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Review article

Current state and the concept of a modern platform for chemical, biological and radioactive decontamination

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INFORMATION

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ABSTRACT

The paper addresses decontamination as a system of troop protection in the event of a risk of contamination in functional and task terms. It presents the analysis of technical equipment and decontamination procedures in the Polish Armed Forces and NATO. The concept of a modern platform for liquidation of chemical, biological and radioactive contamination has been described.

KEYWORDS

chemical, biological and radioactive decontamination,
complete liquidation of contamination,
equipment and a platform for decontamination

Introduction

According to the doctrine of the chemical forces DD/3.8(A), "decontamination is a process aimed at ensuring the safety of personnel, facilities, and areas by removing radioactive substances from the surface, as well as collecting, destroying, neutralizing, and removing biological and chemical agent contamination on or near surfaces" [1].

According to NO-01-A006:2010 "decontamination – a process aimed at ensuring the safety of people, facilities, or areas, consisting in sorption, destruction, neutralization, inactivation, or removal of chemical or biological contaminants or removal of radioactive substances from them or their surroundings" [2].

The Polish Standard PN-V-01009 defines the contamination elimination as follows: "this term is understood as the process of bringing people, individual equipment, armaments, objects, or land to a safe level. The process is performed using physical methods – absorption, chemical (reducing the contamination degree) – neutralization, or removal of chemical or biological contamination and radioactive materials" [3].

To sum up – decontamination is the only element in the military security system in which the combat readiness lost as the result of chemical, biological, and radioactive (CBR) contamination is restored.

Decontamination units of specialist chemical troops (WChem) are designed to eliminate contamination actively and can be used for military purposes, ensuring national security and removing effects of natural disasters.

As part of international cooperation, these sub-units should achieve world-class training level and equipment as a fully-fledged element of the Multinational CBRN Defense Battalion (OPBMR), which belongs to the NATO Response Force. Within its frame-work, separate sub-units participate in exercises, courses, and pieces of training aimed at improving the removal of the effects of the weapons of mass destruction (WMD) use, and the elimination of contamination resulting from the release of toxic industrial agents (TSP) [4]. Decontamination is treated as a priority in the NATO Armed Forces, both as an element of combat security and support in crises [5]. It means that training and equipment of the decontamination sub-units of the Polish Armed Forces must be at the highest level so that they can provide full combat capability to our sub-units and the cooperating forces of NATO Member States, and fulfil our allied obligations.

It is crucial that chemical troops are used to protect mass events (Olympics in Athens, Euro 2012 Poland-Ukraine [6]), eliminate the effects of natural disasters (flood in 2010 [7]), and secure activities of larger units during exercises. According to the national legal status, the use of chemical troops is permitted when the use of other forces is insufficient or impossible [8, Art. 18]. In the event of contamination or infection over an extended area (a flood or the current COVID-19 pandemic [9]), it is fully justified. The use of decontamination units in actual operations confronts the possibilities with the demand. The troops are required to effectively eliminate contamination from large amounts of equipment and people in the shortest possible time. While being demanding, various types of contamination, limited working time possibilities, and the need for long-term stay in protective clothing additionally hamper the task. It should be noted that currently, the OPBMR is not fully prepared to perform all decontamination tasks, especially for the civilian population.

A solution to the problems of decontamination subunits could be to equip them with highly specialized platforms allowing for the elimination of contamination of people, large areas, and equipment of various sizes.

The correct choice of one of the methods for contamination elimination is not an easy task, and many limitations will make this task difficult, extending the time of combat operations [10].

1. Complete decontamination

According to NO-01-A006:2010, the complete decontamination is carried out by the force of the unit, with or without external support, to eliminate contamination on people, equipment, materials, and/or in the operation area, and thus enable partial or complete removal of individual means of protection against contamination and carrying out combat operations with minimal reduction of combat capabilities [2].

According to the regulations of the US Land Forces, FM 3-5, the purpose of the thorough decontamination is to reduce or eliminate the need to use means of protection against contamination. Sub-units run it in cooperation with chemical troops to minimize the contamination of soldiers, equipment, and materials to the lowest possible level, enabling the performance of tasks without protective measures limiting combat capability. It may also include the elimination of contamination from the site.

Its scope includes thorough elimination of contamination of combat equipment (from outside and inside) to a safe level, replacement or elimination of contamination of individual means of protection against contamination, and complete radiological and chemical control of equipment after the contamination elimination process. Chemical troops perform it in cooperation with a contaminated sub-unit. As a result, it is possible to restore the full combat capability of the sub-unit. After decontamination, radiological and chemical control is necessary due to the possibility of traces of toxic or radioactive agents remaining in hard accessible places. It is carried out after the contaminated sub-unit has completed a combat task, during the reconstruction of combat capability, or after crossing a particular line [5].

In the Polish Armed Forces, decontamination is organized and carried out to remove (or neutralize) radioactive substances and toxic chemicals from the surface of the body, uniforms, equipment, structures, and land. The aim is also to exclude or minimize soldiers' paralysis and losses caused by chemical, biological, and radioactive contamination, and reduce the size of the equipment surface contamination to a level allowing its use without the necessary action in personal protective equipment, as well as restoring the functional properties of contaminated uniforms and protective measures [11].

Under the WChem nomenclature, decontamination includes the elimination of human contamination (sanitary measures), combat equipment, weapons, uniforms, equipment, terrain, and buildings (following the old nomenclature – special measures). The forces of contaminated troops carry it out with the help of full-time equipment and WChem means (sets and packages). Specialized sub-units of chemical troops can be used to eliminate contamination of those elements of a grouping of troops, which decides on the success at a given stage of the fight [11; 12].

Human decontamination comes down to the removal (neutralization) of radioactive and toxic substances from the body surface. It is divided into partial and full sanitary procedures. The resources at the Armed Forces' disposal allow them to perform only partial operations. The complete elimination of contamination of people may be carried out by the personnel decontamination sub-units, which are part of the decontamination chemical troops. These sub-units develop sanitary treatment points, which are part of the contamination removal points. These treatments can also be carried out with the use of field infrastructure (municipal, company, and garrison baths). Complete elimination of contamination from persons is performed only when, after partial decontamination, the degree of radioactive contamination of soldiers exceeds safe values. In the event of contamination with biological agents, complete sanitary procedures are conducted in every situation, regardless of whether the soldiers were wearing protective clothing and underwent partial disinfection [11-13]. Unfortunately, the regulations and instructions do not contain strict and unambiguous procedures for dealing with chemical contamination.

The elimination of contamination of weapons, combat equipment, ammunition, and other materials can also be partial and complete. In most cases, the equipment and means for decontamination ensure that the Armed Forces conduct only partial liquidation of contamination. Only the operators of combat vehicles equipped with on-board decontamination kits (ZO1, ZO2, ZO-E) can carry out complete decontamination (disinfection). In other cases, it is impossible due to insufficient capacity of the tanks for disinfectants (deactivation agents) and the lack of resolution packets in the kit. Funds can be replenished from the PZLS-1 Sub-Unit Contamination Removal Kit, which has a supply of organic disinfectants for on-board sets and is intended for operational and complete decontamination of the surface of combat vehicles and vehicles at the battalion level.

Decontamination sub-units conduct complete (thorough) decontamination at developed decontamination points or by decontamination directly in the deployment (grouping) areas. These points are developed in pre-planned areas or areas designated ad hoc.

Uniforms, contamination protective measures and equipment may be subject to partial decontamination procedures. Currently, there are no forces, measures, and methods for complete (thorough) liquidation.

Decontamination and disinfection of sections of the area, as well as roads and facilities, are to protect people and combat equipment against recontamination and to restore convenient conditions for movement and maneuver for troops and logistic units. Decontamination and disinfection of roads are carried out to a limited extent and only when it is impossible to circumvent the contaminated road sections. Road junctions, approach roads to crossing areas, access roads to depots and warehouses, etc. can be disinfected. Radioactive dust is washed only from asphalt and concrete surfaces. Decontamination units perform the tasks as mentioned above.

The dissolution of sub-units for the so-called uniform disinfection created a void in the Polish Armed Forces. Assuming that the filter-absorbent protective clothing with insulating elements (shoes, gloves, cape) and the gas mask are disposable, the matter is still not resolved. The soldier's other equipment, e.g., bulletproof vests, weapons, and other items of equipment, is not treated as disposable and, therefore, should be subject to decontamination processes.

At present, the Polish Armed Forces lack technologies and means to decontaminate equipment, electronic and optoelectronic apparatus, paper products, and military technology interiors. They are not susceptible to the liquidation of contamination with "wet" methods.

Specialized platforms are used in NATO armed forces for complete (thorough) decontamination. An example of such a solution can be the TEP-90 modular system of the Kärcher group (Fig. 1-5) [14]. The platform has four modules and a boom, which are mounted on the vehicle chassis. Three people can deploy the entire platform within 20 minutes. It consists of four modules:

1) the first one includes equipment for decontamination of large vehicles outside and the terrain, including cooperation with the boom,
2) the second one is designed to decontaminate personal equipment (steam at ~170°C),
3) the third one is intended to eliminate human contamination (sanitary measures) – a tent and a shower device,
4) the fourth one – "Decon Shuttle" is a mobile device used to eliminate interior contamination.

The whole thing is adapted to sea, rail, and air transport. Table 1 presents the decontamination capacity per hour.

Module 4 (Decon transfer) is designed for independent decontamination inside vehicles, helicopters, aircraft, etc. The liquidation of contamination is based on chemisorption. The preparation is sprayed onto the surface and sucked (vacuumed) after it dries.

A similar solution is offered by the Italian company Cristanini in the form of a CBRN/2 decontamination platform [15].

CBRN/2 is a self-sufficient, mobile field installation for continuous, parallel liquidation of contamination of people, equipment, and materials. It can also be used to eliminate land

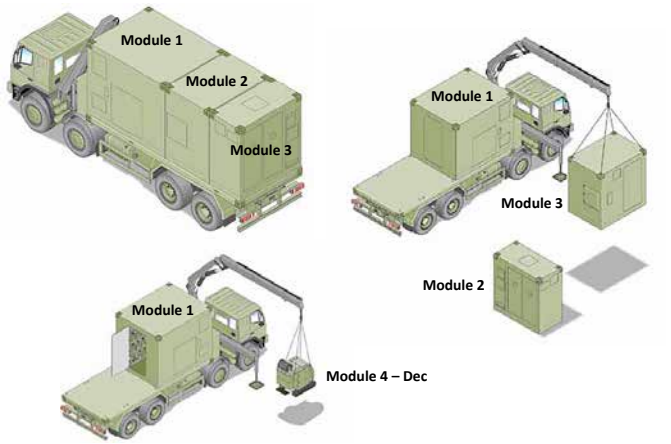

Fig. 1. Decontamination platform – TEP 90 modular system – folded and unfolded. When removing module 2 and 3. Removing module 4 – Decon Shuttle
Source: [14].

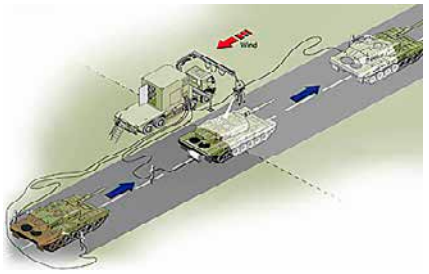

Fig. 2. Decontamination platform – TEP 90 modular system, module 1, during three-stage decontamination with a boom
Source: [14].

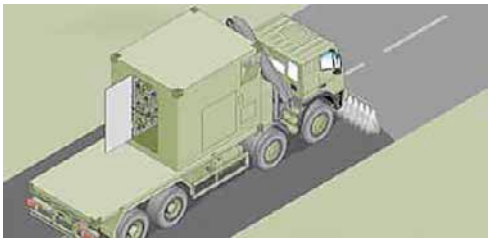

Fig. 3. Decontamination platform – TEP 90 modular system, module 1, hardened surface decontamination
Source: [14].

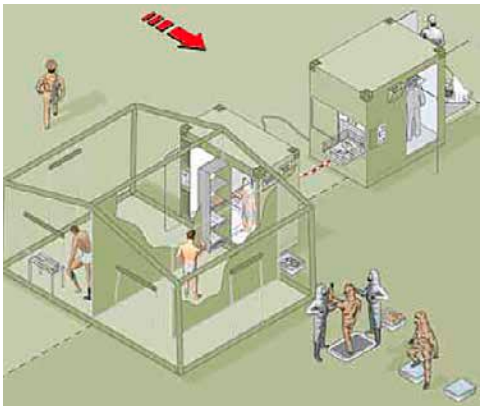

Fig. 4. Decontamination platform – TEP 90 modular system, modules 2 and 3, decontamination of people and their equipment
Source: [14].

Fig. 5. Decontamination platform – TEP 90 modular system, module 4
Source: [14].

Table 1. Summary of the TEP-90 system capabilities

Specification	Quantity
people	40
weapons and equipment	up to 20 sets
land	1500 m² (one tank filling)
vehicles	4 to 6 tanks or 6 to 10 vehicles or 1 aircraft
equipment sensitive to traditional decontamination	up to 20 sets
protective clothing	up to 20 sets
liquidation of interior contamination	device up to 500 m³/up to 4 vehicles or up to 1 aircraft
road sections (as an alternative to large vehicles)	up to 1500 m²

Source: [14].

contamination and extinguish fires. The installation takes 40-50 minutes to be prepared and requires 2 or 3 people. It can be transported on a vehicle chassis capable of carrying 20 feet ISO containers. Both sides of the container open and allow access to the equipment. The container under the floor has a water tank. With the use of the CBRN/2 installation, it is possible to eliminate contamination of 180 people, 15 units of equipment, and additional equipment and the area in one hour. The installation is designed to work independently for 72 hours, including work in a contaminated area (it has autonomous ventilation and filter-ventilation system). It has an entrance airlock (vestibule) for the decontamination of the staff or other contaminated people who want to enter – Figures 6-9.

2. Decontamination platform

2.1. Purpose of the platform

Purpose of the platform:

- the platform should be a mobile element of the decontamination system of the Polish Armed Forces,
- the platform should be adapted to the elimination of contamination of people, the surface of combat equipment, weapons, elements of equipment and disinfection of the interior of military latest machinery.

2.2. Functional and technical solutions

Functional solutions:

- the operational parameters of the devices included in the platform should allow decontamination processes in the temperature range from –30°C (243 K) to +50°C (323 K) according to NO-06-A504 and NO-06-A-101-103 [16-19],
- platform equipment should enable decontamination processes in night conditions,

Fig. 6. Decontamination platform – Cristanini CBRN/2 unfolded
Source: [15].

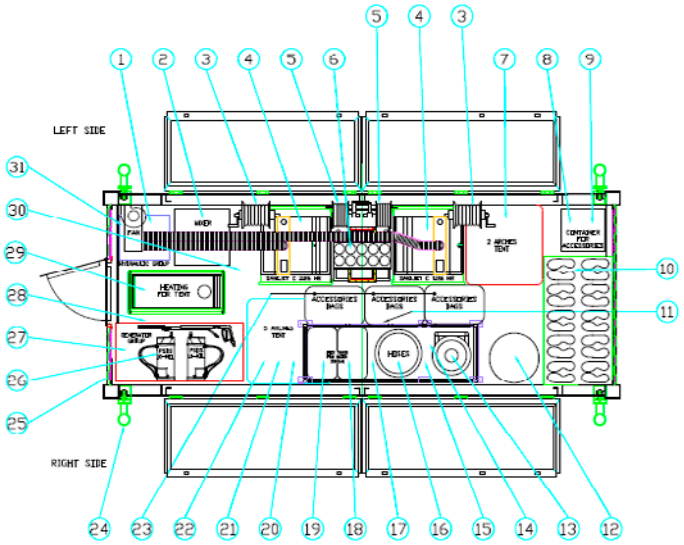

Fig. 7. Equipment for the Cristanini CBRN/2 decontamination platform: 1 – BX24 disinfectant container, 2 – hydrodynamic mixer, 3 – fire hose with a nozzle on a reel, 4 – Sanijet C.1126 HR high-pressure car wash, 5 – high-pressure steam hose on a reel, 6 – BX 24 cartridge box, 7 – 2-arched tent to decontaminate equipment, protective clothing, and materials, 8 – container for storing consumables, 9 – container for accessories, 10 – container for clean clothes (protective clothing), 11 – WW105 and WW75 lances, fire lances, 12 – 200-dm³ tank for storing polluted (contaminated) water, 13 – system for vacuum collection of polluted water, 14 – stainless steel container for the area decontamination (disinfection) system, 15 – wastewater collection hose, 16 – collector with a hose for the area decontamination, 17 – container for accessories, 18 – flexible semi-closed clean-water tank for supply – 1000 dm³, 19 – flexible tank for collecting polluted water – 1000 dm³, 20 – flexible tank for collecting water used during the vehicle decontamination, 21 – stainless steel tripod for lighting, 22 – 5-arched tent for sanitary procedures, 23 – accessories for a 5-arched tent, 24 – lifting system, 25 – electrical panel, 26 – PDS 10MIL portable decontamination equipment, 27 – 12 kW, 220V AC, 50Hz diesel power generator, 28 – grounding, 29 – tent heating system, 30 – container with BX29 disinfectant, 31 – oleo-dynamic sockets
Source: [15].

– the platform should be a container-type mobile device with the possibility of adding additional equipment,
– the platform in the “marching” position should be suitable for air transport.

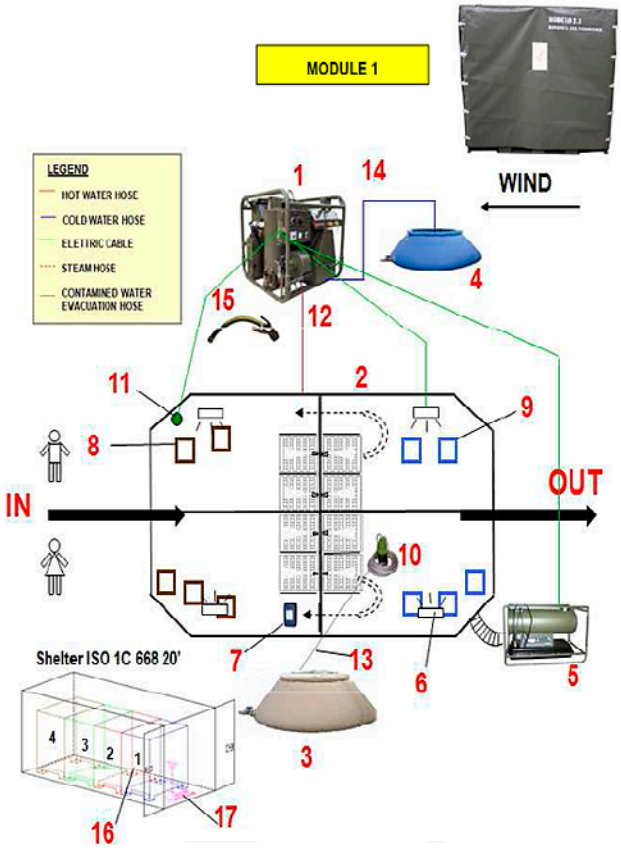

Fig. 8. Variant of the development of human decontamination set: 1 – Sanijet C.921 car wash, 2 – tent (8 shower places), 3 – flexible tank for polluted water, 4 – clean-water tank, 5 – air heater, 6 – lighting, 7 – means for sanitary procedures, 8, 9 – containers for contaminated clothing and equipment, 10 – "dirty" water suction pump, 11 – turbocharger, 12 – hose for supplying shower attachments, 13 – hose, 14 – power cord, 15 – shower faucet. Capacity: sanitary procedures of 180 people/h (0.3-0.5 MPa of water at the temperature of 34°C)
Source: [15].

Fig. 9. Variant of the development of equipment decontamination set: 1 – car wash Sanijet C.921, 2 – WW 220M lance, 3 – Sanijet-gun lance, 4 – high-pressure hose, 5 – suction hose of the car wash, 6 – flexible clean-water tank, 7 – water tank after contamination removal, 8 – "dirty" water suction pump, 9 – hose, 10 – chassis washing system, 11 – SX34 CBRN decontamination kit for sensitive equipment, 12 – contaminated water tank, 13 – container for SX34 spray application, 14 – BX24 disinfectant. Capacity: decontamination of 20 vehicles/h (water at the temperature of – 80-85°C and the pressure of 9 MPa) and 20 interiors (vehicle cabins, apparatus, etc.)
Source: [15].

Platform equipment:

- the platform should include devices and components mounted in/on a ten-foot container,
- the general concept of the decontamination platform, modeled on the solutions by Kärcher and Cristanini, is presented in Figures 1 and 7,
- a set of devices for decontamination of the surface of weapons and military machinery (including the running gear),
- a boom with a basket for decontamination in large-size objects,
- a device for decontaminating (disinfecting) large surfaces (interiors) of objects,
- a chamber for decontamination of equipment (apparatus), fixtures, etc.,
- systems for powering the platform devices (electricity, water),
- a set of devices for human decontamination,
- a stock of personal protective equipment,
- inventory of resources for the elimination of contamination enabling the 24-hour process (without water),
- internal (between positions) and external communication means and the GPS system,
- instruments for checking the effectiveness of decontamination and deactivation,
- water tanks securing 24-hour processes.

2.3. Design and technological solutions

Equipment surface decontamination

Devices, means, and technologies verified through appropriate tests should be used to eliminate contamination of the surface of weapons and military equipment. SANIJET C.921D high-pressure car washes with accessories can prove useful for the application of active factors in the processes of surface decontamination – Figure 10.

Portable disinfection devices with a single nozzle and three-fold foaming nozzles (IRS-2C equipment or from the PZLS-1 sub-unit decontamination kit) can be used for the application of active agents in the processes of decontamination of wet susceptible interiors [21].

Fig. 10. Conducting decontamination
Source: [20].

Running gear decontamination

Currently, the Armed Forces of the Republic of Poland does not have any technical equipment or technology for removing contamination of the running gear, e.g., of transporters or tanks. The decontamination platform should have such a solution – a ramp with a system of spray nozzles. The ramp should be adapted to place between the running elements (tracks, wheels). The ramp arm should be about 10 mm long (the length of the PT-91 tank – 10.3 m, the "Leopard 2A4" tank – 9.7 m, the KTO "Rosomak" – 7.8 m). Spray nozzles must be set in a way that enables the application of the agent to the entire chassis (width – approx. 4 m, ground clearance – approx. 0.4 m).

Boom

The decontamination boom must be a foldable element of the container or body. The boom should be equipped with a basket enabling the decontamination process to be carried out by one man using a lance from a car wash. The operating radius of the boom with the basket should allow treatment from the height of 15 m. The position of the basket is to be controlled from the basket by the operator using a portable control panel and the control panel located in the container.

Means for the equipment surface decontamination

The surface decontamination process should be carried out with the universal UOP powder disinfectant from high-pressure washes. It is a tabular disinfectant used in the Polish Armed Forces.

The disinfectant has no documented disinfecting properties. It can be initially assumed that the active agent of the disinfectant, namely the sodium salt of dichloroisocyanuric acid, has sufficient disinfecting properties (it is part of many disinfectants) [22].

Aqueous solutions of SF-M powder are used for inactivation in the Polish Armed Forces. For the needs of the platform, the RDM-type agent (marine deactivation solution – a solution of a surfactant and complexion agent) should be developed and applied from a car wash. The deactivation efficiency, defined through the deactivation factor, increases several times compared to washing with water with a surface-active agent [23].

The problem of decontaminating road surfaces, runways, etc., remains unresolved. Tests were conducted in Poland on the application of active foams containing active substances in the form of peroxide systems (e.g., sodium (ammonium) persulfate or hydrogen peroxide) and surfactants. The foams had excellent disinfecting and bactericidal properties [24-27].

Equipping the platform with a human de contamination set

Sanitary measures consist in the complete removal of radioactive substances, poisons, biological agents, and disinfectants from the body surface. They are carried out in baths or specially organized sets of special devices. For the platform, it should be a set of tents.

A tent set serving as a field bath for the platform must contain:

– air heating devices,
– water heating devices,
– filtering devices,
– pumps for water and sewage transport,
– showers,
– tents (containers),

– water tanks (clean and sewage),
– bath equipment (containers for contaminated and clean clothes, chairs, tables, etc.),
– exchange fund for underwear, uniforms, individual protective clothing (ISOPS) and equipment.

Figure 11 displays the scheme of bath installation development.

The scheme of the bath installation presented in Figure 11 is a typical contemporary solution to the problem of human decontamination. The filter and ventilation devices force the air draft in the tents. The air flows from the dressing room tent towards the medical tent. The structure of pneumatic tents is based on inflatable spans, which ensures lightness and allows for quick and easy setup. The outer shell should be made of high-quality double-sided gummed fabrics with mixtures based on neoprene rubbers, guaranteeing adequate protection against weather conditions and complete waterproofing. The floor of the tents should be made of a fabric coated on both sides with PVC joined by welding. In the washroom, there should be shower sets supplied with soapy water, e.g., from a low-pressure car wash with an appropriate capacity.

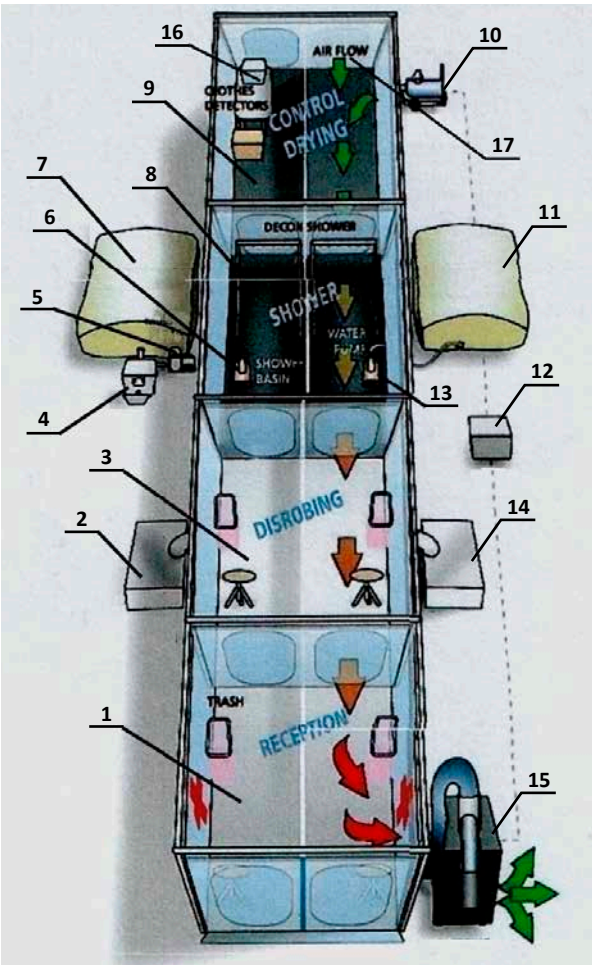

Fig. 11. The scheme of bath installation development based on tents: 1 – medical tent, 2, 14 – containers for contaminated clothes, 3 – cloakroom, 4 – water heater, 5 – detergent pump, 6 – water pump for shower devices, 7 – clean-water tank, 8 – washroom, 9 – dressing room, 10 – air heater, 11 – sewage tank, 12 – power generator, 13 – sewage pump, 15 – filtering device, 16 – irradiation degree and medical control, 17 – clean air intake
Source: [28].

2.4. Equipping the platform with a kit for the contamination elimination from surface that is not susceptible to decontamination processes

A known and effective method for the chemical and biological decontamination is the application of gaseous detoxifying mixtures instead of previously used liquid mixtures, foams, or powders. While testing, particular attention was paid to the biocidal and oxidizing properties of the gaseous hydrogen peroxide GNW (vaporized hydrogen peroxide). Decontamination with vaporized hydrogen peroxide is a "dry" process, using much lower active substance concentrations than in the case of methods based on aqueous solutions of active substances. No condensation of water vapor with hydrogen peroxide results in the lack of strong corrosive properties. The "dry" disinfection technology with the use of hydrogen peroxide has been used for over 10 years in various industries, mainly in disinfection processes in health care. Systems enabling "dry" disinfection are produced by the American companies Steris and Bioquell [29; 30].

Decontamination tests were performed on hard surfaces (steel, glass, electronic equipment), textile and rubber derivatives (individual and collective protective measures), and disinfection of selected biological forms was carried out as part of the research and development project No. OR00001812 "Development of a decontamination technology for large confined spaces using gaseous hydrogen peroxide and its mixtures with organic and inorganic peroxides, ammonia, and amines", financed by the Ministry of Science and Higher Education [31-33].

A container installation for decontamination has been developed – Figure 12.

The platform container should have a chamber for decontamination of sensitive equipment, weapons, and ISOPS elements, and a mobile set based on GNW technology.

The mobile set could be used to eliminate large contamination, e.g., inside containers, tents, airplanes, etc., but also, among others, to disinfect correspondence or archives. The tests confirmed the material compatibility of metal and varnish surfaces, electronic and optoelectronic devices, textiles, and paper products (books, manuscripts, printouts).

2.5. Equipping the decontamination platform with essential devices

According to the concept, the platform should replace the decontamination platoon.

The analysis of the equipment of the WChem decontamination platoons shows that it is not uniform. For the purposes of the concept, the following was adopted:

Fig. 12. View of the hydrogen peroxide vaporization system and the process chamber
Source: [32].

– six “SANIJET C-921” (or similar) high-pressure washes with accessories – two pre-washing ones; two for applying the disinfectant (liquidation of contamination); and two final-wash washes,
– two tent sets (3 pneumatic tents each) for human decontamination,
– two air heaters with balanced heating power for a system of 3 tents for an ambient temperature of –10°C and an internal air temperature of approx. 40°C,
– two filtering devices with a minimum capacity of 300 m^3/h with steam traps,
– two shower devices (sets) with 5 shower attachments each or a system of spray nozzles in the form of a gate,
– in the case of powering the bath system from a high-pressure wash, no other equipment is needed; if not, two devices for heating and feeding water to the bath system and/or a pump for dispensing the soap solution are required,
– a ramp with a system of spray nozzles.

2.6. Equipping the decontamination platform with auxiliary devices

Equipping the decontamination platform with auxiliary devices:

– systems for supplying the platform devices with electricity. The platform should have a diesel and energy unit with the power to cover the needs of devices for decontamination, lighting of the elements of the decontamination point (PLS) and elements of the point for human decontamination (PZSan) – air and water heaters, water and sewage pumps, UFW, etc.,
– systems for supplying the platform equipment with water. The platform should be equipped for storing and pumping water. For the needs of PLS and PZSan, these should be rubber water tanks. The platform needs water pumps (e.g., floating), cables (with accessories) for the construction of a water reservoir – e.g., an open source, and a PLS or PZSan hydrant,
– tanks with equipment for collecting sewage after decontamination processes,
– internal (between positions) and external communication means and the GPS system.

Summary

Decontamination processes (C + R + R) require the involvement of specialized equipment and methods.

There are relevant technical and technological studies in the country. As part of the research project: “Technologies and instrumentation for the elimination of chemical contamination of soldier’s equipment, sensitive surfaces of apparatus and interior of military technology with the use of nanosorbents” [34], there was developed:

– a modernized version of the individual decontamination package with the use of a nanostructured decontaminant and elements of the IPLS-1 package used so far – Figure 13,
– an autonomous set for decontamination with a nanostructured disinfectant was developed, manufactured, and tested – Figure 14,
– a mobile set for decontamination with the use of a nanostructured disinfectant was developed, manufactured, and tested – Figure 15.

Fig. 13. Decontamination of small arms and components of equipment with a nanoabsorbent glove
Source: [35].

Fig. 14. Autonomous (backpack) device for decontamination with the use of nanosorbents (weight – 9.2 kg, decontamination capability – 10 m² of surface)
Source: [35].

Fig. 15. Mobile device for decontamination using nanosorbents (weight – 63 kg, decontamination capability – 50 m² of surface)
Source: [35].

In the part of the work on the modernization of the individual decontamination pack-age IPLS-1, new construction of the glove enabling the effective use of a nanosorbent decontaminant and other elements of the package adapted to the applied decontamination technology were developed, and a batch of 30 pieces of a new package was prepared. The conducted field summer and winter tests on eliminating contamination with the use of the modernized package gave positive results. The required degree of decontamination was achieved. Simultaneously, the second goal assumed in the study, i.e., a significant reduction in the package weight (by 28%), was met.

As part of the research and development project No. OR00001812 entitled "Development of a decontamination technology for large confined spaces using gaseous hydrogen peroxide and its mixtures with organic and inorganic peroxides, ammonia, and amines", the effectiveness of disinfection and decontamination with gaseous (vaporized) hydrogen peroxide was tested, the container installation was made, and material compatibility tests were performed [36].

The research confirmed the very high effectiveness of gaseous hydrogen peroxide against bacterial spores (Geobacillus stearothermophilus, Bacillus subtilis), mold fungi (Aspergillus niger), yeast-like fungi (Candida albicans), gram-positive bacteria (Enterococcus hirae, Staphylococcus aureus), and gram-negative bacteria (Escherichia coli, Pseudomonas aeruginosa) at the gaseous hydrogen peroxide concentration of 2000 ppm for 10 minutes [31].

The research confirmed the very high efficiency of gaseous hydrogen peroxide in the decontamination of metal surfaces, paint coatings, textiles, and products made of rubber, rubber-like materials, and plastics [31; 32].

Material compatibility with materials made of metals, plastics, fabrics, rubber, paper, and electronic, optical, and optoelectronic equipment was confirmed [37]. At present, the disinfection method using gaseous hydrogen peroxide is employed to disinfect shipments for the most critical state institutions [38].

The issue of defense against weapons of mass destruction, and mainly decontamination, requires constant attention. The current scale of the threat enforces taking steps to improve the methods of preparing troops to act in the event of the WMD usage or the occurrence of contamination of non-military origin, mainly industrial.

The existing system in the Polish Armed Forces should be modernized and adapted to the NATO armed forces' solutions. Except for procedural and standardization changes, the changes should concern technical solutions. A right solution is platforms enabling comprehensive decontamination of people, equipment, armaments, and infrastructure interiors. The introduction of platforms, apart from strictly technical solutions, will necessitate procedural changes. In the first place, equipment and accessories should be defined generically as disposable. That will require procedures specifying how and when to replace them. For equipment and fittings qualified for decontamination, the so-called susceptibility to decontamination processes and determination of their susceptibility to these processes need to be specified.

Conclusions

1. The Polish Armed Forces do not have modern solutions (in the form of a universal platform) for the comprehensive decontamination of equipment (chassis, large dimensions, interiors, sensitive surfaces, damaged equipment, and that to be repaired) and sanitary measures. The Polish Armed Forces have essential elements of the CBRN decontamination system, which require integration into the decontamination platform, or at least partial automation.
2. The condition for obtaining positive results of contamination elimination is to carry it out in the shortest possible time with the use of effective and efficient technology. That requires introducing modern technical, technological, and procedural solutions to the equipment of the Armed Forces of the Republic of Poland and defining priorities. Introduction of modern decontamination platforms would fill the gap in the OPBMR system. In Poland, apart from specialized high-pressure car washes, all the elements that may be included in the decontamination platform are available.

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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.

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Stan obecny oraz koncepcja nowoczesnej platformy likwidacji skażeń chemicznych, biologicznych i promieniotwórczych

STRESZCZENIE W pracy scharakteryzowano likwidację skażeń – jako system zabezpieczenia wojsk w przypadku zagrożenia skażeniami w ujęciu funkcjonalnym i zadaniowym. Przedstawiono analizę wyposażenia technicznego oraz procedur postępowania po skażeniach w SZ RP i NATO. Przedstawiono koncepcję nowoczesnej platformy likwidacji skażeń chemicznych, biologicznych i promieniotwórczych.

SŁOWA KLUCZOWE likwidacja skażeń chemicznych, biologicznych i promieniotwórczych, całkowita likwidacja skażeń, sprzęt i platforma do likwidacji skażeń

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