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Catastrophe Medicine

Rules for the use of collective protection measures against BST contamination in accordance with NATO normative documents

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Summary:

Personal protection against contamination is essential for soldiers, assuring their survival in the wake of the effect of weapons of mass destruction and their continuing ability to conduct combat operations. In order to meet the requirements of maintaining the capacity to act in the aftermath of contamination, OPBMR (Defense Against Weapons of Mass Destruction) measures must be continued, be flexible, mobile and characterized by systems enabling quick operational transition.
The following issues are presented in this report:
1) Elements of collective protective measures against contamination;
2) General standards for the construction and operation of collective means of protection against contamination;
3) Guidelines for work on improving systems of collective protection on the basis of NATO normative documents.

Key words: Key words: collective means of protection against contamination, contamination zone control, ST contamination, systems procedures of collective protection.

Introduction

The use of Poisonous Combat Substances (BST) during the First World War contributed to the development of individual means of protection against contamination (ISOPS), which included means and measures of protecting the respiratory tract and skin.

Personal protection measures against contamination are essential for the survival of personnel in the aftermath of the use of weapons of mass destruction and continued combat ability. Despite assuring basic protection, the application of ISOPS in combat conditions causes difficulties in performing tasks and weakens psychophysical abilities. Significant impact on the efficiency of continuing activities and time spent in such environments is the insulation / protection measures used for the skin in ambient temperature conditions and the type of activity that needs to occur.

Technical development has allowed for the replacement of hitherto used insulation protection measures for the skin by filtering techniques, but this does not eliminate all problems related to ISOPS requirements.

In order to maintain a high level of combat readiness, ISOPS is not the sole issue to be addressed. Therefore, all personnel, regardless of the tasks which must be done, must be able to benefit from the collective means of protection against contamination, to ensure the organization of rest periods, eating meals and addressing individual, physiological needs. In addition, Collective Means of Protection Against Contamination (ZSOPS) must assure the protection of the following work posts and facilities:

- Headquarters and operational centers;
- Hospitals, medical facilities and places of rest;
- Workshops and repair/maintenance facilities.

1. Classification of collective means of protection against contamination (ZSOPS)

Collective means of protection against contamination are divided into:
Permanent type – when once installed, without the possibility of displacement. These include installations of the hardened, semi-hardened and unhardened type. This breakdown is due to the degree of resistance of a given system as exposed to very serious factors of conventional weapons and weapons of mass destruction.

a) hardened or semi-hardened classification – military command positions, air bases and ports are included herein, requiring collective protection measures where ZSOPS can provide protection against conventional attack and attack with Weapons of Mass Destruction (WMD).

b) unhardened classification – buildings that do not have protection from the effects of conventional means of destruction, but protecting personnel against the obvious effects of weapons of mass destruction. Nonetheless, protection against conventional attack can be afforded by buildings and other structures (sheltered hangars), in which ZSOPS has been applied.

Existing buildings may be adapted in such a way to ensure collective protection, by the application of certain finished coatings or materials resistant to the penetration of poisonous materials (ST). Such coatings need to correspond to the sizes and shapes of any structures or premises, for which these shall be specified.

Collective protection measures possible for transport - the collective means of protection against contamination, which can be installed/applied and transported to any place depending on the need. These are mainly un-hardened (tent-type) collective protection measures and other satisfying these same criteria.

Mobile type - collective protection systems, which can be used in both armored and un- armored vehicles, having or not having the possibility of working at the time of driving. Most of the known systems do not have integral airlocks or contamination control zones.

The systems are mounted in tanks, transporters, radio/location stations, radar stations, command posts, guidance positions and missile stations, as well as special vehicles (ambulance type vehicles and fire trucks), driver's compartments (cabs) in transportation vehicles.

2. Elements of collective protective measures against contamination

All kinds of ZSOPS regardless of their size and type must have the following items:

Clean zone – in this zone personnel may be present without applying ISOPS. The zone can be divided into several areas, which must be sufficiently airtight to provide an overpressure (positive pressure) condition and protect the system from excessive "leaking" of air to the outside. In addition, the air flow must be directed in such a way, so as to prevent the formation of air stagnancy, especially in locations of connections to successive spaces.

Filtration unit - this unit should ensure a continuous process of air purification from all the particles and radioactive, chemical and biological vapors and their delivery, in order to:
- create a positive air pressure situation;
- deliver the required quantities of clean air exchange to the airlocks;
- ensure that the needs of the resident personnel are met.

In addition, so that people or equipment can leave or enter the clean zone assuring the collective protection system, the following items must be included:
Air lock - the air lock shall comply with the following features:

- be the only way through which the filtered air leaves the clean zone;

- be designed in such a manner as to be able to maintain a positive pressure situation when there is a sudden pressure drop due to any leaks in the airlock from the outside or to the contamination control zone;

- assuring the protection of the clean zone, through the exchange of air in the stipulated time and in such a manner, that will assure passage safety thereto without the likelihood of carrying in an amount of ST vapors that could cause a contamination threat. In addition, the use of the airlocks should protect against contamination originating from ST vapors, when the user has a guarantee, that the ZSOPS have not been penetrated by liquid-form ST. The threat of harm to the interior of the system of collective protection may result from the ability of de-sorption of transferred ST vapors on clothing, hair and skin. The level of risk from those sources is relatively small, when air flow is sufficient enough to allow for several air changes per hour. However, in situations where there has been an accumulation over a longer period of time, ex. of ST vapors because of improper air flow, the level of risk may be considerable.

Contamination control zone - this area is located in front of the airlocks and clean zone in order to reduce the level of contamination from completely contaminated personnel to a safe level. The size of the contamination control zone depends on many factors, of which the most important are: the number of persons, type of activities they were involved in and the rate of entry and exit from the zone.

The contamination control zone contains:

- the area of contamination threat by liquid ST- located on the outside and allowing for the carrying out of disinfection and the storage of handling and processing equipment used within the contaminated zone. This area can be placed in front of the building, in a structure that is covered with an ST impermeable coating, where the supply of purified air is not required;
- changing area - in properly designed ZSOPS, the personnel can move directly from the zone with a danger of liquid ST contamination to the changing rooms. For the proper functioning of the changing rooms, conditions must be fulfilled for the safe removal or the dressing into protective clothing. To ensure such conditions, a large enough amount of airflow must occur, from the clean zone to the area of contamination control;
- area of ST vapor threat - located in front of the air locks, serving the area where gas masks are removed and kept along with other remaining component parts serving the needs of individual means of protection against contamination.

3. General ZSOPS protection and equipment requirements

The level of protection

The respiratory tract and eyes of personnel remaining in the clean zone for a period of 24 hours cannot be exposed to toxic contamination exceeding the following levels:

- 2 mg min/m^3 FOST;
- 25mg min./m^3 H, L;
- 1 000 mg/m^3 AC, CK.

The respiratory tract and eyes of personnel remaining in the clean zone for a period of one week cannot be exposed to toxic contamination exceeding the following levels:

- 2 mg min./m^3 FOST;
- 50 mg min./m^3 H,L;
- 2 000 mg min./m^3 AC, CK.

Where:
FOST-Vx, GB-Sarin
H - sulphur mustard, L-lewisite;
AC - hydrogen cyanide;
CK - cyanogen chloride.

All of the personnel remaining within the system of collective protection for a period of one week must be protected at such a level, so as not to be in contact with liquid ST up to the following levels:

- 2 mg Vx;
- 20 mg-GD;
- 0.001 mg/cm^2 (H), (L).

Where:
GD - Soman

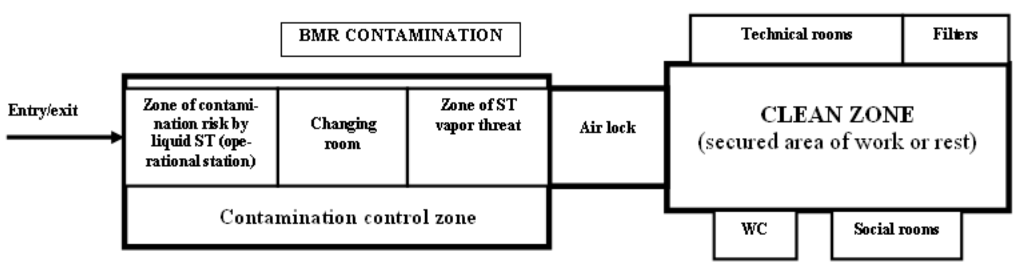


Figure 1: Components of a stationary area for collective means of protection against contamination

Note:
In simplified systems for collective protection, the changing room and the zone for contamination by ST vapors can be combined.

Operating parameters, air (filtering) purification

Filters must be designed and constructed so that they can clean the air from solid particles of toxic materials, and poisonous vapors. The filtration system must be adapted to the designed system of collective protection so as to ensure appropriate technical characteristics and interchangeability within NATO standards. Any filter replacements should take place without having to wear gas masks by the personnel inside. So, therefore, in order to safeguard appropriate working conditions of all those benefitting from the means of collective protection, an additional (back-up) system of filtering and ventilating is required.

Air flow quantities must be calculated taking into account such factors as the volume of the space served, the number of personnel and most significantly, the number of air locks, and the implications of the number of exits and entrances to the building.

The required air flow is as follows:

- 8.5 m3/h - for each inactive person;
- 17 m3/h - for each working person.

In addition, the system should ensure an adequate exchange of air in the air locks and ensure the tightness of the entire system by maintaining the required positive pressurization. All filtering systems should be designed so as to use standard filters (specified below), or use a connection of a max. of 3 filters:

- -100 m^3/h;
- -400 m^3/h;
- -800 m^3/h.

Preference is given to the principle that any system of collective protection has a separate system of filter-ventilation. Work of the system's filters should be carried out with maximum +/-10% fluctuation from the adopted technical parameters. The system should have the instrumentation to measure the parameters of the air flow and an automatic alarm system to signal any disruption in the provision of sufficient quantities of air.

The resistance of the air flow must be at least 900 Pa (+/-) 5%. High-performance filtering systems, should have the associated hardware/instrumentation to allow for the carrying out of control functions of the resistance of air flow.

There are two types of high performance filtering systems:

- high-efficiency filters to clean the air of particles, which should stop their migration found in the air. However, the same filter should offer protection against any migration of solid particles of a diameter of 20 micrometers and larger;
- high-efficiency filters to clean the air from ST vapors should provide protection against all known ST vapors. In the case of carbon filters, the designer must ensure that the parameters of the filters will not change during their transport, storage and operation once installed.

General operating characteristics:

The system should provide for the proper functioning of personnel in different atmospheric conditions:

- external temperature from -25 ° C to + 30 ° C;
- outside humidity conditions to 100%;

The system must maintain the following internal conditions:

- -the internal temperature of + 10 ° C to + 30 ° C;
- -indoor humidity is below 80%.

Servicing, including the exchange of filters, should be so simple, so that it can be done by one person in individual protective garb in not more than 30 minutes.

The system should be powered by an autonomous source of electricity and have the ability of being hooked-up to other, reserve sources.

4. Design principles and equipment requirements for hardened/semi-hardened systems of collective protection

For hardened/semi-hardened buildings/structures assuring collective protection, the following criteria for zone contamination control shall be applied:

- A two-door entry system and entry hall should be so constructed as to minimize the possibility of transmitting BST vapors from outside the building to its inside, in a situation when the entry/exit doors to the zone of contamination by liquids are open, especially during windy weather conditions. The order of the opening and closing of the doors will be required when entering or leaving the contamination control zone. The doors should be resistant to the wind and should be controlled so that only one door may be open at a time.

- The contamination control zone and entrance should be hardened to the same level as the clean zone, so that it can provide protection for the personnel, equipment, devices, filter-ventilation equipment, etc. from the effects of an explosion.
- The contamination control zone must be divided into two sections (the liquid BST contamination risk section and BST vapor contamination risk section), by a full height separation wall (from floor to ceiling), which will stop most of

the contaminants which may want to migrate from one zone to another. These two sections (the liquid BST contamination risk section - in which occurs liquid BST and the BST vapor risk contamination section) must be accessible – i.e., have a connection between each other only by a single door (preferably, jalousie type)

- The liquid BST contamination control zone adjacent to the entry hall, is an area where equipment and clothing contaminated by BST liquids can be removed and stored or held for further decontamination or subsequent use. Articles which may again be worn or carried back to a zone where there may be BST vapor contamination, must be de-contaminated by removing the BST liquid contaminants from their surfaces. In the contamination control zone, ground personnel must be assured the ability to change their ISOPS. Appropriate changing rooms can be added to the contamination by BST liquid risk zone in order to remove the overlay of their ISOPS. Changing rooms must have sufficiently large clean air flow, so as to reduce the concentration of burning (caustic) BST vapors to such an extent, so as not to endanger the skin during the removals and/or overlap. The liquid BST risk contamination zone must be so designed that the ground personnel removing their ISOPS, can safely and quickly move from the changing rooms to the BST vapor contamination risk zone, only by low concentration levels of BST vapors. In order to achieve the required concentration, make sure that there is no recycling of BST vapors from the storage area for the contaminated clothing and equipment found in the liquid BST risk contamination zone.

- The vapor BST contamination risk zone adjacent to the entry air locks before the clean zone must be designed to allow personnel to leave any equipment they might have and their ISOPS (which is free from contamination by liquid BST), before entering the air locks leading to the clean zone. The design should take into account the real needs of storage and handling equipment and have procedures which allow for the safe transport of gas masks to the clean zone area. In addition, and in accordance with national requirements, the vapor BST contamination risk zones can have showers installed or other equipment serving to wash-down radioactive fallout.

- Technological nodes should be equipped with handrails leading through the threshold of doors leading to controlled liquid BST contamination risk zones , and the vapor BST contamination risk zone. These access routes should be equipped with decontamination vessels, during which time personnel can decontaminate their protective footwear.

- In order to avoid excessive congestion in the BST vapor contamination risk zone, of extreme importance are the routes of exit and entry of personnel. In addition, due to the differences in the equipment used by the flying personnel and ground personnel, procedures of removal and dressing and storage may necessitate the designation of separate circulation routes for various personnel categories (for sub-units, consisting of both flying and ground personnel) in the zone of contamination control, where the process of removing and applying ISOPS occurs simultaneously for two categories of personnel.

- In collective protection buildings, special electrical outlets need to be installed meeting national requirements and codes.

- Electric lighting shall be so arranged within the contamination control zone to allow staff to perform all necessary operations. In situations where there is a possibility that the means of protection against contamination with the lighting in place may not function properly, emergency lighting at the appropriate level must be provided.

- Buildings/structures providing collective protection against contamination can be used in peacetime. Therefore, at the time of design the building should take into account the situation in which the non-contaminated personnel can pass through the contamination control zone to the clean zone.

- The design of the collective protection system must ensure safety conditions and permit for the implementation of in/out access procedures.

Air filtration system

1) All hardened and semi-hardened buildings offering collective protection must have an air filtration system that provides clean air, free of radioactive, chemical and biological agents. In addition, this system should be resistant to the impact of a war-induced shock wave and provide adequate ventilation and positive pressure conditions in the clean zone. Air patterns within the space should ensure a flow of filtered air from the clean zone area through to areas with increasing concentrations of contamination. For the contamination control zone the arrangement must ensure an adequate flow of air in order to achieve the following conditions:

a) In the BST vapor contamination risk zone as well as in the BST liquid contamination risk zone, between the partition/separating wall and the changing room, the air flow should 'rinse out' the BST vapors, which could otherwise definitely threaten uncovered/exposed parts of the skin, so that one can safely remain in that section and only wear a gas mask.

1b) In the doorways or passages through the walls between the zones, air flow must be sufficiently large to prevent excessive penetration of BST vapors, respectively from the liquid BST contamination risk zone to the BST vapor contamination risk zone.

2) The flow of air in the liquid BST risk contamination zone. In a situation where personnel is garbed in ISOPS (clothing and gas masks), the level of BST concentration is not a significant problem. However, when the personnel removes contaminated clothing and equipment, it turns out that the zone must have a certain large enough area, with adequate amounts of clean air delivered in such amounts as to ensure the safety of personnel once the protective clothing is removed. The dose absorbed by exposed parts of the skin should be several orders of magnitude smaller in relation to the dose accumulated in the process of movement through the contamination control zones.

3) The flow of air in the vapor BST risk contamination zone. The concentration of BST vapors in the zone must be kept at a sufficiently low level so as to ensure safe conditions for personnel stationed there, even if burning (caustic) substances have been found there. Despite the fact that some quantity of vapor will be emitted by the absorbers, even after disinfection, the risk to the skin is considered negligible in a room where the air is exchanged several times per hour. The main problem in this area is not to allow the penetration of the zone by BST vapors originating from the liquid BST risk contamination zone. Therefore, a very important issue is addressed by the partition/full-height separating wall between the zones. The flow of air through the door (transition) between zones must be adequately secured so as to prevent the undo backing up of air to the zone.

4) Environmental control. Temperature control in the contamination zone is very important due to the reduction of potential adverse effects which may result in its increase.

4a) the emission of BST vapors from contaminated clothing and equipment can be significantly reduced while maintaining proper temperature readings;

4b) low temperature can reduce heat stress and provide thermal comfort for the crew while in all parts of the contamination control zones .

Thermometers should be placed in both zones. System control parameters of supplied air to the collective protection zones should have the capacity for action in a wide range of temperature conditions. The system should ensure that the internal temperature remains in the range of 10-30 ° C and relative humidity below 80%.

5) Apparatus for measuring parameters of air flow and pressure

Apparatus for measuring parameters of air flow and pressure shall be used to monitor the positive pressure levels in the clean zone and the air flow in each air lock and contamination control zone. These systems should be equipped with alarms, which would signal any decrease below a safe level.

CHANGING ROOM

The changing rooms must have a reduction in the threat of contamination levels to the skin by BST vapors during the removal and dressing in contaminated protective clothing.

Protective clothing and equipment worn on the outside may be contaminated by liquid BST. In this situation, protective clothing should be removed in the BST liquid risk contamination zone area, where BST vapors coming from the same clothing as well as from the contaminated equipment of an individual may be present in concentrations of danger to exposed skin. To ensure appropriate conditions for the dressing and removal of protective clothing, the changing room may be the appropriate place, where clean air flows with a subsequent risk reduction to the body, which is otherwise not protected by the individual means of protection against contamination. Exposure of the body to BST vapors must be maintained at an appropriately low level, so that the personnel moving several times a day between control contamination zones remains not adversely effected. Protective clothing worn underneath the outer clothing layer, which has not been affected (contaminated) by liquid BST, may be applied and removed in the liquid BST contamination risk zone, where the concentration of vapor BST is low. In this situation, a changing room is not required.

It is advisable that the changing rooms be designed and built in as small a size possible, while not admitting or leaving liquid BST on its walls. Each changing room must have doors with mechanical ventilation provided at the end for supply air purposes.

AIR LOCK

The air locks are planned between the clean zone and the contamination control zone areas and serving as a barrier to the vapors. Each air lock should have two doors which are connected with each other in such a way, so as to allow for the opening of any one door at a time. In the airspace, there must be achieved a proper reduction in the coefficient of concentration of BST.

Regardless of the size of the air lock or number of persons simultaneously passing through the air locks, the coefficient of reduction of concentration of BST levels needs to occur.

INTERNAL COMMUNICATION

Internal communication devices are required between different areas of the contamination control zone and the clean zone, in order to ensure the proper management of the collective protection areas.

WASH UP ROOM

As a necessary minimum required is the positioning of a stainless steel sink with cold water as a source of clean water for use in the BST vapor contamination risk zone for the cleaning of gas masks. Washing, as part of the procedure for individual decontamination in the liquid BST contamination risk zone or BST vapor zone can be determined separately in accordance with national requirements and the law. If the deactivation of falling radioactive contamination is required, these treatments should be carried out immediately before the personnel would enter the clean zone in accordance with national procedures. Decontamination must be carried out in the wash up room sinks or showers in the contamination control zone. In addition, one should secure the spent, contaminated water after the wash up occurs.

ROOMS FOR THE STORAGE OF CONTAMINATED ITEMS

Rooms for the collection of discarded contaminated clothing and equipment must be integrated in with the collective contamination protection building and should be adjacent to the contamination control zone.

FINISHES OF THE CONTAMINATION CONTROL ZONE

The interior walls must be finished with materials resistant to chemical agents. In addition, it is required to finish the floors in the contamination protection zone areas with non-slip, chemically resistant, non-absorptive paints.

The power supply. The collective contamination protection building should be fitted with an independent source of electricity-as an essential system, ensuring the proper functioning of the building.

PROCEDURES FOR THE USE OF COLLECTIVE PROTECTION SYSTEMS

The time during which hardened/semi-hardened collective protection systems will be used in combat situations, will be different for different units depending on the rules of operation and their deployment. Guidelines for use of these buildings for collective protection are as follows:

1) a threat level of zero or very low: check the availability of all hardened/semi-hardened buildings to serve as buildings of collective protection.
2) a low level of WMD threat. One should regularly check all elements of the systems of collective protection in terms of completeness and performance.
3) an average level of WMD threat. Enter the systems of collective protection to a state of readiness for inclusion.
4) a high level of WMD threat. Keep all of the buildings for collective protection in operation.

GENERAL EQUIPMENT - REQUIREMENTS

In this chapter were listed all the basic items concerning the equipment of contamination control zones needed to maintain an efficient operation for each zone where contamination control is required. Staff must have access to:

- decontaminants (in bulk) to decontaminate equipment.
- Non-breakable wall mounted mirrors to aid personnel in decontamination procedures, during the dressing and removing of their individual means of protection against contamination.
- Wall-mounted control list/checklists with essential steps identifying the sequential order for dressing and removing ISOPS, based on the requirements of ST ANAGU 2941. Individual countries should be aware of the differences in applicable equipment and procedures and, where necessary, obtain a clarification in their respective languages.

- Containers for contaminated items should be properly placed in the contamination control zones. All containers must be equipped with a cover.
- The number of bags for contaminated clothing (calculated as to the expected consumption per day) for the hauling away of contaminated clothing and individual equipment from the contamination control zones.
- Equipment for use in the liquid BST

contamination risk zones and changing room to help personnel in the decontamination of gas masks and in the vapor BST contamination risk zone to help in the completion of the final disinfection of the masks in the "dirty" course before the final transfer of the mask racks and masks to the clean area.
- A workbench in each contamination control zone for the decontamination of individual equipment, which can be taken to the clean area.
- Measures to remove decontaminants from the contamination control zone.
- The master clock to synchronize watches, which once contaminated cannot be taken to the clean area.

ADDITIONAL EQUIPMENT

Additional equipment necessary for the proper implementation of procedures for the contamination control zones include:

- Stands for weapons and individual equipment (helmets, personal weapons, bags for gas masks, etc.), which again will be used, should be stored in the liquid BST contamination risk zone.
- A bench for the removal of protective shoes.
- Racks for protective clothing.
- Carrying (rolling) racks for gas masks and other specialized equipment, in accordance with national procedures.

Additional equipment is to ensure the safe completion of the procedures of operations prior to the entry/exit to the clean zone, regardless of the type of ISOPS, as well as other, individual equipment.

5. Non-hardened collective protection measures. Design criteria and hardware requirements. General requirements.

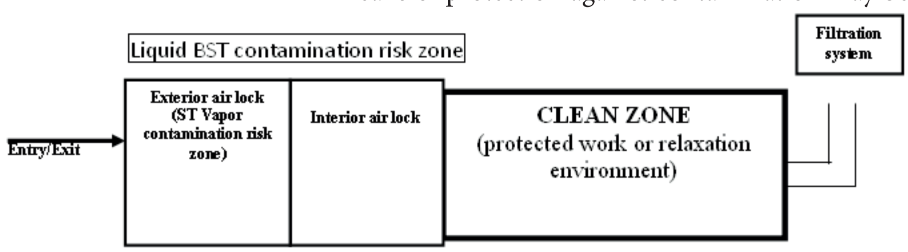
Non-hardened protection measures used against contamination will be necessary to maintain operations in a contaminated environment, where other collective protection systems are not available. They will be needed to provide rest periods and eating a meal in clean zones in two types of installations: fixed and mobile.

Permanent means of protection against contamination - requirements. Personnel in permanent means of collective protection must consistently remain at their work stations and also may be forced to act in the affected environment for a long time in their assigned ISOPS. Displacement of protection means against contamination into non-contaminated areas and may be unlikely, therefore, personnel will need access to a clean area close to their place of work, to be able to remove their ISOPS, relax, and meet their physiological needs.

Mobile means of protection against contamination - requirements. Personnel carrying out activities on the battlefield may have less risk than personnel in the permanent premises of the collective protection zone. It is unlikely that a moving, mobile object would be targeted for destruction, and in addition, there is the possibility of movement – to a non-contaminated area, however, a change of position or the avoidance of contaminated land is not always possible. In addition, a mobile role will indicate that is not in a position to prepare a sustainable, permanent means of protection against contamination to allow for rest, so one will need some form of mobile or transportable non-hardened protection system against contamination allowing personnel to rest without having to stay in their ISOPS.

GENERAL DESIGN CRITERIA

The constructions of non-hardened, collective means of protection against contamination may be



done in many different shapes and sizes. A schematic plan for such a system is illustrated in Figure 1. The structure can be made from a fabric resistant to chemical substances. This structure does not provide protection against the effects of fire, however. To provide some protection from the effects of fire, the structure could be placed inside a building or other structure, which will provide some degree of protection.

6. Threats

In order to determine the real threats, testing has been carried out to determine the possible concentration of poisonous air in relation to the protective properties of the individual and collective means of protection against contamination. It was found that non-hardened collective protection measures deployed in defense as a plain target may be exposed to a concentration of

ST < 2000 mg min m^3. Hardened collective protection measures in the intense activity area of an enemy may be exposed to higher concentrations, but not exceeding 30000 mg min m^3. For example, a warship which is within range of multi-targeted rocket launchers or in the range of other measures of gunnery activity, can be exposed and "meet" contamination levels < 10000 mg min m^3. For comparison, vapors of hydrogen cyanide should not reach higher concentration levels than 25000 mg min m^3.

In addition, the frequency of attacks on targets was gauged. Depending on the arrangement on the battlefield theatre, during one campaign, one should expect from 10 to 20 chemical-based attacks.

Bearing in mind the possibility of long-term pursuit of wartime activities in a contaminated zone, works are being carried out on filtration systems to find regenerative recovery opportunities. The essential factors affecting performance parameters are weather conditions, the types of systems of destruction employed and experience gained from previous conflicts.

It is assumed that the possibility of new filtration systems, mounted in armored vehicles, can effectively protect the unit against chemical attacks. It is assumed that such an installation can withstand 60-120 chemical attacks, which is equivalent to 6 operations involving chemical weapons. However, the effectiveness of the protective system can be significantly impacted by atmospheric conditions, which may limit the defensive parameters by approximately 30%, which corresponds to 18-36 chemical attacks.

Table 1 shows the results of a study, conducted by specialists from the United Kingdom, with a view to identifying possible concentrations of ST vapors on the battlefield depending on the type of a poisonous substance used.

Table 1: Possible concentrations of toxic substances resulting from the use o chemical weapons

Concentration of contamination levels (mg min m3)	Type of ST	Comments
12750	Organophosphorus, generally toxic, penetrating ST	Average concentration levels
75000	Organophosphorus, generally toxic, penetrating ST	Very high concentration levels (extreme), though possible
6000	Concentrated ST	

The threat from liquid toxic substances.

An important risk that must be taken into account in the design and selection of suitable material for the construction of a collective protection building, comes from liquid toxic substances. Contamination with drops of ST is serious among other reasons, because of the density and viscosity of ST, allowing for its persistent lingering on different surfaces.

Currently, the permissible contamination density for combat vehicles is 10 g/m^2, however the aim is that new systems for collective protection ensure safety for the crew unit at a density of contamination - 50 g/m^2. For individual means of protection against contamination this value is respectively 10 g/m2 and in view is a level of 20 g/m^2. In relation to collective means of protection against contamination, tests are still being carried out.

Permissible ST contamination and the period of effective protection.

Currently, work is underway by a task group to determine the amount of allowable contamination. A group of experts from the United Kingdom has presented the results of its previous work in this area. Permissible ST contamination levels are as follows:

- GB (Sarin) – the LCt_{50} for working, active staff is 50 mg min m^3, whereas for sedentary personnel - 70 mg min m^3.
- (H) (sulfur mustard)-50 mg min m^3, can cause damage to the eyes;
- AC (hydrogen cyanide)-1000 mg min m^3 is the upper limit;
- CK (cyanogen chloride)-50 mg min m^3, causes irritation to the mucous membranes and eye watering.

To calculate protection factor (PF), the following conditions were assumed; exposure time-24 hours, during this period, there is an exposure to more than one chemical attack.

NATO normative documents do not indicate any concentration limits for toxic chemical combat. Based on extensive research concerning the effects of BST on organisms, guidelines have been developed, which contain values of concentrations, which have a negative health impact. Physically, these values reflect the NDS and NDSCh. The table shown below is a summary of risk concentrations, the value for which should not be exceeded in protected areas as well as the values for doses and inhalation.

Table 2: Summary of risk concentrations

Chemical substance	Deadly dose by injection LD50 [mg/kg]	Deadly dose by inhalation LCT50 [mg*min/m3]	NDS [mg/m3]	NDSCh [mg/m3]
Tabun	21.4	120	0.00003	0.0001
Sarin	24.3	60	0.00003	0.0001
Soman	5	60	0.00003	0.001
Cyclosarin	5	60	0.00003	0.001
VX	0.07	15	0.000001	0.00001
Sulfur mustard	20	1710	0.0004	0.003
Phosogene*	Lack of data	3 200	0.08	0.16
Lewisite	8-30	1 200-1 500	0.0004	0.003
Cyanogen chloride	Lack of data	11 000	0.6	0.77
Arsenic compounds	5	Lacko f data	0.01	0.5
Chlorine*	Lack of data	6000 – 19000	0.7	1.5
Ammonia*	Lack of data	7 500	14	28

***** Data as based on the Directive of the Polish Ministry of Labor and Social Policy in terms of maximum limits of concentration levels allowable

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Maximum concentration values listed in the table should be taken into account in determining the protective parameters at the design stage of the ZSOPS, assuring the possibility of long-term military action in contaminated circumstances.

In view of the remote probability of atmospheric contamination of chemical weapons occurring over large areas, with the newly proposed recovery systems for air-cleaning, it should be sufficient to maintain concentrations of toxin below the permitted time - NDSCh.

Presented and conducted research was made to identify realistic parameters, which should have future implications on collective protection systems. Currently, the PF factor for collective protection measures 30,000, but for filters based on ST respectively AC-2,000, CK-8,000 and GB-25,000.

Permissible contamination levels of SB and the period of effective protection.
For biological agents, characteristic indicators of risk of infections for the calculation of PF is the CFU (Colony Forming Unit). That coefficient for biological agents is essentially from 106 to 108.

For biological agents, specified doses causing infections ID50, ex. for anthrax, is generally 10,000 spores, while the expected dose is 100 spores, which is the same ID50 dose for smallpox. It was considered, that a 50% dosage leading to infections is a permissible concentration of biological agents in a clean zone. This means that in a 24 hour duration, there is the likelihood of escape to the clean zone - 50% of the dose of a biological substance, which an individual can absorb. The calculation assumes that one person's use of air is 30 dm/min.

It should be noted that recently work has intensified to solve a series of unresolved biological weapons' problems in the development of effective protection systems.

Permissible radioactive contamination levels and time effective protection.

In considering the impact factors of nuclear weapons on the objects of collective protection, it was determined that the main threat will come from radioactive fallout. The research on the development of a system of collective protection uses a scenario involving radioactive contamination as a result of a land-based nuclear explosion. It was estimated that a nuclear strike would result in radioactive particles with a diameter of 20 to 200 micrometers. The average density of radioactive precipitation at ground level, in such terms, 64 g/m2 and the radioactive dosage is 50 mSv/h.

The conclusions of these studies have huge importance when designing filtering systems, as well as in the selection of appropriate materials to cover objects/buildings of collective protection. At present, the results of the work are being reviewed by nuclear weapons' experts and it should be expected that there will be changes made to existing documents, together with the part concerning protection from biological agents, because they are smaller particles in size (2-3 micrometers). In addition, it is planned to introduce an appropriate test to control filter parameters.

7. Development directions on the improvement of systems of collective protection

Having in mind the requirements of NATO and the broad development of appropriate hardware providing comprehensive protection against contamination, intensive work is being carried out, among other aspects, on the improvement of parameters of individual means of protection against contamination as well as on the development of the non-hardened (light) systems for collective protection. An excellent example of the work being done on measures for collective protection was a recently implemented project by the British company DERA.

In ongoing work, the aim is to achieve interchangeability of components (filters) at a high level, and thus to achieve full compatibility to connect individual panel system, regardless of their place of origin. These tasks are carried out by the introduction of new construction requirements, including the increasing of resistance requirements of materials to the impact of chemical, biological and radioactive doses.

For the main areas of interest, which today are the themes of work of the working groups of NATO, the following might be adopted for application:

- introduction of tests for determining the effectiveness of measures of protection against biological agents, and:
- determination of the essential factors of protection;
- defining the requirements for complete systems and systems input-output after taking into account all aspects of the battlefield using weapons of mass destruction (in an atmosphere of chemical and biological vapors and radioactive substances);
- improvement/modernization of tests to check collective protection measures in a toxic vapor atmosphere;
- introduction of tests to check the auto-regeneration qualities of filtering systems.

8. Summary

Collective protection against contamination is a defense element, whose goal is maintaining the required capacity to act in terms of contamination by WMD and thus is an integral part of the overall means of protection for troops. In order to meet the requirements of maintaining the capacity to act in terms of toxic pollution, OPBMR agents must meet the following conditions of: durability, flexibility, mobility, and a short time period of implementation. The objective of collective protection is to ensure the continuity and functioning under the threat of WMD, the organization of rest periods for personnel and treatment of affected personnel. Collective protection devices contribute to easing psychological and physiological effects of prolonged use of ISOPS. This objective can be achieved through selective application of the various types of collective means of protection against contamination.

In order to ensure interoperability in NATO, the ATP-70 document is a general standard for the construction and operation of collective means of protection against contamination. Application of similar constructions and operations of the procedures to create the conditions for the efficient and effective use of ZSOPS, aim at eliminating long-term training of personnel, also of other nationalities. The rules contained in this standardization document can be used also in collective protection to protect civilians. The ensuring of air, free from contamination inside a building/structure can be attained after the completion of the necessary requirements for the design, which includes a ZSOPS room with its functional purpose, measures to eliminate contamination and contamination detection. An essential condition for security in the ZSOPS is the setting up and consistent observance of procedures of entry/exit to the building/structure and the rules for contamination control. In the case of ZSOPS intended for a large number of people, the key to success is following appropriate guidelines and the development of detailed procedures and tasks for each functional person. In this way, an adequate level of protection from contamination and physical protection can be achieved.

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