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CONVERSION OF THE T-72 TANK. NEW LINK IN THE PRODUCT LIFECYCLE

Abstract. The paper presents a proposal to convert decommissioned weapons to be reused in different versions of engineering vehicles illustrated with the example of the T-72 tank. The solutions presented illustrate the possibilities of constructing new tracked vehicles of various use at relatively low cost.

The proposed methodology may be used as a commercial offer of the Polska Grupa Zbrojeniowa (Polish Armaments Group) (PGZ) in the form of know-how (upgrade packages) or deliveries of complete vehicles of various use, particularly to countries that have T-72 tanks in service.

Keywords: tank conversion, engineering equipment, quick action couplings, base chassis, functional characteristics of a converted product.

1. INTRODUCTION

Resources of military technology in service of the world's armies usually have a planned 30-year lifespan of armaments and military equipment (A&ME), inclusive of major overhauls (depending on the course of duty and wear of the components) and processes of modernization and/or modification. After the 30-years period of service many vehicles are still technically fit and offer a defined functional value that can be employed in the process of converting into another type of application.

Reconstruction of decommissioned A&ME that does not meet modern battlefield requirements because of obsolete weapons, or lack of fire control systems, or poor armour, etc., is the simplest and most economical way to create a new quality of vehicles. At present the vehicles that are withdrawn from service in the Polish Armed Forces (PAF), stripped of combat features (dismantlement of weapons, communications equipment, etc.) are designated for sale to fans of armoured equipment or are scrapped, without any prior segregation of materials (steel, plastics, rubber, metals, non-metals, cables, etc.). Lack of a systematic approach to materials segregation in the process of A&ME scrapping entails financial losses in the disposal process.

2. EXAMPLES OF TANK CONVERSION

Conversion of armament and military equipment is an idea that has been known for a long time. Canadians were pioneers in this area. In Normandy they used redesigned RAM medium tanks (a Canadian modification of the American M3 Lee tank) as ammunition carriers, mobile observation posts and, primarily, as KANGAROO armoured personnel carriers taking up to 11 combat-equipped soldiers. Several hundred of these were manufactured. The design was also used by the British, and after World War II by the Dutch. The chassis of the PRIEST self-propelled howitzer was also adapted to serve similar purpose [1] (Fig. 1).



Fig. 1. M4A1-based medical evacuation vehicle

The idea of creating a heavy armoured carrier based on a tank came up after the Yom Kippur War of 1973, when the surprised Israeli Defence Forces suffered severe losses. The total surprise and nearly three thousand dead was a strong shock for the Israeli nation and severely undermined its confidence in the security services. The Israelis had in service M113 armoured carriers, which earned the nickname of "mobile crematoriums". This term can be considered accurate, because the crew of such vehicle struck with a shaped charge missile often burned alive. As reactive armour could not be used, the problem was addressed using more provisional methods. Before the "Peace for Galilee" operation, the M113 carriers were modernized.

Another vehicle based on captured tanks was the Israeli armoured personnel carrier "Achzarit" (translates into English: "cruel"). This is the best known armoured carrier built in Israel. The core of the vehicle was the Soviet-built T-54/55 tank, many of which (ca. 500) were "acquired" during the Six-Day War in 1967 and conflicts in 1973 and 1982. Many of these tanks were rearmed with 105 mm guns. However, since the 1980s these vehicles did not meet the requirements of modern battlefield and were retired. Conceptual work on the "Achzarit" armoured personnel carrier was launched in the early 1980s, and the first prototype left the repair facility in 1987. Mass production based on the T-54/55 tank chassis (with replaced power train) started in 1988, and the first military unit to be provided with these carriers was the elite infantry brigade "GOLANI" [1] (Fig. 2).



Fig. 2. ACHZARIT APC based on T-55 chassis

The Russian Tank Support Fighting Vehicle BMPT (Russian: Боевая машина поддержки танков) (unofficial name "Terminator") is based on the T-72 MBT [2] (Fig. 3). It was designed to cooperate with infantry and special/armoured troops, mainly for combat in urban and hilly areas, based on combat experience gained in Chechnya. BMPT armament consists of two coupled 30 mm 2A42 cannons, two automatic 30 mm AGS-17 grenade launchers, PK/PKS machine gun and four 130 mm 9M120-1 Ataka-T ATGM launchers. The vehicle is also provided with reactive armour. The crew comprises 5 members of combat stations, including two landing force members. The first vehicles went into service in the Russian army in 2005.



Fig. 3. BMPT – Russian heavy fighting support vehicle based on T-72 MBT chassis

In Poland too, in the early 1990s, vehicles offering completely new functions and designed for new purposes were created on basis of vehicles decommissioned in the PAF. One example of such a vehicle, developed at OBRUM and based on the T-55 tank chassis, is a tractor used in coal mining for levelling mining waste heaps (Fig. 4).



Fig. 4. ATS tractor based on T-55 tank chassis

The problem of using the T-72 chassis in new vehicle designs, including those fitted with an articulated or telescope jib, was the subject of development projects undertaken by OBRUM's research and engineering staff [3].

Further on in this paper we present the possibilities of using subassemblies of decommissioned T-72 tanks, especially the chassis, to build recovery and engineering vehicles with the intention to sell them as support and maintenance vehicles for armoured and motorized units to countries that have T-72 (T-90, T-90S, M-84) tanks in service.

Another possible area of using recovery and engineering vehicles are sites destroyed by conventional arms, zones of natural and environmental disasters, including radiation contaminated land. The solution is then dedicated to services, including national crisis response services.

T-72 tanks are in service in many countries. The USSR granted licence for the manufacture of the T-72 to several countries, among them Poland, Czechoslovakia, Yugoslavia and India. As a consequence of this about a total of 20 thousand such vehicles have been built since the mid-1990s, many of them still in service in the armies of various nations; for instance: the Russian Army had 1,200 vehicles in active service and 8,000 retired vehicles, Bulgaria – 430, Czech Republic – 543, Slovakia – 272, Ukraine – 2,200, Belarus – 1,200, India – 1,700, Syria – 1,500, Kazakhstan – 600, Turkmenistan – 500. Apart from the countries listed above the following nations have this type of tank in its service: Algeria, Libya and Egypt.

The described tasks will enable the reuse of selected, approved subassemblies and assemblies of the T-72 chassis in subsequent years. Many of the design solutions applied in the T-72 tank, despite the passage of time, remain attractive, and are characterized by high durability and logistical availability. The number of T-72/PT-91 tanks to be decommissioned in Poland is about 540, and the reconstruction thereof into vehicles serving other purposes seems to be the most efficient way of utilizing them. The handling of large numbers of run-down T-72 tanks is a problem encountered not only by the Polish Army. Dumped vehicles will also affect the environment. In addition to steel plates, combat vehicles also contain many electric and electronic systems, as well as plastics, chemical components, etc. Leaking hazardous materials, such as lubricants and hydraulic fluids, are harmful for the environment. They pose a hazard for the soil, water and the atmosphere.

3. POSSIBILITIES OF PROVIDING EQUIPMENT AND CARRYING OUT THE CONVERSION

Initial conceptual work carried out at OBRUM confirms the feasibility of a quick conversion of the T-72 tank into engineering vehicles of the following versions: basic, engineering tank (two variants), recovery vehicle with extended basic equipment with a view for further development.

3.1. Basic version

This design corresponds to recovery vehicles WZT-3 in a configuration based on the T-72 body.

The attachments in this vehicle version include:

- a crane with an articulated jib located on the right-hand sponson of the hull with a minimum lifting capacity of 20 kN, proportional control using a CAN network;
- earth moving attachments mounted onto hitch couplers (maintenance-free couplers and mechanical/hydraulic/electric sockets) located on the front plate, enabling discarding damaged implements by the driver without the need to open hatches, even under the conditions of growing threat (e.g. in an area of increasing contamination from NBC weapons or damaged nuclear reactor systems);
- hydraulically driven main and auxiliary winches provided with proportional control system, also operable from outside the vehicle;

- other systems for rescue, recovery and maintenance operations.

The weight of the vehicle formed by conversion, and corresponding to WZT-3 in terms of equipment, is increased by about 700 kg in relation to the standard version of the WZT-3.

3.2. Typical engineering tank version [5][6]

The design of this tank corresponds to that of MID Engineering Tank of which 13 were manufactured by OBRUM, and 3 of which are in service in the AF of the Monarchy of Malaysia.

3.3. Modified version of typical engineering tank

This design corresponds to the Recovery Vehicle shown in Fig. 5 with the following main features:

- articulated jib for operating an excavator scoop, grabber jaw, ripper tooth [4],
- vision systems installed on a jib (with thermovision recording capability) with image transmitted to decision-making stations.

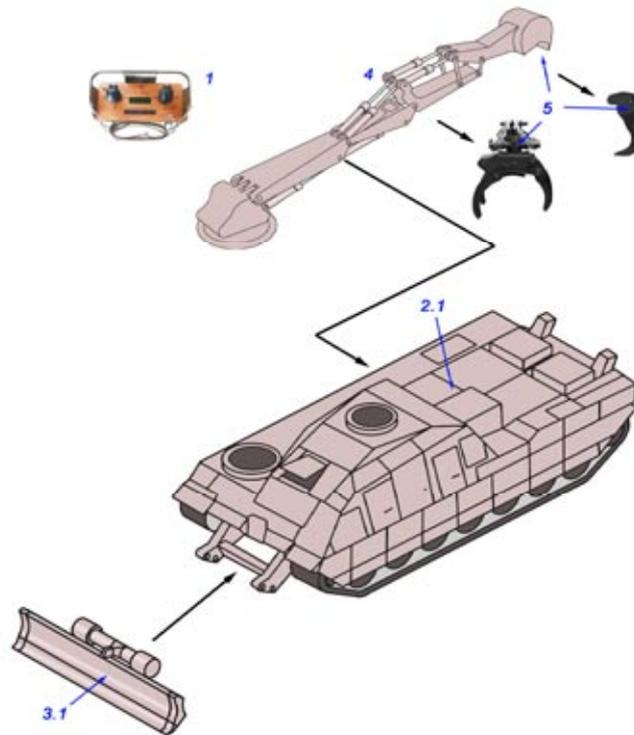


Fig. 5. Concept of a recovery vehicle based on T-72 tank

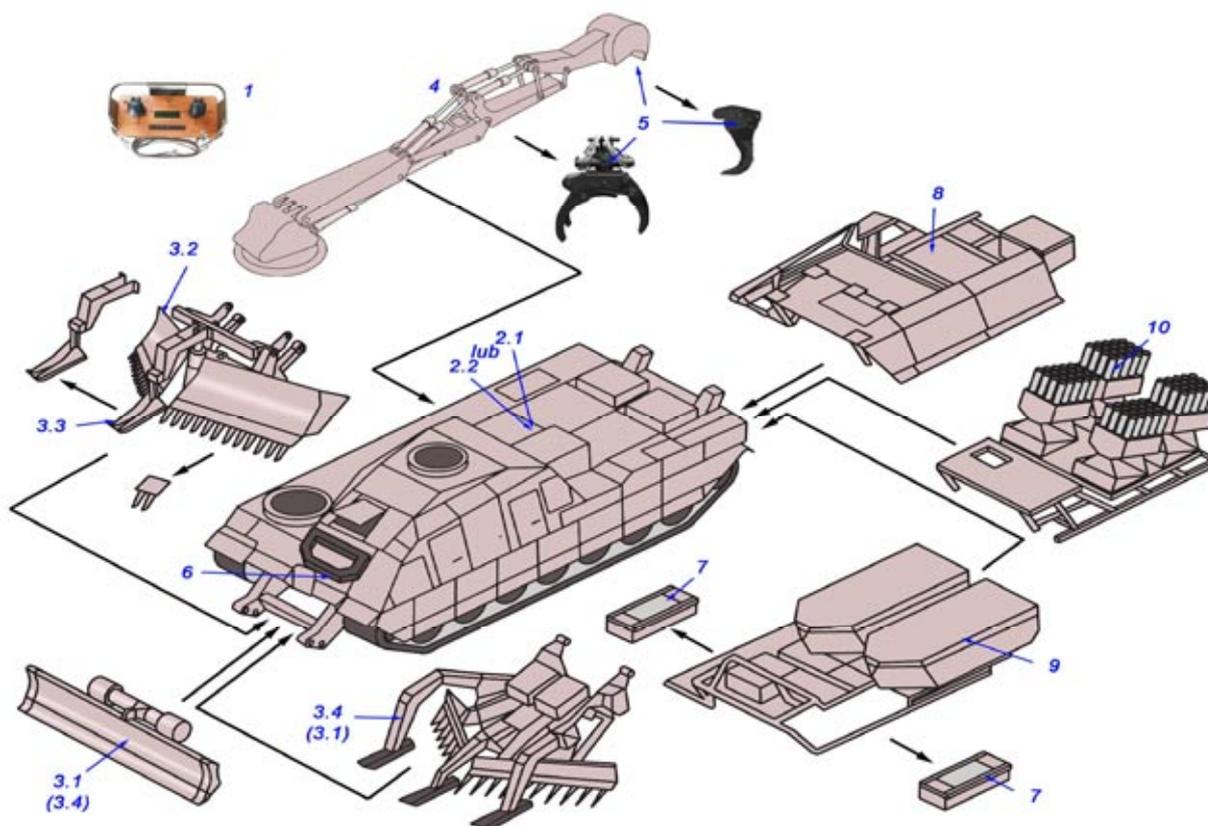
1. Electric control of hydraulic system; 2.1. Hydraulic system;
3.1. Front casting dozer, 4. Jib assembly, 5. Jib attachments:
excavator scoop, grabber jaw.

3.4. Extended version

This version corresponds to recovery vehicles WZT-4 manufactured by Bumar-Łabędy S.A. for AF of the Monarchy of Malaysia. Estimated weight increase in relation to standard WZT-4 vehicle is about 700 kg.

3.5. New proposal developed by OBRUM

The proposed new configurable version that combines the recovery and engineering support features (Fig. 6) is a proprietary design developed by OBRUM [4][7].



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Fig. 6. Fully equipped Recovery and Engineering Vehicle

1. Electric control of hydraulic system; 2.1. Hydraulic system modification unit - option I; 2.2. Hydraulic system modification unit - options II - V; 3.1. Front casting dozer with extended cutting width; 3.2. Front casting and V arrangement dozer; 3.3. Front casting and V arrangement dozer with mineclearing teeth; 3.4. Full Width Mine Plough (FWMP); 4. Jib assembly; 5. Jib attachments: excavator scoop, grabber jaw, ripper tooth. 6. Electromagnetic minesweeper; 7. Cleared path marking device; 8. Exchangeable engineering equipment module; 9. Exchangeable module with mine-clearing line charges; 10. Exchangeable module with mine throwers

4. PERFORMANCE SPECIFICATIONS OF WZT JIB MANIPULATOR in CONCEPT 3.5

The operating ranges of attachments installed on the jib (excavator scoop, grabber jaw, ripper tooth, drill rig, etc.) determined in preliminary geometrical analyses are shown in Figs. 7-9.

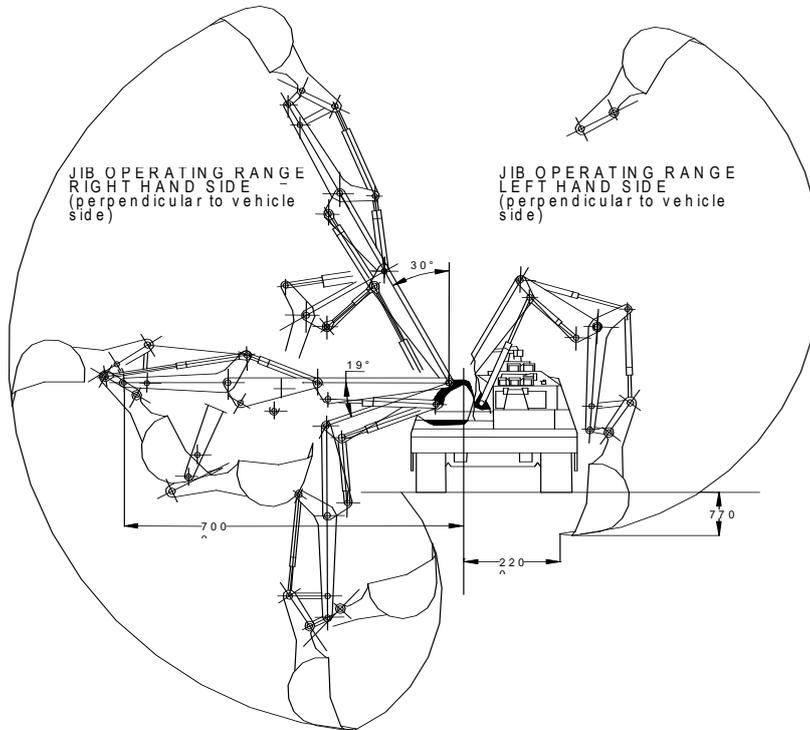


Fig. 7. Operating range of jib manipulator
Excavating depth and lifting height – perpendicular to vehicle body side

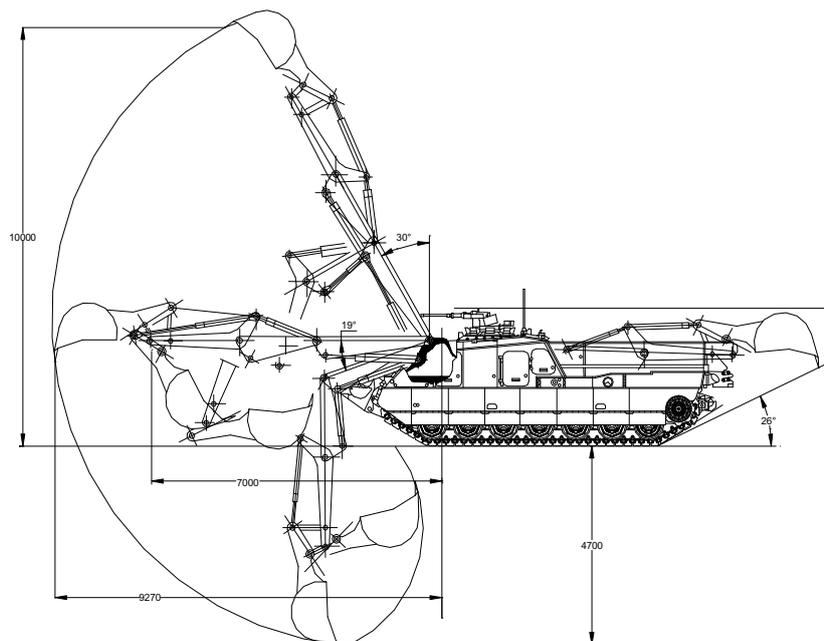


Fig. 8. Operating range of jib manipulator
Excavating depth and lifting height – in front of vehicle

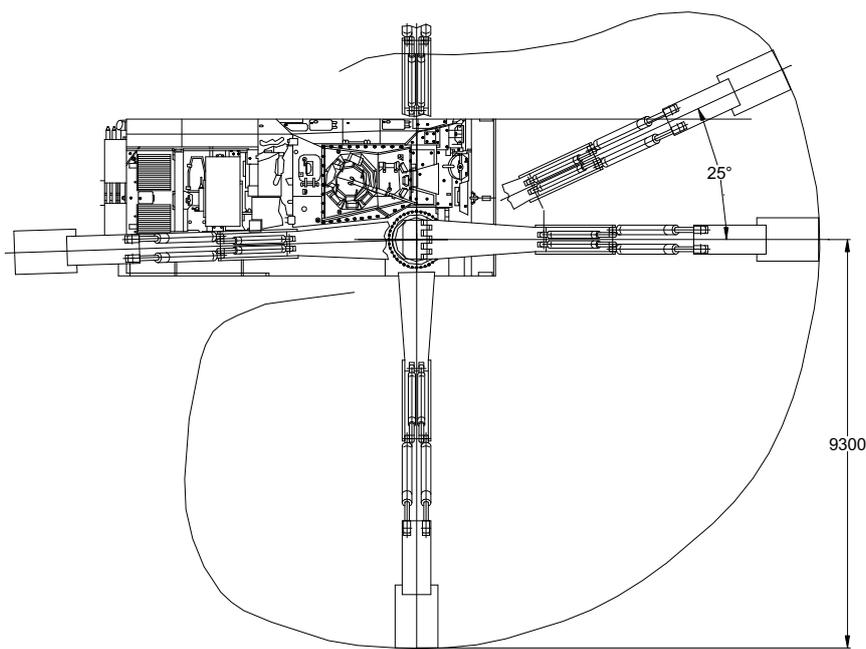


Fig. 9. Operating range of jib manipulator in horizontal plane

The assumed performance specifications attained after conversion, such as:

- load lifting height (excavated material in excavator scoop or load in grabber jaw),
- maximum scoop discharge elevation,
- excavating depth (jib lowering),
- jib side rotation range,

are comparable to those of traditional excavators of non-military use [3].

5. APPLICATIONS OF THE RECOVERY AND ENGINEERING VEHICLE (R&EV)

Possible applications of R&EV are closely related to the assumed application and depend on the details of the contract, setup or purpose. R&EV may be used for:

- field repairs of tanks, mainly of the T-72 class and derived vehicles, within the scope covered by the maintenance and repair kit (called ZOR in WZT-3/4 vehicles);
- recovery of immobilized tanks and vehicles by means of winches and towing bar, including fire extinguishing and first medical aid;
- flame (electric) cutting and welding;
- high capacity crane operations, e.g. for removal of turret, gun, suspension components, main engine, etc. under field conditions;
- clearing paths in minefields using equipment installed in front (innovation in quickly replaceable attachments and the ability to automatically "dump" the attachment in the event of damage, or the need to escape) - interchangeable excavation and rotor sweeping gear, and a set of line charge launchers, with automatic cleared path markers, with indication on maps via the BMS system;

- crossing enabling tasks, including exit and entrance driveways, using exchangeable front-mounted attachments on quick action couplings;
- earthwork fortification works - construction/destruction tasks using excavator scoop mounted on the jib (excavation depth same as in MID - ca. 5 m).
- allocation of hazardous materials in grabber jaw mounted on the jib.
- removing the effects of conventional weapons in technical rescue and zones of natural and environmental disasters.

6. CURRENT STATE OF CONCEPT DEVELOPMENT AND TECHNICAL DOCUMENTATION DRAWN UP AT OBRUM

The existing documentation on WZT-3/4 designs requires updating [8,9]. OBRUM's concept designs that require reviewing include:

- concept of a jib of articulated supporting structure,
- concept of a rotor mine trawl,
- concept of a semi-trailer with a charge line launcher unit and control panel and cleared path marker.

Complete documentation of the technical solution of the recovery and engineering vehicle includes:

- mechanical/hydraulic/electrical quick action couplings for interchangeable front-mounting attachments,
- a set of exchangeable front-mounted attachments (dozer, minesweepers, etc. with quick action coupling components),
- manufacturing and design documentation of simplified instruments for making changes in tank body,
- welding nodes, including the process of welding frame for supporting winch and shape adjusting inserts for superstructure of crew compartment,
- jib of articulated supporting structure,
- other, pertaining to, for instance, alterations in wiring system, internal communications, etc.

7. INNOVATIVENESS OF SOLUTIONS CONTAINED IN THE PROPOSED CONVERSION OF TANK INTO A RECOVERY AND ENGINEERING VEHICLE

The conversion of the T-72 tank to a recovery and engineering vehicle structural form presented in this paper includes an innovative method of utilizing decommissioned equipment by providing it with new technical and operating features and systemic approaches to the problems of crew and vehicle survivability in future operations area, as well as design and process solutions. The following items should be mentioned here:

- solutions aimed to improve crew survivability;
- diversity of systems supplied from one source and control using CAN network;
- new special steel cutting and welding processes;
- new design of attachments for special purpose machines;
- methodology of design work aimed at attaining optimum functional features in the process of converting decommissioned equipment.

Major units of the T-72 tank and necessary operations required to convert the tank into a recovery and engineering vehicle are listed in Table 1.

Table 1. List of major units of the T-72 tank and necessary operations required to convert the tank into a structural form of the recovery and engineering vehicle

Item	Unit	Scope of works
1	Tank body T-72	<ul style="list-style-type: none"> – body dismantling (hatches, covers); – cutting out front plate with direction wheel brackets, and under-turret plate; – design and fabrication of fillings for welding of crew compartment, along with direction wheel brackets of modified shape; – welding in of frame for winch; – welding in of inner and outer brackets; – reconstruction of rear beam.
2	Wheels, tracks, suspension	Only hydraulic shock absorbers need to be redesigned to enable suspension locking.
3	Fuel system	Requires redesign based on WZT-4/MID-M.
4	Power transmission and engine	Only the intermediate transmission gear should be modified using all of its parts. Transmission casing changed.
5	Hydraulic system and electric control of hydraulic system	Fabrication based on verified MID/WZT-4 documentation supplemented with quick action couplings powering.
5	Cooling system	Comprehensive solutions according to the WZT-4 documentation.
6	Mechanical/hydraulic/el ectrical quick action couplings	New design to improve safety of vehicle and crew.
7	Jib	New design solutions.
8	Front-mounted attachments	New design – according to concepts developed at OBRUM.
9	Flame cutting and welding equipment	New design using the current set of equipment.
10	Maintenance and repair kit and equipment	Setup of the kit agreed with the user.
11	Onboard communications	FONET type system.
12	Covers and hatches in body	Utilization of all covers and hatches of T-72 and fabrication of new ones according to existing documentation.
13	Towing bar	According to WZT-3 documentation.
14	Main winch	According to WZT-4 documentation.
15	Cable feeder with packing	According to WZT-3 documentation.

Item	Unit	Scope of works
16	Auxiliary winch	According to WZT-3 documentation.
17	Navigation	Upon agreement with the user, the current TNA-3 system may remain or the solution applied in WZT-4/PT-91M can be adopted.
18	Kit for negotiating deep water obstacles - <i>optional</i> .	According to WZT-3 documentation.
19	Other equipment adapted to final user needs.	No problem in setting up.

The concept of converting the T - 72 tank is a new project, not undertaken yet by any other research and development unit in the country. Project implementation by OBRUM is feasible upon acquiring T-72 by way of purchase or lease after concluding appropriate agreements with the vehicle provider.

Until now the main activities of research staff at OBRUM were focused on developing new products in a complete R&D cycle, with the new product adapted to customer requirements. This approach was extended by the provisions included in the decision of the National Defence Minister of 22 March 2013 on acquiring armaments and military equipment (A&ME) for the Polish Armed Forces, these provisions indicating the need to take into consideration the utilization or conversion of decommissioned equipment in the "Product Lifecycle".

The conversion formulated here is some kind of proposal for extending the scope of T-72 modernization tasks performed earlier at OBRUM by indicating the possibilities of utilization. This is an alternative for the product disposal process and seems to be an efficient way of utilizing decommissioned armoured vehicles.

The conversion process, as proposed by OBRUM, will follow the schedule:

- acquiring one T-72 tank from MOD resources and concluding appropriate agreements to accomplish the task,
- drawing up documentation to accomplish the task: successively up to five months from the date of decision on fabricating a prototype - OBRUM, supported by Bumar Łabędy S.A.,
- approval of crane/jib documentation by the Military Technical Inspection Authority (WDT),
- construction of a prototype and acceptance testing, including tests by WDT: up to 12 months from the date of acquiring the vehicle to be converted,
- manufacture of subsequent products: six to eight months from order receipt (final manufacturer: Bumar-Łabędy S.A.).

The proposed method of converting decommissioned A&ME (T-72 tank base) into engineering, recovery, transportation, etc. vehicles, may constitute a commercial offer of the Polska Grupa Zbrojeniowa (Polish Armaments Group) (PGZ) in the form of know-how (upgrade packages) or deliveries of complete vehicles of various use, particularly to countries that have T-72 tanks in service. Moreover, this action will contribute to the strengthening of the market position of both the developer and the manufacturer.

Under current legislation, i.e. act of 7 October 1999 on supporting the restructuring of the industrial defence potential and technical modernization of the Polish Armed Forces (Dz. U. No. 83, item 932, as amended), OBRUM functions as an enterprise of the State industrial defence potential sector and at the same time it is a research facility the economic activity of which is fully devoted to State security and defence, and also an enterprise of special economic and defence importance, which is confirmed by the following legislation:

- Ordinance of the Council of Ministers of 4 October 2010 on the register of state companies and units conducting scientific research for the purposes of national security and defence, and companies involved in foreign trade in goods, technology and services of strategic importance for national security and keeping international peace and security (Dz. U. No. 198, item 1313),
- Ordinance of the Council of Ministers of 4 October 2010 on the list of entrepreneurs of key economic and defence importance (Dz. U. No. 198, item 1314).

In addition OBRUM has been granted:

- Licence No. B-016/2003 by the Minister of Internal Affairs and Administration to perform economic activities of manufacture and trading in arms, ammunition and products and technology for military and police purposes,
- NATO Commercial and Government Entity Code NCAGE 0225H,
- Certificate of Appreciation for an entity seeking to cooperate with NAMSA.

OBRUM has implemented a certified Quality Management System that meets the requirements of:

- PN-EN ISO 9001:2009 standard,
- AQAP 2110:2009,
- Internal Control System.

According to the classification of the Ministry of Science and Higher Education, OBRUM has the status of a research and development centre and is a category A research unit in exact and engineering sciences.

8. CONCLUSIONS

The historical analyzes of the development of the conversion process of engineering equipment products and OBRUM's current achievements in this area of science and research allows us to formulate the following conclusions:

- Conversion of armoured equipment into products for other purposes may constitute a new stage in the product lifecycle that precedes the disposal phase.
- Change of the functions of decommissioned equipment brings about economic benefits and is a process effected by leading states of the world, mainly those of high economic status, which is confirmed by examples presented in the paper.
- The proposed conversion of T-72 tanks to be decommissioned by the Polish Armed Forces, based on technical analyses, is an example of the possibilities of extending product life. This may also be applicable to other A&ME, e.g. WZT-2, BWP-1, etc.
- Conversion of A&ME will, on the one hand, enable the Polish Army to acquire equipment that is competitive in financial terms and at the same time adapted to the conditions of the modern battlefield. On the other hand this approach will enable liquidation of obsolete equipment stored by the Military Property Agency (AMW).

- The presented conversion of the T-72 tank to a recovery and engineering vehicle structural form under development at OBRUM constitutes a plausible project that can significantly expand the scope of future R&D activities of the research facilities of the Polish defence industry.

9. REFERENCES

- [1] <http://www.militarium.net/viewart.php?aid=313>.18.03.2014.
- [2] [polish.ruvr.ru/.../W Rosji-zostanie-zaprezentowany-wóz-bojowy](http://polish.ruvr.ru/.../W-Rosji-zostanie-zaprezentowany-woz-bojowy) – 27.03.2014.
- [3] Zajler W., Grabania M.: Osprzęt inżynieryjny na podwoziu T-72. Szybkobieżne Pojazdy Gąsienicowe (22) no. 1, 2007, pp. 55-60. OBRUM sp. z o.o., Gliwice. ISSN 0860-8369.
- [4] Holota M., Zajler W., Żuk T.: Określenie możliwości zwiększenia zbioru zadań wykonywanych przez wojska inżynieryjne przy użyciu MID. Szybkobieżne Pojazdy Gąsienicowe no. 13, 2000, pp.19-34. OBRUM sp. z o.o., Gliwice. ISSN 0860-8369.
- [5] Knapczyk H., Zajler W., Holota M.: Maszyna inżynieryjno-drogowa MID. Szybkobieżne Pojazdy Gąsienicowe no. 4, 1993, pp. 39-46. OBRUM sp. z o.o., Gliwice.
- [6] Szafraniec A., Holota M.: Osiągnięcia OBRUM sp. z o.o. jako jednostki badawczo-rozwojowej w zakresie sprzętu inżynieryjnego. SPG (24) 2009. pp. 17-28. OBRUM sp. z o.o., Gliwice. ISSN 0860-8369.
- [7] Holota M., Tybińkowski D.: Współczesne zapory minowe oraz koncepcja i struktura konstrukcyjno-funkcjonalna bezzałogowego pojazdu torującego. Szybkobieżne Pojazdy Gąsienicowe (21) no. 1, 2005, pp. 75- 86. OBRUM sp. z o.o., Gliwice. ISSN 0860-8369.
- [8] Design documentation of WZT -4, MID- M : OBRUM sp. z o.o. files, unpublished
- [9] Supplementary documentation of WZT-4, MID-M (technical description, instruction manual; OBRUM files - unpublished.