

**Jan FURCH\***  
**Tomasz SMAL\*\***

## **DESIGN OF CONTAINER WORKPLACE FOR PERFORMING MAINTENANCE OF LAND COMBAT VEHICLES IN FIELD CONDITIONS**

*The paper introduces a container workplace design for performing maintenance<sup>1</sup> of the Czech Republic's land combat vehicles in field conditions. The presented workshop consists of two ISO 1C size range containers with special equipment. The first container is called a 'working unit' and the other one is a 'special purpose unit'. During combat activities the containers would be arranged in an L shape with rolled out roof.*

**Key words:** *maintenance of armament and military equipment, mobile repair workshops, logistic support*

### **INTRODUCTION**

NATO countries require that the maintenance of land military vehicles is performed both in peacetime and in field conditions (during missions, etc.) where full preventive and corrective maintenance is provided [1]. According to the allied doctrine, maintenance and especially repairs of military equipment should be conducted as close to the broken object as possible, so these functions can be effectively and efficiently performed by logistic units and armed forces troops equipped with mobile workshops [2].

The following trends might be considered when discussing the development of mobile container workshops [3]:

- lowering the types and the number of mobile workshops;

---

\* dr hab. Jan FURCH - Department of Combat and Special Vehicles, University of Defence, Kounicova

\*\* ppłk dr inż. Tomasz SMAL – Instytut Dowodzenia Wyższej Szkoły Oficerskiej Wojsk Lądowych

<sup>1</sup> According to AAP-6 maintenance is defined as all action taken to retain equipment in or to restore it to a specified condition until the end of its use, including inspection, testing, servicing, modification(s) classification as to serviceability, repair, recovery, rebuilding and reclamation and cannibalization.

- providing basic technical parameters for land, air and rail transport, and shipment;
- using the functional bodies of a container type for higher organizational logistic levels;
- providing the maintenance of land combat vehicles used in missions.

## 1. ANALYSIS OF NATO MOBILE WORKSHOPS

The mobile workshops of crucial NATO forces use as a special purpose body either a panel body wired in a workshop chassis, or – mainly with present modern mobile workshops – the functional body of a container type.

Although widely used in the army, the ISO size and mass range is not the only one. The manufacturing of the military applications of box shelters and containers (standard and non-standard) is fully subject to specific submitter requirements. Therefore in NATO armed forces there are 44 lengths used in total, ranging from 1,173 to 12,0 m, 22 widths ranging from 0,88 to 2,5 m, and 34 heights ranging from 0,73 to 3,02 m. The mass of these box shelters and containers has 44 values in total and ranges from 750 to 8 500 kg [3].

Apart from that, contemporary armies rapidly increase the use of the containers with a flexible construction height. The flexible construction height of a container means that it is usually possible to change the height of sidewalls and front walls, and roll out a top wall. When raising the container, we mostly use hydraulic (pneumatic) cylinders with piston rods placed in the joints of the container sidewalls and front walls. Working liquid (compressed air or liquid) is provided by the systems of a vehicle – carrier or the container's source. When it comes to the redundant way of rolling out the top wall, again, a mechanical way is used. The arrestment of top wall final positions is provided in a similar manner. The aim of the non-standard container design introduced above is to get the changeable height of a container profile. In order to secure the container from a lengthwise and crosswise shift, standardized anchor gears might be used. Mounting the container on a vehicle carrier and its dismounting might be provided either by a hanging gear and a mobile (or other) crane of a relevant mass, or with installed auxiliary devices (functional jacks) designed for independent field operations (Fig. 1).

One of the unquestionable advantages of using the containers with a flexible construction height is the possibility of lowering the top wall of a profile during transport and when fighting in front lines or nearby. Such container is not only much more difficult to detect, but it also becomes a less vulnerable target for an enemy. The container with a flexible construction height might be used mainly for command, control, staff and communication, workshop, medical and other functional units. It is also possible to use this container for transporting different material. The container can be adapted so that it could provide transported people and equipment adequate ballistic protection. Moreover, people will be able to pass through (e.g. using a front and a back door) and daylight will be let in when using windows and shutters for example. Also other modifications (like overhead manholes, holes with lids, artificial lighting, intercom for connecting with the vehicle – carrier crew, etc.) are expected when providing the functional equipment of the container [4] (Tab. 1).



Fig. 1. Forward Repair System workplace of US Army

Source: [online] [dostęp: 29.06.2009]. Dostępny w Internecie:  
<http://www.armyproperty.com/Equipment-Info/M7-FRS.htm>

Table 1. Workshop containers used for the mobile workshops of NATO armies

Name and symbol of mobile workshop	Country of origin	Country of using
MODULMED	B	B, I, P
Baeten P 7601	B	B
SOFRAME UMC	F	F, +
Dornier TransHospital mobile medical systems	D	D
MAN/Dol	D	D, +
Zeppelin Mobile Systeme	D	D
Euro-Shelter NG2	F	F, +
Boneschi	I	I
Marshall SPV CB 300	GB	GB
Marshall Power Pack Repair Facility (PPRF)	GB	GB
Penman	GB	GB
CSC	GB	GB
MSI-Defence Systems	GB	GB,+
AAR Cadillac Expandable Shop Container (EMSC)	USA	USA, +
AAR Cadillac S-280	USA	USA, +
AAR Cadillac S-350	USA	USA,+
Gichner 20 ft ISO shelter/container	USA	USA,+
Gichner Nomad 2	USA	USA,+
Gichner shelter, electrical equipment S-250	USA	USA,+
Gichner shelter, electrical equipment S-280	USA	USA,+
Craig S-250	USA	USA,+
Craig S-280	USA	USA,+
Craig S-350	USA	USA,+
Marion Composites Army Standard Family (ASF) shelters	USA	USA,+

Notes:

- in order to designate nationality, the symbols of international automobile transport were used,
- + there are other users in NATO countries who are not specified more.

Source: S.C. Connors, Ch. F. Foss, *Jane's Military Vehicles and Logistics, Twenty-fourth Edition 2003-2004, ISBN 0710624409*

The Army of the Czech Republic is equipped with a few special container workshops. They are the container workshops designed for the maintenance of wheeled combat vehicles, tracked combat vehicles, an armament container workshop and an electro-technical container workshop. These are separated containers the interior of which is impossible to convert into something else.

## 2. GENERAL DESCRIPTION OF A WORKPLACE

### 2.1. Determination of a container workplace

A wheeled container workshop (a functional module) along with a special tool store is designed for the repair level 2 and 3, namely:

- the chassis of the car model range TATRA and Land Rover;
- the chassis of the automobiles P-V3S and UAZ-469;
- the chassis of the wheeled armoured vehicles PANDUR II.

A tracked container workshop (a functional module) along with a special tool store is designed for the repair level 2 and 3, namely the tracked combat vehicles BVP and T-72 M4CZ.

Crew structure and the technical skills of the crew members are selected according to the types of supported combat vehicles and can change. For this workplace we recommend a 6-member crew consisting of a crew leader – an auto mechanic – a welder, a senior auto mechanic, an auto mechanic – a welder, a senior mechanic, a senior auto electrician, and a senior electrician.

### 2.2. Standardized workplace solution

The container workshop is made from two pieces of ISO 1C size special containers arranged in an L shape [5].

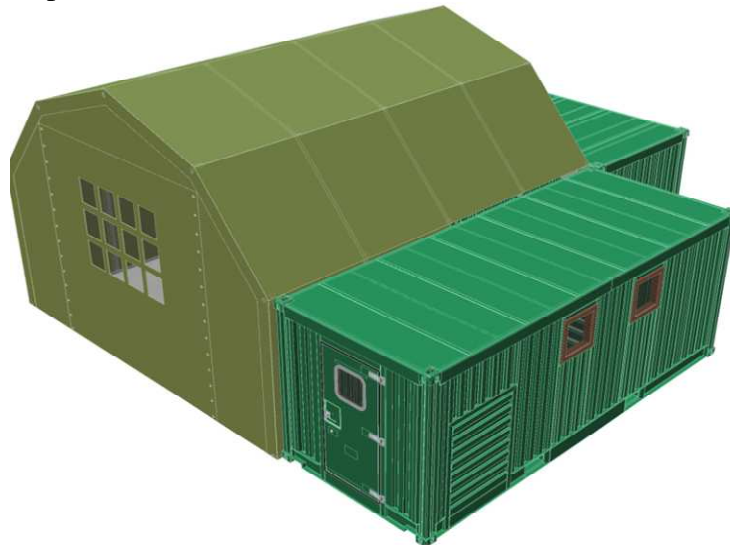


Fig. 2. A container workshop project arranged in an L shape

Source: J. Furch, O. Těšík, J. Glos, J. Marek, : *Kontejnerová dílna...*

The workplace consists of a container workshop, i.e. a workplace module which is universal for the maintenance of tracked and wheeled combat vehicles. The work-

place module is placed in one ISO 1C container and is heat insulated with sandwich panels. In the other ISO 1C container there is a special tools' store which is actually a functional module equipped according to the kind of supported combat vehicles. The functional module then might be used for the maintenance and the repair of wheeled combat vehicles as well as tracked combat vehicles depending on internal facilities which might be changed according to the kind of supported vehicles. The tools might be combined, where appropriate. In certain situations the module can be equipped with extra tools used for the maintenance and the repair of armaments, communication equipment, etc. An outdoor workplace intended for the repair of land combat vehicles is designed with a roof which might be rolled out in the space between containers (Fig. 2).

### 2.3. Basic tactical and technical properties of a workplace

The body of containers will be welded using steel sections and trapezoidal metal plates which will make a covering for the containers. The upper and bottom corner container elements of ISO 1C size will be built into basic bodies. The container panels themselves (peripheral and roof ones) will be filled with 40 mm thick insulating sandwich panels made of Elastopor SH 226/003 polyurethane foam which has been authorized to use in the Army of the Czech Republic after long-term tests [6]. As for the covering material of insulating panels, it will be a 0,8 mm thick surface-modified aluminium plate.

A container floor will be made from isothermal floor panels with a plywood, and covered with anti-slip PVC. The floor panels will be filled with the same Elastopor SH 226/03 polyurethane foam. The floor panels will be 50mm thick. Entry doors to the containers will be equipped with a special door lock with the possibility to be locked by locks, and rigid clips for sealing.

General outside dimensions of 1C container are standardised. The mass of projected workplace modules will be as follows:

1. A workplace module
  - a) service weight..... 3 000 kg,
  - b) effective weight ..... to 16 500 kg,
  - c) total weight ..... 19 500 kg.
2. A special tools store – a functional module
  - a) service weight..... 2 730 kg,
  - b) effective weight ..... to 22 000 kg,
  - c) total weight ..... 24 730 kg.

The workshops can be used for the work:

- a) in mild climate zones, i.e.
  - in the areas of average monthly temperatures from -15 °C to +25 °C,
  - with the lowest temperatures rarely below -32 °C, and the highest above +44 °C,
  - with extreme temperatures -40 °C and +50 °C,
- b) with relative air humidity to 90 % and a temperature of +33 °C,
- c) with air dustiness to  $1,5 \text{ g}\cdot\text{m}^{-3}$  taken 0,5 m above the ground level,

- d) with the speed of air flow to  $20 \text{ m}\cdot\text{s}^{-1}$ ,
- e) with atmospheric precipitation such as rain, snow and hail,
- f) at above sea level to 3 000 m (to 4 000 m for a short term).

Driving fuel supplies are big enough to provide currently: heating operation for 48 hours, power source function for 20 hours, hot-air heating operation in a workshop tent for 10 hours.

The requirements regarding the work in a workshop are as follows:

- a) the concentration of harmful substances will not exceed during 12-hour work  $20 \text{ mg}/\text{m}^3$  of carbon monoxide,  $200 \text{ mg}/\text{m}^3$  of oil fumes,  $70 \text{ mg}/\text{m}^3$  of petrol fumes, and  $0,3 \text{ mg}/\text{m}^3$  of sulphuric acid fumes,
- b) there will be natural light as well as artificial light provided in the workshop,
- c) the workshop will be equipped with lamps for main, spare, local and cover illumination according to the ČSVN 83 960,
- d) illumination level will be at least 50 Lx in the check points 1m off the ground and 0,5m off the wall. The most illuminated place to the least illuminated place ratio will be bigger than 1 to 3,
- e) the illumination of the workplace in a tent will be provided with a 230 V portable illuminating set with a screening slide.

For concealing the container workshop a fish net of 12x15 m is used with supporting components and needles. In order to fasten a camouflage cover, the containers are on the sides equipped with clips for supporting components holding stability against wind. It takes approximately 20 minutes to conceal the container, and 15 minutes to remove the camouflage [6].

### **3. EQUIPMENT OF A WORKPLACE AND A FUNCTIONAL MODULE**

#### **3.1. Equipment of a workplace module designed for the maintenance of wheeled and tracked combat vehicles**

A workplace module was divided into two basic rooms (Fig. 3):

1. Sealed (work-related) – is the main room for a functional workplace where work might be done.
2. Non-sealed (technological) – is the room intended for placing basic technological equipment consisting of the filter and ventilation plant FVZ 98, the air handler K 4A, the independent hot air heating D5LC, sources and electric and light distribution.

The main equipment of the workplace module consist of [5] (Fig. 4):

- 2 pieces of worktables. On one of them there is a table-mounted double-wheel grinder and on the other one there is a support stand for a hand electric drill and the vice YORK 100;
- the decontamination set OS-3 and the chemical detector CHP -71;
- the radio station RF 135 and the hardened notebook Dolch Note Pack;
- universal locksmith, electric and assembly tools, small expendable supplies placed in worktables;
- extra electric tools (an impact driver, hand electric drill, etc.);

- selected diagnostic and adjusting equipment;
- a welding inverter with a wire feeder and an electrode dryer, and the startonic 500 for charging lead and gel accumulator batteries capable of emergency (auxiliary) start 12 and 24 V to 50 A;
- personal hygiene facilities for a crew and facilities for preserving foodstuffs and preparing food.



Fig. 3. Workplace module profile

Source: J. Furch, O. Těšík, J. Glos, J. Marek, : *Kontejnerová dílna...*

The non-sealed part of a workplace module include following devices: the filter and ventilation plant FVZ 98, the power source of a minimum power capacity 15 kVA, the air conditioning of a power capacity to 5 kW, oil firing (6 kW), 2 pieces of an oil can, a set for lighting the workplace.



Fig. 4. Top view of workplace module

Source: J. Furch, O. Těšík, J. Glos, J. Marek, : *Kontejnerová dílna...*

### 3.2. Equipment and main parameters of a functional module designed for the maintenance of wheeled or tracked combat vehicles

Basic equipment of a functional module designed will consist of [5]:

- welding equipment used for welding by a welding arc, and charging accumulator batteries;
- a set for gas welding (1 piece of an acetylene bottle, 2 pieces of an oxygen bottle, a bottle trolley, a welder set);
- a tent fly;
- portable oil firing;







Fig. 6. Hydraulic crane in an operating position

Source: J. Furch, O. Těšík, J. Glos, J. Marek,: *Kontejnerová dílna...*

In the functional module it is also advisable to place the set of coupling and suspension tools used for manipulating with the systems and subsystems of supplied technical equipment when dismantling and mounting vehicles. The tools are chosen from the unified set introduced within the Army of the Czech Republic.

In the mobile container workplace we also suggest putting the sets of battle damage repairs kits such as: metallurgical material, connection accessories, electrodes for electric arc welding, welding material for flame welding, soldering process, adhesives materials and materials used for repairing tire tubes and tires. The selection of demanded repair kits can be conducted on the basis of the other armies of NATO experiences (Fig. 7). Beyond that we suggest choosing selected, according to statistical data, spare parts which should be available since they are frequently used during the maintenance of land combat vehicles in field conditions.



Fig. 7. Examples of repair kits used in Norwegian Army

Source: *Materials from the 15<sup>th</sup> Battlefield Maintenance (BM) Panel, NATO Standardization Agency, 2010*

#### 4. TRANSPORT AND MANIPULABILITY OF CONTAINERS

As for the structural design, the containers follow the ISO 1C container according to the standard ČSN 1496-1, and they are designed for transporting and manipulating, using the following equipment:

- a) the container carriers T 815 260R 81 36 255 - 8x8 with the hook lifter MULTILIFT MK - IV when using H-frame (Fig. 8),
- b) the container side re-loaders T 815 26 OR 81 36 255 - 8x8 and VOLVO FL 12 - 8x4 with the manipulating system KM 24 E - 293/S KLAUS (Fig. 8),
- c) the container carrier T 815 PR2 6x6,
- d) the vehicles T 815 26 265 8x8R with the transport flat FLATRACK 20' of the model M version,
- e) the saddle trailer VPE 45T with the towing unit T 815 6x6/10 TERRNO 1,
- f) the rail trucks Sgns, Sgjs a Sgs with the fastened ISO 1C container in the ISO container clips.



Fig. 8. T-815 – Multilift hook lifter (left) and T-815 KLAUS (right)

Source: [online] [access: 19.04.2011]. Available on the Internet:  
<http://www.militaryphotos.net/forums/showthread.php?134814-Tatra-Day-Military-Technical-Museum-at-Le%9Aany-Opens-Season>

When placing the containers on rough terrain, it is advisable to use the set for putting the container into a horizontal position. The set consists of two lifting jacks and four supporting stands. With this set it is possible to put the container into a horizontal position on the unpaved and rough, sufficiently ground bearing terrain of the 3° gradient at most in both directions. As for less bearing terrains, it is necessary to use tie-plates so that the lifting jacks could not sink into the ground. Ground bearing capacity measuring instrumentation is part of the set too.

## CONCLUSION

The paper presents the design of the container workplace designed for the maintenance of wheeled and tracked combat vehicles in field conditions. A quick and cheap replacement of functional module equipment according to the type of supplied technical vehicles is one of the advantages of this design. With replacing internal facilities, the wheeled version module might be changed into the tracked one and vice versa. Using a unified workplace module for the maintenance of both wheeled and tracked combat vehicles is another advantage of the paper. The real benefit of the project lies in achieving the unification and reduction of the number of mobile workshops within the Army of the Czech Republic, because at present there are about 80 kinds of them. Just for the maintenance of tracked equipment in field conditions there are 15 kinds, and for the maintenance of wheeled equipment there are 10 kinds. The mobile workshop as the authors have suggested is designed for the equipment maintenance of levels 2 and 3. Re-

garding the wheeled equipment maintenance of level 1, it is necessary to introduce a unified container box on the chassis T-815 or T-810. For the maintenance of Pandur II vehicles, which have been put into the Army of the Czech Republic recently, it will be necessary to design an armoured workshop on the same vehicle, the traffic ability of which will be the same as that of combat vehicles.

#### LITERATURE

- [1] *MC 319/1: NATO Principles and Policies for Logistics*, Brussels 1997.
- [2] *Stanag 2406: Land Forces Allied Logistics Doctrine - ALP-9(B)*, 1995.
- [3] Safr G., Chladil J., *Analýza pojízdných dílenských prostředků*. Studie. VTÚPV. Vyškov 2005.
- [4] Connors S.C., Foss Ch.F., *Jane's Military Vehicles and Logistics*, Twenty-fourth Edition 2003-2004, ISBN 0710624409.
- [5] Furch J., Těšík O., Glos J., Marek J., *Kontejnerová dílna pro opravy pásové techniky*, [in:] Sborník mezinárodní konference „Armament and Technics of Land Forces 2008“. Akadémia ozbrojených síl generála M.R. Štefánika, Liptovský Mikuláš 2008. ISBN 978-80-8040-356-0.
- [6] *KAR-BOX: Vizuální návrh kontejnerového pracoviště pro údržbu pásové a kolové techniky v polních podmínkách*. Hořice 2007.

### PROJEKT MOBILNEGO WARSZTATU DO EKSPLOATACJI POJAZDÓW WOJSK LĄDOWYCH W WARUNKACH POLOWYCH

#### Streszczenie

W artykule zaprezentowano koncepcję warsztatu napraw polowych, zabudowanego na znormalizowanym kontenerze ISO 1C, którego wyposażenie przeznaczone będzie do realizacji napraw i obsługi pojazdów Wojsk Lądowych Republiki Czeskiej. Opracowanie koncepcji poprzedzono analizą rozwiązań stosowanych w innych krajach NATO. Proponowany warsztat składa się z dwóch jednostek, z których jedna przeznaczona jest do realizacji prac obsługowo-naprawczych, a druga do realizacji zadań specjalnych, takich jak np. szybkie naprawy doraźne techniki wojskowej na polu walki. W artykule przedstawiono parametry taktyczne i techniczne warsztatu, opisano jego wyposażenie specjalistyczne oraz możliwości transportu.

**Słowa kluczowe:** eksploatacja uzbrojenia i sprzętu wojskowego, warsztaty naprawcze ruchome, zabezpieczenie logistyczne

Artykuł recenzował: dr hab. inż. Andrzej BAIER, prof. nadzw. PŚl.