

## EXPEDIENT METHODS OF SUSTAINING WEAPON SYSTEM AVAILABILITY

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### Abstract:

*The paper presents an expedient repair system in the context of sustaining weapon system availability under combat operations. Firstly, the crucial processes of battlefield maintenance were defined and principles and nature of expedient (temporary, improvised) repairs were described. Additionally, basic allied documents related to battlefield maintenance and expedient repair were mentioned. Furthermore, expedient repair systems in selected allied armies were briefly described in order to identify the basic elements of the expedient repair system, which are common for all allies. The identified elements were shortly characterized.*

### Keywords:

*combat service support, availability, weapon systems, expedient repair, battle damage repair*

## INTRODUCTION

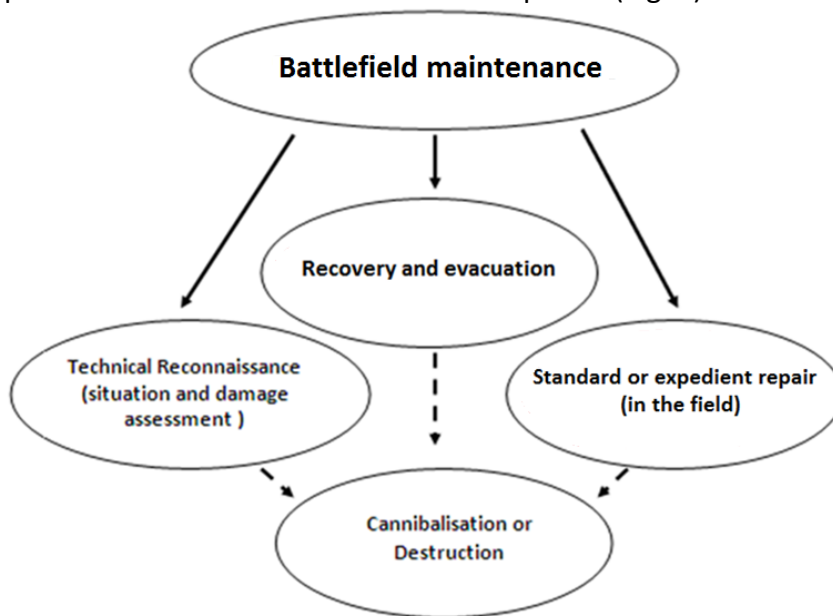
Due to the fact that Poland joined NATO, the intensity of Polish participation in overseas operations has increased. Nowadays, the alliance is in great need of forces which would be mobile according to up-to-date standards, have logistical autonomy in order to fulfil predictable requirements occurring in various fields of modern warfare, and also would be available to meet the needs of the whole scope of operations; especially, those requiring high intensity and conducted abroad. National forces have to be mobile, inter-operational, well-equipped, trained and commanded, as well as able to act in complex conditions, and, last but not least, they need to have logistical autonomy [6,15].



Polish troops conduct overseas operations fulfilling their tasks within the zones deprived of combat means, along with high exploitation of military equipment in harsh field and climate conditions [12]. Such a situation causes damages which do not take place in day-to-day peace-aimed usage at home. Along with intensive utilization effects and combat damages, also accident-related failures can grow sharply, usually as a result of terrain obstacles, limited visibility and great dynamics of operation. Therefore, countries, which for decades have been taking part in various military conflicts or peacekeeping operations, are looking for new methods of expedient sustaining of the availability of weapon systems directly in the combat area.

**1. EXPEDIENT REPAIR IN A BATTLEFIELD MAINTENANCE SYSTEM**

Combat operations are very dynamic processes varying in time and space. The combat and tactics situation in the battlespace changes instantly and randomly. However, all combat service support processes are determined and they require precise planning, organization and supervision. Taking into account this point of view, combat service support system slows down the dynamics and pace of combat. Therefore, maintenance actions will be often limited to recovering weapon systems, that is: quick assessment of situation, evacuation, quick expedient repair, cannibalization or destruction of equipment which cannot be evacuated or repaired (Fig. 1).



**Fig. 1.** Maintenance tasks of weapon systems under combat operation

*Source: Own work*

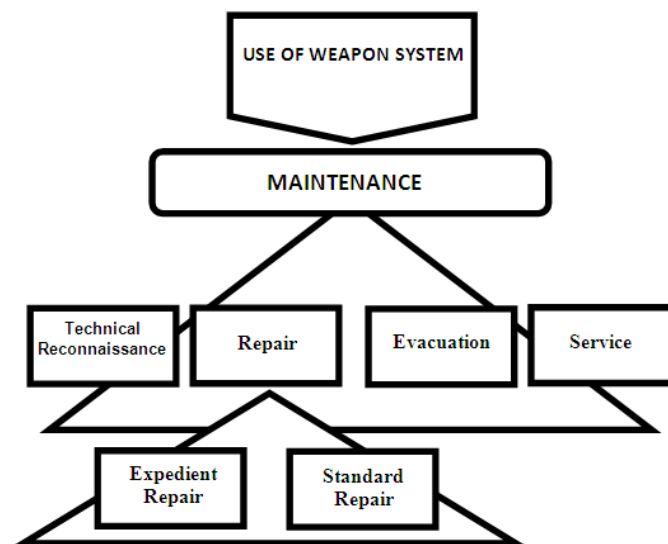
It should be emphasised that weapon systems belong to the group of technical objects used in a random mode [18], also as agricultural, city or rescue service equipment, they require a special maintenance system which is designated to perform tasks just on time and place. Maintenance assets will be heavily taxed on the battlefield. Because resources are limited (personnel, tools and parts), it is imperative that maintenance resources are not wasted. Crewmembers must make repairs within their capabilities



immediately rather than requesting maintenance personnel to perform simple mechanical tasks. On the battlefield, the objective is to return the system to battle with enough combat capability to get the mission accomplished. Cosmetic repairs are not necessary and are a waste of time and resources. If a broken item does not affect the ability to shoot, move or communicate, and does not pose a serious safety concern, it should not be repaired until the equipment is returned to maintenance where standard repair procedures can be performed [20].

The crucial processes of battlefield maintenance are evacuation and repair of weapon systems used to perform combat operations (Fig. 2). The efficiency of this process will determine success in the current battlespace which is connected with logistics forces and means supporting recovery tasks during operation [3,7,28]. The Yom-Kippur War conducted in 1973 was a perfect example of this thesis. The Israeli Armed Forces suffered a lot during the first 18 hours of combat, especially their tanks suffered a serious damage since 80% of them were affected. However, the Israelis had a very efficient evacuation and repair system and small dimensions of the battle area was an additional advantage. Most repairs were executed on a front line, because those 80% of tanks were recovered to operation within 24 hours. Some tanks were damaged and recovered many times. Finally, a very dangerous counterattack of the Egypt-Syria coalition was fought off thanks to 15 repaired tanks.

As the history and experiences of last wars have shown, modern and nonconventional means of fire cause increasing losses in weapon systems. As far as military equipment is concerned, most of its damaged part is recovered on the battlefield and reused. It is very often the basic source of supplying military units during combat operations [5,8].



**Fig. 2.** Expedient repair in the maintenance system of military equipment

*Source: Own work on the basis of [5]*

According to the allied standardization agreement [26], there are the following types of expedient repair: Type 1: An improvised (non-conventional) repair which can be considered as permanent. This repair does not require a subsequent replacement, but



must meet all relevant legal and safety requirements. Type 2. An improvised (non-conventional) repair which is considered only temporary by nature. This repair allows the equipment to complete the immediate mission or task, before being replaced by a standard repair. This repair should meet the agreed legal and safety requirements. Type 3. An improvised (non-conventional) repair which rapidly returns the equipment to use under combat operations. This repair is unlikely to be permanent or may not meet legal and safety requirements but is essential in order to maintain military capability in periods of conflict or war. This type of expedient repair is considered to be Battle Damage Repair.

Taking the above into consideration, an expedient repair can be defined as a repair which can be temporary, it restores equipment, both deployed and in-barracks, to a specified condition by non-conventional (improvised) methods bounded by legal constraints. On the other hand the Battle Damage Repair can be defined as essential repairs which can be improvised and/or temporary repairs carried out rapidly in a combat environment in order to return damaged or disabled equipment to further contribute to operations. As a result, it can be stated that the concept of expedient repair includes battle damage repair, improvised repair and non-conventional repair. Therefore, the name of expedient repair is used as the name for all kinds of the above mentioned activities (Fig. 3).

In the Logistics Doctrine of the NATO Land Forces it is also stated that expedient repairs, conducted in the fighting area, are the crucial tasks of the battlefield maintenance system. They should be improvised and executed as close as possible to broken equipment in order to quickly restore damaged weapon systems. An expedient repair is conducted if:

- there is not enough time or lack of spare parts to provide standard repairs;
- the operational situation makes it necessary to quickly restore damaged weapon systems;
- after an expedient repair and accomplishing the task, a restored object must be repaired using standard methods.



**Fig. 3.** Sample methods of expedient repairs: hulls with adhesive composites (left), lines with fast-joints (middle) and radiators with bent or damaged lines

*Source: Own work*

According to the NATO Standard [17], the evacuation and repair of a weapon system should be executed very close to fighting units and the latest technology should be



used, this allows to quickly recover damaged equipment and accomplish the task. Recovery means the extrication of an equipment casualty and, if necessary, its removal to a place where it can be repaired. Depending on a tactical situation, recovery operations may be limited to just moving equipment from the direct line of enemy fire. It is usually the first step in returning disabled or damaged equipment to the battle. It is also possible to repair a damaged object without recovery or to restore the working order of an object only partially with the use of improvised and temporary methods and technologies.

The last NATO document which refers directly to the battle damage repair of weapon systems is Stanag 2418, it introduces the idea of expedient repair. Repair is defined as a temporary activity executed with the use of nonconventional (improvised) methods in barracks or in field conditions. The expedient repair can be conducted only in accordance with the accepted procedures and instructions [28]. According to the quoted document, the expedient repair also includes a battle damage repair.

The analysis of battle damage repair systems in other NATO armies [5] [23] has proven that the system is an essential component of battlefield maintenance and it is constantly improved and developed due to its significance and complexity. The improvement of the system is provided by a lot of research, numerous analyses and tests of state-of-the-art technologies, lessons learned programs and trainings.

## 2. EXPEDIENT REPAIR SYSTEM

The article presents the systems in the U.S. and Norwegian Armies in order to briefly describe sample expedient repair systems in the allied armies. Expedient repairs in the U.S. Army are conducted at four levels: crew/operator level, Combat Repair Team (CRT), Maintenance Support Team (MST) and Unit Maintenance Collection Point (UMCP). Each next level is called for support only when the extent of damage is broader than the possibilities of executing the repair by a lower level [7]. Depending on the level of BDAR, different kinds of repair kits are available to support the crew and maintainers in performing expedient repairs [10] (Fig. 4).



**Fig. 4.** FRS on a HEMTT-type vehicle during transportation (left), working post after removal from the transporting vehicle (middle) and during repair works (right)

*Source: Own work on the basis of [27]*

BDAR kits allow repairs in numerous areas, such as fuel, hydraulics, cooling, tires, electrical systems, and hull repair. Each unit is expected and encouraged to modify its kits to suit their special operational needs and geographic environment. Crew members and drivers are expected to know the newest regulations and manuals of assessment





procedures and BDAR kits use. Commanders are obliged to perform the BDAR training to acquaint soldiers with the components of BDAR kits that enable many repairs. Each crew member should know how to perform battle damage assessment and repairs.

The U.S. experiences from the Allied Effort in Serbia and the Desert Storm in Iraq operations have proven that thanks to the implementation of the execution improvised repairs in the centralized intermediate repair facilities, approximately 30-40% percent of all removed parts were found to be serviceable and were returned to the original units [1,2].

The Norwegian Army operates a three-levels Battle Damage Repair system (Fig. 5). At the first level there is a BDR kit for operator/crew of military vehicles; at the second level the recovery vehicle is used, it is equipped with a BDR kit deployed in 3 aluminium boxes, and at the third level, a special mobile workshop with BDR stuff is used [14].



**Fig. 5.** The Norwegian Army three-level Battle Damage Repair system

*Source: Own work on the basis of [14]*

The above mentioned first level of BDR includes the following repair equipment: basic tools, regenerating taps, a repair kit for electrical and hydraulic installations, universal clamps, bands, pins and gaskets, epoxy adhesives and sealing agents for the installations. Every mechanic in the Norwegian Army, in addition to regular training, is trained during a 5-day-course in the BDR system and procedures of executing expedient repairs and using BDR components. The BDR kit of the second level is located on the wheeled recovery vehicle 6x6 Scania. It consists of three aluminium boxes with 11 drawers for BDR materials and tools separated according to the purpose: epoxy adhesives, hydraulic installation, pneumatic installation, locksmith treatment, etc. [24]. According to Norwegian officers, the selection of components for BDR kits is based on two years of experiments and analysis. The equipment, which is used to execute expedient repairs, is automatically supplemented without any additional record of consumption. Placing the BDR kit in the recovery vehicle is a very interesting idea, because it enables combining evacuation and repair tasks. The crew of such vehicles can take action in the field of recovery concerning the circumstances, accessible time and the extent of damage by conducting evacuation, repair or a combination of both tasks [14]. The analysis of Norwegian experience from the ISAF operation has shown that recovery teams are able to carry out about 20% of expedient repairs in the site of damage with using the expedient repair kits [13].

The third level of BDR involves equipment of a specially designed mobile workshop in the standardized container 1C (20 ft.). The container weight is up to 20 tons and it in-

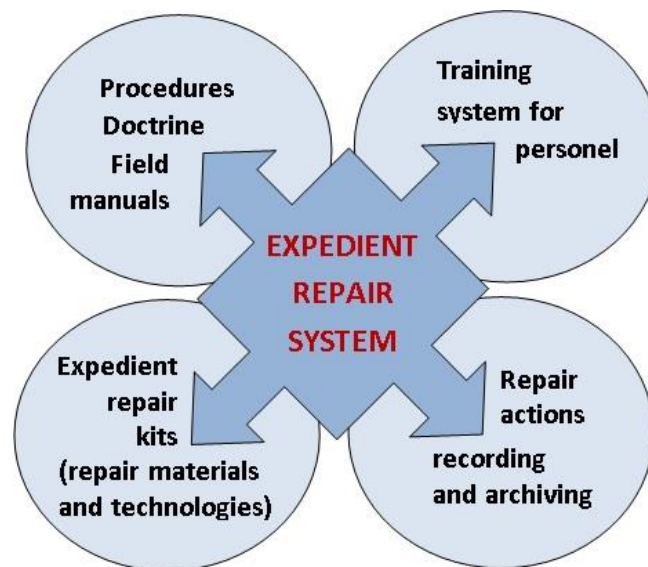


cludes all BDR components of the second level and, additionally, universal tools, such as a welder, soldering irons, a wheel repair kit, a power supply, an air compressor, a lifting device, a set of gas and plasma cutting, auxiliary equipment (e.g. vice) and air conditioning. The presented workshop is a prototype and its equipment and range of tasks are still being developed [14].

Regardless of the way and method of creating an expedient repair system, each such a system should include (Fig. 6):

- doctrines and procedures concerning rules and the extent of expedient repairs and manuals (instructions) for a single weapon system;
- training system for maintenance personnel;
- expedient repair kits including cutting edge technologies and tools;
- repair actions recording and archiving systems which allow to provide and support further recovery actions and use recorded data to conduct training and support maintenance personnel.

In addition to the general expedient repair doctrine at the level of land forces, which should be implemented primarily, specific instructions and procedures dedicated to particular weapon systems as well as instruction regarding the use of expedient repair kits on the various level of the system should be developed.



**Fig. 6.** Basic elements of the expedient repair system

*Source: Own work*

A training system should allow to train soldiers in the rules of expedient repairs and the proper use of expedient repair tools and materials which will be used at their level. As a result, a manual should be provided for all drivers and crews (1st level), recovery teams and mobile recovery – repair sections (2nd level) and specialists of expedient repair squads of maintenance units (3rd level).



There are many modern and efficient methods and technologies which can be successfully applied to expedient repairs of weapon systems in the field. They were already precisely described in many publications [4] [9] [16] [19] [21] [22] so there is no reason to do it again. It is obvious that the diversification of various solutions and the adequate design of equipment (reparability) will support maintenance units in recovering weapon systems and can help to create an advantage over an enemy.

Statistics are an invaluable tool for collecting, processing and using of all information referring to the maintenance of weapon systems, in particular special computer systems designed for supporting maintenance and supply management. The use of these systems in the future should allow to eliminate a large portion of faults and defects resulting from faulty design, production technology or used materials and any other engineering solutions. It will also be possible to take advantage of the experiences and reports of already executed repairs. The implementation of a computer system would support not only current maintenance planning and execution but also permanent weapon systems improvement, design of new weapon systems considering expedient repair needs, prediction of battle and maintenance faults, planning recovery and repair operations, as well as potential technical assessment, cost of repair calculation and stocks record for repairs.

## CONCLUSIONS

On the basis of the conducted analysis concerning expedient sustaining of the availability of weapon systems, the following conclusions can be formulated:

- Weapon systems belong to a group of technical objects used in a task (random) mode and they require a specific maintenance system, which should be aimed at executing tasks in a specific place and time regardless of circumstances. The properly developed battlefield maintenance system can create an advantage over an enemy by quickly recovering and restoring all damaged objects with the exception of heavy combat damages. This is why, new, diverse and flexible solutions should be searched for in order to support fighting units by providing them with capable weapon systems without the necessity of evacuation to stationary workshops.
- Maintenance activities under combat operations will often be limited to basic actions, that is: quick assessment of situation, recovery and evacuation to the unit collection point or an expedient (temporary) repair under combat operation, or cannibalization or destruction of equipment which cannot be evacuated or repaired.
- The allied armies, especially those numerous ones, such as the U.S. Army, have got advanced expedient repair systems, while smaller armies and those which have recently joined NATO, such as the Norwegian Army are in the process of creating their systems. Individual armies organize expedient repair systems in a somewhat different way (they have various numbers of repair levels, repair time disposal, different equipment and expedient repair





kits), which is caused by the size of Land Forces, specificity of tactics and weapon systems.

- An effective expedient maintenance system should provide expeditious means of combat damage assessment for deferment, repair or recovery. Regardless of the way and method of creating an expedient repair system, each such a system should include: doctrines, procedures and manuals (instructions); the training system for maintenance personnel; expedient repair kits, including cutting edge technologies and tools and repair actions recording and archiving systems.

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