Scientific Journal of the Military University of Land Forces
ISSN: 2544-7122 (print), 2545-0719 (online)
2020, Volume 52, Number 3(197), Pages 660-676
DOI: 10.5604/01.3001.0014.3960

Original article

Immediate decontamination

Władysław Harmata
Faculty of New Technologies and Chemistry, Military University of Technology, Warsaw, Poland,
e-mail: wladyslaw.harmata@wat.edu.pl

INFORMATION

Article history:
Submited: 5 October 2018
Accepted: 29 October 2019
Published: 15 September 2020

ABSTRACT

The article is devoted to a vital issue for the Polish Armed Forces, namely to the containment and elimination of contaminations. The main factors which are likely to cause the direct or indirect release of hazardous substances and the emergence of contaminations in the territory of the Republic of Poland (RP) include military operations, disasters and technical failures in industrial facilities, as well as terrorism. The containment and elimination of contamination is an element of the WMD defense system, in which the combat capability of the army's troops, equipment and military technology is restored after a contamination. The most important element of the system is the immediate elimination of contamination, as it can affect the health, and often also the life, of the contaminated. The doctrinal document DD/3.8(A) contains the main principles for immediate containment, the main one being "as soon as possible". It is important to be aware that the so-called insulating protective clothing does not provide adequate protection for the skin and uniforms. At the same time, it can be a source of secondary contamination. Technical equipment comprising individual packages will suffice, but the Polish Armed Forces should acquire one IPLS-type decontamination package with pharmacological agents and a new skin disinfectant. Such solutions are preferred in NATO armies.

KEYWORDS

decontamination, disinfection, disinfection, deactivation

Introduction

The main factors which are likely to cause the direct or indirect release of hazardous substances and the emergence of contaminations in the territory of the Republic of Poland (RP) include military operations, disasters and technical failures in industrial facilities, as well as terrorism.

Too many phenomena are often included in hazard analyses, a part of which can be construed as security challenges, contrasted with actual hazards. They are described as new situations or emerging trends. They require careful examination to formulate responses and take specific action, as unresolved confessions in unfavorable circumstances may generate potential risks to health and often life.

According to the doctrinal document of Chemical Forces "Defense against Weapons of Mass Destruction (OPBMR)", Training ref. 869/2013 (DD/3.8(A) – document consistent with AJP-3.8(A) "Allied Joint Doctrine For CBRN Defence": "Protection Against Contaminants includes the use of Individual Decontamination Equipment, Collective Decontamination Equipment as well as anti-contamination equipment installed in infrastructure facilities, aircrafts, ships, vehicles and special equipment. It is organized in order to ensure the survival of the troops and to enable further action to be taken in conditions of contamination hazards and actual contaminations. (…) Protection against contamination is an undertaking consisting in maximum use of the functional characteristics of individual and collective protective measures against contamination and the protective properties of combat equipment, engineering structures and terrain. Protection against contamination aims to increase the army's ability to survive. The Operational Commander/Joint Force Commander should take into account the vulnerability of subordinate troops to WMD threats, considering any restrictions imposed by the application of protective measures against contamination during military operations. Protection against contamination is divided into:

– individual protection against contamination, which includes all activities aimed at equipping each soldier with a gas mask and insulating or filtering skin protection measures to ensure their safety when performing various tasks in contamination hazard or contamination conditions,
– collective protection against contamination – all activities aiming at providing troops with such protection in the conditions of contamination, which ensures the possibility of staying and performing tasks without ISOPS.

Equipment and measures to protect against contamination are necessary to reduce equipment losses, to contain the contamination and to manage the elimination of contamination. They are divided into individual and collective measures for protection against contamination.

Individual protection against contamination (ISOPS) includes: (a) dosimetric equipment, (b) gas mask and protective clothing, (c) first aid equipment, (d) individual decontamination packages" [1].

Considering the problem of elimination of contamination according to the said document "a process to *ensure the safety of troops, facilities and areas* through the removal of radioactive substances from the surface and the collection, destruction, neutralization and disposal of biological and chemical agents contaminating surfaces or situated in their vicinity.

Decontamination is carried out in accordance with the following principles:

1) as soon as possible,
2) only what is necessary or required by operational needs,
3) as close as possible to the contaminated area,
4) in accordance with the agreed operational priorities" [1].

Quoting the above document further – "Decontamination depending on operational needs may be passive or active: *active decontamination* is the collection and disposal of radioactive substances, as well as the collection, destruction, neutralization and removal of chemical and biological substances from contaminated personnel or equipment (land and infrastructure) through the use of chemical or mechanical processes. Within the framework of active decontamination, the following activities are carried out: *immediate elimination of contamination* *by individual soldiers directly after the occurrence of contamination in order to minimize losses and protect the life of the contaminated troops, as well as to limit the spread of the contamination. It may include the elimination of contamination from parts of the uniform or equipment*" [1].

1. Immediate decontamination – procedural considerations

According to NO-01-A006:2010 "Immediate decontamination – removal of contaminants by an individual immediately after the occurrence of contamination in order to save lives or minimize losses [AAP-6(2008)] [AAP-21(B)]. NOTE May include the removal of contaminants from uniforms and/or equipment" [2].

The decontamination of skin contaminated with combat poisonous agents is extremely complicated. Research has shown that after the skin is contaminated with combat-grade poisonous substances, their penetration into the body is almost instantaneous. It is proved by research conducted on biological material Figure 1.

The results of these studies show that the maximum time (counted from the moment of contamination), after which no symptoms of poisoning are likely to occur is approx. 5 minutes.

Our own experience shows that washing contaminated skin with soapy water is very effective, but only immediately after contamination. In field conditions, this may not be feasible. Therefore, for the elimination of chemical skin contamination, individual counter-chemical packets are to be used [4].

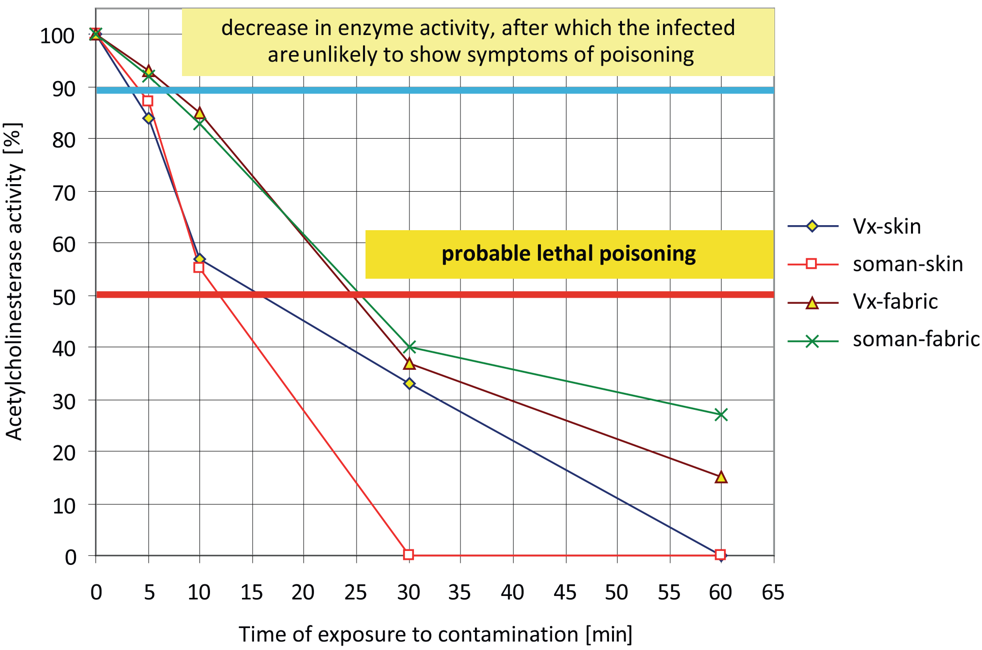

Fig. 1. Decrease in acetylcholinesterase enzyme activity in rats after the contamination of skin and cotton fabric with US-9-Pa-25soman or Vx. Contamination density approx. 1 g/m²

Source: Own study based on [3].

In addition to exposed skin, weapons, equipment and protective clothing should be subjected to the process of decontamination.

In the first period, after the chemical warfare agent (CWA) has contacted the substrate, the contamination of rubber and plastic rubber derivatives is purely superficial, analogous to the contamination of e.g. glass or metal surfaces. Different plastics display significant difference in the wetting by chemical weapons. Less wettable substances include polytetrafluoroethylene (Teflon) and rubber compounds.

Table 1 presents experimental numerical data characterizing surface contamination.

Table 1. Aerosol and droplet penetration parameters of chemical weapons

Characteristic value	**mustard gas S C_0 = 7.0 g/m²**		**soman C_0 = 7.0 g/m²**		**Vx C_0 = 1.0 g/m²**	
	m drops in mg		**m drops in mg**		**m drops in mg**	
	0.5	**5**	**0.5**	**0.8**	**0.02**	**0.1**
n $[m^{-2}]$	14000	1400	14000	8750	50000	10000
V $[mm^3]$	0.392	3.92	0.490	0.785	0.0186	0.093
d [mm]	1.32	2.84	2.06	2.42	0.51	0.87
A $[mm^2]$	1.37	6.32	3.33	4.59	0.20	0.59
Σ_A $[m^2]$	0.019	0.009	0.046	0.040	0.01	0.006
$\overline{\Sigma_A}$ $[m^2/m^2]$	0.014		0.043		0.008	

Source: Own study based on [5].

Experimental data on the penetration of mustard gas, soman and Vx into the rubber mixture are shown in Figure 2.

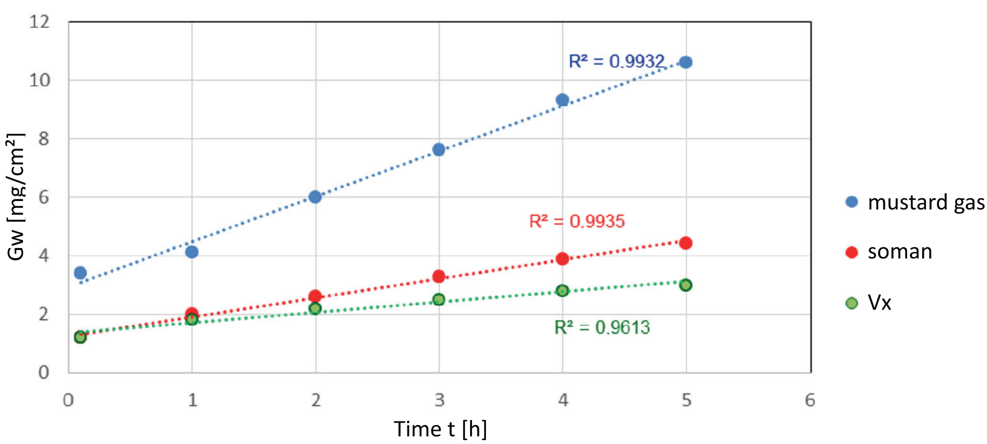

Fig. 2. In-depth contamination Gw of a Gw = f(t) rubber mix
Source: Own study based on [4].

The curves on the graph show the local density of in-depth contamination of the Gw [mg/cm²] material as mass [mg] of the poisonous agent penetrating into the substrate from the surface unit [cm²] as a function of time t [h] for conditions of full liquid coverage of the surface.

The part of the CWA which has penetrated into the material with a solid external surface shall not be accessible for simple mechanical decontamination procedures or washing with water or detergent solutions. This type of treatment, assuming relatively short contact time of the disinfectant with the surface, is not able to remove the CWA from the surface layers. Materials which easily absorb poisonous substances are more susceptible to contamination than the definition of persistent poisonous substances would suggest. This contamination, referred to as persistent contamination Gt, is a component of the primary general contamination and its magnitude increases with time of contact of the CWA with the contaminated surface, according to the presented phenomena of in-depth penetration.

According to the above data, protective clothing made of polymeric fabrics (rubber and rubber-like) should be covered with a highly effective disinfectant immediately after contamination and then replaced with a new one. What is also noteworthy, L-2 and OP-1 protective clothing is not fully hermetic. In the chlorine chamber tests, significant chlorine leaks were found mainly in the areas of face shield and glove connections – Figure 3.

With reference to the data shown in Figure 1, it can be stated that symptoms of poisoning occur when the enzyme activity decreases by 10÷20%, and heavy poisoning (often lethal) occurs when the enzyme activity decreases by 50%, and a decrease in enzyme activity by 80÷90% causes death within a few or a dozen minutes.

Fig. 3. Possible areas of CWA vapor transmission under protective clothing
Source: Own study based on [6].

The most important element is the time of contact of the poison and the skin, during which the enzyme activity will not fall below the defined limit. For exposed parts of the skin, it is 2-3 minutes, and for skin covered with fabric, it is approx. 6 minutes, which, depending on the type of material, can increase or shorten this time. A test was carried out on the Us-9-Pa25 fabric, which was used in field camo uniforms model 68. It contained 75% cotton and 25% polyamide of 275±14 g/m² in grain size. The modern combat uniform wz 2010 is designed in two basic versions: summer and year-round. The summer uniform is made of US-21 fabric in 83% cotton and 17% polyester in a ripstop weave of 190 g/m² in grain size. The year-round uniform is made of US-22/1 fabric in 50% cotton and 50% polyester in a rip weave of 255 g/m² in grain size [7]. Aside from the issue of the materials used, and focusing at the weight of the fabrics, one can conclude that the new field uniform model 2010 is likely to pose an even weaker barrier to a CWA. No research of the so-called susceptibility to decontamination of the fabric model 2010 have been conducted.

2. Immediate decontamination – technical solutions

In accordance with the requirements of NO-01-A006:2010, the decontamination package contains a set of preventive and disinfectant agents intended for the immediate decontamination, which may also contain a set of pharmacological agents used to counteract the effects of contamination, together with equipment enabling their use. In the Polish Armed Forces, the IPLS-1 decontamination package [8] is the basic decontamination tool, intended for:

- preventive protection and immediate elimination of contamination of exposed skin surfaces (face, hands, neck) against the effects of poisonous combat agents,
- immediate elimination of contamination from personal weapons and equipment.

The package includes a plastic tube with prophylactic ointment, three packages in aluminum foil with a decontaminating powder agent and six napkins made of gauze. The contents of the package are placed in a suitably shaped plastic box – Figure 4. Figure 5 presents the method of applying powder disinfectant on exposed skin surfaces.

Fig. 4. Individual IPLS-1 decontamination package: 1 – two napkins, 2 – sprinkler head with a pump, 3 – sprinkler tank with organic disinfectant, 4 – tube with prophylactic and disinfectant ointment, 5 – powder disinfectant in a glove
Source: Own study based on [8].

The Polish Armed Forces are equipped with an Individual Syringe Set IZAS-05. It is a set of pharmacological agents to counteract the effects of contamination.

The set consists of three autoinjectors placed in a plastic box:

Powder disinfectant glove

Method of covering exposed skin surfaces with powder disinfectant

Removal (shaking off) of powder disinfectant from the skin

Fig. 5. Skin disinfection using powder disinfectant
Source: own study based on [8].

– blue autoinjector – designed to relieve severe post-traumatic pain,
– green autoinjector – designed to counteract organophosphorus CWA poisoning, e.g.: soman, sarin. It contains: 2 mg atropine, 7.5 mg diazepam and acetylcholinesterase activator – 220 mg toxogonin or 600 mg pralidoxim,
– yellow autoinjector – designed to maintain the lytic choline action in CWA poisoning (supplementing the large green autoinjector). Contains 2 mg of atropine – Figure 6.

Fig. 6. Individual Set of Autoinjectors IZAS-05
Source: [9].

Additionally, the individual equipment includes a red autoinjector containing 10 mg of morphine, designed to relieve pain – Figure 7.

Fig. 7. Auto-injector with morphine
Source: [9].

3. Immediate decontamination – effectiveness

The disinfectants from the IPLS-1 packet were analyzed [10, 11]. In accordance with its intended use, the package is intended for:
– conducting individual decontamination processes immediately after their occurrence, in the combat group of the army,
– conducting treatments in field conditions regardless of time of day and weather conditions,

– protection of the skin against contamination using the prophylactic and disinfecting ointment,
– disinfection of exposed skin and individual equipment using the powder disinfectant,
– disinfection of equipment and firearms with organic disinfectant.

The research was conducted according to the methodology contained in the study ref. RTM-SO-86 [12].

The prophylactic and disinfecting ointment is designed for prophylactic protection of the skin against contamination. The results of the decontamination efficacy studies are set out in Tables 2 to 4.

The ointment has no irritant effect on the skin. The package contains 90 g of ointment in a plastic tube. The duration of the protective effect is 3 hours.

Table 2. Prophylactic and disinfecting properties of ointments in relation to sulfuric iperythrite

Sample no.	1	2	3	4	5	Average
Total residual contamination on sorption pads after 1 h of exposure and 30 min CWA [mg/m²]	95	99	90	88	95	**93**
Total residual contamination on sorption pads after 3 h of exposure and 15 min CWA [mg/m²]	57	44	62	53	55	**54**
Permissible residual contamination density according to RTM-SO-86 **q = 420 mg/m²**						

Source: [8, 11].

Table 3. Prophylactic and disinfecting properties of ointments in relation to Vx

Sample no.	1	2	3	4	5	Average
Total residual contamination on sorption pads after 1 h of exposure and 30 min CWA [mg/m²]	0.37	0.40	0.41	0.36	0.37	**0.38**
Total residual contamination on sorption pads after 3 h of exposure and 15 min CWA [mg/m²]	0.15	0.13	0.13	0.12	0.17	**0.14**
Permissible residual contamination density according to **RTM-SO-86 q = 3.0 mg/m²**						

Source: [8, 11].

Table 4. Prophylactic and disinfecting properties of ointments in relation to soman

Sample no.	1	2	3	4	5	Average
Total residual contamination on sorption pads after 1 h of exposure and 30 min CWA [mg/m²]	26	25.5	26.2	25	25.9	**25.9**
Total residual contamination on sorption pads after 3 h of exposure and 15 min CWA [mg/m²]	42	42.8	41.7	43	41.6	**42.2**
Permissible residual contamination density according to RTM-SO-86 **q** = **19.0 mg/m²**						

Source: [8, 11].

The second element of the package is an organic disinfectant. The main problem was to determine the effect of the uniform covered with disinfectant on the exposed skin. Organic disinfectant codename R-18 was selected for the study [13].

The results of tests of the effectiveness of disinfection of uniform fabric Us9-Pa25 are presented in Tables 5 to 7. The research was conducted according to the methodology contained in the study ref. RTM-SO-86 [12]. Organic disinfectant is a very effective agent for textile,

Table 5. Effectiveness of disinfection of field uniforms contaminated with mustard gas using the R-18 disinfectant from the package. Initial concentration c_0 ~ 5 g/m², T = 298 K, disinfection density 250 cm³/m²

Sample No.	Mustard gas dose sorbed (g/m²) on sorption pads after (h):						
	0÷1.0	**1.01÷2.0**	**2.01÷3.0**	**3.01÷4.0**	**4.01÷5.0**	**5.01÷24.0**	$\sum_0^{24} c$
1	0.013	0.014	0.013	0.014	0.012	0.014	0.08
2	0.003	0.0025	0.0031	0.0021	0.0022	0.0041	0.017
3	0.015	0.016	0.015	0.014	0.014	0.016	0.09
4	0.0031	0.0011	0.0022	0.0015	0.0013	0.0018	0.011
5	0.0042	0.0031	0.0036	0.0029	0.0026	0.0036	0.02
6	0.0062	0.0046	0.0057	0.0046	0.0052	0.0047	0.031
$\sum_0^{24} c_{max} = 0.08 < 0.420$ g/m²							
Permissible residual contamination density q = 0.42 g/m²							

Source: [11].

Table 6. Effectiveness of disinfection of summer field uniforms contaminated with soman using the R-18 disinfectant from the package. Initial concentration c_0 ~ 5 g/m², T = 298 K, disinfection density 250 cm³/m²

Sample No.	Soman dose sorbed (g/m²) on sorption pads after (h):						
	0÷1.0	**1.01÷2.0**	**2.01÷3.0**	**3.01÷4.0**	**4.01÷5.0**	**5.01÷24.0**	$\sum_0^{6} c$
1	$5.3\ 10^{-5}$	$4.8\ 10^{-5}$	$5.8\ 10^{-5}$	0	p.p.w	p.p.w	$1.6\ 10^{-4}$
2	$9.0\ 10^{-6}$	$8.4\ 10^{-6}$	$8.7\ 10^{-6}$	$8.7\ 10^{-6}$	0	p.p.w	$3.5\ 10^{-5}$
3	$4.5\ 10^{-5}$	$4.1\ 10^{-5}$	$4.6\ 10^{-5}$	$4.6\ 10^{-5}$	0	p.p.w	$1.8\ 10^{-4}$
4	$5.6\ 10^{-5}$	$4.4\ 10^{-5}$	$5.0\ 10^{-5}$	0	p.p.w	p.p.w	$1.5\ 10^{-4}$
5	$2.0\ 10^{-5}$	$2.0\ 10^{-5}$	$2.0\ 10^{-5}$	0	p.p.w	p.p.w	$6.0\ 10^{-5}$
6	$4.7\ 10^{-6}$	$4.8\ 10^{-6}$	$4.9\ 10^{-6}$	$4.6\ 10^{-6}$	0	0	$1.9\ 10^{-5}$
$\sum_0^{6} c_{max} = 1.8\ 10^{-4} < 1.9\ 10^{-2}$ g/m²							
Permissible residual contamination density q = $1.9\ 10^{-2}$ g/m²							

Source: [11].

rubber, rubber and metal products. It is a surfactant and loses its properties as a result of carbonization of sodium alcoholates.

Table 8 presents the results of tests of general and dermal toxicity of R18 disinfectant. The tests were carried out in accordance with the methodology specified in the standard: NO-42-A200:1996 Individual anti-chemical package. General requirements and test methods.

Figure 8 shows the results of the effectiveness of disinfection of using the organic disinfectant from the IPLS-1 package.

Table 7. Effectiveness of disinfection of summer field uniforms contaminated with Vx using the R-18 disinfectant from the package. Initial concentration $c_0 \sim 1.4$ g/m², T = 298 K, disinfection density 250 cm³/m²

Sample No.	Vx dose sorbed (g/m²) on sorption pads after (h):						
	0÷1.0	1.01÷2.0	2.01÷3.0	3.01÷4.0	4.01÷5.0	5.01÷24.0	$\sum_0^6 c$
1	8.50 10^{-4}	6.20 10^{-4}	5.60 10^{-4}	2.50 10^{-4}	8.10 10^{-4}	8.00 10^{-4}	3.89 10^{-3}
2	8.70 10^{-4}	8.20 10^{-4}	8.60 10^{-4}	2.20 10^{-4}	1.80 10^{-4}	2.17 10^{-4}	3.17 10^{-3}
3	1.10 10^{-3}	1.10 10^{-3}	1.00 10^{-3}	5.60 10^{-4}	1.10 10^{-4}	1.00 10^{-4}	3.97 10^{-3}
4	7.80 10^{-4}	8.50 10^{-4}	5.50 10^{-4}	9.20 10^{-5}	1.13 10^{-4}	3.10 10^{-4}	2.70 10^{-3}
5	1.20 10^{-3}	8.00 10^{-4}	8.00 10^{-4}	5.00 10^{-4}	1.00 10^{-4}	8.00 10^{-5}	3.48 10^{-3}
6	9.50 10^{-4}	5.50 10^{-4}	4.40 10^{-4}	7.10 10^{-4}	1.40 10^{-4}	9.40 10^{-5}	2.88 10^{-3}
$\sum_0^6 c_{max}$ = 3.89 10^{-3} < 4.5 10^{-3} g/m²							
Permissible residual contaminant density q = 4.5 10^{-3} g/m²							

Source: [11].

Table 8. Results of total and dermal toxicity testing of the disinfectant from the package

Test results	
Determination of total and dermal toxicity of the disinfectant from the package	According to the report of the Military Medical Academy: The disinfectant exhibits a dermal toxicity of 5 g/kg bw whereas the acceptable level is 2.5 g/kg bw. It is also confirmed by the observed amounts of erythrocytes and platelets and the increase in aminotransferases which only occurs in the dose exceeding the acceptable level twice. The disinfectant is characterized by relatively significant damaging effect when applied directly on bare skin. The disinfectant has a much milder effect on the eyes (2.5 points – at 3 permissible points). However, additional tests of the irritating effect of the R-18 disinfectant through the uniform did not reveal any skin irritation. On this basis, the R-18 disinfectant was qualified to test the effectiveness of disinfection with biological control. The results of the tests indicate that it has a good efficacy for soman and VX. Analyzing all the results obtained, it can be concluded that the organic disinfectant R-18 can be used for decontaminating uniforms as an active substance comprised in the developed package.

Source: Own study based on [14, 15].

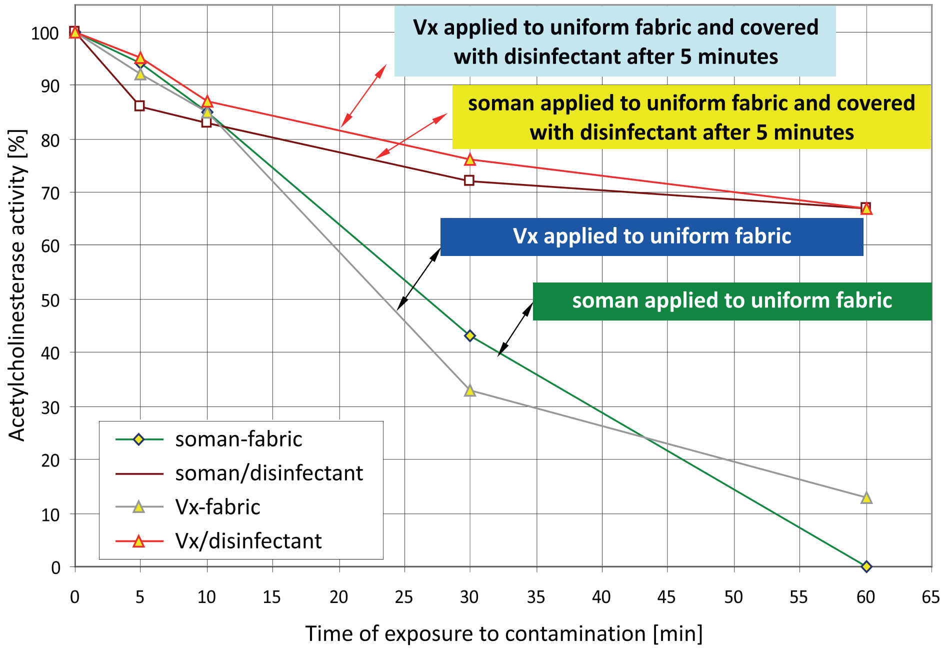

Fig. 8. Decrease in AChE activity in rats after the contamination of uniform fabric with soman or Vx and after 5 minutes, covered with organic disinfectant from IPLS-1 package. Density of disinfection using the organic disinfectant from the package – 250 cm^3/m^2

Source: Own study based on [14].

The final element of the package is a powder disinfectant for disinfecting exposed skin. It is an adsorption type disinfectant based on magnesium oxide. The tests have proven that it is an effective agent for the decontamination of exposed skin surfaces [8, 11].

In modern studies, excessively high concentrations of CWA vapors were found on surfaces covered with the disinfectant [16].

The Military Institute of Chemistry and Radiometry in Warsaw and the Institute of Catalysis and Surface Physicochemistry of the Polish Academy of Sciences in Warsaw have developed nanocrystalline, high-surface forms of active mixed magnesium and aluminum oxides.

X-ray analysis showed that the sizes of elementary crystallites are 3.5 nm, whereas in magnesium oxide (IPLS-1), they are about 37 nm. This results in large differences in their specific areas (BET 231 and 18 m^2/g). The results of efficacy studies on the removal of mustard gas and soman from contaminated surfaces are shown in Figures 9 and 10.

Particularly noteworthy is the sorbent marked AC-10K. Contrary to other sorbents, it is highly effective in removing both mustard gas and soman.

High efficiency of CWA removal from contaminated surfaces is a very important parameter of sorbents, but even if is completely removed from the surface, the problem of contaminated sorbent waste remains. The release of CWA from used sorbents can cause secondary contamination. This is a phenomenon that needs to be taken into account, as the surface from which CWA can be released is very large as a result of the strong fragmentation of the

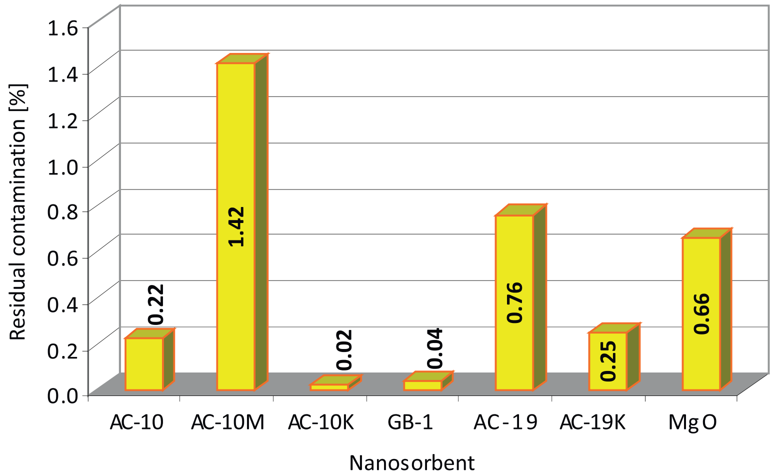

Fig. 9. Residual contamination with mustard gas after disinfection with various magnesium-aluminum sorbents and IPLS-1 sorbents
Source: Own study based on [16].

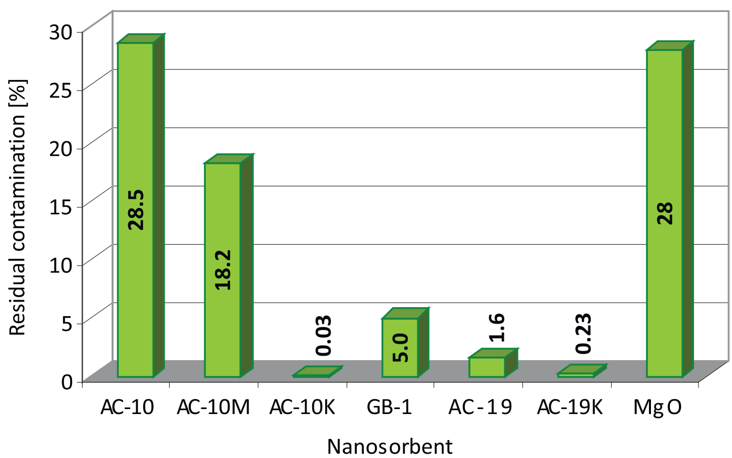

Fig. 10. Residual contamination with soman after disinfection with various magnesium-aluminum sorbents and IPLS-1 sorbents
Source: Own study based on [16].

sorbent, and therefore large quantities of CWA can be released into the atmosphere in a short period of time. Vapor pressure of the CWA above it is the second parameter which characterizes a sorbent. Figures 11 and 12 show the results of measurements of vapor pressure of CWA above contaminated sorbents.

Also in this case, the AC-10K sorbent displayed the most favorable properties, the relative vapor pressure of both mustard gas and soman was lower than 0.2. Magnesium oxide, used as a sorbent in the IPLS1 package, was quite effective in removing mustard gas from the surface, but the CWA vapor pressure above it was the same as over CWA fluids. A very desirable property of sorbents is their ability to decompose the CWA sorbed on them. This is the ideal solution to the problem of contaminated waste. This property was confirmed for the AC-10K

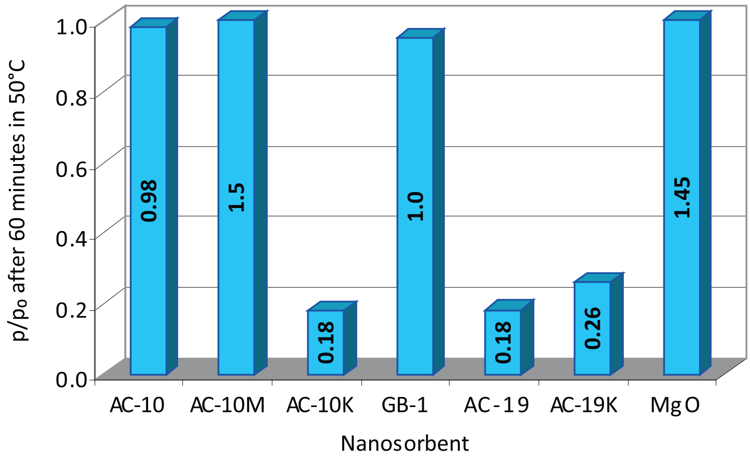

Fig. 11. Relative vapor pressures of mustard gas above sorbents at 50°C (5 mg HD/100 mg of the sorbent)
Source: Own study based on [16].

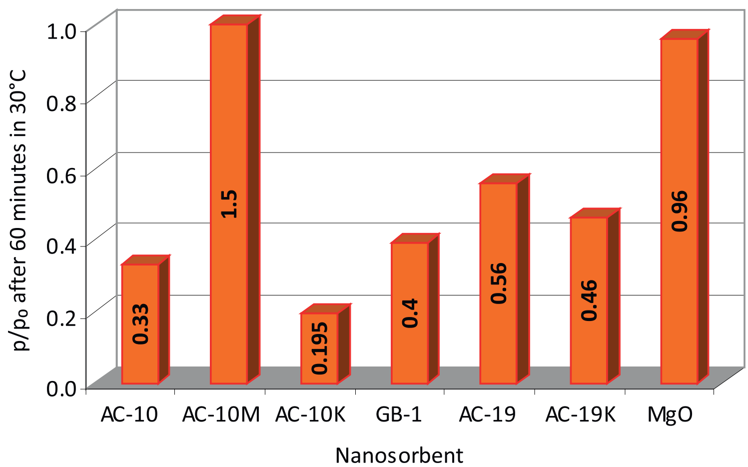

Fig. 12. Relative vapor pressures of soman above sorbents at 30°C (5 mg GD/100 mg of the sorbent)
Source: Own study based on [16].

sorbent in relation to soman. The results are shown in Figure 13. At 30°C after 2 hours, the sorbent was decontaminated in over 97%.

A new glove design was developed to enable the efficient use of nanosorbent disinfectants. A batch of 30 pieces of the new package was produced and the effectiveness of disinfection in summer and winter conditions was tested. The required effectiveness of disinfection has been achieved [17].

Despite the promising results of the tests, no disinfectant has implemented in the Polish Armed Forces so far. It is important to be aware that any work on the packages can be very difficult since the defence standard NO-42-A200:1996 Individual anti-chemical package – General requirements and test methods was revoked without replacement. The standard was

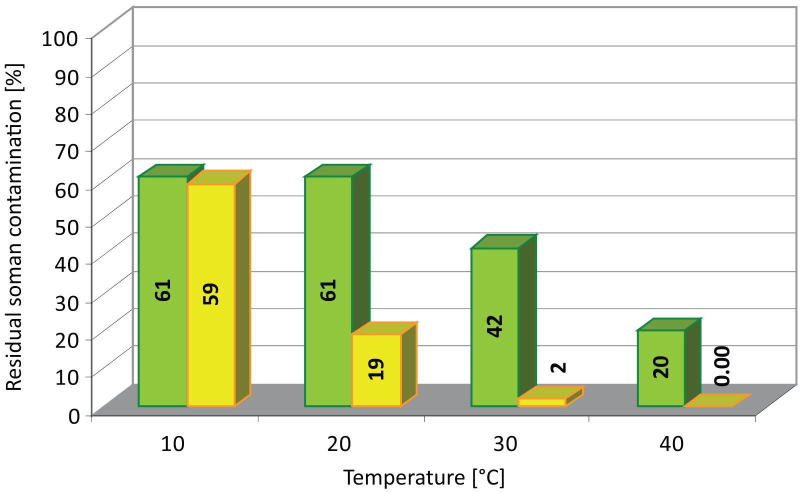

Fig. 13. The amount of soman remaining on AC10K and -1 MgO sorbents from the IPLS-1 package after 2-hour storage of the contaminated sorbents (5 mg GD/100 mg of the sorbent) at 10, 20, 30 and 40°C
Source: Own study based on [16].

developed as a result of research conducted in the Military Medical Academy, the Military Institute of Chemistry and Radiometry and the Military Institute of Hygiene and Epidemiology. It is important remember that research teams that carried out research no longer exist.

Conclusions

1. In the Polish Armed Forces, the decontamination is carried out in the OPBMR system. The procedures existing in the Chemical Unit instructions should be aligned with applicable NATO documents.
2. IPLS-1 is a global solution and has no equivalent in other armies in the world. The package should be modernized, i.e. the powder disinfectant should be replaced and an IZAS-05 autoinjector set should be included in the package. This solution is preferred in NATO armies.
3. Immediate decontamination must be carried out immediately after contamination. This provision should be included in tactical manuals and training programs. Immediate decontamination procedures should be adapted to standardization requirements and the DD-3.8(A) doctrinal document, taking into account existing technical developments.

Acknowledgement

The presented research results originate in research projects financed by the then Committee for Scientific Research, the Ministry of Science and Higher Education and the Ministry of National Defense.

Conflict of interests

The author declared no conflict of interests.

Author contributions

The author contributed to the interpretation of results and writing of the paper. The author read and approved the final manuscript.

Ethical statement

The research complies with all national and international ethical requirements.

ORCID

Władysław Harmata https://orcid.org/0000-0001-6271-9000

References

1. *Obrona przed bronią masowego rażenia w operacjach połączonych DD/3.8(A)*. Warszawa: Ministerstwo Obrony Narodowej, Centrum Doktryn i Szkolenia Sił Zbrojnych; 2013.
2. *NO-01-A006:2010. Obrona przed bronią masowego rażenia – Terminologia*. Warszawa: Wojskowe Centrum Normalizacji, Jakości i Kodyfikacji; 2010.
3. Harmata W. *Problemy indywidualnego odkażania umundurowania*. Biuletyn Informacyjny WIChiR. 1988;1(15).
4. Harmata W. *Ochrona przed skażeniami. Cz. IV. Wybrane zagadnienia metodologiczne, organizacyjne i techniczne likwidacji skażeń*. Warszawa: WAT; 2019.
5. Buda S, Szczucki E. *Chemia procesów odkażania*. Warszawa: WAT; 1981.
6. *OP-1*, [online]. Available at: https://pl.wikipedia.org/wiki/OP-1 [Accessed: October 2019].
7. *Umundurowanie i wyposażenie indywidualne Wojska Polskiego po II wś*, [online]. Available at: http://uwiwp.pl/pages/02_00000.html [Accessed: June 2018].
8. Harmata W et al. *Sprawozdanie z badań indywidualnego pakietu przeciwchemicznego IPP-2001*. Warszawa: WIChiR; 2001.
9. Zielonka Z, Pich R. *Najnowsze indywidualne środki ochrony przed skażeniami stosowane w PKW*. Zeszyty Naukowe WSOWL. 2008;2(148).
10. Harmata W, Marcinak W. *Założenia taktyczno-techniczne na indywidualny pakiet przeciwchemiczny Atlas*. Warszawa: WIChiR; 2000.
11. Harmata W, Czerwiński P, Marciniak W, Kowlaska G et al. *Indywidualne środki do zabiegów specjalnych. Indywidualny pakiet przeciwchemiczny. Projekt wstępny, wykonanie i badanie układów modelowych. Realizacja pracy badawczo-wdrożeniowa ATLAS*. Warszawa: WIChiR; 2000.
12. *RTM-SO 86 – metodyki badań skuteczności odkażania*. KT ZSZ UW Praga 1986 – materiały WIChiR.
13. Rybandt T, Harmata W. Sprawozdanie z badań kwalifikacyjnych indywidualnego pakietu do odkażania umundurowania, oporządzenia i broni strzeleckiej bezpośrednio na żołnierzu, Radamantys-1. Warszawa: WIChiR; 1990.
14. Smok W, Harmata W. *Kontrola biologiczna skuteczności odkażania*. Łódź: WAM; 1989.
15. Smok W, Grande G. *Kontrola biologiczna skuteczności odkażania*. Warszawa: WAM, WIChiR; 1988.
16. Pirszel J, Marciniak W, Kuźnia E, Serwicka EM. *Sorbenty nanostrukturalne – nowa generacja środków do likwidacji skażeń chemicznych*. Warszawa: WIChiR; 2012.
17. *Syntetyczny opis projektu nr OR00000412*. Warszawa: WIChiR; 2009.

Biographical note

Władysław Harmata – PhD, DSc, Eng., graduated from the Faculty of Chemistry and Technical Physics of the Military University of Technology in Warsaw in 1978. He is a professor at The

Faculty of Advanced Technologies and Chemistry of the Military University of Technology and specializes in ecology, decontamination and protection against contamination. He has co-authored 9 national patents and 20 implementations. The results of the research have been published in over 400 original scientific papers. He is the author of 8 monographs and academic textbooks.

Natychmiastowa likwidacja skażeń

STRESZCZENIE Niniejszy artykuł dotyczy aktualnej problematyki, jaką jest system likwidacji skażeń w SZ RP. Głównymi czynnikami, które w sposób pośredni lub bezpośredni mogą spowodować uwolnienie substancji nie-bezpiecznych i powstanie skażeń na terytorium Rzeczpospolitej Polskiej (RP) będą działania militarne, katastrofy i awarie techniczne w zakładach przemysłowych oraz terroryzm. Likwidacja skażeń jest elementem systemu OPBMR, w którym następuje odtworzenie zdolności bojowej stanów osobowych, wyposażenia i techniki bojowej po skażeniach. Najważniejszym elementem systemu jest natychmiastowa likwidacja skażeń gdyż może dotyczyć zdrowia, a często i życia skażonych. W doktrynalnym dokumencie DD/3.8(A) zawarto główne zasady prowadzenia natychmiastowej likwidacji skażeń, a główna z nich „natychmiast, jak tylko to możliwe". Należy zdawać sobie sprawę, że tzw. odzież ochronna izolacyjna nie zapewnia ochrony skóry oraz umundurowania. Jednocześnie może być źródłem skażeń wtórnych. Wyposażenie techniczne, w postaci indywidualnych pakietów jest wystarczające, ale w SZ RP powinien być jeden pakiet typu IPLS z środkami farmakologicznymi oraz nowym odkażalnikiem do skóry. Takie rozwiązania są preferowane w armiach NATO.

SŁOWA KLUCZOWE likwidacja skażeń, odkażanie, dezynfekcja, dezaktywacja

How to cite this paper

Harmata W. *Immediate decontamination*. Scientific Journal of the Military University of Land Forces. 2020;52;3(197):660-76.

DOI: http://dx.doi.org/10.5604/01.3001.0014.3960