

## ORIGINAL ARTICLE

# MODULAR CONCEPTION OF MASS PERSONNEL DECONTAMINATION

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### Summary

Personnel decontamination belongs to one of the crucial measurements performed to personnel's protection within hazard management after either employment of Weapons of Mass Destruction or leakage of Toxic Industrial Materials. Suitable personnel, technical and material conditions corresponding to current demands and trends are necessary to create its realization in this area. Knowledge gained within solution problems of personnel decontamination, casualty decontamination, immobile people decontamination, decontamination of personnel weapons, selected Individual Protective Equipment, personnel garments, accoutrements and other materials with the usage of modular elements are summarized in this paper. A conceptual proposal of solution of a mobile decontamination system for personnel decontamination is also stated in this paper.

*Key words: Personnel decontamination; modular system; containerization; decontamination site.*

## INTRODUCTION

Enemy actions can lead not only to a direct Weapons of Mass Destruction (WMDs) usage but also to accidental accidents or intentional destructions of territory infrastructure connected with Toxic Industrial Materials (TIMs) leakage. Creation of contaminated zones is a consequence of both WMDs usage and TIMs leakage. Protective measurements are necessary to organize after WMDs usage or after TIMs leakage into the environment in an amount which is threatening soldiers' and inhabitants' lives. Terrorist attacks

with the employment of radiological weapons, biological weapons and highly toxic chemical compounds, eventually terrorist actions led against nuclear power stations, petrochemical, chemical, biological facilities are very real threats for all countries of the world.

One of the measurements which is necessary to deal with within hazard management of WMDs employment or TIMs leakage is realization of personnel and material decontamination wherever its necessary parts of technical devices for decontamination are.

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## CURRENT STATE OF RESEARCHED PROBLEMS

In current time the Czech Armed Forces (CAF) Chemical Corps' (CCs) decontamination units have equipment and vehicles which were conceived

mostly for realization of mass decontamination of armaments, equipment, materials and personnel in a framework of military operations of a huge scope with supposed mass employment of WMDs. Their transportation into the area of operation was performed mostly on their own eventually by means of railway. After the Czech Republic joined NATO and incorporated their units into their multinational NATO Response Forces it is demanded to ensure quick transportation by all means of transportation, to combat deploy people and needed military equipment to interest areas practically within the whole world.

Due to a permanent threat of CBRN terrorism in the world the attention of NATO armies' decontamination units is focused on ensuring mass personnel decontamination respectively hygienic clearance in current time. Its realization is supposed within fulfillment of tasks concerning hazard management not only after WMDs employment in military operations but also after realization of terrorist CBRN attacks on territories of countries. With regard to the fact that CAF CCs' decontamination units are prepared to fulfill these tasks and they actively take part in operations there is a necessity to accept principal steps in change of organizational structures and in their equipment.

Based on the above mentioned facts the need of modernization of armament of CAF CCs decontamination units with employment of container modular systems followed. Mass personnel decontamination is a perspective area in which modular systems can be fully used. The decontamination set of SDO coming out from personnel decontamination conception realized in the 70' of the 20<sup>th</sup> century is used in current time. This conception calculated not only with personnel decontamination but also with decontamination of their armaments, clothing, personal equipment and individual protective equipment (IPE). It is necessary to say that this conception of decontamination set equipment is not too good in current time and it does not correspond to the needs and CAF units' equipment, armaments, vehicles and material.

After the literature retrieval from available sources of information in the area of technical equipment and devices for decontamination within foreign armies it is possible to claim that these ones are conceived in mobile, lightly deployable modular systems. Two directions of technical solutions are exerted in a scope of systems designated for

personnel decontamination. In modern and highly mobile models there are special containers of classic or extensive production, containers with open walls, with body parts fixable to the containers. The combination of all systems is used very often. This combination enables either their mutual connection or connection with tent systems or sheds while keeping demanded tightness. On the other hand some armies primarily prefer the employment of tent systems of different construction enhanced with technological modules which are inbuilt either into containers or case body parts with containerization fixtures. In some cases these systems are integrated into bulk truck semitrailers or into truck trailers. Modular decontamination systems with elements of containerization fulfilled demands on current approach of troops' activity. These demands mainly cover easy and quick deployment, easy and quick launching of the system, transportability by all means of transportation, variability of usage, enhanced resistance, launching of the system without energy sources and other equipment. These systems used for military purposes are possible to utilize even in the civil sector for solving crisis situations connected with leakage of TIMs or for consequence management of nature disasters [1].

## **RESULTS WHICH HAVE BEEN REACHED WITHIN SOLUTION OF MASS PERSONNEL DECONTAMINATION WITH THE EMPLOYMENT OF MODULAR ELEMENTS**

Based on the solution of the mobile modular decontamination system for personnel decontamination a lot of knowledge has come out. This knowledge is used for development of technical devices for decontamination and increasing of decontamination performed by CAF CCs. This knowledge can be summarized as following [1]:

- In the area of *decontamination compounds and mixtures* used within CAF CCs it is necessary to make their revision and rationalization. It is necessary to exclude obsolete and non-enough effective compounds and mixtures and to develop and introduce new polyvalent compounds and mixtures into the armament in accordance with the Czech Defence Standard and NATO Standardization Agreements. Based on finished research on a perspective decontamination mixture for decontamination of non-sucked surfaces, a peroxide density micro-emulsion

mixture seems to be the most efficient one. This mixture can also be very effective for decontamination of IPE. Introduction of an effective mixture for decontamination of inner non-sucked and sensitive surfaces is a crucial problem. For example, nanostructured oxides employment is a way how to solve this problem. Furthermore, it is necessary to develop and introduce an effective polyvalent decontamination mixture for decontamination of a body surface. This mixture can be applied with the help of a special spatial frame.

- For *personnel decontamination or hygienic cleaning of personnel*, water which cannot cause any infectious and allergic reaction has to be used. This water has to enable decontamination of the whole body surface. In accordance with STANAG 2136 MED [2] and STANAG 2885 [3] for purposes of decontamination and hygienic cleaning it is demanded that water has to fulfill demands for drinking water or emergency drinking water. When water from natural sources is used it is therefore necessary to perform its control and its modification with the help of suitable technological equipment.
- A lot of *output procedural water* is created within the personnel decontamination which is necessary, mainly in conditions of humanitarian, peaceful conditions and other operations, to catch, to clean or to ecologically liquidate. Big storage bath flexitanks and reservoirs can be used for catching and collecting water. It is necessary to either clean and subsequently leak the captured water into a public sewage system or to transport it to a wastewater treatment plant for further cleaning. Clean water can be used in the process of decontamination again. It has a big importance mainly in areas with chronic lack of water. Within manipulation with output water which contains radioactive compounds it is necessary to respect restrictions resulting from legislative and law norms valid on territory of a country where this activity is realized [4]. For ensuring the process of procedural water cleaning it is necessary to develop or purchase suitable equipment.
- For ensuring mass personnel decontamination it is necessary to perform a *control of the propriety of used natural water sources* and output water after its cleaning before leaking or reusing for further decontamination. This action should be preferably realized by forces of field chemical

laboratories PPCHL AL-2/ch,r and a movable hygienic-epidemiological laboratory PHEL. In this way, however, performed control of water cleanness is very complicated in real situations. For fulfillment of this task it is necessary to equip the modular decontamination system with sets for operative microbiological and chemical control. For performance of chemical control of natural water sources it is suitable to use sets based on a visual colorimetric (for example Aquamerck® or Aquaquant®) or alternatively fotocolorimetric principle of activity (for instance Spektroquant®). For a basic orientation finding of contamination caused by radioactive compounds it is possible to use established military devices, for example Handheld Contamination Monitor MICROCONT II, dosimeter device DP-86 or RDS-200. For quick microbiological control of water cleanness there is no commercially offered product according to available sources. For performance of output procedural water control after its cleaning or reuse for decontamination it is possible to use the field chemical laboratory for water analysis CAW-2000. For radiometric control of cleanness of this procedural water it is possible to use above mentioned dosimeter devices of MICROCONT II, DP-86 or RDS-200. The orientation microbiological control of output procedural water can be realized by a simple set based on methods of biochemical oxygen demand measurement.

- The mobile *decontamination system* for mass personnel decontamination can be *deployed* as fully or mostly fully continuous in accordance with realization of people's movement on a personnel decontamination site. Conceptual solution of a mostly continuous way of people's movement is suitable mainly for realization of mass hygienic clearance and personnel decontamination of people who have been protected by IPE within WMDs attack or after leakage of TIMs. The new conceptual mobile modular decontamination system for mass personnel decontamination enables traffic ability in both above mentioned conceptual solutions. In this way it creates conditions for its variant deployment in dependence on a place for fulfillment of an engaged task.
- For *people's registration* it is necessary to establish a modern identification system based on identification marks employment. Marks have to be resistant to water, decontamination compounds,

mixtures and mechanical abrasion. For a newly conceived modular system it can be recommended to use either an identification system with a simple design of an identification mark or an electronic identification system with a radio-frequency chip mark (RFID) enhanced for visual control concerning carrier's name and surname.

- In a system of people's registration it is necessary to order the *systematic control* of contamination of personnel documents, subjects and accessories of contaminated people and, if needed, to realize their decontamination or their disposal. Concerning their acceptance, takeover, handover or liquidation, this fact has to be recorded. The establishment of cooperation with Military Police, eventually with state or local Police, is crucial for solving this matter.
- To manage the *organization, command and control of decontamination processes* it is necessary to equip modular systems with an appropriate monitoring, communicational, informational and warning systems. From ensuring needed communication and data sharing, modern technologies for wireless information transfer have to be used [5]. For the need of control of harmlessness for outer environment, devices for monitoring mainly radiation and chemical situation can be used. These devices are going to be automatically connected with the warning system. For command, control and release of decontamination, an information system with an electronic light information board enabling operational changes of text in both Czech and English language can be employed.
- *Technological equipment and material* needed for the activity of simple modules of the decontamination system is suitable to locate and transport in marked transport palettes, eventually cases. For easy manipulation these ones have to be furnished with handrails, added wheels and holding loops. Trucks designated for their transportation have to be equipped with a drop platform or with other suitable devices for manipulation with them.
- *Decontamination of personnel weapons* is suitable to perform by immersing into a bath with the decontamination mixture or solution. For increasing of decontamination effectiveness it is suitable to mix a content of the bath within

the decontamination process when mixtures of a non-emulsion type are used. It is necessary to separate added and supplementary parts of weapons with a sensitive surface from the weapon, to mark them with an identification label and to perform their decontamination in the related module.

- *Decontamination of the gear* which is a part of the garments carried on dressed IPE has not been considered and performed in a framework of personnel decontamination in the CAF. For detoxification and disinfection of IPE it can be possible to use an introduced non-rinse peroxide decontamination mixture which is designated for decontamination of absorptive surfaces. This mixture has to be verified by the probe. For removal of radioactive compounds from its surface it is possible to use only mechanical ways of deactivation.
- For *decontamination of the armaments, devices and equipment with sensitive surfaces* which are parts of personnel equipment, there are no suitable devices within decontamination units introduced in current time. As a perspective one it is possible, based on research results, to consider introducing powder dispersion mixtures with nanostructure oxides applied with the help of technical devices. For example, the decontamination kit of SX-34 can be used from commercial available devices.
- Related to *IPE decontamination* on a personnel decontamination site it is necessary to ensure taking and manipulation with body's protective devices of a filtration type. It is needed to take of used protective filters, protective devices' decontamination designed for breathing organs including bags for their storage and gas proof gloves from a set of filtration protective garment of FOP. Within mass personnel decontamination we do not realize decontamination of protective body surface equipment of an isolative type (for example JP-90). Furthermore, it is possible to practically exclude decontamination of hermetic protective garments of the isolative type concerning body surface protection (for instance OPCH-05). Exceptionally it is possible to suppose performance of their decontamination within rescue operations in favour of other specialists equipped with the same isolative garments, for example members of the Czech Republic Fire Rescue System. A concentrated

peroxide micro emulsion mixture can be considered as perspective for decontamination of IPE. It is, however, necessary to verify with the test, if this mixture and the proposed emulsion decontamination mixture cannot cause damage to rubber materials.

- When performing *detoxification of mask surface* by wiping with the help of the decontamination mixture, this results only in its surface decontamination. For fulfillment of the total surface detoxification it is necessary to use procedures introduced in ČOS 841501 [6]. These procedures can be only applied in suitable infrastructures. Regarding to duration of decontamination work performed on the personnel decontamination site and equipment of the proposed decontamination system it is not possible to ensure this detoxification. Masks have to be only collected into collection bags and either get liquidated or transferred to a deep detoxification procedure. In the future it is necessary to either develop this further or purchase a suitable technical device for enabling this detoxification and subsequently put it into the decontamination system.
- An *extension container* produced by UNITEAM, DAHER KARBOX or SCHALL companies can be recommended for buildings up containerization modules which are tandem in so called “decontamination line”. In this case it will be necessary to demand its adjustment in dependence on traffic ability, inner organization and equipment of the module. For technological modules the modified containers of ISO IC introduced in the CAF can be used. In the case that *tent systems* with a blowing carried construction are going to be used in a framework of middle decontamination system, it will be suitable to complete them with supporting carried constructions in order to eliminate damage of their carried body tubes. Tents should be equipped by once-and-for-all polyethylene filler and have to have elements for their easy attachment on solid areas without disturbance of their surface. For ensuring easy move and manipulation it is suitable to deposit tent systems in marked, closed and easy decomposable pallets with handrails, added wheels and hanging loops.
- It is necessary to create an *optimal air fluxion* with the aim to minimize both harmful substances and water steam storage in areas of modules in a framework of a produced “decontamination line”. This fluxion has to be ensured by forcing both warm and cold air into modules areas based on outer climatic conditions and module effective ventilation. Fluxion or created overpressure of the air should be regulated depending on a conceptual solution of people movement through this line.
- For *managing of people passage* through the “decontamination line” it is necessary to use a light signalization set connected with moveable registration and time sensors or impulsive sensors. The signalization set can be completed with a phonic system.
- For *deposition of slightly viscose decontamination solutions and mixtures* and also for *showering people* with warm water it is suitable to use three-dimensional frames with suitable spreading and pulse nozzles with automatic dosage of needed amount of liquid. An automatic system of dosage has to be doubled with a spare, manually controlled system. Personnel drying can be realized by warm air running from the frame. For decontamination of casualties and immovable persons some hand showers have to be used. Single use paper towels seem to be perfect for their drying.
- The *check of personnel deactivation* can be realized by means of a controlling dosimeter station which is going to run in an automatic regime. For the check of heavy wounded and immobile persons a portable monitor of contamination can be employed.
- The *process of personnel decontamination, casualties and immobile persons’ decontamination, their armaments, selected IPE and other materials decontamination*, has to be ensured by a service of the modular decontamination system, respectively by the personnel decontamination unit with no need of the force detachment from the number of contaminated units.
- *Spare accoutrements, other material and once-and-for-all suit and boots* outgoing to decontaminated persons will be performed from modules for their release connected to modules of the “decontamination line”. This activity must be realized in cooperation with related logistics organs and units.



- Personnel *decontamination*, casualties' decontamination, personnel weapons, other material and selected IPE decontamination *is possible to realize collaterally* in the proposed decontamination system. This *activity will have to run in different time intervals*. Thus, it will be necessary to determine organizational measurements form taking the above mentioned material on the personnel decontamination site. An alternative solution can be a replacement of it with adequate non-contaminated material which will be distributed by CAF logistic organs. After decontamination work is completed, decontaminated material has to be handed over to logistic organs either for further usage or for ecological liquidation.
- For needs of the CAF CCs it is possible *to recommend a variety of performance of the middle decontamination system*. This one could be formed from variable extension containers with built technologies enabling connection of tent systems.

### THE PROPOSAL OF THE MOBILE MODULAR SYSTEM FOR PERSONNEL DECONTAMINATION

Based on the above mentioned recommendations, a conceptual proposal of the mobile modular decontamination system for personnel decontamination has been elaborated within NBC Defence Institute [1]. This system is designated for performance of mass personnel decontamination and, moreover, for decontamination of casualties and immobile persons. Alternatively it can be used for hygienic cleaning. It is created by the set of special equipment and supported technologies placed into in-built containers or containers connected with tent systems and accompanied by special vehicles of logistic support. In accordance with the need, other workplaces for decontamination of personnel weapons, selected IPE and sensitive material are created and technologically ensured.

In this modular system, the term of "module" is understood as a set of technical equipment, devices, used technologies and other materials built-up into a functional complex either in the container or in the container case and, furthermore, located in the tent which is used to fulfill either

a particular stage or a partial activity demanded within realization of personnel decontamination, decontamination of personnel weapons and selected material.

The modular decontamination system for personnel decontamination will be an autonomy decontamination device which is able to work for 10 hours without the need of filling both functional and decontamination components. It is the decontamination equipment of the CAF CCs personnel decontamination units designated for the action in both field conditions and urban areas for performance of:

- mass personnel decontamination or their hygienic cleaning, decontamination of casualties and immobile persons;
- decontamination of personnel weapons surfaces, protective devices of breathing organs and bags for their storage;
- collection and packaging of contaminated underwear, garments and other accouterment;
- release of clean underwear, garments and other accouterment eventually of spare once-and-for-all garment and boots to decontaminated persons in cooperation with logistic organs;
- collection and packaging of filters of protective equipment of breathing organs and protective equipment for body surface protection of the filtration type;
- collection and packaging of masks after their surface detoxification;
- decontamination of surfaces of selected garments carried on FOP;
- decontamination of armaments, devices and material with sensitive surfaces in personnel equipment,
- check of contamination and decontamination performance related to personnel stuff and subjects;
- collecting, cleaning or adjustment of procedural waters;
- decontamination during the day, at night, in common and worse climatic conditions.

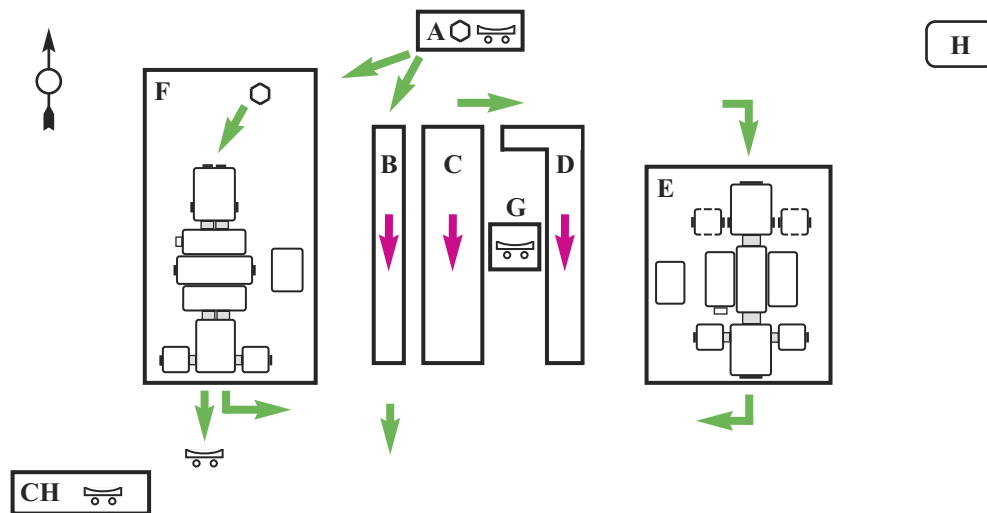
The mobile modular system for personnel decontamination is composed of:

- command and control module (module No 1);
- meeting and separated module (module No 2);
- chain of decontamination modules composed of the module for decontamination of personnel weapons (module No 3), module for decontamination

- of other material (module No 4) and module for decontamination of selected IPE (module No 5);
- module for undressing people (module No 6);
- module for personnel decontamination (module No 7);
- module for dressing people (module No 8);
- decontamination shelter (module No 9);
- module for undressing garments – C (module No 10);
- module for personnel decontamination – C (module No 11);
- module for dressing garments – C (module No 12);
- technological module I (module No 13);
- technological module II (module No 14);
- module for clearing and water purification (module No 15).

Parts of the decontamination system are vehicles for transportation of containers, material, decontamination components, water storage and devices and equipment for manipulation with containers and material.

The decontamination system is thus composed of overall 15 isolated modules and enables operational usage of only some of those modules which are necessary for fulfillment of a particular task. Service of modular system for personnel decontamination created in this way is provided by personnel decontamination platoon. A scheme of the site for personnel decontamination with the employment of the above mentioned chains and modules is introduced in figure 1.



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|---|--|
| A Meeting and separated module (module No 2)  | F Area with modules designated for decontamination of casualties and immobile persons and technological module II (modules No 9, 10, 11, 12, 14) |
| B Area with modules designated for personnel weapon decontamination (module No 3)                                 | G Command and control module (module No 1)   |
| C Area with modules designated for decontamination of other material (module No 4)                                | H Module for cleaning and water purification (module No 15)  |
| D Area with modules designated for decontamination of IPE and its bags (module No 5)                              | CH Area for logistic equipment   |
| E Area with modules designated for personnel decontamination and technological modules I (modules No 6, 7, 8, 13) | ➡ Direction of movement – persons  |
|   | ➡ Direction of movement – material   |

**Figure 1:** Placement of modules on the personnel decontamination site

The mobile modular system for personnel decontamination should enable the following during the period of one hour:

- decontamination and hygienic clearness of as many as 76 people and 25 casualties and immobile persons;
- as many as 32 pieces of personnel weapons;
- as many as 32 pieces of bulletproof vests or splinters, tactical vests and so on and as many as 32 pieces of helmets and coverage;
- as many as 101 pieces of protective devices for breathing organs;
- as many as 48 bags from protective devices for breathing organs;
- as many as 2,5 m<sup>2</sup> of the area of devices and equipment with the sensitive surface.

Based on the above mentioned knowledge, the proposed mobile modular system for personnel decontamination is conceived for the need of not only forces decontamination but also for decontamination of civilian people. For this purpose it is also fully useable. Its introduction will fulfill the demand mentioned in Standardization Agreement AEP-58 concerning creation of the autonomy mobile decontamination system. Decontamination units will have the modern decontamination system available. This system enables the complex of personnel decontamination, casualties and immobile decontamination and their armaments, IPE and other material.

## CONCLUSION

Personnel decontamination units will have the modern decontamination system available. Decontamination of military equipment and material, objects, terrain and people remains, from the military point of view, a crucial part of chemical support of the battle and operations in the future. Devices for decontamination performance introduced into the CAF CCs armaments are always necessary to improve and modernize. The aim of this process is to create autonomous, multi purpose, highly mobile modular systems of decontamination which will be able to develop and launch into the action without the help of external equipment and technological sources as it is demanded within NATO armies in current time. With the development of vehicles and equipment of the CAF CCs with usage of elements

of containerization, the demands on easy and quick transportation of the armaments, vehicles and material with all means of transportation will be reached, whereas the main demand is put on own air transportation for long distance. The proposed mobile modular decontamination system for personnel decontamination will be fully used in favor of the Czech Republic Integrated Rescue System. Its employment is supposed to be used during natural disasters, industrial accidents connected with TICs leakage or after terrorist WMDs usage. Its potential users will be units of decontamination of the CAF CCs and the Czech Republic Fire Rescue Brigades.

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