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LATEST CBRN DECONTAMINATION TECHNOLOGY AT THE HUNGARIAN DEFENCE FORCES

Abstract

At the age of asymmetric warfare the CBRN[1] threat level has been increasing and the importance of CBRN decontamination is more revaluated. At the beginning of the 21st century, modern CBRN procedures and devices appear in the world, which represent more effective technologies. The Hungarian Defence Forces is committed to develop their own CBRN decontamination technology according to the principles of NATO STANAG's. New decontamination procedure has naturalised with bringing the DECOCONTAIN 3000 GDS system into service, which is capable of taking out the old fashioned, outdated technology and making an appearance of a new operational capability possible. The examination of technology and procedure could demonstrate at the subunit level that the new decontamination system is able to face the CBRN challenges at the present time.

Az aszimmetrikus hadviselés korában az ABV fenyegetettség szintjének emelkedésével az ABV mentesítés jelentősége is felértékelődik. A 21. század elején korszerű mentesítési eljárások, eszközök jelennek meg a világban, amelyek hatékony technológiát képviselnek. A Magyar Honvédség elkötelezett a saját ABV mentesítési technológia fejlesztésében a NATO STANAG alapelvek szellemében. A DECOCONTAIN 3000 GDS berendezés rendszeresítésével olyan új mentesítési eljárás honosodik meg, mely képes kiváltani a régi, elavult technológiát és egy új műveleti képesség megjelenését teszi lehetővé. Az alegységszintű technológiai- és eljárás vizsgálat bebizonyította, hogy az új mentesítő eszközrendszer a kor ABV kihívásaival képes megbirkózni.

Keywords: *CBRN decontamination, asymmetric warfare, Hungarian Defence Forces DECOCONTAIN 3000 GDS system. ~ ABV mentesítési eljárás, aszimmetrikus hadviselés, Magyar Honvédség, DECOCONTAIN 3000 GDS rendszer.*

[1] CBRN – Chemical, Biological, Radiological and Nuclear, formerly called NBC (Nuclear Biological, and Chemical) referring to the types of Weapons of Mass Destruction (WMD). The new CBRN abbreviation stands in order of dangerousness, as chemical threat is the most seriously possible.

INTRODUCTION

Since the attacking enemy force usually has the initiative in terms of where and when it will attack, a defending commander must take a wide range of actions to protect his forces from losses due to enemy actions. These steps include ensuring all-around defence, among other things, NBC (or, in latest terms, CBRN) defence. In the course of offensive operation the surprise, concentration, tempo, and audacity characterize the offense. The commander manoeuvres his forces to advantageous positions before contact. [1]

The rapid and accurate conduct of decontamination activities is very important both in defence and in offense in order to help commanders maintaining combat power and manoeuvre flexibility.

CBRN contamination may cause casualties, degrade performance, slow manoeuvres, restrict terrain and disrupt operations. CBRN decontamination prevents the erosion of combat power and reduces possible casualties resulting from inadvertent exposure or failure of protection. Decontamination allows commanders to sustain combat operations. Decontamination principles involve:

- conducting decontamination as quickly as possible;
- decontaminating only what is necessary,
- decontaminating as far forward as possible, and
- decontaminating by priority. [2]
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Use of CBRN weapons creates unique residual hazards that may require decontamination. In addition to the deliberate use of these weapons, collateral damage, natural disasters, and industrial emissions may require decontamination. Contamination forces units into protective equipment that degrades performance of individual and collective tasks. Decontamination restores combat power and reduces casualties that may result from exposure, thus allowing commanders to sustain combat operations. [3]

Against the background of the increasing number of terrorist attacks, effective NBC defence is of principal importance for the armed forces as well as for civil defence and disaster management units either. Chemical, biological, radiological, and nuclear decontamination is the elimination of undesirable hazardous CBRN materials from humans, vehicles, weaponry, equipment, terrain, e.t.c. Decontamination reduces the dose that soldiers may receive from polluted surfaces, clears chemical, biological, radiological, and/or nuclear contamination away, and reduces the disposal costs associated with the components or the materials. [4]

Prompt and effective decontamination of persons, tanks and other vehicles, air- and watercrafts, personal weapons, clothing and equipment as well as sensitive materials ensure the ability of the concerned troops to survive.

Kärcher[2] develops and produces market-leading products for the most varying needs in the area of NBC defence and delivers them to its customers all over the world.

The DECOCONTAIN 3000 GDS was designed and constructed for the application of revolutionary non-aqueous decontamination agents such as GDS 2000 and forms the technical basis for the quick set-up of an on-site decontamination station. [5]

[2] Alfred Kärcher GmbH & Co. is one of the largest manufacturers of cleaning equipment

GENERAL PRINCIPLES OF DECONTAMINATION

CBRN contamination is a hazard to the life and health of personnel. Contamination places constraint on the use of equipment and areas affected, compels personnel to take NBC defence measures and may thus considerably impede or prevent mission accomplishment by units. Active decontamination operations reduce hazard levels by removing or neutralising liquid or solid contamination. It is carried out when CBRN contamination, which cannot be avoided, will adversely affect the unit's operational capabilities. [6] However, CBRN contamination can have an adverse effect on certain materials (i.e. composites) and can cause significant functional damage to surfaces of optical and sensor equipment.

Working or combating in Individual Protective Equipment (IPE) will degrade troops' performance, increase fatigue and possibly lower force cohesion and morale. Moreover, it reduces the overall speed, cohesion and freedom of movement of forces in the local area because of contaminated areas and assets. It also restricts the local use of ground and operational assets. If decontamination has become necessary, it needs to be undertaken as quickly as other operational priorities allow it. [7]

Decontamination is valuable in terms of manpower, time, space, and materials. These resources are also required to fight the battle, so commanders must apply them wisely and sparingly. The wisest way to conserve these resources and still sustain combat power is by following these four principles:

- speed,
- need,
- limit and
- priority.

Decontaminate as soon as possible (SPEED):

This is the most important principle out of the four. Commanders must consider this principle before considering any other. Speed is essential when the unit is contaminated. Contamination on personnel not in mission oriented protective posture (MOPP) gear poses an immediate hazard and can be lethal within minutes after contamination. Combat power drops as soon as personnel put on MOPP Gear. As soon as contamination is removed, commander can reduce MOPP level and restore combat power.

Decontaminate only what is necessary (NEED):

If commander expect to survive and win on the contaminated battlefield, he mustn't waste precious resources decontaminating everything. Commander must consider mission, time, extent of contamination, MOPP status, and decon assets available and decontaminate only what is mission essential to conserve resources and help sustain combat power.

Decontaminate as far forward as possible (LIMIT):

Commander must organise the decontamination as close to the site of contamination as possible to limit the spread of contamination. It is prohibited to move contaminated equipment, personnel, or remains away from the operational area, if it is possible to bring decon assets, organic or supporting units, forward safely. This will keep the equipment on location, speed up decontamination, and limit the spread of contamination. Limiting the number of personnel and amount of equipment in the area helps to prevent the spread of contamination. Commander makes every effort to confine NBC contamination to as small an area as possible. This also reduces the amount of decon required. Units moving from a contaminated area into a clean area should decontaminate at or near the edge of contamination. The unit marks all contaminated areas and reports their location to other

friendly units to keep them from entering the contaminated area unknowingly. Contaminated materiel presents additional problems for limiting the spread of contamination. If the situation permits, materiel can be left and allowed to weather. If the equipment is mission essential, it must be decontaminated on the spot or brought back to the rear and decontaminated. If the situation permits, decontaminate as far forward as possible. If this is not possible, then materiel may have to be transported to the rear for decontamination. If contaminated materiel must be moved:

- Use as few transport vehicles as possible.
- Use one route, especially around congested areas.
- Monitor the route periodically for contamination.
- Cover the materiel to keep confined.
- Warn personnel downwind if a vapour hazard is present.
- Monitor and decontaminate transport vehicles before transporting noncontaminated materiel.
- Ensure that transport crew wears appropriate MOPP Gear.

Decontaminate by priority (PRIORITY):

The commander must decontaminate the most important items first and the least important items last. Naturally, as human lives are the most important, decontamination of persons has the key priority. Than unit commanders decide which vehicles and equipment are most important to the mission. Battalion and brigade commanders decide which elements to pull "off line" to decon or whether to decon during the reconstitution process. Division and corps commanders must set priorities and concentrate decon assets. [8]

THE DECOCONTAIN 3000 GDS DECONTAMINATION SYSTEM

The DECOCONTAIN 3000 GDS is used for the simultaneous decontamination of vehicles, persons, equipment and road sections, and stands out due to its compact design and immediate readiness for operation. It forms the mobile material basis for the establishment of a complete decontamination site. The integrated 3000 litre stainless-steel tank enables the transport or storage of drinking water.

1. figure. The Kärcher DECOCONTAIN 3000 GDS decontamination system (source: authors)

Development

The Kärcher DECOCONTAIN 3000 GDS decontamination system was designed for deployment at battalion level or higher and forms the technical basis for the fast establishment of a decontamination site. The DECOCONTAIN 3000 GDS is a new-generation compact, high-performance system mounted in a standard six metre ISO container. The DECOCONTAIN 3000 is designed to manage all essential decon activities simultaneously following NBC contamination: vehicle, personnel, clothing and equipment.

Description

"The DECOCONTAIN 3000 GDS is comprised of various modules:

- Independent diesel-powered MPS 3200;
- Pre-treatment module (HD-4000);
- Main-treatment module (AMGDS-2000);
- Post-treatment module (HDS-12/14 ST Eco);
- Shower module (HWM-35C).

The procedure used is dependent on the type of decontamination. Radiological decon uses a hot-foam procedure, while disinfection uses various biocidic solutions. CW-agent decon uses the GDS 2000. Personnel decon is conducted using a two-step, pulsating shower procedure in special decontamination site. Clothing and equipment decon is accomplished by using hot steam inside a collapsible tent. In addition, terrain is treated with an aqueous decontaminant solution. The system is equipped with a 57 kW high-performance generator and an insulated heatable water tank which allows the DECOCONTAIN 3000 GDS to operate independently for long periods." [9]

Regarding the DECOCONTAIN 3000 GDS Containerised Full Decontamination System handbook the operational capabilities are the followings:

- Personnel decontamination: up to 120 persons/h.
- Road decontamination: 600 meters/h.
- Vehicle decontamination: 6 to 8 tanks, or 12 to 16 average size vehicles/h.
- Clothing decontamination: 20 to 30 sets/h.

2. figure. Vehicle decontamination with GDS 2000 solution (source: authors)

GDS 2000 solution against chemical live agents

"In consideration of the huge increase in environmental awareness, Kärcher has developed a new non-aqueous decontamination agent (GDS 2000; NATO Supply No. 6850-12-366-1321) against chemical warfare agents which has important advantages compared to the known decontamination agents with regard to storage, handling, efficiency, application and corrosiveness as well as a considerably improved ecological behaviour. It is produced industrially and is available for application. It meets the requirements of water pollution class 1 (low hazard level to waters) and is biologically degradable. For example, the complete detoxification of a combat tank requires only 12 to 24 litres of GDS 2000. The high decontamination efficiency of GDS 2000 against all relevant chemical warfare agents (including chemical warfare agents containing thickeners) has been proven in many laboratory and field tests carried out by WISABC-SchutzBw and other independent test institutes. Industrially manufactured, ready-to-use non-aqueous decon agent, which works universally against all known chemical warfare agents and warfare agents containing a thickener.

Complete C (chemical) decontamination requires only approximately 0.1 – 0.2 l/m². BTR-80 and other armoured vehicles can be totally decontaminated in 5 – 10 minutes, using only 10 – 20 litres of GDS 2000. GDS 2000 may be stored for more than 10 years, if kept in its original packaging, unopened and under the given storage conditions. GDS 2000 can be applied by means of appropriate devices at temperatures ranging from -30 °C up to +49 °C". [10]

Generally one of the limiting factors of the decontamination is the availability of water. The actual amount of water required varies by the vehicle and its contamination level. The use of new decontamination solution facilitates to develop a water resupply plan for thorough decontamination operations.

DECONTAMINATION TECHNOLOGY AND PROCEDURES WITH DECOCONTAIN 3000 GDS

Decontamination of Vehicles

Decontamination of materials means radioactive decontamination, disinfection or detoxification of tanks, wheeled vehicles, artillery systems, engineering equipment, aircrafts, helicopters, etc. Pre-treatment, main treatment and post-treatment are carried out simultaneously using special electrically-driven decontamination modules.

First of al the contaminated unit performs predecontamination actions, to include segregating vehicles by checking for contamination.

1. The vehicle crews, except for the drivers, dismount. As the crews dismount, they remove all contaminated equipment, including sensitive items (i.e. electro-optical), from the top and sides of the vehicles. Once the crews have exited the vehicle, they will not re-enter. This prevents contamination from being spread into the vehicle interior.
2. Using the pioneer tools from the contaminated vehicles, the crew removes all heavy mud and debris. They concentrate on the undercarriage, which would be the most likely place for contamination to collect and the hardest place to decontaminate. Once the crew is finished with the pioneer tools, they are placed back on the vehicle. The initial removal of the mud and debris makes it more likely that the decontamination wash will remove any remaining contaminants.

3. Seat covers (when applicable), canvas items, camouflage netting, wooden rails, and any other material that can absorb liquid contamination are removed. These items create a potential transfer hazard and are not easy to decontaminate.
4. Equipment and supplies that are exposed after removal of coverings should be checked for contamination. If the items that can be removed are uncontaminated, they should be moved via a clean route to the postdecontamination area. Contaminated equipment and supplies will be decontaminated or disposed of properly. [11]

Pre-treatment:
During pre-treatment, coarse dirt with its CBRN contaminants is removed from tanks, vehicles, etc. by applying cold water under high-pressure (approx. 60 bar) using the HD 4000 decon module with two high-pressure spray lances.

Main treatment:
The main treatment depends on the type of CBRN contamination:

Chenical (C) decontamination: Detoxification using the highly effective GDS 2000 detoxification solution (AMGDS 2000 decon module).

Biological (B) decontamination: Disinfection is using the effective BDS 2000 disinfectant system (HDS 12/14-4 ST decon module).

Radiological/nuclear (RN) decontamination: Radioactive decontamination is using the highly efficient RDS 2000 hot foam (HDS 12/14-4 ST decon module).

Post-treatment:
During post-treatment, the decontamination residues are removed from the decontaminated surface using hot water under high-pressure (approx. 80 °C and 60 bar) or hot steam (approx. 140 °C) which is applied via one or two high-pressure spray lances.

3. figure. Vehicle decontamination with hot and high-pressure water
(source: authors)

Decontamination of Persons

Decontamination of persons means removal of contaminants from the skin to avoid any damage to health.

In the standard model, thorough decontamination of persons is carried out by means of a shower system integrated into the container side walls through which persons can pass. This

system includes an inflatable tent for undressing and a second tent for re-dressing. The persons to be decontaminated enter the shower section via the entrance stairs, thereby activating the first showers via an IR sensor. These showers automatically spray water enriched with a special decontamination agent. Subsequently and after a certain time interval, further showers delivering clear water for rinsing are activated. The decontaminated persons leave the shower section via the exit stairs. A tunnel installed between the tents and the shower section protects the persons from being seen and from the effects of the weather. The shower water is supplied via the hot water module integrated into the container. The waste water can be pumped off, collected and, for example, be used for material decontamination pre-treatment. Further shower types integrated in different shower tents are available on request.

Decontamination of road sections

NBC decontamination of road sections, take-off and landing runways is carried out using decontamination solutions. These decontamination solutions are applied by means of two AMGDS 2000 decontamination modules in a sufficient quantity directly during the decontamination process via four special spray nozzles. The DECOCONTAIN 3000 GDS covers a spray width of more than 2.60 m.

Decontamination of Personal Equipment

This means NBC decontamination of clothing, personal CBRN protection equipment and personal combat equipment. Decontamination is carried out using hot gas/hot steam in a specially designed hot gas/hot steam chamber. Thermal BC decontamination depends on temperature and time. Optimal decontamination temperatures vary between 130°C and 170°C. The necessary decontamination conditions inside the chamber are ensured by the decontamination module particularly suitable for this decontamination method.

Decontamination of the interior

Rooms are preferably decontaminated by means of aerosols. B decontamination of the interiors of shelters, vehicle cabins, aeroplanes, etc. is carried out by means of a highly efficient aerosol technology using a special thermal aerosol generator.

For thorough interior decontamination, the optionally available SN 50 Decon hot fogger is used. This thermal aerosol generator atomises the active agent of the thermally stable peroxyaceticacid (Wofasteril SC 250) in an effective droplet size.

EXAMINATION AND TEST OF DECOCONTAIN 3000 GDS SYSTEM

The examination and technical test of DECOCONTAIN 3000 GDS system were carried out by CBRN decontamination company. The examination procedures were executed at the base of CBRN decontamination coy and the testing period was 10 months. The testing of DECOCONTAIN 3000 GDS system was divided into two separate phases during the examination.

The following functions of the decon system were tested during the first phase:

Design and loading:

- The completeness of DECOCONTAIN 3000 GDS equipment.

- The mechanical equipment management and control units of marker signs, presence of signs, their placement.
- Protection of metal surfaces, the paint design and quality.
- The loading of built-in units and their placement, ensuring their accessibility.
- Immobility of loaded units and equipment inside the container.

Operation and handling:

- The testing of functional operation of the equipment.
- The operation of decontamination container, its handling and operational safety.
- The operation of safety systems.
- The assuredness of continuous operation.
- The applicability of decontamination containers during night and in low visibility conditions.
- The assuredness of water supply.

Several kind of predefined tasks were performed at the first phase. One of the most important was the container loading examination during railway transportation. The establishment was that the normal ISO standard container is suitable for railway transportation, but the loading procedure needs skilful operators. The other part of the examination focused to the handling of built-in modules and portable decontamination equipments and installations. The result of this part of the examination showed that devices and instruments are well designed, trustable and the ergonomic features are really outstanding. The training of the members of CBRN decon coy was the vital part for carrying out this really difficult examination and that is why every key members of the test had received special preparation from the decontamination procedures. The "Dragon Fire 2011" cooperative infantry exercise was one the best opportunity to test the decontamination containers with operators from the CBRN decon coy, where thorough decontamination of an infantry company was carried out at the simulated combat enviroment.

4. figure. The examination and technical test of DECOCONTAIN 3000 GDS system (source: authors)

The following functions of the decon system were tested during the second phase:

Installation and deployment:

- The conceptual scheme of CBRN decontamination station (tools installation, water supply, and contaminated liquids collection of environmentally friendly design options).
- The deployment time and standards.
- The determination of equipment capacity and capability.

Operation and handling:

- The operation and storage of DECOCONTAIN 3000 GDS system at winter weather conditions.
- Theoretical feasibility of CBRN decontamination patterns.
- The determination of time requirements for different CBRN decontamination methods.
- 7 and 23 days of reckoning for the application of CBRN decontamination data base definition.

Performed tasks during the second phase:

- Application and impact assessment of CBRN decontamination solution.
- Determination of time requirement at the CBRN decon station.
- Definition of commander's and operators' tasks at the CBRN decontamination station.
- The requisition of DECOCONTAIN 3000 GDS system at winter weather conditions.
- The examination of camouflage possibilities for CBRN decon sites.
- The examination of CIS possibilities for CBRN decon unit.
- CBRN decontamination station deployment at the training field of MH BHK Csörlőháza.
- Determination of technical and logistic service system of DECOCONTAIN 3000 GDS equipments.

Positive experiences:

- *Application security:* Due to the strict separation between the "clean" and "unclean" areas, and taking other general decontamination principles into consideration, a sluice-gate function is generated, which reliably avoids the spread of contamination.
- *Variability:* The commander can choose one of three shower variants for the decontamination of persons.
- *Multifunctionality:* The compact decon system is equipped with all necessary components for the establishment of a full decontamination site. Simultaneous, highly effective operation for CBRN decontamination of persons, material and equipment.
- *Operational safety:* Due to the integrated 3000 l water tank, the DECOCONTAIN 3000 GDS can also be used for independent decontamination tasks. It can be transported by rail, vehicle, ship, and air.
- *Central energy supply:* All electrical consumers are supplied with energy via a central electrical power generator.
- *Efficiency:* All stations of the decontamination site for vehicles can be run simultaneously and in parallel to the decontamination of persons without any

capacity restrictions. Also very suitable for use in military or special civil defence facilities.

Negative experiences:

- *Ineffective decontamination kit of road sections:* Road decontamination system is not fixable to the front of Hungarian RÁBA H-25 trucks. Suggestion: Road decontamination system is recommended to redraft to plan for using of Hungarian RÁBA H-25 trucks.
- There is not any C decontamination solution for SN 50 Decon hot fogger at the present time, only B decontamination solution is available. Suggestion: C decontamination solution is under the testing phase at Kärcher laboratory. After this testing period the C decontamination solution is needed to provide for CBRN decon units.
- The chassis washing system is not able to control the amount of liquid and the consuming of water is strongly wasteful. Suggestion: The chassis washing system is useless without a control device. This chassis washing system is replaceable with high pressure decon spears.
- Hoses of AMGDS module are too short (15 meters) and they are not suitable for carrying out the vehicle decontamination. Suggestion: Hoses of AMGDS module are needed to extend for more than 15 meters (all together 30 meters) hoses.
- In absence of stepladder the opening-closing procedures of container side-doors are not secure. Suggestion: The DECOCONTAIN 3000 GDS container is placed and used at the platform of a Hungarian RÁBA H-25 truck, the lock of container side-doors is relatively high and that is why the stepladders are necessary.

These born suggestions have already been approved by dealer firm and they are going be solved within a couple of months.

CONCLUSIONS

For deployed forces, and those operating in a potential or actual CBRN threat area, all active defence functions must be operable in CBRN environment without prejudicing operational tempo and combat effectiveness. [12]

At all levels, decontamination capability should be reserved, in order to carry out decontamination of attacked sub-units or those unable to bypass contaminated areas at the earliest possible moment to maintain combat effectiveness. Therefore each combat means should accompanied by an appropriate decontamination equipment in order to accomplish crew level immediate decontamination without waiting on superior's support.

Decontamination process has to be well integrated into coherent operational and tactical concepts in order to ensure the continuity of the operation.

Generally speaking, while the fighting unit is under decontamination it is especially vulnerable to enemy fires. The decontamination station has to be deployed over the range of enemy indirect fire. In this case the time is essential, and also specialist CBRN subunits can only conduct independent decontamination operations for short periods.

With the increase in the intensity of threats perception and possibility of mass casualties in case of a chemical, biological, radiological, and nuclear emergency, there is a need to develop novel and effective systems for decontamination. [13]

The decontamination ensures preserve the forces so the commander can apply maximum combat power. Preserving the force includes protecting personnel, may provides the success of the operation.

The participant units of military operations can keep their survivability through to employ CBRN defence rules, inter alia contamination avoidance, CBRN protection, and CBRN decontamination. All units have to be trained to operate in a CBRN environment to survive and accomplish their missions, and after training and many exercises have to be able to accomplish the decontamination in order to increase their fighting capacity through reducing their MOPP level. Decontamination assets within these units are limited, and these circumstances determine their capability, so the fastest and most effective decontamination only CBRN decontamination subunits can provide. The time plays key role during operations, therefore supplying the decontamination platoon with sophisticated items - which allows enhancement in the CBRN decon platoon's performance – is very important.

The DECOCONTAIN 3000 GDS represents the state of the art in its performance class. Due to its modular construction, this decontamination system can be set up readily and flexibly and is adaptable to the operational situation. In addition, the decontamination agents foreseen for the DECOCONTAIN 3000 GDS fulfil the strict regulations of reliable environmental protection. The Hungarian Defence Forces have a new operational capability which can be used in a wide spectra of military operations or disaster relief tasks without limited deployment capabilities.

Following a confirmed CBRN incident NATO military forces must be fully prepared to respond to and recover from the consequences of a CBRN incident against their own forces, infrastructure and assist to their partners, if necessary. In addition due to the likelihood that major civil emergencies can pose a threat to security and stability and because CBRN consequence management is challenging and could be a massive, costly and protracted effort, NATO should be prepared to support national authorities, if requested. This includes eliminating contamination to required levels of cleanliness, restoring operational capabilities, re-establishing conditions which are as close to the "status-ante" as possible, providing support to civilian lead consequence management operations and conducting CBRN forensic investigations. [14]

The decontamination platoon is required to meet the above challenges that include carrying out decontamination of civilian population and material assets. In this case the decon sub-unit have to look after the force protection only.

Technology changes continues to be a key driver of developing the performance of the decon platoon that will pose both new problems and new opportunities. As access to current and emerging technology becomes more widespread, there will be greater opportunities for the CBRN units to develop effectively their means for assembly their enhanced decontamination process.

References[3]

[1] Field Manual No. 3-90: Tactics, Headquarters Department of the Army Washington, DC, 4 July 2001.

[2] Field Manual 3-11-4: Multiservice tactics, techniques, and procedures for nuclear, biological, and chemical (NBC) protection, June 2003.

[3] Field Manual 7-20: The infantry battalion, Headquarters Department of the Army Washington, December 2006.

[3] The last download date of the internet references was: April 20, 2012

[4] Vinod Kumar, Rajeev Goel, Raman Chawla, M Silambarasan, Rakesh Kumar Sharma: Chemical, biological, radiological, and nuclear decontamination: Recent trends and future perspectiv, http://www.jpbsonline.org/article.asp?issn=09757406;year=2010;volume=2;issue=3;spage=220;epage=238;aulast=Kumar

[5] Futuretech Kärcher: The Swedish Army Orders Four Additional Containerised DECOCONTAIN Full-Decontamination Systems, http://www.karcherfuturetech.com/futuretechfr_en/news/2007/the_swedish_army_orders.htm

[6] STANAG 2426 NBC (edition 2) - Nuclear, biological and chemical (NBC) hazard management policy for NATO forces.

[7] AJP-3.8 Allied joint doctrine for NBC, July 2003.

[8] Field Manual 3-5, Headquarters, Department of the Army: NBC Decontamination.

[9] Futuretech Kärcher: DECOCONTAIN 3000 GDS Containerised Full Decontamination System- Handbook.

[10] Product Details: GDS 2000 Decontamination Solution, https://www.rkb.us/contentdetail.cfm?content_id=177883

[11] Field Manual 3-11-5: Multiservice tactics, techniques, and procedures for nuclear, biological, and chemical (NBC) decontamination, April 2006.

[12] Guidelines for operational planning (GOP) final revision 1, June 2005.

[13] Abdul Wadood Khan, Sabna Kotta, Shahid Hussain Ansari, Rakesh Kumar Sharma, Vinod Kumar, Sudha Rana, and Javed Ali: Chemical, biological, radiological, and nuclear threats-Decontamination technologies and recent patents, http://jrse.aip.org/resource/1/jrsebh/v4/i1/p012704_s1?isAuthorized=no

[14] Comprehensive NATO Chemical, Biological, Radiological, Nuclear (CBRN) Defence Concept, Headquarters, Supreme Allied Commander Transformation, Norfolk, Virginia, December 2010.