Biuletyn WAT
Vol. LXVII, Nr 2, 2018

Defence against weapons of mass destruction. Technical and functional solutions in personal protection for Territorial Defence Forces

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Abstract. The paper characterises methods of defence for use against weapons of mass destruction, as a form of troop protection system in the event of a contamination (infection) hazard from both the functional and the task-oriented perspective. The basic equipment of troops are described, taking into account the classification of equipment and the means used for: identification of the contamination, protection from the contamination, and the elimination of the contamination in terms of personal protection.
Keywords: protection against weapons of mass destruction, equipment, personal protection of soldiers
DOI: 10.5604/01.3001.0012.0984

Introduction

Operations of chemical subunits in the Territorial Defence Forces

In the current geopolitical situation, the Territorial Defence Forces (TDF) appear to be the only relatively quick, inexpensive and effective method of strengthening our military security.

Primary TDF tasks are likely to include:

— conducting defensive actions in cooperation with operational and support forces, and with extra-military system elements (ESE);
— conducting independent anti-diversion and anti-airborne operations, and — in specific situations — irregular operations;

— participation in the reception and deployment of allied reinforcements in their designated areas;
— performing duties related to crisis management;
— performing information actions.

Territorial defence (TD) is a form of conducting general defence by the state, and includes operational/tactical, technical/defensive and training operations intended to prepare specific assets to provide support and protection to operational forces, and to conduct independent combat operations and rescue operations. These could be conducted anywhere in the country. These duties are executed by territorial defence forces, which include territorial command bodies, territorial defence troops, militarised units and others. Territorial defence forces comprise mobile and fixed units. The mobile units consist of TD brigades, which may conduct operations both as part of the operational forces and independently. These are self-reliant units with supplies usually sufficient for 2-3 days of combat. Fixed units (TD battalions, engineering battalions) are intended to perform tasks within a voivodeship (region) or at a specific site or defence infrastructure facility. Their structures include the necessary logistical subunits to provide them with the ability to perform their tasks independently. Effective use of territorial defence forces in the initial stages of a war depends on the correct execution of screening operations and choice of defensive regions, positions and facilities. The armament of TD forces predisposes them for operation in terrain having varied features and cover, which limit the range of enemy fire and channel his forces, while at the same time enabling effective close range combat. A Territorial Defence Brigade (TDB) can be used in the first wave or deep within a defensive formation. When in the first wave, a TDB should be used for less threatened directions, or in gaps between different formations of operational troops. In each case, defence should be organised in varied terrain, especially in urban areas, forest complexes, in mountains, behind water obstructions, etc. The predicted nature of the threat to the country and the resulting conditions for defensive operations affect a multitude of phenomena. The hypothetical nature of the battlefield supports the need to expand the current scope of duties expected and performed by the TDF. The capabilities of combat assets, organisational structures and equipment available to modern armies, as well as offensive operation concepts provide grounds for the statement that any potential warfare will be conducted in rapidly shifting conditions. The air-land nature of operations conducted with strong fire and electronic support will add a spatial dimension to the combat and battles conducted.

In light of the current situation of the Polish Armed Forces (PAF), in particular Poland's membership in NATO and the European Union, Poland could play a leading part in the development of selected defence against weapons of mass destruction (DAWMD) technologies, in particular in the field of basic issues concerning WMDD, military chemistry, radiometry, chemical safety, chemical contamination of the environment, hazardous materials and waste, and WMD hazard assessment.

Due to the size of our country and its scientific and technical achievements, research tasks in the field of WMDD technologies should concern: detection and elimination of biological (B), chemical (C) and radiological (R) contaminations, development of BCR contamination monitoring and early warning networks, as well as protection against WMDs. The issue of counteracting and eliminating the consequences of chemical, biological and radiological terrorism, as well as ecological and natural disasters that could have negative consequences for society and the armed forces is also of great importance.

Among the urgent subjects proposed for study and implementation, in cooperation with NATO member states, the following are of note:

1. Standoff detection of biological and chemical contamination using optical methods (laser-stimulated fluorescence, passive infra-red, and Raman spectroscopy).
2. Integrated systems for real time detection of BCR contaminations in actual conditions:
   a) detection platforms, "electronic sniffing";
   b) ion mobility spectrometers;
   c) surface acoustic wave detectors;
   d) miniaturisation;
   e) data transmission and processing.
3. Integrated systems for chemical and radiological sampling, on-site pre-treatment, transport and instrumental analysis of samples:
   a) development of sampling methods and equipment;
   b) automation and robotisation of the sampling process;
   c) on-site treatment and analysis.

Scientific methods of identifying and monitoring the international flow of dual use technologies, materials and equipment for the prevention of WMD proliferation — together with the USA.

Improvement of methods to neutralise poison and biological warfare agent contaminations on special sites following terrorist attacks:

a) wet neutralisation methods utilising decontaminants containing surfactants and catalysts — improved decontaminants and optimisation of their deployment methods;
b) dry neutralisation methods utilising physical (electromagnetic and ionising radiation) and chemical methods (neutralising gases and dusts).

Improvement of mobile Chem-Bio-Rad laboratories in terms of their analytical capabilities during deployment and in the event of terrorist attack. The consequences of WMD deployment can be limited by passive defence*and the use of various

* Passive defence usually encompasses all actions intended to minimise the consequences of the enemy deploying WMDs as defined by Training 869/2013.

means of prevention. This will enable the armed forces and civilian organisations to support the allies and partners that have been affected by WMDS.

Regardless of the international agreements concerning non-proliferation of WMDs and prohibition of their use, one must be aware that works related to WMD improvement continue. Furthermore, the process of urbanisation and global industrialisation opens a broad range of possibilities for the accidental release or intentional employment of Toxic Industrial Agents (TIA).

Such conditions also create opportunities for the armed forces to operate in the event of a contamination or infection threat. Operations by armed forces carry the risk of exposure to the accidental or intentional release of hazardous substances. Survivability following the deployment of chemical, biological, radiological and nuclear weapons (CBRNs) requires cooperation by multiple services, including DAWMD and the medical services.

In terms of operation planning and execution, it is imperative that the commanding officer performs an assessment of the CBRN threat and adapts the scope of the DAWMD operations to the threat level (Fig. 1.1).

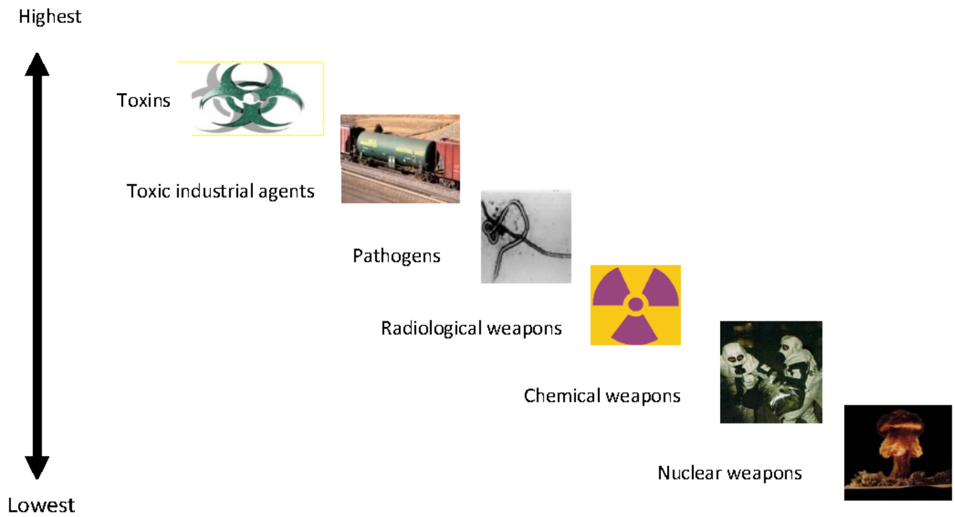

Fig. 1.1. Probable use of the components of weapons of mass destruction [1]

1. Protection of troops

According to the Ministry of National Defence Doctrine and Training Centre doctrine (Training 869/2013), protection of troops involves the use of all available assets to protect manpower, equipment, materials and hazard prevention operations, to maintain the freedom and effectiveness of military operations. The primary objective of troop protection is to maintain the combat potential of forces deployed in the area and the elements thereof. Troop protection also ensures that disruption during combined operations, caused by the civilian population and asymmetric threats, is minimised [2].

2. Defence Against Weapons of Mass Destruction

Defence Against Weapons of Mass Destruction is a set of planning and operational actions intended to mitigate or neutralise the effects of enemy interference in combat operations and on manpower, related to the deployment or threat of deployment of CBRN agents, as well as devices containing these agents [2].

The objective of DAWMD is to create conditions necessary for troops to perform their tasks under conditions of contamination or the threat of contamination, and to provide them with the ability to conduct rescue operations.

2.1. Tasks related to defence against weapons of mass destruction

DAWMD consists of five tasks, performed as dictated by the DBRN threat. These include [2]:

1) **detection, identification and monitoring of contamination** — includes detection of CBRN events, qualitative and quantitative identification of the weapon payload, determination of areas affected and monitoring the contamination situations;
2) **CBRN information management** — includes the systematic collection and distribution of warning messages, exchange of CBRN information and DAWMD specialist knowledge acquisition capabilities. Furthermore, it includes the analysis, storage, use, prediction and guidelines used in operational planning before, during and after a CBRN event;
3) **contamination protection** — includes the use of Personal Protective Equipment (PPE), Collective Protective Equipment (CPE), as well as contamination protection equipment installed in infrastructural facilities, aircraft, warships, vehicles, specialist equipment, etc. It is organised in order to ensure the survival of manpower and enable operations to be continued under conditions of contamination and the threat of contamination.
4) **contamination threat containment** — this task is necessary to limit the impact of contamination on the operation. This can be performed through:
   a) avoidance of contamination,
   b) containment of contamination spread,
   c) contamination level control,
   d) contamination elimination;
5) **medical protection against CBRN threats** includes the use of medical prevention measures and evacuation of affected personnel from the contamination

area, and their treatment as part of medical support, and is intended to reduce the susceptibility of manpower to CBRN threats.

3. Detection, identification and monitoring of contamination

3.1. Contamination detection equipment — portable measures

The detectors and sensors utilised around the world and in Poland employ various methods of stimulus-contamination detection in the environment. The particular method of chemical, biological and radioactive agent detection employed is fundamental to the reliability and speed of measurement results obtained this way.

3.1.1. *Chemical contamination detection devices*

Initially, the detection of poison agents around the world was commonly effected using equipment (e.g. indicator tubes or plates) based on colourful chemical and biochemical reactions. These had several benefits, such as low production cost, simplicity of use, sufficient sensitivity to PWAs. However, the long wait for contamination identification, low specificity and difficulties in automating the processes of analysis and notification has resulted in them being phased out in recent times in favour of equipment based on physical and physicochemical methods.

Indicator paper

Indicator papers are one of the simplest detectors used to confirm the presence of poison warfare agents in the environment where troops are conducting operations. For example, the PChR-54M device contains PWCh-1 indicator papers (Fig. 3.1a) for detecting sarin, soman and Vx on the surface of uniforms, protective clothing and equipment. The advantage of indicator papers is that they are relatively easy to use, since the change in paper colour (Fig. 3.1b) provides soldiers with a clear and simple indication of a change in their environment. The reverse side of the indicator papers is frequently covered with a self-adhesive coating, enabling them to be attached to the uniform or another external surface of protective clothing (filtrating or insulating). Unfortunately, indicator papers have relatively low sensitivity and selectivity, and their detection capabilities are in most cases limited to drops of liquid (poison warfare agent). Additionally, some of them undergo colourful reactions when in contact with organic solvents, diesel fuel and other chemical substances — which creates a false impression of PWA presence in the environment. The most popular indicator

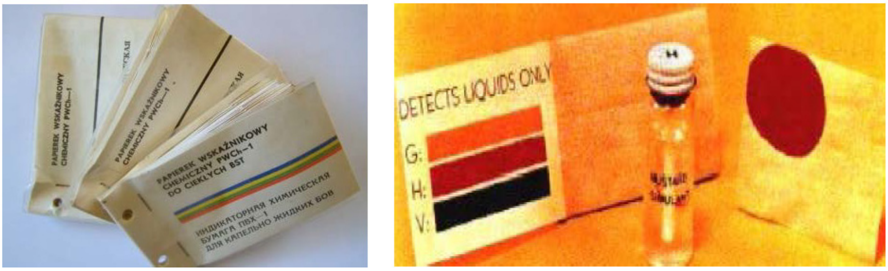

Fig. 3.1. a) PWCh-1 indicator paper; b) indicator paper reaction with type H PWA [3, 4]

papers used for detecting PWAs include: PWCh-1 and PWS — used in the Polish Armed Forces to detect PWA droplets and aerosols.

Personal PWA and TIA detector — LCD 3.3

Fig. 3.2. Personal PWA and TIA detector — LCD 3.3 [5]

The LCD-3.3 is a lightweight personal detector of poison warfare agents, which utilises an improved ion mobility spectrometry technique without the use of a radioactive source [5].

The LCD 3.3 personal detector is commercially available but has not been adopted by the PAF.

3.1.2. *Radioactive contamination detection devices*

The radioactive contamination detection equipment utilised by the PAF can be classified as:

a) **individual dosimeters** — their purpose is to measure the dose of radiation absorbed by the soldier and give very quick signalling in the event that the pre-defined alert thresholds are exceeded. They frequently contain semiconductor detectors, and some of them, aside from gamma radiation dose measurements, also enables the measurement of α and β radiation doses. An example of the state-of-the-art dosimeters employed by most NATO countries is the **SOR/T** dosimeter (Fig. 3.3a). It is used to measure the doses and power of γ and neutron radiation. It is able to present results in grays (Gy), sieverts (Sv) and rems (Rem). It has 4 programmable alert thresholds and can store up to 750 readings made at 10 second, 1 minute, 1 hour or 1 day intervals. It utilises a special type of memory that enables the storage of measurement results for up to 10 years without a power supply. The measurement range of the SOR/T device is 1 μGy-10 Gy, and the dose power ranges from background level to 10 Gy/h (relative reading error ±20%). Aside from direct readings using the SOR/T display, the measurement results can also be read using the **XOM** reader (Fig. 3.3b). XOM can also be used to configure and download SOR/T measurement results using remote data transmission (radio communication) from distances of up to 1 km. The SOR/T weighs 55 g and its working temperature range is from –20°C (–40°C for the enhanced version) to +50°C [6].

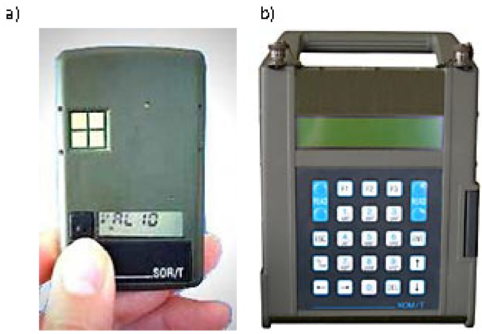

Fig. 3.3. Individual dosimeters a) SOR/T; b) XOM

3.1.3. *Biological contamination detection devices*

No such devices in the PAF.

Portable biological hazard detector — BIO-SEEQ PLUS

The BIO-SEEQ PLUS is a portable detector with a thermocycler system that is able to quickly and accurately detect bacterial and virus pathogens. Quick and accurate detection of common pathogens is possible due to the use of the polymerase chain reaction (PCR) technology. This is a highly specialised method able to detect 1 CFU (colony forming unit) in less than 50 minutes [7].

Fig. 3.4. BIO-SEEQ PLUS [7]

The BIO-SEEQ PLUS portable biological hazard detector is commercially available, but has not been adopted by the PAF.

3.2. Smokescreen agents

Optoelectronic systems and devices have gained a decisive role on the modern battlefield. With such equipment, combat can be conducted equally effectively at night, during the day, and under conditions of reduced visibility.

In order for a smokescreen to provide a benefit on the battlefield as an effective method of camouflage, it must be deployed sufficiently quickly, over a sufficiently large area, and must be maintained for a sufficiently long time. The most effective solution would be to gain a negative balance between identification and camouflage. Effective camouflage that prevents identification and detection provides a substantial advantage to friendly forces.

Hand smoke grenade — RGD-2

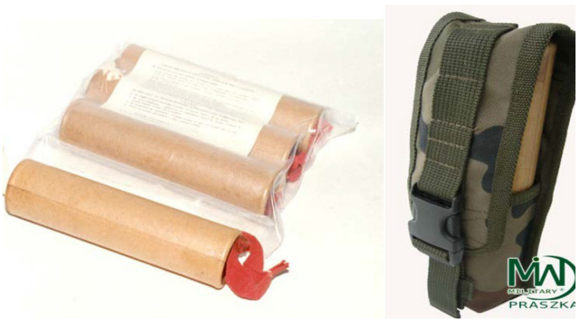

Fig. 3.5. Smoke grenade, type RGD-2db, duration of intensive smoke is 50-80 s, does not mask IR radiation (8-14 μm) [8]

Fig. 3.6. Smokescreen in visible light — first smokescreen section with a length of up to 25 m. Test object invisible. Screen height of about 3 m at a distance of 10 m from the smoke source [9]

a) b)

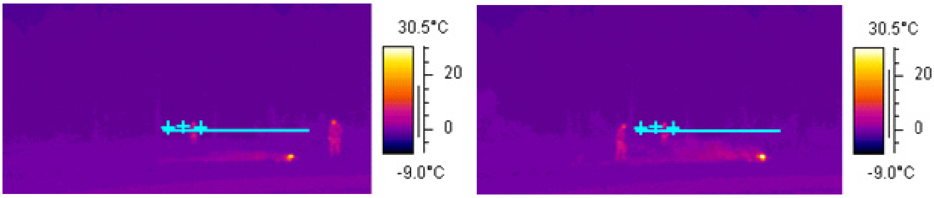

Fig. 3.7. a) Test object thermogram; b) Test object thermogram after 20 s of smoke production — no camouflage effect in infrared [9]

Hand smoke grenade — RGD-3

Fig. 3.8. Hand smoke grenade, type RGD-3

Fig. 3.9. Smokescreen in visible light — first smokescreen section with a length of up to 25 m. Test object invisible. Screen height of about 5 m at a distance of 10 m from the smoke source [9]

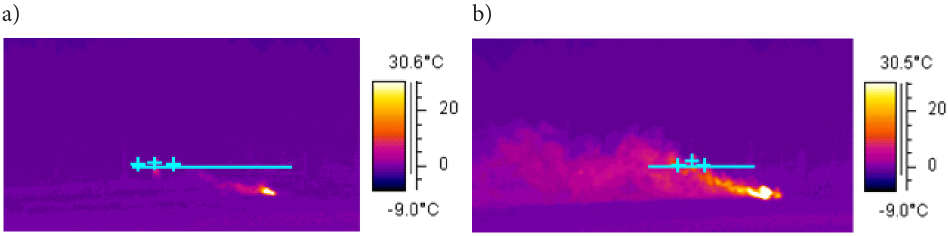

Fig. 3.10. a) Thermogram for a test object 25-30 m from the wind axis — start of smoke production; b) Test object thermogram after 20 s of smoke production [9]

After 20 s of smoke production, the test object is indistinguishable from the background. The distinguishing peak has disappeared and the smoke has increased the background temperature.

Product adopted by PAF — not in production.

4. Contamination protection

According to the Chemical Troops doctrinal document "Defence against weapons of mass destruction (DAWMD)" (Training 869/2013 (DD/3.8(A)), **contamination protection** is the primary purpose of the system. The document specifies the scope of operations and basic terminology, including contamination protection:

— contamination protection is a task consisting of the maximum utilisation of the functional properties of personal and collective means of protection against contamination, as well as the defensive properties of combat equipment, engineering facilities and terrain;

— Contamination protection is broken down into:

  personal contamination protection as a task that involves equipping each soldier with a gas mask plus insulating or filtering skin protection in order to ensure their safety during the performance of tasks under conditions of contamination or the threat of contamination;

— **Contamination protection measures and equipment** are necessary to reduce equipment losses, contain contamination spread and eliminate contaminations. These are classified as either personal or collective means of contamination protection [2].

4.1. Personal protection equipment

Important NATO normative documents on this subject are Stanag 2984 [10] and publication ATP-65 [11]. These provide commanding officers with guidelines concerning the reduction of the combat capability of soldiers and units as a result of employing means of contamination protection. The capability reduction depends on the adopted level of protection (PPE readiness level), defined as personal protective equipment dress level, which indicates how many PPE elements a soldier (or soldiers in a unit) are currently wearing. The recommended PPE protection levels correspond to those adopted in Stanag 2984. The following protection levels are distinguished:

— "LOW" — soldiers wearing field uniforms, gas mask carried;
— in marching position, protective clothing available immediately (Level 1 according to Stanag 2984);
— "MEDIUM" — protective equipment partly on — clothing on, protective footwear and gloves can be put on or not, gas mas carried by the side (levels 2, 3 and 4 according to Stanag 2984);
— "HIGH" — complete protective equipment worn — clothing, protective footwear, gloves, mask (with hood, if used), all fully secured.

4.1.1. *Filtration gas masks*

Toxic agents may penetrate into the human organism through the respiratory tract, eyes and skin, but the respiratory tract is the most exposed. In an adult person, the surface area through which gas exchange occurs is 75 to 100 m^2 (40 times the surface area of the skin). Additionally, it is the thinnest membrane, through which gases diffuse directly into the blood circulation. For most chemical agents, other penetration routes only become important once respiratory tract protection is provided. For this reason, the availability of appropriate means of respiratory protection is an issue of paramount importance.

a) MP-5 filtration gas mask

The MP-5 filtration gas mask is intended to protect the upper respiratory tract, eyes and face of the user against poison warfare agents, biological agents and radioactive dust. It enables tasks to be performed in a contaminated atmosphere and additionally is suitable for taking in fluids without the necessity to remove the mask. Other than the facial section of the mask and the FP-5 combined carbon filter, the set includes a bottle and a bottle with a valve. The structure of the mask's facial section provides an excellent field of view (above 90% normal field of view) and enables convenient manipulation of targeting and optical instruments. MP-5 technical data (based on the manufacturer's data): mask switching time from marching to combat position — 9 s; continuous mask wearing duration — 1 day; fluid intake capability — 200 g/min; mask weight (in combat position) — 800 g; automatic sweat removal from facial section — 60 g/min; absorption filter can be replaced in contaminated areas; 0.5 dm^3 fluid container; multi-gas or selective absorption filter can be installed; absorption filter thread in the facial section

— Rd 40 × 1/7". The facial section is made of polyurethane, and is susceptible to contaminant elimination processes [12].

Fig. 4.1. a) MP-5 mask; b) MP-5 mask with FP-5 combined filter and UPP device [12]

b) MP-6 filtration gas mask

The MP-6 filtration gas mask meets all the requirements included in international standard PN-EN-136:2001 — Respiratory tract protection equipment. Masks. Requirements, testing, marking; and defence standard NO-42-A2014:2016 — Respiratory tract protection equipment. Gas masks. Requirements and testing.

Fig. 4.2. a) MP-6 mask set; b) MP-6 mask with helmet; c) MP-6 mask with helmet and optical system [12]

The facial section is made of rubber with a woven fabric head strap and two slots for combined filters. The mask has significantly lower breathing resistance than the MP-5, improved fitting ability and improved ability to use targeting equipment, etc.

c) Combined filters for MP-5 and MP-6 masks

According to standard PN-EN 132:2003 — Respiratory protective devices. Terminology and marking:

— filter — purification element intended to remove particles from air — requirements as per PN-EN 143:2004;
— absorber — purification element intended to remove specific gases and vapours from air flowing through — requirements as per PN-EN 14387:2008;
— multi-gas absorber — absorber that meets the requirements for more than one type of absorber — requirements as per PN-EN 14387:2008;
— combined filter — purification element intended to remove scattered solid and/or liquid particles as well as specific gases and vapours from the stream of air flowing through — requirements as per PN-EN 14387:2008 [12].

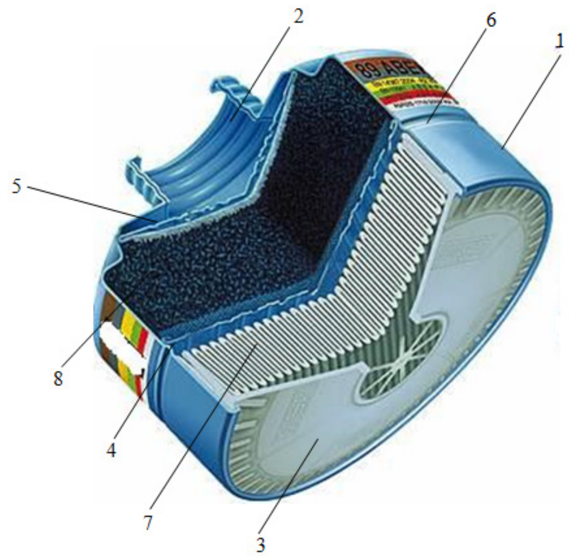

Fig. 4.3. Combined filter structure diagram: 1 — body (steel, aluminium or plastic sheet); 2 — thread (Stanag 4155 and PN-EN 148-1:2002); 3 — bottom cover; 4 — resistance element; 5 — resistance elements with screen; 6 — sealing rib; 7 — filter (referred to as anti-aerosol); 8 — carbon sorbent

FP-5 and FP-6 combined filters meet all the requirements included in defence standard NO-42-A205:2001 — Gas mask combined filter. Requirements and testing. The Cr+Cu+Ag carbon sorbent has excellent protection properties against PWAs (chlorocyan: penetration time > 60 minutes compared to the required 33 minutes) and limited against TIAs (ammonia — penetration time 60 minutes compared to the required 50 minutes, hydrogen sulfide > 60 minutes compared to the required 40 minutes). The combined filter utilises filtration materials of at least class H-14, which enables providing effective filtration at a level of 99.995% for the most penetrating particle size, d = 0.14 mm — according to PN-EN 1822-1:2009 — High-performance air filters (EPA, HEPA, ULPA). Part 1: Classification, parameter testing, marking.

4.1.2. Protective clothing

Due to the protection mechanism (and related materials), protective clothing currently utilised by the armed forces is divided into two groups:

- insulating, which includes such solutions as: common military clothing, capes and special clothing*;
- filtering — sorption filtering (permeable), which includes common (combat) clothing and special purpose clothing (suits and undergarments)**.

Insulating skin protection

Insulating clothing was widely employed until the end of the 1970s. Currently, common military insulation clothing is used in some countries of the former Warsaw Pact (including Poland) due to remaining stocks and financial limitations. This type of clothing takes the form of a cape used together with stockings, or a one- or two-piece suit*. Compared to contemporary standards, the structural solutions utilised in this type of clothing can hardly be described as comfortable. Additionally, the materials utilised provide relatively short of protection against PWAs (1-4 h). An example of common military insulation clothing is the OP-1M protective coat (fig. 4.4), utilised by the PAF. It is used in combination with PO-1M protective stockings and RO-1 protective gloves. The principles of utilising the protective coat depend on how it is employed. It can be used in the form of a cape, coat, or suit.

Putting it on is burdensome and time-consuming due to the complex fastening system. It is manufactured in three sizes, which leads to poor fitting and low wearer comfort. Protection time against liquid PWAs for individual clothing elements ranges from 80 to 180 minutes.

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* Insulating protective clothing — a type of military protective clothing made of materials that create a barrier against poison, biological and radioactive agents, and protects the soldier from their effects [PN-V-01010].

** Filtration protecting clothing — a type of military protective clothing made of composite filtering materials, protecting the soldier's skin from contamination [PN-V-01010].

Fig. 4.4. OP-1M protective coat as a coat and suit [12]

Weight with protective stockings and gloves is approx. 2.3 kg (depending on size). Compared to filtration clothing, insulation clothing has the advantage of not losing its protective properties after unpacking, which enables its broader use in training. It can also be decontaminated.

Insulation materials are used to manufacture protective capes, utilised to provide additional protection for filtration clothing against liquid combat agents and radioactive dust. These products are one-piece (cape or poncho), with an integrated hood, disposable, characterised by low mass and volume when packed, and low

Fig. 4.5. Locally manufactured disposable protective cape [12]

price. They also provide protection for the equipment carried. Even a backpack can be fitted underneath. To provide as small a volume as possible when packed, they are vacuum-packed.

The protective cape utilised in the PAF (Fig. 4.5) is intended to protect the soldier against droplets of poison and biological warfare agents and radioactive dust.

It is a one-piece clothing element, put on over one's head. The cape's structure enables the soldier to put it on while wearing a gas mask and helmet. The cape has an integrated hood fitted with a drawstring. The cape's front features symmetrically placed holes covered with flaps, used to extend the arms from underneath the cap. The achieved protection time exceeds 24 hours (required 4 hours), which is comparable to global solutions. It is manufactured in three sizes, and its mass in its packaging is 490 to 540 g, depending on size.

The special purpose clothing includes solutions whose primary intended use is not as a common PPE element throughout the armed forces. This clothing is used mainly in subunits of chemical troops (contamination detection and elimination), chemical emergency units, medical and technical services, and other military branches (clothing for the Navy). Example solutions from this group include: L-2 one-piece suit (fig. 4.6), intended for chemical troops, and L-1 two-piece suit for the Navy. This clothing has protection parameters similar to the OP-1M coat and similarly can be decontaminated [12].

Fig. 4.6. L-2 suit [12]

A modern solution employed in many countries is lightweight clothing. This element of clothing is disposable, cheap to produce, characterised by low mass and relatively long protection time (approx. 12 h), worn over the uniform and footwear. This clothing can also be part of PPE. Light Insulating Protective Clothing (IZO) (Fig. 4.7) is intended for Land Forces, crews of Navy warships, airplane and helicopter crews, and ground crews. It can also be part of the equipment of military chemical emergency subunits, sampling teams, as well as shelters for the collective protection of troops and civilian population. It is a two-piece element of clothing comprising a jacket with integrated hood, and trousers with integrated rubber boots. Its protection time against PWA droplets is at least 12 hours, and total weight does not exceed 1.5 kg. It is available in three sizes. Storage life is 15 years.

Fig. 4.7. IZO lightweight insulation clothing [12]

Composite filter skin protection

Insulation protection clothing can provide significant protection to the skin against poison, radioactive and biological agents, and at times even against light radiation. However, this type of clothing has a number of drawbacks, mainly due to its sanitary, hygiene and utility properties (disruption of natural thermal regulation of the body, limited duration of use, constriction of movements, large weight, and no provision of sealed connections with other protective equipment).

For this reason, aside from insulating protective clothing, human skin protection — mainly against PAs — is achieved using filtration (composite filter) clothing made of special woven fabrics, and most commonly in multi-purpose systems.

Polish FOO-1 clothing: two-piece (jacket and trousers) (Fig. 4.8), two-layered, external layer made of non-woven fabric with a hydrophobic, oleophobic and fire retardant finish, with a green, brown and black camouflage pattern applied. Internal layer made of the SARATOGA composite filter material, with activated carbon balls applied to a woven fabric. The jacket is fastened with a zip, externally protected with a cloth flap fitted with a Velcro fastener along its entire length. Connection with a gas mask is provided with additional sealing using a rubber drawstring placed in a tunnel at the hood edge. Sleeve and glove connection is sealed using seals sewn on the outside of the sleeves, seal length is adjusted with a tape and Velcro fastener. Loops worn over the thumbs are sewn on the sleeves. At waist height, the jacket has a tunnel with a drawstring adjusted from the outside. The lower edge of the jacket has a drawstring placed in a tunnel. The trousers, with attachable textile and rubber holders, have broad legs enabling them to be put on without removing any footwear. The fly is closed with a zip, protected along its entire length with a flap and Velcro fastener. Leg connections with shoes are sealed with seals sewn on the outside of the legs [12].

Fig. 4.8. FOO-1 composite filter protective clothing [12]

Main parameters:
- air permeability — 170 [mm/s],
- area density — 390 [g/m^2]
- protection time against yperite vapours:
  a) new — 165 h,
  b) once affected by water — 139 h,
  c) once affected by artificial sweat — 132 h,
  d) once affected by diesel fuel — 28 h,
  e) required — 24 h [2].

5. Contaminant elimination

According to the Chemical Troops doctrinal document "Defence against weapons of mass destruction (DAWMD)" (Training 869/2013 (DD/3.8(A)), elimination of contaminations is a process whose purpose is to ***ensure the safety of manpower, facilities and regions*** by removing radioactive substances from the surface, as well as collecting, disposing, neutralising and removing biological and chemical agents contaminating the surface or present in their vicinity" [2].

Elimination of contamination is performed in accordance with the following principles:

1) immediately, as soon as possible;
2) only what is necessary or required due to operational needs;
3) as close to the contamination area as possible;
4) according to operational priorities.

Quoting the above document further — "according to requirements of the operational situation, contamination elimination may take a passive or active form:

1. **active contamination elimination** involves collecting and removing radioactive substances, as well as collecting, disposing, neutralising and removing biological and chemical agents from contaminated manpower or equipment (terrain and infrastructure) using chemical or mechanical processes. The following are conducted as part of active contamination elimination:
   — **immediate** contamination elimination ***by individual soldiers directly after contamination occurrence in order to minimise losses and***

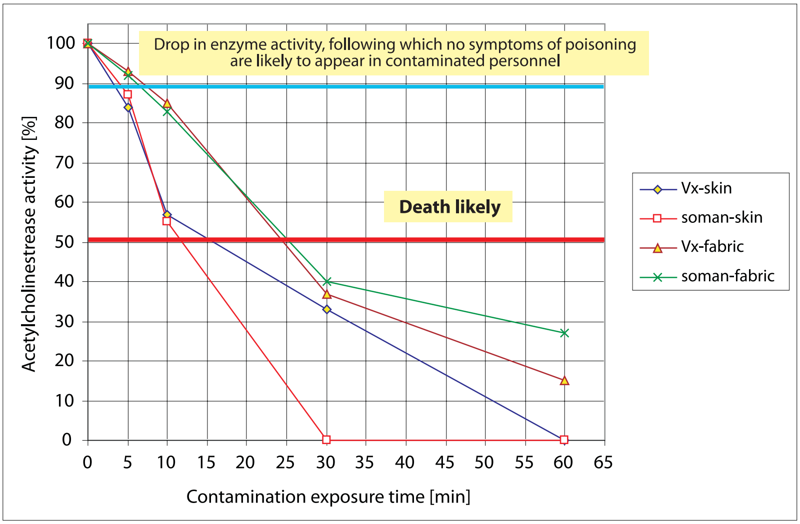

Fig. 5.1. Drop in activity of the acetylcholinesterase enzyme in rats once skin and cotton fabric is contaminated with soman or Vx. Contamination density approx. 1 g/m^2 [1]

> ***protect the life of contaminated manpower***, as well as limit the spread of the contamination. It can include the elimination of contamination of parts of uniforms or equipment."

Why is this element of DAWMD so important? Fig. 5.1 shows the action of the Vx compound through the naked skin and outer garments.

5.1. Technical equipment for immediate elimination of contaminants

According to the NO-01-A006:2010 requirements, **contamination elimination package:** is a packaged set of prevention and decontamination agents intended for **immediate elimination of contaminants**. The package can also contain a set of pharmacological agents that prevent the effects of contamination, including from equipment, enabling them to be used.

Individual contamination elimination package, type IPLS-1 [1]

IPLS-1 is intended for:

- preventive securing and immediate elimination of contaminations discovered on the surface of the skin (face, hands, neck) against the effects of poison warfare agents;
- perform immediate elimination of contamination of personal weapons and equipment.

Technical characteristics:

— package weight	460 g
— weight of prevention and decontamination ointment tube	90 g
— weight of powder decontaminant with glove	95 g
— weight of container with organic decontaminant	210 g
— maximum duration of preventive effects of ointment	approx. 3 h
— time to prepare for use	20 s
— time to perform decontamination of a uniform set	300 s
— duration of protective properties of decontaminant-covered uniform	approx. 2 h

Design:

The package comprises a plastic tube with a preventive ointment, three packages in aluminium foil, containing a powdered agent for eliminating contaminations, and six gauze napkins. Package contents are placed in a specially shaped plastic box.

IZAS-05 Individual **Automatic Syringe Set** [14]

IZAS-05 is a set of pharmacological agents preventing the effects of contamination.

Fig. 5.2. Individual contamination elimination package, type IPLS-1: 1 — two napkins; 2 — spray head with pump; 3 — spray tank with organic decontaminant; 4 — tube with preventive/decontaminant ointment; 5 — powdered decontaminant in glove


Glove with powdered decontaminant

Covering areas of bare skin with powdered decontaminant


Removal (dusting off) of powdered decontaminant from the skin

Fig. 5.3. Skin decontamination with the powdered decontaminant

Technical characteristics — design

The set comprises three automatic syringes placed in a plastic box:

— **blue automatic syringe —** used to relieve strong post-traumatic pain;

— **green automatic syringe** — used to prevent phosphoorganic PWA poisoning, e.g. soman, sarin. Contains: 2 mg atropine, 7.5 mg diazepam, and acetylcholinesterase activator — 220 mg toxogonin or 600 mg pralidoxime;

— **yellow automatic syringe** — used to maintain the cholinolytic activity in PWA poisoning (supplements large green automatic syringe). Contains 2 mg atropine.

Additionally, individual equipment includes a red automatic syringe, containing 10 mg morphine, used to relieve pain.

Fig. 5.4. a) IZAS-05 Individual Automatic Syringe Set; b) automatic syringe with morphine

Summary

A certain shift in threats can currently be observed. So-called asymmetric threats with the ability to deploy elements of weapons of mass destruction systems, and civilizational threats related to the development of industrial and communications infrastructure are on the rise. DAWMD is an element of troop protection and a leading element of crisis response, so it should be developed for the new challenges. It appears that an extremely important element of the system, the detection, identification and monitoring of contaminations, is technologically outdated. Another extremely, if not the most important element of the system, is contamination protection. This paper has described elements of personal protection systems. Insulation clothing is a technical solution from the middle of the 20th century and should be replaced with lightweight disposable elements. The combination of disposable clothing (with a protective cape) with the MP-6 mask seems to be a sufficient solution for the time being. The introduction of the "Tytan" system (21st century soldier), currently in development, should markedly improve troop protection. Elimination of contaminants is an element of contamination threat containment. The paper has described the equipment (packages) that provides individual contamination elimination. These are solutions similar to solutions existing in NATO. To summarise, the DAWMD system in the Polish Armed Forces presented here requires significant modernisation in technical and procedural terms as soon as possible.

This work was funded personally by the authors.

Received January 4, 2018. Revised February 26, 2018.

Paper translated into English and verified by company SKRIVANEK sp. z o.o., 22 Solec Street, 00-410 Warsaw, Poland.

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W. HARMATA, M. WITCZAK

Obrona przed bronią masowego rażenia. Rozwiązania techniczne i funkcjonalne w ochronie indywidualnej w Wojskach Obrony Terytorialnej

Streszczenie. W pracy scharakteryzowano obronę przed bronią masowego rażenia, jako system zabezpieczenia wojsk w przypadku zagrożenia skażeniami (zakażeniami) w ujęciu funkcjonalnym i zadaniowym. Przedstawiono podstawowe wyposażenie techniczne wojsk z uwzględnieniem podziału na sprzęt i środki do: rozpoznania skażeń, ochrony przed skażeniami i likwidacji skażeń, stosowane w ochronie indywidualnej.

Słowa kluczowe: obrona przed bronią masowego rażenia, sprzęt, ochrona indywidualna żołnierza
DOI: 10.5604/01.3001.0012.0984