

## MOTOR VEHICLE DIAGNOSTICS IN MILITARY UNITS

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### **Abstract**

*Transport pertains to all functional areas of the State's activities on every administrative level. Road transport is a very important branch of global economy and constitutes a part of the logistics network. It pertains to the transportation of cargo, items, and people. Cooperation between the branches of civilian transportation and military logistics must be the focus of continuous improvement efforts. Enhancements in this respect can serve to avoid possible failures and disruptions. The quality and availability of infrastructure plays a significant role, not only with respect to civilian, but also military assets. The condition of the vehicle is important for the safety of road transport. The provision of transport services in a military unit should mainly rely on military-civilian cooperation and effective communications. The condition of the means of transportation has been indicated as a factor influencing transport safety. Employing new technology and solutions enables constant improvements to the diagnostic system, broadening the knowledge and enhancing the skills of the motor vehicle driver in terms of proficiency in operating and maintaining the vehicle used.*

**Keywords:** *motor vehicle diagnostics, vehicle operation, vehicle condition, military-civilian cooperation, transportation support*

### **1. Introduction**

The term “diagnostics” is derived from the Greek word “diagnosis”, which refers to discerning, specifying [1]. Technical diagnostics involve tests and assessment of the condition of motor vehicles, identifying causes, performing modifications and adjustments as a result of the diagnosis [2]. A diagnostic test can refer to an examination of e.g. a process, an assembly, a subassembly, kinematic pair, mechanism, system, a motor vehicle. In order to perform technical diagnostics, one must know the procedures, diagnostic systems, the relevant conditions, and methodology. This refers also to the instruments and devices, and diagnostic measures, including equipment, the status of damaged areas as well as the control algorithms. The methods of performing motor vehicle diagnostics are as follows [3]:

- continuous or periodic tests,
- technical condition assessment performed by using external diagnostic devices and instruments,
- technical condition assessment performed by using the on-board diagnostic systems connected to the vehicle,
- comprehensive diagnosis – combination of both systems.

One can distinguish the following types of diagnostic instruments:

- analogue
- analogue-digital
- computer-based.

Diagnostic instruments should be characterized by a simple, yet optimal functioning algorithm, automatic diagnosis generation in the form of printouts and records, the ability to inspect and

locate damage, simple operation and use, low operation costs and clarity of diagnosis. One should employ a comparative or expert method based on expert or professional experience.

## 2. Diagnostic tests of military motor vehicles

Diagnostic tests of military motor vehicles are performed at a motor vehicle inspection station (MVIS) or diagnostic stations. If these are not available, the tests are performed at appropriately prepared service stations in technical workshops. The diagnostician enters the performed technical inspection in the vehicle registration book. They also make a relevant record of the vehicle's roadworthiness and specify the date of the next diagnostic test. Motor vehicle tests and their assessments are divided into two stages:

- 1) technical condition inspection,
- 2) damage location.

The basis for the functioning of a vehicle maintenance system should be informed by the methods and principles of technical diagnostics. The basic algorithm for the location and operations of motor vehicle inspection stations within the Armed Forces of the Republic of Poland is presented in Tab. 1. One must keep in mind, however, how crucial it is for the elements of the service chain to properly link and interlock.

Tab. 1. MVIS location algorithm for particular phases of military vehicle operation [3]

Military equipment operation phase	Location and service provider	Scope of activities
Routine maintenance (OB)	CM station, driver, crew	Selected inspection activities
Periodic maintenance	MVIS, diagnostic station, diagnostician	Technical diagnostics before and after maintenance operations
Technical inspection of wheeled vehicles	Motor vehicle inspection stations, authorized diagnostician	Verification of the vehicle's compliance with the technical requirements specified in applicable regulations
Locating damage	MVIS, maintenance-repair workshop of the appropriate type, diagnostician, mechanics	Specifying the scope of repair work
Running repair (NB)	MVIS, diagnostic station, diagnostician	Full or partial diagnostic tests (quality acceptance of the work)
Vehicle breakdown	MVIS, diagnostic station, diagnostician, commission	Identifying the causes of the breakdown
Medium-level repair (NŚ), Maintenance repair (NK)	MVIS, diagnostic station, diagnostician	Full diagnostics as quality acceptance
Establishing a target normative standard of operation (acc. to mileage, years in operation)	MVIS, diagnostician, commission	Identifying the technical condition and submission of a final ruling in order to extend the target normative standard of operation
OR (annual maintenance) inspection	Military unit commission with the diagnostician	Annual assessment of the fitness of military equipment (SpW) for use following an OR
Each operation phase	MVIS, diagnostic station, diagnostician	As per the instructions of Regional Logistics Base (RBLog), Military Economic Department (WOG), Telecommunications and Information System Support Region (RWT), Technical Workshop (WT) commanding officers, commanders of military units

## **2.1. The nature and purpose of transportation support services**

The purpose of the transport system is to enable military transport and shipments. This includes maintaining the traffic flow in the transport system and traffic management within the transport network. The transport-related units and devices, together with the executive bodies, form the entirety of the transport system in each military unit. The Regulation of the Minister of National Defence of 28 September 2012 specifies the conditions for transport using military vehicles belonging to the Armed Forces of the Republic of Poland. The system cooperates with bodies and units, which derive from non-military branches and they are assigned by civilian departments. In wartime, the assignment is performed for the purposes of executing transportation tasks in the following scope:

- cargo transport,
- relocating military personnel.

The main purpose of transportation support services is to prepare (in time of peace) transport networks of defensive importance, the relevant systems and means of transportation, as well as the transport-related units and executive bodies appointed for the execution of tasks related to the defines and technical support of the transport network and relocation of personnel.

In wartime, the basic task of the transportation support services is to safeguard the timeliness and continuity of military transport. This consists in maintaining the continuity of traffic flow within the transport network of defensive importance through the appropriate use of means of transportation and the relevant forces. Transportation support targets are deemed to have been met once the relocated cargo or personnel reach the destination within the allotted time. Military transport is executed by means of a shuttle system. This shuttle system includes two primary and basic directions:

- towards the front,
- return.

The front direction includes transportation of military equipment, supplies, and relocation of personnel. The return direction includes the technical evacuation of armaments and remaining military equipment, medical evacuation of the sick and wounded, evacuation of personnel [4]. Armaments and military equipment (UiSW) include [5]:

- general purpose equipment used in the national defines department,
- products, technological solutions.

In order to complete transport tasks, different means of transportation are employed, including e.g. combined transport solutions. The performance of transportation services involves using more than one branch of transport. By rule, one handling unit is used throughout the entire transport route. The centre-army formation routes include mainly rail and road transport. In army formation-tactical formation-unit routes, the service is provided mainly by means of road transport. Critical situations are an exception. In such cases, air transport is employed. Defence transport networks used and intended for transport tasks as part of defensive efforts include:

- sections and technical infrastructure of motor roads
- railway lines and train stations,
- airfields and airports,
- river and sea ports,
- fuel pipelines.

The technical maintenance of the transport network is another important aspect. The technical scope of transport network maintenance covers distinct initiatives in individual categories. These include reconstruction of destroyed facilities, restoration of destroyed road sections, technical reconnaissance, construction of detours, technical support of the transport network, execution of operational tasks, construction of reserve bridge crossings and bridges, clearing and demining as well as deactivation of the transport network. The execution of the above transport network

technical maintenance operations is organized by immediate patrols and groups, e.g. reconnaissance, clearance, military unit reconnaissance formations. Providing cover support to the network involves [6]:

- preparation of supplies,
- maintenance of reserve forces,
- maintenance of communication measures,
- provision of technical duty service,
- project execution.

## **2.2. Military-civilian cooperation**

Military logistics have always been a model and source of inspiration for both theoreticians and practitioners involved in organizing physical asset and information flow within the national economy framework [9]. Nowadays, however, one can observe a reverse trend. Today, military logistics experts take advantage of mechanisms and tools that have been proven on the civilian market. Logistics as a discipline pertaining to people and organized entities touches on practically all the functional fields of the state, on all levels of public administration. The Armed Forces of the Republic of Poland and the logistics system present in its structures is strictly linked to the economic and defines-related non-military cells. The non-military system is formed by institutions and economic organizations, which are tasked with defines-related operations. The institutions and organizations are not part of the armed forces [9]. In time of peace, they create a system of providing the necessary conditions to facilitate the armed forces' preparedness in the event of potential conflict or war. This system safeguards the ability to maintain supply shipments and provision of services. The above-mentioned services are necessary for the survival of both the nation and state structures, as well as for maintaining the ability to perform and execute tasks in the appropriate period outside the borders of the Republic of Poland [7]. The components of the non-military system are as follows [8]:

- state reserves,
- research and development units operating for defines and state security purposes,
- state enterprises ,
- the entire defines infrastructure.

State reserves include [9]:

- raw materials,
- fuel,
- materials,
- machinery and equipment,
- medical products, food products and ready-to-cook food.

State reserves can be divided into:

- mobilization reserves,
- economic reserves,
- armament production,
- services.

Each part of the state reserves covers particular functions and purposes. They serve the need for basic raw materials and fuel, while some of them are related to the performance of defines-related tasks, modernization of military equipment and restoration of technical capacity. State reserves can also be dedicated for training purposes. One must consider the fact that the define infrastructure is part of the broader state infrastructure. The armed forces use the define infrastructure to perform logistical tasks. Military-civilian cooperation takes place in virtually every area of operation, in many fields and using different systems, and is regulated through numerous legal documents.

### 3. Survey for users of military motor vehicles

For the purposes of performing a survey among the users of military motor vehicles, an awareness questionnaire has been prepared; the questions are related to the technical condition of the military vehicle and its influence on road traffic safety. The survey has been performed in a military unit on 8-10 January 2018; the respondents were users of military motor vehicles. The survey respondents were soldiers from the same military unit; however, they belonged to different sub-units.

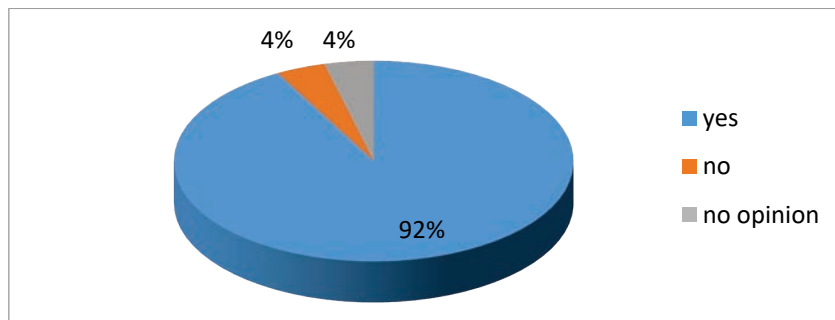


Fig. 1. Is road traffic safety determined by the technical condition of the vehicle?

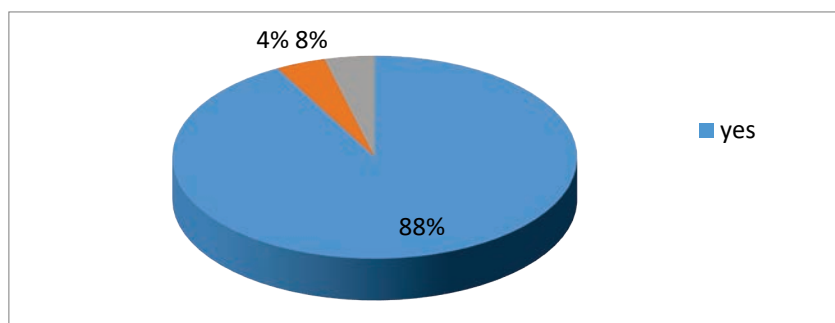


Fig. 2. Does the technical condition of the vehicle comply with applicable requirements and regulations?

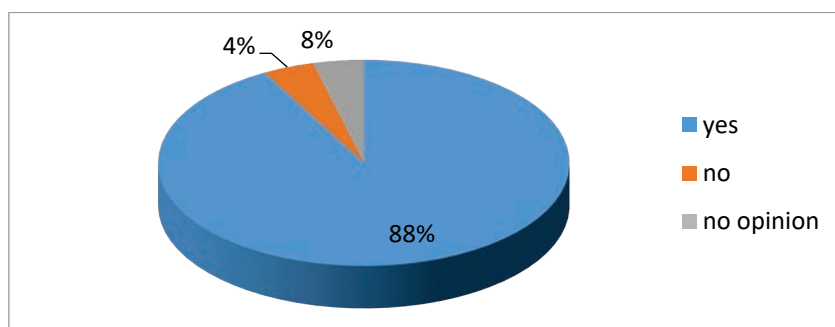


Fig. 3. Who is responsible for the timely performance of technical inspections?

The survey has been performed on 8-10 January 2018. The survey has been conducted with drivers of military vehicles in a military unit. The survey respondents are drivers of military vehicles in a military unit. A total of 25 people have completed the survey – 2 women and 23 men (8% and 92%, respectively). Thirteen respondents were 21-30 years old, eleven – between 31 and 40, and one person was over 40 years old. The survey was anonymous. The respondents received the questionnaire through electronic means.

The scope of the survey covered the following:

- gender,
- age structure,

- years of service,
- assessment of the technical inspection system in the military unit,
- impact of various factors on the causes of road accidents,
- identifying the participation of a motor vehicle user in a traffic incident as caused by a technical fault in the vehicle,
- responsibility for the timely performance of technical inspections,
- awareness of the relation between road traffic safety and the technical condition of the vehicle,
- driver competence in relation to the vehicle used as per applicable regulations and legal requirements.

As part of the statistical surveys performed, a supplementary survey has been conducted with users of military motor vehicles. This survey took place on 12 January 2018 with the participation of 10 respondents. Based on the survey for users of military motor vehicles it can be concluded that the technical condition of the vehicle plays a very important role in maintaining safety, and the drivers pay particular attention to the technical condition of their vehicle, while ensuring its correct operation. Any potential faults and malfunctions have been detected and resolved without disrupting vehicle operations. Based on the surveys it has been concluded that the technical condition of the drivers' vehicles complies with the applicable requirements and regulations. The positive result of diagnostic tests when periodic maintenance service or running repair has been performed for a given motor vehicle is confirmed by an authorized person's signature and an appropriate stamp in the router sheet, i.e. the technical service sheet (KUT). In such case, the vehicle is placed in further service. In the event that irregularities related to the technical condition of the motor vehicle are detected during diagnostic parameter checks, the result of such test is also entered directly on the router sheet. Such vehicle is deemed out of order. An authorized diagnostician identifies the status and scope of the faults or malfunctions and enters all reservations in the vehicle technical condition protocol. Upon receiving the protocol from the driver, a technician from the sub-unit to which the vehicle has been assigned arranges the date of the running repairs at the tank and automotive service repair workshop. Vehicles are performed in accordance with the repair technology applicable for a given vehicle's type and make. Responsibility for the correctness, timeliness, and quality of the repairs in a given military unit rests with the commander of the repair sub-unit and the chief of the S-4 section, and in WOGs – the chief of the tank and automotive service, and the workshop supervisor. Upon completion of the repairs with all faults removed, the vehicle and its relevant documentation is once again subject to an inspection at a diagnostic station or motor vehicle inspection station. If the vehicle obtains a positive result, it is permitted for road traffic and placed in further service with an annotation of the date of the next periodic technical inspection. The process is presented in a summary manner; however, based on the practical application of diagnostics, this indicates that it constitutes a basic tool for road traffic related to the operation of technically faulty vehicles. It allows predicting the future condition of the vehicle, yet it is mainly concerned with the assessment of its current status. Fig. 4 shows the process map for the diagnostic model of a vehicle technical inspection.

#### **4. Summary**

Diagnostics is a basic tool with system features. Its purpose is to continuously maintain motor vehicles in appropriate condition. This is made possible through the assessment of the current technical condition, which provides the vehicle user with all the relevant basic information. With diagnostics, one is able to predict future conditions, which forms the basis for the prospective planning of appropriate periods for subsequent diagnoses, repairs, and maintenance jobs. It also aids in removing faulty units from operation. Performing vehicle diagnostics prior to maintenance service in a military unit consists in checking and adjusting its systems and all its assemblies. The scope of maintenance is also established.

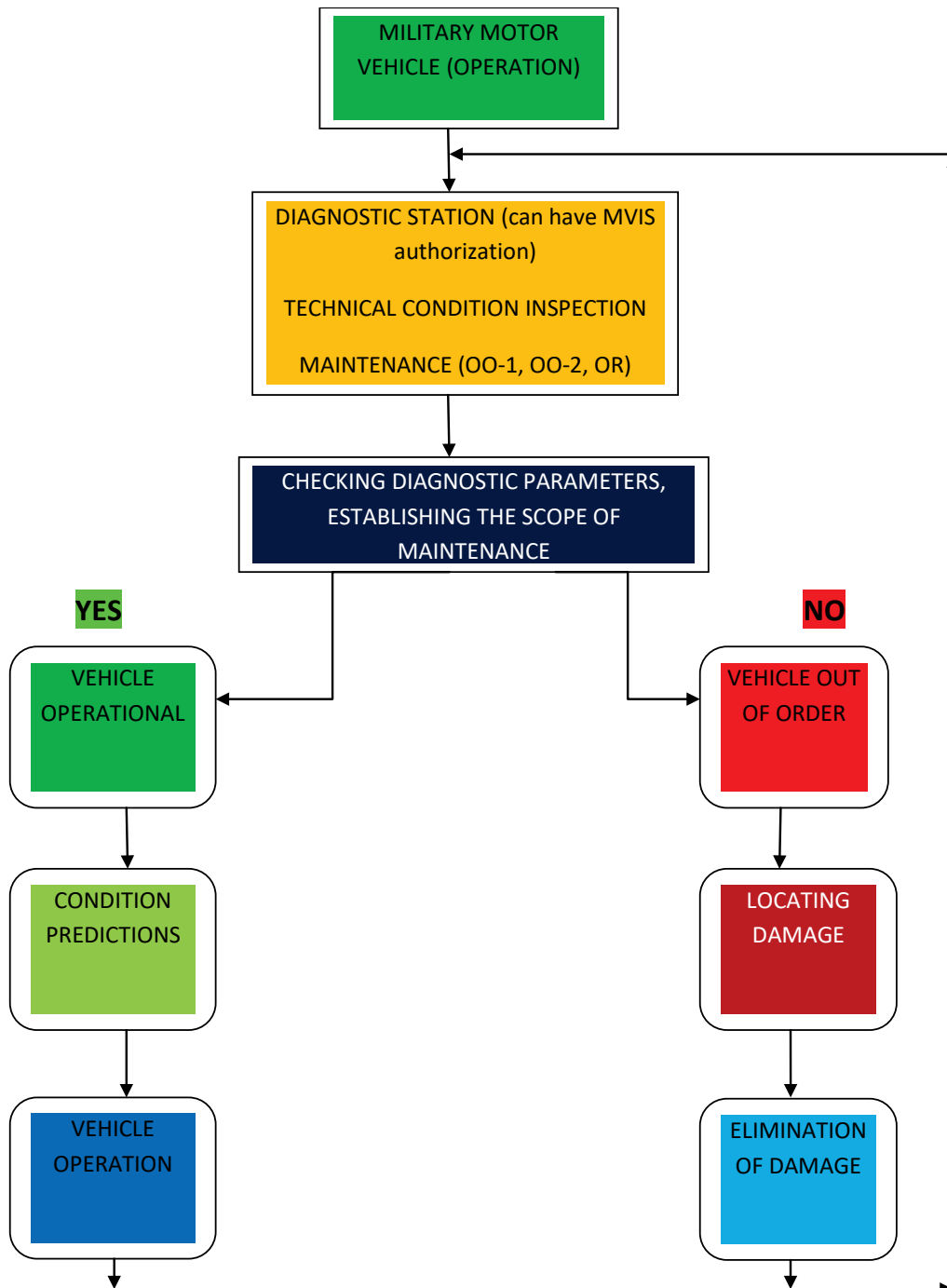


Fig. 4. Process map for the diagnostic model of a vehicle technical inspection

Technical or diagnostic inspections are recorded in electronic format by using IT systems or in a traditional way, in the form of books. These records are destroyed upon expiration of a two-year safekeeping period. The elements of military logistics, its system, nature, and relations between its components play an important role in the functioning of the military unit.

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