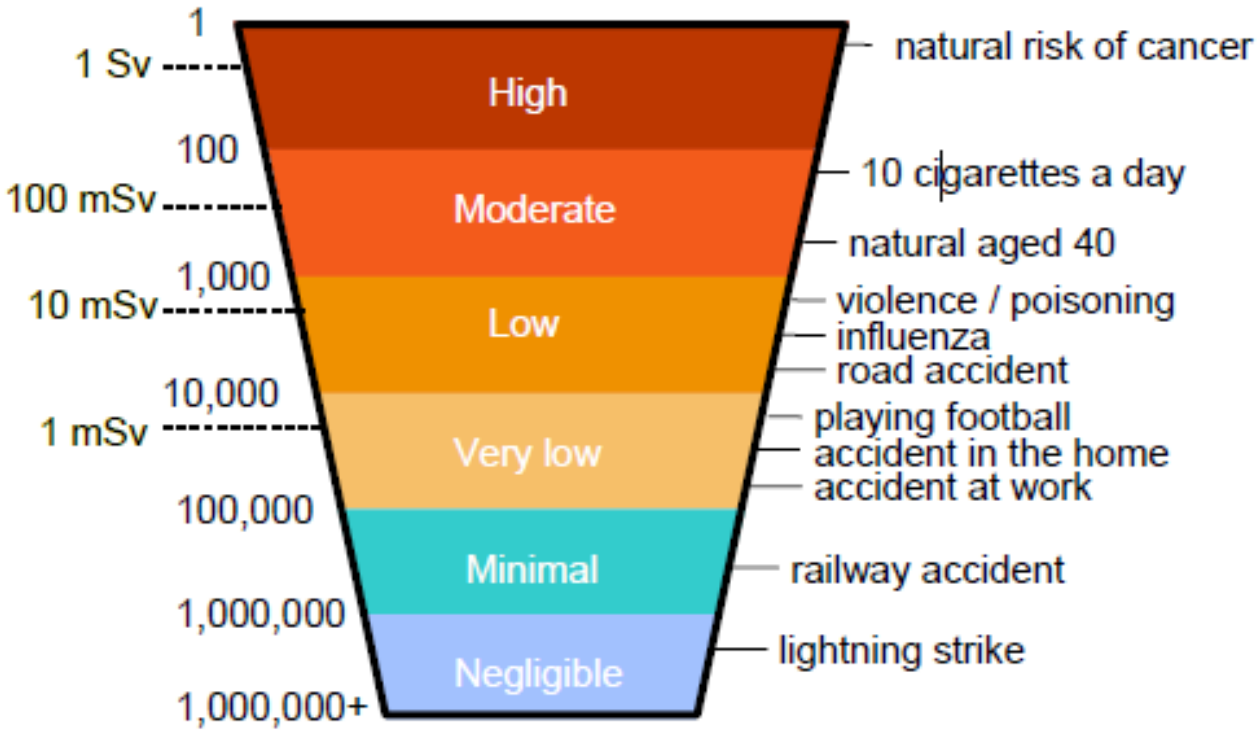

Figure 1 - Risks to Public Health

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The clearance levels shown in Table 1 are used to provide guidance that would result in no individual receiving a radiation dose greater than of 10 microsieverts per year. Using the clearance levels in Table 1, the resulting exposure to any individual would be 1/100th of long-term effects, such as cancer, when considering a public dose limit of 1 millisievert/yr. This radiation dose rate is protective of public health, promotes consistency with international guidance, and is several orders of magnitude below any known adverse health effects and below established public dose limits. The screening levels are based on the consideration of conservative estimates of the maximum dose to an individual and are thus more likely to overestimate, rather than underestimate, potential radiation dose.

If unable to decontaminate materiel/platforms down to levels required for unrestricted release, materiel/platforms should be evaluated for consideration as Surface Contaminated Objects as detailed by the International Atomic Energy Agency (IAEA) Specific Safety Requirements (SSR)-6 Rev.1, Regulations for the Safe Transport of Radioactive Material. Tables 2 and 3 are used to provide guidance for international shipments.

Equipment capable of verifying conformance with the screening levels established in Table 1 to 3, with consideration of multiple radionuclides should be used to measure residual radiation on decontaminated platforms and materiel. Radiological measurements performed for the purpose of radiological clearance certification should include direct field surveys of the platforms and materiel, laboratory analysis of representative samples of the platforms or materiel, or a combination of the two. Field equipment must be capable of detecting at the levels in Table 1 to 3; if not, laboratory analysis will be needed.

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Table 1: Guideline Thresholds for Exemption of Materiel/Platforms for Unrestricted Release.

Guideline Thresholds for Exemption of Materiel/Platforms for Unrestricted Release	
Radiological Hazard	Surface Screening Removable + Fixed Averaged over 100 cm^2
Group 1: High Energy gamma, radium, thorium, transuranics, and mobile beta-gamma emitters: ^{22}Na, ^{46}Sc, ^{54}Mn, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{129}Ic, ^{134}Cs, ^{56}Co, ^{60}Co, ^{65}Zn, ^{94}Nb, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{182}Ta, ^{207}Bi, ^{210}Po, ^{210}Pb, ^{226}Ra,^{228}Ra, ^{228}Th, ^{229}Th, ^{230}Th, ^{232}Th, ^{232}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{244}Pu, ^{241}Am, ^{243}Am, ^{245}Cm, ^{247}Cm, ^{248}Cm, ^{249}Cf, ^{251}Cf, ^{246}Cm, ^{254}Es and associated decay chains.	≤ 0.1 Bq/cm^2
Group 2: Uranium and selected beta-gamma emitters: ^{14}C, ^{36}Cl, ^{95}Zr, ^{105}Ag, ^{59}Fe, ^{57}Co, ^{58}Co, ^{75}Se, ^{85}Sr, ^{90}Sr, ^{99}Tc, ^{109}Cd, ^{113}Sn, ^{124}Sb, ^{123m}Te, ^{139}Ce, ^{140}Ba, ^{155}Eu, ^{160}Tb, ^{181}Hf, ^{185}Os, ^{204}Tl, ^{206}Bi, ^{234}U, ^{235}U, ^{190}Ir, ^{192}Ir, ^{233}U, ^{238}U, natural uranium, ^{237}Np, ^{236}Pu, ^{243}Cm, ^{244}Cm, ^{248}Cf, ^{250}Cf, ^{252}Cf, ^{254}Cf, and associated decay chains.	≤ 1 Bq/cm^2
Group 3: General beta-gamma emitters ^{7}Be, ^{74}As, ^{93}Mo, ^{93}Zr, ^{103}Ru, ^{114m}In, ^{125}Sn, ^{127m}Te, ^{93m}Nb, ^{97}Tc, ^{129m}Te, ^{131}I, ^{131}Ba, ^{144}Ce, ^{153}Gd, ^{181}W, ^{203}Hg,^{202}Tl,^{225}Ra, ^{230}Pa, ^{233}Pa, ^{236}U, ^{241}Pu, ^{242}Cm, ^{191}Os, ^{237}Pu, ^{249}Bk, ^{253}Cf, and associated decay chains.	≤ 10 Bq/cm^2
Group 4: Other beta-gamma emitters: ^{3}H, ^{35}S, ^{45}Ca, ^{51}Cr, ^{53}Mn, ^{55}Fe, ^{97m}Tc, ^{115m}Cd, ^{115m}In, ^{125}I, ^{59}Ni, ^{63}Ni, ^{86}Rb, ^{91}Y, ^{135}Cs, ^{141}Ce, ^{147}Nd, ^{147}Pm, ^{151}Sm, ^{170}Tm, ^{171}Tm, ^{185}W and associated decay chains.	≤ 100 Bq/cm^2

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Table 2: Guideline Thresholds for Shipments of Surface Contaminated Object Type 1.

Guideline Thresholds for Shipments of Surface Contaminated Object Type 1						
Radiological Hazard	Removable	Fixed	Removable + Fixed	Exposure (External Surface of Package or Overpack)		
	Averaged over 300 cm^2			Possible Excepted Package	Non-exclusive Use Transport	Exclusive Use Transport
Beta and Gamma Emitters	≤ 4.0 Bq/cm^2	≤ 4E4 Bq/cm^2	≤ 4E4 Bq/cm^2	≤ 5 µSv/hr	≤ 2 mSv/hr	≤ 10 mSv/hr
Alpha Emitters	≤ 0.4 Bq/cm^2	≤ 4E3 Bq/cm^2	≤ 4E3 Bq/cm^2			

Table 3: Guideline Thresholds for Shipments of Surface Contaminated Object Type 2.

Guideline Thresholds for Shipments of Surface Contaminated Object Type 2						
Radiological Hazard	Removable	Fixed	Removable + Fixed	Exposure (External Surface of Package or Overpack)		
	Averaged over 300 cm^2			Possible Excepted Package	Non-exclusive Use Transport	Exclusive Use Transport
Beta and Gamma Emitters	≤ 400 Bq/cm^2	≤ 8E5 Bq/cm^2	≤ 8E5 Bq/cm^2	≤ 5 µSv/hr	≤ 2 mSv/hr	≤ 10 mSv/hr
Alpha Emitters	≤ 40 Bq/cm^2	≤ 8E4 Bq/cm^2	≤ 8E4 Bq/cm^2			

Regulatory exemption levels for radioactive material are often based around 'negligible' levels of risk e.g. radiation exposure in the order of 10 µSv (equivalent to an increased risk of less than 1 in 1,000,000). In an ideal situation clearance decontamination levels could also be based upon this same level of risk. However, this might not be practical (e.g. it might be prohibitively expensive) and/or justified (the decontamination procedure might do more harm than good). Consequently, it may be necessary to base clearance decontamination on higher levels of risk (and dose) that are nevertheless still tolerable or concede that true clearance decontamination is not possible, and the material may need to be destroyed. In some cases, if the clearance level cannot be met and there is no national appetite.

**APPENDIX 4 of
Annex B to
AEP-4784**

APPENDIX 4 TO ANNEX B – LIST OF REFERENCES

LIST OF REFERENCES –

TABLE 1

1.	NATO AC/323(SAS) TP/30 (2002)
2.	USAPHC - Chemical Agent Health-Based Standards and Guidelines Summary – Table 1: Criteria for Airborne Exposures as of July 2011(2011)
3.	Protection from chemical and biological agents - GROMET Technologies (2005)
4.	OPCW - Quality document/health and safety branch/standard operating procedure 003 Health and Safety policy for inspection (2006)
5.	NIOSH - Pocket guide to chemical hazards (n°94-116), US department of health and human services. June 1994.
6.	NATO Long Term Scientific Study (LTSS) Report SAS-024, RTO-TR 057
7.	American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents; Biological Exposure Indices. Cincinnati, OH, ACGHI (1997).
8.	USACHPPM. Evaluation of airborne exposure limits for sulfur mustard: Occupational and general population exposure criteria. Technical Report 47-EM-3767-00 (2000).
9.	EPA Compiled Acute Exposure Guideline Values (AEGLs) (July,27 2018)
10.	Centers for Disease Control. Recommendations for protecting human health against potential adverse. Effects of long-term exposure to low doses of chemical warfare agents. Morbid. Mortal. Weekly Rep. 37(5), 72-9(1988).

TABLE 2

1.	JAMA Vol 281 (22):2127-2137 (1999)

TABLE 3

1.	Regulations for Safe Transport of Radioactive Material, 2018 Edition, Specific Safety Requirements No. SSR-6 (Rev. 1), IAEA

TABLE 4

1.	ANSI/HPS N13.12-1999 (R2010)
2.	Adapted from IAEA SSR-6 Rev.1 (2012)

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ANNEX C – DEFINITIONS

as low as reasonably achievable
ALARA
A risk management principle that mandates the minimum exposure of personnel to biological, chemical, radiological or nuclear hazards, subject only to the overriding demands of the operational mission.
(Not NATO agreed).

as low as reasonably practicable
ALARP
A computation must be made by the owner in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them – the risk being insignificant in relation to the sacrifice.
(Not NATO agreed)[8]

chemical, biological, radiological and nuclear defence
The plans, procedures and activities intended to contribute to the prevention of chemical, biological, radiological and nuclear incidents, to protect forces, territories and populations against, and to assist in recovering from, such incidents and their effects.
(NATO agreed)

clearance decontamination
Decontamination of materiel to a standard sufficient to allow unrestricted transportation, maintenance, employment or disposal.
(NATO agreed)

decontaminant
A substance used to absorb, destroy or neutralize chemical, biological, radiological and nuclear substances.

decontaminable
The ability of a system to be rapidly and effectively decontaminated using standard CBRN decontaminants and procedures available in the field to the point that any remaining contaminant poses no casualty-producing hazard to unprotected personnel exposed for the duration of the mission.
(Not NATO agreed)

decontamination
The process by which the hazard from chemical, biological, radiological and nuclear substances is reduced or removed.
(NATO agreed).

hazard management
In chemical, biological, radiological and nuclear defence, all preparatory and responsive measures taken to mitigate chemical, biological, radiological and nuclear hazards through avoidance, control of hazard spread, control and management of exposures, decontamination and waste management.

immediate decontamination
Decontamination carried out by individuals upon becoming contaminated. This may include decontamination of some personal clothing and/or equipment.
(NATO agreed)

off-gassing
The process by which a liquid or vapour leaves a surface or material. In the case of chemical agents, sometimes also described as desorption off-gassing.
(Not NATO agreed)

operational decontamination
Decontamination restricted to specific parts of operationally essential assets and/or working areas, carried out in order to sustain operations.
(NATO agreed)

thorough decontamination
Decontamination carried out in order to permit the partial or total removal of individual protective equipment, with the aim of restoring operational tempo.
(NATO agreed)

ANNEX D – ACRONYMS

AEGL-1
Acute Exposure Guideline Level. The concentration of a substance at or above which it is predicted that the general population, including 'susceptible' but excluding 'hyper-susceptible' individuals, could experience notable discomfort. Airborne concentrations below AEGL-1 represent exposure levels that could produce mild odour, taste, or other sensory irritation.
(Not NATO agreed)

ALARA
as low as reasonably achievable

ALARP
as low as reasonably practicable
(Not NATO agreed)

CBRN
chemical, biological, radiological and nuclear

GPL
General Population Limit
(Not NATO agreed)

IDLH
The concentration at which it becomes Immediately Dangerous to Life & Health
(Not NATO agreed)

LD_{50}
The dose necessary to cause death in 50% of the population with skin exposure.

LCt_{50}
The vapour or aerosol exposure necessary to cause death by inhalation in 50% of an exposed population in 10 minutes.
(Not NATO agreed)

STEL
The concentration at which a short-term exposure limit (STEL) can be implemented to allow a period of 'safe' exposure. (in this case: 15 minutes x 4 times per day).
(Not NATO agreed)

TLV
Threshold Limit Value
(Not NATO agreed)

TWA
Time Weighted Average
(Not NATO agreed)

WPL
Worker Population Limit
(Not NATO agreed)

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