

# STATISTICAL RESEARCH OF OPERATING RELIABILITY OF EUROPEAN PRODUCTION OF LORRY CONVOYS

*Alexander Kravchenko*

East Ukrainian National University named after V.Dahl, Ukraine

**Keywords:** motor-car trains, control group, failings of operability, failure, disrepair.

**Abstract:** The inspection results of control group of autotractors in exploitation are given. Characteristic failings of serviceability of autotractors are got, conformities to the law of time expenses on debugging are certain.

## Introduction

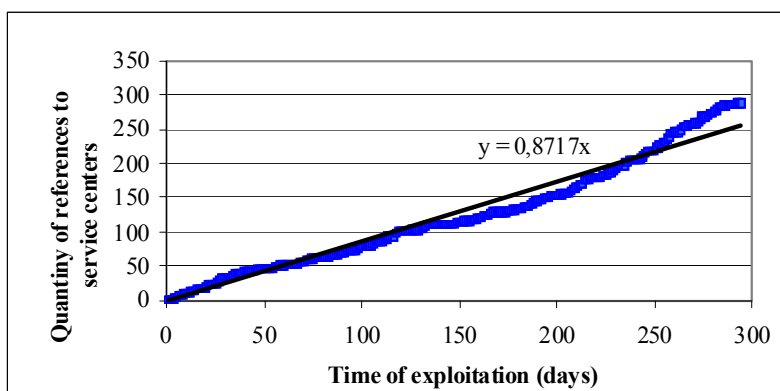
A motor transport plays an important role in growing rates of integration processes. The use of lorry convoys is provided by connection of markets of Europe and Asia, Baltic and Black Sea States. Greater part of lorry convoys, executing freight traffic, behaves to the leading world producers the considerable stake of which is made by MERCEDES-BENZ 1844 ACTROS LS, "SCHMITZ", "KRONE", "KÖGEL" autotractors. Authority of producers does not cause doubts, however in the conditions of the real exploitation the real reliability has an important role. For ferrymen the question of reliability of prominent producers remains opened. Realization of high technical and economical indexes of lorry convoys is possible only at high potential of reliability and its decline will substantially influence on efficiency of the use of lorry convoys on the whole.

Works of leading domestic scientists expose the problem of reliability of motor-car technique of ZIL, MAZ, KRAZ car factories and other (1). Not enough attention is spared to the present tense the analysis of disrepairs and defects of the European production autotractors. The purpose of work was an inspection of control group of cars-tractors of MERCEDES-BENZ 1844 ACTROS LS in a guarantee period of exploitation and trailed chassis of "SCHMITZ", "KRONE", "KÖGEL".

## Statement and problem solving

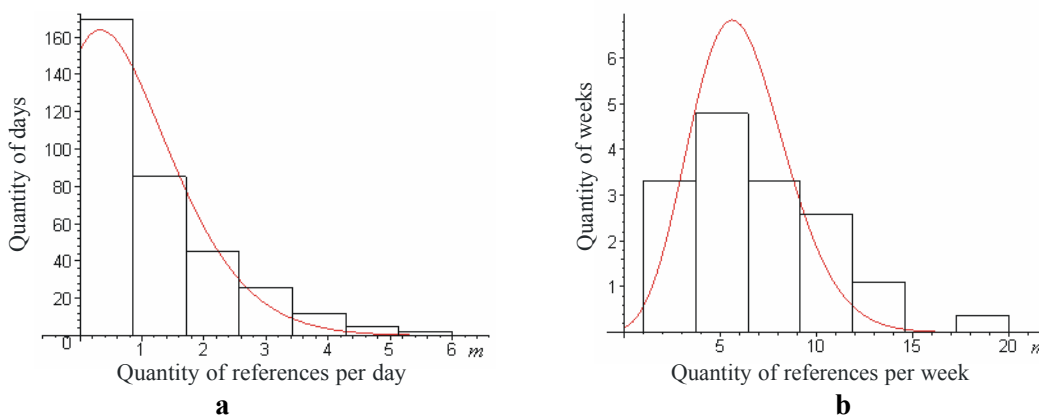
The inspection of lorry convoys in an amount one hundred units in the flow of first-year of exploitation has shown that guarantee repair is required most autotractors. At the middle annual run of 89,4 thousand kms for the removal of defects, implementations of regulation and diagnostic works of lorry convoy about 300 times must it was be presented on the brandname service centers of MERCEDES-BENZ of Germany, France, Italy. For this period about 800 requests are considered on violation of operability of autotractors. More than 50% autotractors were visited by service centers on once, more than 25 % - for 3 - 4 - times, about 20 % - 5 - 10 times. For 300 days of exploitation of lorry convoys a stream of references in guarantee repair is the Puasson's stream and origin of disrepairs is satisfactorily approximated linear dependence with a coefficient 0,8717 (fig. 1), and the intervals of time between the origin of two successive disrepairs are up-diffused on an exponential law (2).

The expenses of time on the removal of refuses and disrepairs on the different intervals of run made: there are 0 - 25 thousands of km on a run - 13,0 h., 25 - 50 thousands of km - 8,9 h., 75 - 100 thousands of km - 14,1 h and on a run 100 -125 thousands of km 20,2 hours. Histograms and proper by Puasson's distributing for the number of appeals in repair calculating on one day and on one week resulted on fig. 2. Calculation 95% confiding scopes of parameter  $\mu$  Puasson's distributing is certain as roots of equalization  $\sqrt{292(0.8717 - \mu)} / \sqrt{\mu} = \pm 1.96$ . For the amount of appeals 95% is during days got in repair confiding scopes 0,767 and 0,980, for the number of appeals in repair within a week accordingly - 6,358 and 5,796.



**Figure 1: Quantity of references to guarantee repair**

The conducted analysis of removal of defects allowed to distribute them on the types of works on four groups: replacement of details, units, aggregates (57,5%), regulation works (22,9%), reinforce works (10,1%), diagnostic works (9,5%).



**Figure 2: Description of quantity of references in guarantee repair calculating per one day (a) and per one week (b)**

To the most characteristic works of the first group behave: replacement of steering tractions (41 pieces), replacement of stuffing-box of leading cog-wheel of main transmission (34 pieces), replacement of fuel tank (11 pieces), replacement of cabin's tortion (98 pieces), repair or replacement of autonomous heater (56 pieces), replacement of takhograf (16 pieces). Replacement of sprayers, electronic blocks of management of aggregates and units, display, air and oily pipelines, sensors, cable of ABS, generator, shock-absorbers, brake mechanisms, storage battery, tape recorder, refrigerator 29,0% made from a general amount (tab. 1).

The second group is related to regulation works: faucet of management a suspension (61,1%), corners of setting of wheels and coupling device (17,4%), headlights (16,8%), engine on toxicness (4,7%).

**Table 1: Distributing of failings of operability, causing replacement of details, units, aggregates**

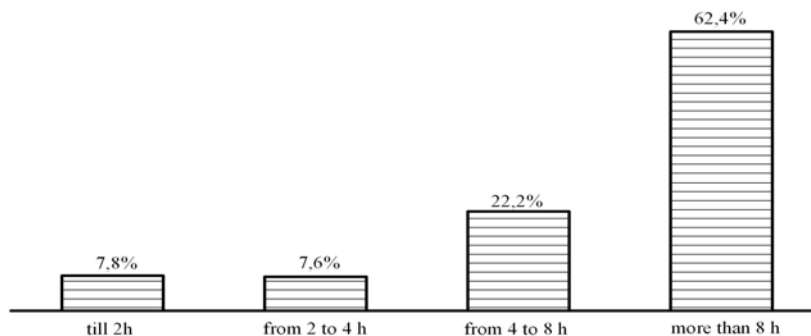
Name of detail, unit, aggregate	To general amount, %	Name of detail, unit, aggregate	To general amount, %
Cabin's tortion	21,0	Takhograf	3,3
Autonomous heater	20,5	Fuel tank	2,3
Steering draft	8,6	Turbo-compressor	1,7
Glasses of lanterns	8,6	Other	29,0
Stuffing-box of leading cog-wheel of main transmission	7,2		

The third group is related to implementation of reinforce works: cowlings and spoilers (56,4%), faucet of level of suspension(16,6%), fuel tank, refrigerator, autonomous heater and other (27,0%).

To diagnostic works behave: diagnostics of the computer system (35,7%), diagnostics of the fuel system (11,9%), diagnostics of brakes, turbo-compressor, electrical equipment, refrigerator made 13,1%.

Characteristically, that the demurrage of lorry convoys with small time of debugging (till 2 h and from 2 to 4 h) made according to 7,8% and 7,6%. 22,2% made the demurrage of lorry convoys with time of debugging from 4 to 8 h. 62,4% made the demurrage of lorry convoys with time of debugging more than 8 h (fig. 3). Replacement of gear-box, rear axle and control blocks for aggregates, were demanded according to 72, 114 and 216 h (3, 4).

It is set the executed calculations, that on the whole appearance of disrepairs in autotractors at the period of guarantee term of exploitation described the normal law of distributing. Exposed failings of the technical state of autotractors by kind, character, reasons of occurrence and debugging time differ from each other considerably. Research of laws of distributing of times between failures is shown, that take a place symmetric, but in a greater number are the asymmetric distributing; description some, described as  $\beta$ -distributing, resulted in tab. 2. Assimetric distributing laws in a number of cases specify on present in the construction of autotractors or technology of their assembling of failures to complete. Study of these laws, allowed deeper to get to know nature of failures, their physical essence, produce strategy of their warning, design and forecast failings of the technical state of autotractors.



**Figure 3: Distributing the demurrage of lorry convoys debuggings and refuses at times**

**Table 2: Statistical description of appearance of disrepairs and refuses**

Name of aggregate, systems	Distributing law	Density of distributing
Aggregates	$\beta$ -distributing	$0,175 \cdot 10^{-5} (8,71+t)^{1,75} (84,06-t)^{1,67}$
Suspention		$1,054 (0,52+t)^{0,29} (73,43-t)^{0,04}$
Steering draft		$0,0008 (-3,89+t)^{1,30} (72,46-t)^{0,52}$
Electrical equipment		$0,3771 (-4,11+t)^{0,21} (73,88-t)^{0,14}$
Fuel tank		$0,00001 (25,06+t)^{2,05} (71,09-t)^{0,26}$
Stuffing-box of leading cog-wheel of main transmission		$0,0022 (7,60+t)^{0,82} (72,45-t)^{0,58}$
Autonomous heater		$0,3138 (7,92+t)^{0,71} (69,80-t)^{0,39}$

Inspection of semitrailers of “SCHMITZ”, “KRONE”, “KOGEL” is carried out in two stages for two years of exploitation. A middle annual run made on the first year: - “SCHMITZ” is a 98 thousands of km, “KRONE” is a 166 thousands of km, “KOGEL” -300 thousand of km.

Characteristic failings of operability are: refuses and disrepairs of the brake system, refuses or failings of work of ABS, wear of details of mounted and plug-formings elements of gate and sides, failings of impermeability of the pneumatic system, cracks, are in the welded connections, the operability of faucet of level of suspension is violated, fastening of receivers, displacements and defects of axes is vio-

lated. Some conformities to the law and statistical description of types of failings of operability (appearances of refuses and disrepairs) of semitrailers are resulted in table 3.

The analysis of results of inspection set the presence of defect and displacement of axes. This phenomenon are not frequent, however there are cases of displacement to 50 mm and defect to 2°, that fails the dynamics of conduct of lorry convoy.

Reason of this violation can be: precipice or weakening of inhaling of step-ladders of semisprings, weakening of inhaling of fingers of semisprings, damage of hobs of fingers of semisprings. At the ill-timed discovery of this defect there is a wear of regulation plate, fingers and hobs of fingers of semisprings. Displacement of axes causes additional tensions in details and knots of suspension and results in appearance of cracks and stratification of accordion boots, to wrong work of shock absorbers and, as a result, precipice of brackets of shock absorbers, violation of other fixing connections. A defect of axes is reason of overrun of fuel, uneven and enhanceable treadwear tires; results in displacement of centre of gravity of semitrailer, and in difficult travelling terms fails the dynamics of conduct of lorry convoy.

**Table 3: Statistical description of refuses and disrepairs of semitrailers**

Name of trailer	$\bar{M}$ , th. km	$\sigma$ , th. km	$\alpha$	b	Failure density
SCHMITZ	75,24	29,29	2,962	84,232	$0,7 \cdot \left(\frac{t}{84,232}\right)^{1,962} \cdot e^{-\left(\frac{t}{84,232}\right)^{2,962}}$
KRONE	139,55	37,05	4,923	152,753	$0,65 \cdot \left(\frac{t}{16067}\right)^{7,214} \cdot e^{-\left(\frac{t}{16097}\right)^{8,214}}$
KÖGEL	244,7	43,36	6,83	262,56	$0,57 \cdot \left(\frac{t}{262,56}\right)^{5,83} \cdot e^{-\left(\frac{t}{262,56}\right)^{6,83}}$

The repeated inspections of the towed composition were made with the middle run of “SCHMITZ” are 230 thousands of km, “KRONE” are 303 thousands of km, “KÖGEL” are 440 thousands of km.

**Table 4: Distributing of failings of operability of semitrailers on the second stage of supervision, %**

Name of disrepairs	SCHMITZ	KRONE	KÖGEL
Failing of operability of the brake system	3,0	16,0	16,0
Wear of details of bodies and locks of gate and sides	11,0	11,0	18,0
Failing fastenings of shock absorbers	28,0	3,0	–
Untightness of the pneumatic system	11,0	12,0	20,5
Failing fastenings of receivers	–	3,0	–
Defect and displacement of axeles	1,0	5,0	2,5
Failing of operability faucet of level of suspension	–	–	3,5
Cracks are in the welded elements	–	2,0	3,5
Leaks of shock absorbers	2,0	3,0	–
Disrepair of cassette spare wheel	4,0	–	–
Breakage and weakening of fastening of details of framework	17,0	5,0	15,0
Failing of operability elements of electrical equipment	15,0	4,0	12,0
Breakage and failing of cab floor fastening	4,0	6,0	9,0

The results of inspection show that character of distributing of refuses and disrepairs changed considerably. In some systems the amount of refuses diminished (for example, faucet of level of suspension). But here found out refuses and disrepairs which before was not observed (breakage and weakening of fastening of details of framework, violation of operability of elements of electrical equipment, breakage and violation of fastening of chaffs). A precipice and weakening of fastening of step-ladders, defect and displacement of axes, remained in a trace (tab. 4).

Reason of breakage and weakening of fastening of details of framework is a precipice of brackets proof bridges of framework, wear of details in the places of interface and, as a result, increase of loading on other elements of framework and output them from a line-up. Also, in the process of exploitation under influence of external terms there is destruction of isolation of send-offs and electric devices of semitrailer. It results in short circuits in chains, to heating to the high temperatures of send-offs and connections. Under act of external factors there is destruction of timber connections of details of foundation of platform of semitrailer and damage of details of foundation of platform.

### **Conclusions**

The executed estimation of reliability of European production lorry convoy on the generally accepted indexes allowed to expose reliable aggregates and units, needing improvement of construction and quality of making the least. In exploitation this information is used for determination of volume of repair influences on the removal of the proper refuses. It is set researches, that appearance of disrepairs in autotractors of MERCEDES-BENZ 1844 ACTROS LS in a guarantee period of exploitation approximated linear dependence and a stream of appeals in repair is a Puasson's distributing. In the interval of run 0 – 100 thousands of km make mean time of repair 12,1 h. Distributing of all time of removal of defects has shown that prevailing part (62,4%) have a time more than 8 h. To the basic types of works are replacement of details, units and aggregates belongs in a guarantee period of exploitation (57,5%). Distributing of Puasson for the amount of appeals in guarantee repair calculating on one day and one week and distributing of expenses of time of outage of lorry convoys is expected.

Reasons of appearance of disrepairs and refuses of the towed composition are certain. It is set that greater part of reasons of appearance of failing of operability, having asymmetrical laws of distributing, reflect imperfection of construction, failings of technological processes of assembling, maladjustment of mobile composition to the external environments on domestic roads.

### **References**

1. Visotsky M., Galtburt A., Gileles L., Kuznetsov E/ Providing of reliability of cars MAZ in exploitation / Under reduction of E.S. Kuznetsov/ M.: Transport, 183 p., 1977.
2. Pollard G. Reference book on the calculable methods of statistics / Translate from English. B. Zanadvorova. Under reduction and preword of E. Chetirkina / M.: Finances and statistics, 344p., 1982.
3. Baghinov V., Kravchenko A. / Reliability of autotractors. Monograph / Lugansk: Publ. «Knowledge», 412 p., 2009.
4. Kravchenko A. / Motor-car trains: management a capacity. Monograph / Lugansk: Publ. SNU n.V.Dal, 204 p., 2008.