Methodology Analysis Using Exploitation Reliability with the use of the RTOP Main Diesel Engine

Analiza metodologije s pomoću eksploatacijske pouzdanosti uz uporabu RTOP glavnog dizelskog motora

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DOI 10.17818/NM/2016/2.2
UDK 621.436
Preliminary communication/ *Prethodno priopćenje*
Paper accepted / *Rukopis primljen:* 18. 11. 2015.

Summary

As part of the research on high speed radial diesel engines, an analysis had been conducted on the use of the operating systems of the missile boats and comparison of the results with the manufacturer's recommendations. A graphic model had been set up (block – diagram) on high speed radial ship diesel engine. On the basis of research and empirical data collected on defects which cause the inability to use the engine, the total exploitation reliability of complex technical system and the statistical characteristics of the life of the system had been defined, starting from the assumption that the life of the technical system tested belongs to the Weibull distribution. Research results had been achieved by means of the simulation method (the simulation model) and then were tested with the use of the contemporary computer applications. By defining the levels of operational capability, the levels of reliability had eventually been set up and they need to be ensured through modified maintenance procedures so that the investigated technical system could meet the required criteria. In the research of new samples, the needed intervals of preventive replacement of critical system parts will be determined so that the demanded reliability would be ensured.

KEY WORDS

high speed diesel engine
Weibull distribution
exploitable reliability
malfunction intensity
operational ability

Sažetak

U sklopu istraživanja brzookretnih radijalnih dizelskih motora provedena je analiza uporabe pogonskih sustava raketnih topovnjača HRM te usporedba dobivenih rezultata s preporukama proizvođača. Postavljen je grafički model (blok-dijagram) brzookretnog radijalnog brodskog dizelskog motora. Na temelju provedenih istraživanja i prikupljenih empirijskih podataka o kvarovima koji uzrokuju nemogućnost uporabe motora definirana je ukupna eksploatacijska pouzdanost složenog tehničkog sustava te je statistički određena karakteristika vijeka trajanja sustava, polazeći od pretpostavke kako vijek trajanja tehničkog sustava koji se ispituje pripada Weibullovoj distribuciji. Rezultati istraživanja dobiveni su korištenjem metodom simulacije (model simulacije) te su testirani uporabom suvremenih računalnih aplikacija. Definiranjem razina operativne sposobnosti u konačnici su postavljene i razine pouzdanosti koje treba osigurati izmijenjenim postupcima održavanja kako bi istraživan tehnički sustav zadovoljio postavljene kriterije. U nastavku istraživanja novih uzoraka utvrdit će se potrebni intervali preventivne zamjene kritičnih dijelova sustava kako bi se osigurala zahtijevana pouzdanost.

KLJUČNE RIJEČI

radijalni brodski dizelski motor
Weibullova distribucija
eksploatacijska pouzdanost
intenzitet kvara
operativna sposobnost

1. INTRODUCTION / *Uvod*

It is a known fact that the methodology of researching and prevision of exploitation reliability of electronic components is significantly improved, but that does not apply to the mechanical components respectively with the marine propulsion systems and marine operating engine such as high speed radial diesel engine. For those systems conditionally called "mechanical" characteristic is its complexity, which means consistence of diverse technology (mechanical, electronic, energetic, computer etc.) in their construction and performance solutions. In addition to the complexity in order to develop model of reliability attention should be paid to the method of use of this complex technical system, and whether you are using a complex technical system in accordance with the recommendation of the manufacturer in default or typical conditions. Prediction of exploitation reliability of that kind of complex technical system in determined conditions of a warship in the waters of Adriatic is a scientific challenge of this research. In the first part of work the attention will be on the research and analysis of the use of the high speed radial diesel engine as a part of the complex technical system, specifically warships of Croatian Navy. In the second part of the work the author is researching exploitation reliability of a complex technical system, while in the third part of the work he will suggest ways of optimizing reliability of a complex technical system in order to ensure the required operational capabilities of a high speed radial diesel engine.

2. ANALYSIS OF THE USE M 504 B2 ENGINE OF MISSILE BOATS (RTOP-11 AND RTOP-12)[1] / *Analiza uporabe M 504 B2 motora raketne topovnjače (RTOP-11 i RTOP-12)*

On the foundation of data on exploitation of the engine M 504 B2, which are found in the ship records RTOP-11 and RTOP-12, a table was made on the working hours of the engine respectively with the modes of navigation, for about 500 hours of a working engine time.

Table 1 The number of working hours of the engine according to the regime of the sailing

Tablica 1. Broj radnih sati motora prema režimu plovidbe

M 504 B2		RTOP-11	RTOP-12
Navigation mode	[min^{-1}]	Operation hours [h]	Operation hours [h]
PH	750	72:15	73:10
M	750	80:25	78:15
N1	750	62:15	67:10
N2	900	01:15	00:00
N3	1000	51:35	41:30
N4	1200	91:50	63:20
N5	1400	49:35	30:10
N6	1500	52:15	38:35
N7	1700	20:35	65:20
N8	1800	01:25	09:30
N9	1900	00:05	00:30
N10	2000	00:00	00:00
Total operation time		483:30	467:30

Where is:

PH – empty walk

M – manoeuvre

N – forward

On the basis of the table 1. a diagram on the intensity of exploitation of the engine in regard to regimes of the sailing was made, image 1.

Following the table 1. and the diagram (image 1.) the tables 2. and 3. were made and average load of the researched engines were shown.

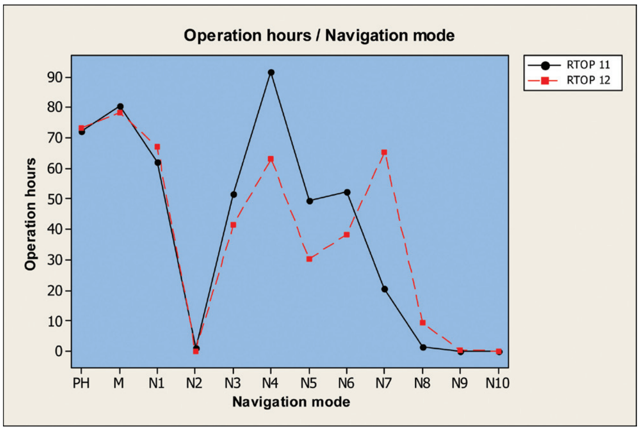

Image 1 Diagram of the intensity of exploitation of the engine M 504 B2

Slika 1. Dijagram intenziteta eksploatacije motora M 504 B2

Table 2.The average load of the engine M 504 B2 on the RTOP-11

Tablica 2. Prosječno opterećenje motora M 504 B2 na RTOP-11

M 504 B2 ENGINE AVERAGE LOAD ON RTOP-11 FOR cca 500 OPERATION TIME					
RPM		Engines power		Operation time	
		P [kW]	P_i[%]	[h]	t_i[%]
PH	750	295	8,00	72,25	14,94
M	750	295	8,00	80,42	16,63
N1	750	295	8,00	62,25	12,88
N2	900	405	11,00	01,25	0,26
N3	1000	700	19,00	51,58	10,67
N4	1200	1325	36,00	91,83	18,99
N5	1400	1620	44,00	49,58	10,25
N6	1500	2060	56,00	52,25	10,81
N7	1700	2650	72,00	20,58	4,26
N8	1800	2950	80,00	01,42	0,29
N9	1900	3270	89,00	00,08	0,02
N10	2000	3680	100,00	00,00	0,00
TOTAL				483,49	100,00

Table 3 The average load of the engine M 504 B2 on the RTOP-12

Tablica 3. Prosječno opterećenje motora M 504 B2 na RTOP-12

M 504 B2 ENGINE AVERAGE LOAD ON RTOP-11 FOR cca 500 OPERATION TIME					
RPM		Engine power		Operation time	
		P [kW]	P_i[%]	[h]	t_i[%]
PH	750	295	8,00	73,17	15,65
M	750	295	8,00	78,25	16,74
N1	750	295	8,00	67,17	14,37
N2	900	405	11,00	00,00	0,00
N3	1000	700	19,00	41,50	8,88
N4	1200	1325	36,00	63,33	13,55
N5	1400	1620	44,00	30,17	6,45
N6	1500	2060	56,00	38,58	8,25
N7	1700	2650	72,00	65,33	13,97
N8	1800	2950	80,00	09,50	2,03
N9	1900	3270	89,00	00,50	0,11
N10	2000	3680	100,00	00,00	0,00
TOTAL				467,50	100,00

[1] Empirical research the author made on 6 high speed radial diesel engines embedded on the rocket launchers of the Croatian Navy, while following their work through 2000 hours.

Based on the previously shown data in tables 2. and 3. a diagram of the average load of the high speed radial diesel engines M 504 B2 as the main engines (GM), embedded on the RTOP-11 and RTOP-12 were made (images 2. and 3.)

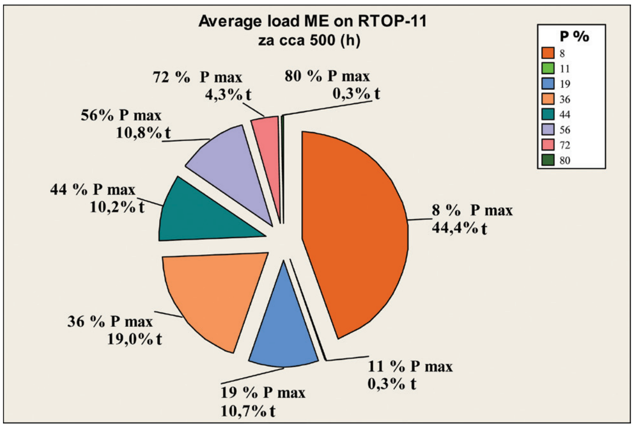

Image 2 Average load on RTOP-11

Slika 2. Prosječno opterećenje na RTOP-11

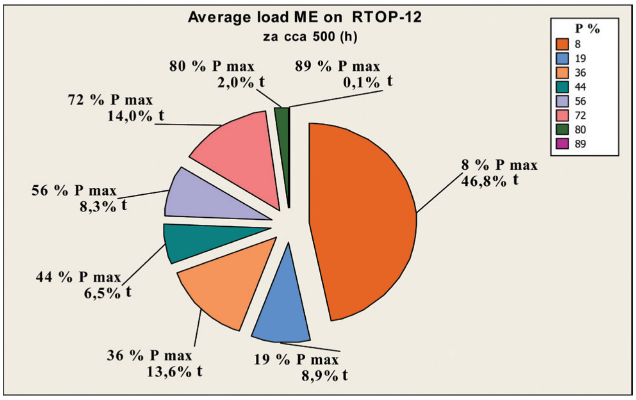

Image 3 Average load on RTOP-12

Slika 3. Prosječno opterećenje na RTOP-12

Based on the data shown in the previous tables and diagrams we can conclude the following:

1. High speed engines M 504 B2, build on the RTOP-11 and RTOP-12, in the period of 500 working hours they were mostly used in the basis of the work (empty walk, manoeuvre and 750 rpm regime), and that is, according to the engine manufacturer [9], extremely not favourably for the operating engine, because in the main regime they worked on approximately 45 % of their whole time, while on the 1500 and more regimes they worked on only 15 % on the RTOP-11 and 24 % on the RTOP-12.
2. This kind of inappropriate use of the engines is contrary to the recommendations of the manufacturer [9] for their use, and it can also cause the malfunction appearances and exploitation unreliability.

Since this is a phenomenon that is not in accordance with the manufacturer's recommendations [9], and the operational conditions of use and capabilities of the Croatian Navy demanded just such a use of the engine in real terms, this kind of occurrence was necessary to investigate in such operating conditions to determine the exploitation reliability of the high speed radial marine diesel engines M 504 B2.

3. NUMERICAL MODEL OF RELIABILITY / *Numerički model pouzdanosti*

The key feature of mechanical systems is its inability to enforce the assumption of constant failure intensity, i.e. in the mathematical modelling of such systems only one distribution is used - exponential distribution. In the references [2], [6] it is known that the mechanical parts of a mechanical system do not deteriorate with constant failure intensity as a function of time of the system, but the present and infinite growth failure intensity as a function of time of operation of complex technical system. This phenomenon is mainly caused by wear, creep, corrosion materials and the others, so with the phenomena which over time only increase the probability of failure. With the goal of researching the appearance of failure of complex technical systems it is necessary to research the behaviour of components and subsystems of the system during its exploitation, in this particular case of the high speed marine diesel engine. So that we could successfully investigate the exploitation reliability of the diesel, it is necessary to study its subsystems through block – diagram of the reliability of the system and primarily in the way the diesel engine shared, subsystems defined by the manufacturer or the constructor of the high speed radial diesel engine. The block-diagram of reliability of the diesel engine M 504 B2 was made on the basis of the technical documentation of the manufacturer of the engine [9] and it is showed on the image 4.

The block-diagram of the reliability shows graphical model of reliability of the high speed radial diesel engine M 504 B2, and as a model it is universally adjustable on any high speed marine diesel engine with smaller modifications depending on the type of the high speed diesel engine and its subsystems.

The complex system of the high speed radial engine M 504 B2 constitutes (according to the manufacturer) twenty – eight serial depending subsystems each consisting of assemblies, subassemblies and other elements. Reliability of the high speed diesel engine M 504 B2 is equal to the product of reliability of all subsystem of which it is composed, and it is described by the following expression [1], [2], [3]:

$$R_{M\,504\,B2}(t)=P(A_1)\cdot P(A_2)\cdot P(A_3)\cdot P(A_4)\cdot\ldots\cdot P(A_{27})\cdot P(A_{28}) \quad (1)$$

Reliability of the engine M 504 B2 as a system in serial connection is determined by the expression [1], [2], [3]:

$$R_{M504B2}=R_1\cdot R_2\cdot R_3\cdot\ldots\cdot R_{28}=\prod_{n=1}^{n=28}R_n \quad (2)$$

There is a difference in definition of ship subsystems as part of this study in relation to the frequent division of ship subsystems in order to analyse the reliability of the [3]. However, due to the credibility of the research there is further division of high speed radial diesel engine subsystems according to the manufacturers literature engine M 504 B2.

According to the technical description of the diesel engine M 504 B2 it is about next subsystems [9]:

- supply oil pump (A1)
- gear level (A2)
- turnover coupling (A3)
- fuel pipeline (A4)
- cylinder blocks (A5)
- pistons (A6)
- connecting rod (A7)
- crankshaft (A8)

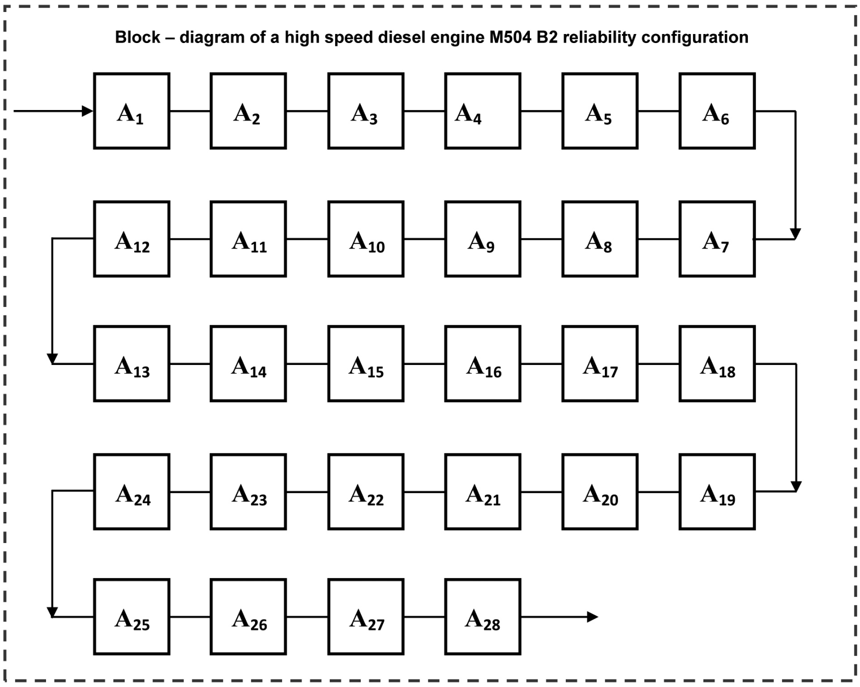

Image 4 Block-diagram of a diesel engine M504 B2 reliability configuration
Slika 4. Blok-dijagram konfiguracije pouzdanosti dizelskog motora M504 B2

- fuel block-pump (A9)
- distribution mechanism (A10)
- fuel block-pump management system (A11)
- exhaust duct (A14)
- mufflers of noise (A15)
- turbocharger (A16)
- air conductor (A17)
- aggregate set (A18)
- gear (A19)
- discharge oil pump from blocks (A20)
- engine block (A21)
- aggregate drive (A22)
- engine discharge fuel pump (A23)
- fuel injector (A24)

Why the exploitation reliability of a complex technical system is necessary to define, research on this particular way?

First of all, the results of research and empirical data collected during the study and the analysis of failures serve to constructors of diesel engines as well as experts involved in the maintenance of diesel engines in finding new construction and technological solutions (in this case high speed radial marine diesel engine), so they less spoiled and were capable in the harshest operating conditions to fulfil its mandate. The above is particularly true in technical systems combat purposes, the propulsion systems of combat ships certainly are.

Having defined the block diagram of reliability should be based on empirical data collected to determine the overall exploitative system reliability (high speed radial marine diesel engine) and its subsystems or components. Practically this means on the basis of empirical statistical sample collected to determine the characteristics of the life of the system and subsystems, on the assumption that the life of the technical system being tested belongs to a certain class of distribution such as exponential, Weibull, normal, lognormal, gamma, etc.

Assuming that Weibull distribution is the best fit for the empirical functions, based on current knowledge about the reliability of diesel engines in general, the testing will be carried out based on the empirical data collected with the help of the program package Minitab 16 and Anderson-Darling (AD) test.

On the image 5. the empirically studied the frequency of occurrence of failures on subsystems of the high speed radial diesel engine M 504 B2.

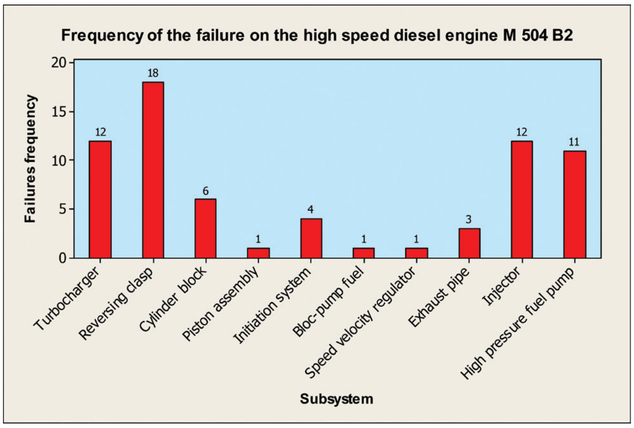

Image 5 Frequency of the failure on the high speed diesel engine M 504 B2
Slika 5. Učestalost kvara na brzom dizelskom motoru M 504 B2

For the purpose of the diagram in image 5. the empirical data, exempt from the shipping documentation, which is prescribed for the records of all changes related to the ship's systems used in the Croatian Navy[2], were used. Boat records make collection of data (relevant databases) which shall record the following data: hours of operation, carried out intervention and maintenance procedures, information on

[2] It is important to accent that during the research of reliability of the high speed diesel engine M 504 B2 only the failures which caused the inability of the use of the drive subsystems in a prescribed manner were considered.

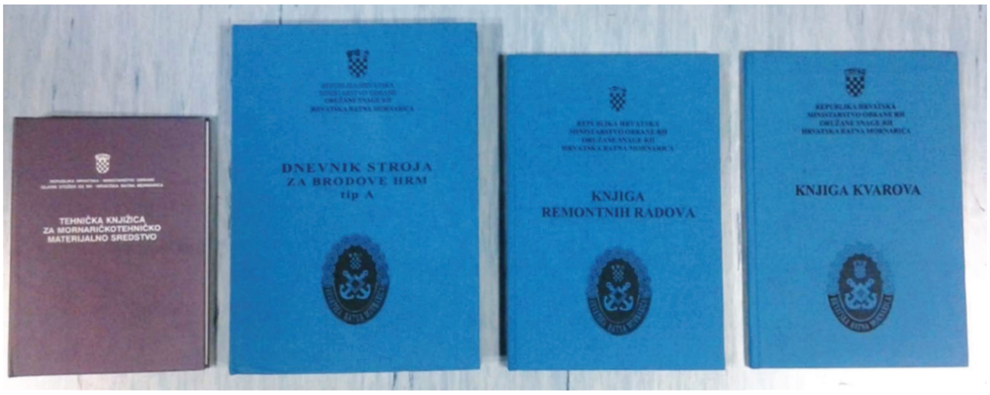

Image 6 Documents for the record of the state of exploitation on the high speed radial marine diesel engine on missile boats
Slika 6. Dokumenti za bilježenje eksploatacije brzog radijalnog brodskog dizelskog motora na raketnoj topovnjači

existing faults, planning procedures, availability of spare parts, special tools, etc. The database in the present study is made with the information contained in the following documents [8], [10], [11], [12], [13], [15]:

- technical booklet of diesel engines
- diary machine for ships of the Croatian Navy,
- book of repairs,
- book of failures.

The image 6. shows the aforementioned ship documents to record the state of exploitation high speed radial marine diesel engines on the rocket gunboats.

The whole exploitation reliability of a complex technical system (high speed radial marine diesel engine) is defined on the basis of the empirically collected sample and statistically determined characteristics of the life span of the system, proceeding from the earlier mentioned assumption that the life span of the technical system which is being tested belongs to the Weibull distribution.

The results of the research are showed with the diagram (image 7.), and were obtained with the use of the method of simulation (the model of simulation) are defined in the reference [2].

According to the literature "the mathematical model of simulation describes the work of a complex system via individual events which appear on the parts of the system, and the simulation is a form of random sampling model that belongs to the tested system" [2].

For example in the process of simulation of facilities maintenance, as stated in the above literature, the simulation input parameters are randomly varying sizes concerning the time of the failure and repair time for the failure. The more complex simulation models may include the intensity repairs, necessary spare parts, downtime due to the limited number of persons trained, status of equipment for maintenance and the like.

The most common kind of simulation today are performed on computers using specialized computer packages, and within this thesis in order of the statistical analysis of empirical data, the computer package Minitab 16th was used.

Test results relevant to the computer package show that Weibull distribution best approximates the empirical function of reliability Re (t), because it is only then the parameter p> 0.05. Comparative diagram of the reliability function R (t) obtained on the basis of approximations using the Weibull distribution and empirical functions of reliability Re (t) is shown in the image 7.

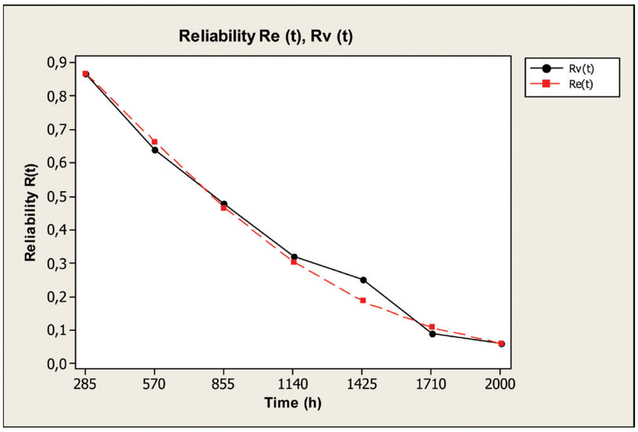

Image 7 Comparative diagram of the function of reliability R(t)
Slika 7. Komparativni dijagram funkcije pouzdanosti R(t)

On the image 8. the calculated parameters of Weibull distribution were showed, and the shape parameter, which is β =1,552 and the scale parameter, which is η = 981,7 hours.

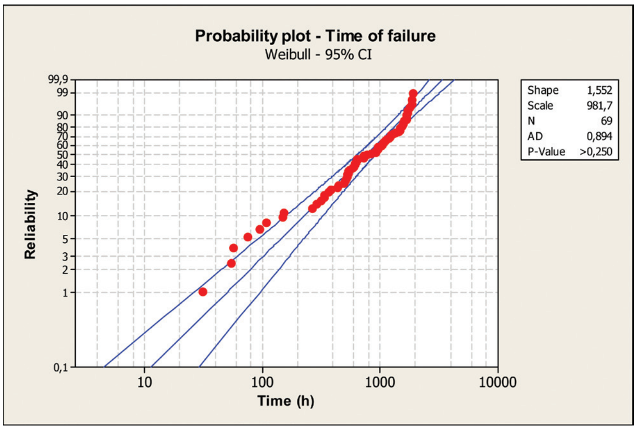

Image 8 The values of the parameters of Weibull distribution
Slika 8. Vrijednosti parametara Weibullove distribucije

Following the results shown in images 7. and 8. below are the summary data: the strength test, the parameters of particular distribution and the value of the mean time between failures MTBF.

Goodness of Fit Test

Distribution	AD	P
Normal	1,135	0,005
Exponential	3,289	<0,003
Gamma	1,129	0,008
Weibull	0,894	>0,250

ML Estimates of Distribution Parameters

Distribution	Location	Shape	Scale	Threshold
Normal*	888,93768		552,36601	
Exponential			888,93767	
Gamma		1,78285	498,60590	
Weibull		1,55200	981,68183	

Descriptive Statistics

N	N*	Mean	St Dev	Median	Minimum	Maximum
69	0	888,938	552,366	780	31,15	1900

The mean time between failures MTBF is 888,938 hours.

The main shortage of the use of this kind of form of simulation refers to the size of the sample, the credibility of the testing pf the set up hypothesis; in general .the bigger the sample the more authentic conclusion.

Specifically in this research the Anderson-Darling test is used and it can be applied on the testing of especially small samples (n_{min}=3), which is said in literature [4], [5]. No matter of the fact, in the case when it is about small sample, the model of reliability can be and is only approximate. Further research with the increase in the sample can tighten the shown results.

On the basis of previously said, and considering that before the said limit, the results of the research conducted on the sample of 6 high speed radial marine diesel engines M 504 B2 and 69 failures, which were recorded during 2000 working hours and cause the stagnation of the system, showed that the function of reliability of the researched complex technical systems according to [4], [5] is:

$$R_{motora} = e^{-\left(\frac{t}{\eta}\right)^{\beta}} = e^{-\left(\frac{t}{981,7}\right)^{1.552}} \quad (3)$$

The function of the failure intensity according to [4], [5] is:

$$\lambda_{motora} = \frac{1.552}{981,7} \cdot \left(\frac{t}{981,7}\right)^{1.552} \quad (4)$$

Thus the expected time without the failure E(T), which according to the relation 4.25 is 882.37 h, the level of reliability of the engine is 43% because:

$$R_{882,37h} = e^{-\left(\frac{t}{\eta}\right)^{\beta}} = e^{-\left(\frac{882,37}{981,7}\right)^{1.552}} = 0,427 \quad (5)$$

If the required level of reliability of the high speed radial diesel engine M 504 B2 is 85%, then the expected time without the failure of the engine M 504 B2 from the equation 1.3 is equal:

$$T = 300h$$

The results received on the basis of the 3., 4. and 5. relations represent the original data in terms of the calculated parameters, obtained based on the empirical research of the exploitation reliability of the high speed radial diesel engines.

The fact is that the results of reliability of the high speed diesel engine are obtained with the empirical research are not in conformity with the expected reliability which on the minimal level of researched systems is 85% and it represents threshold of operational capabilities for the Croatian Navy ships. Optimization of exploitation reliability of the high speed radial marine diesel engine is showed in the next point of this work.

4. OPTIMIZATION OF EXPLOITATION RELIABILITY OF THE HIGH SPEED RADIAL MARINE DIESEL ENGINE M 504 B2 / *Optimizacija pouzdanosti eksploatacije brzih radijalnih brodskih dizelskih motora*

With the operative use of material resources in Croatian Navy, there are three possible standbys, and consequently the speed of reaction of people and all systems of warships. Defined states include the levels of preparation and reliability of all elements which are included in the processes of response on the possible challenges. Demanded levels of operative ability are:

- Full operative ability
- Limited operative ability
- Minimal operative ability

Optimization of exploitation reliability of the high speed radial marine diesel engine is tightly bounded, completely determined with the demanded levels of operative abilities, as well as the ability of the correct use of complex technical systems that use the system in the manner as defined by the manufacturer.

In the table 4. The failures of the subsystem high speed radial marine diesel engine M 504 B2 are showed, divided according to the times of the occurrence of failure, and collected during conducted research of exploitation reliability.

Equally in the table 4. The time intervals in which the researched system, based on the empirical data, reaches the levels of reliability 0,85, 0,50 and 0,25, the intervals which determine the levels of operative ability are defined.

The failures considering the type and the time of occurrence are researched, for the different levels of reliability of the engine are defined with the demanding reliability of the weapon system. So, for the full operative ability the demanding level of reliability is 0,85 and the high speed radial marine diesel engine M 504 B2 keeps that level of reliability in the first 300 hours of work during the maintenance according to the recommendation of the manufacturer. The next threshold of reliability of the researched system defined with the parameter of operative ability which is 0,50, and it implicates limited operative ability of the weapon system and it is reached after 775 hours of work of the high speed radial marine diesel engine M 504 B2.

The last threshold of reliability is 0,25, and it ensures minimal operative ability, it is reached after 1200 hours of work.

Optimizing reliability of the high speed radial marine diesel engine M 504 B2 should be carried out by applying the relevant (changed) process of maintaining the systems that have been identified as critical just based on research exploitation

Table 4 The failures of the subsystems of the M 504 B2 engine

Tablica 4. Greške podsustava motora M 504 B2

Subsystem	Failure	∑ failures to 300 h	∑ failures to 775 h	∑ failures to 1200 h	∑ failures to 2000 h
Turbocharger	Rotor	0	0	1	2
	Control valve	0	0	1	1
	Labyrinth	0	1	1	2
	Gas router	0	1	1	1
	Seal marine	0	0	0	1
	Regulation screw	0	3	3	3
	Housing	0	0	0	2
Reversing clasp	Suport clasp	1	7	13	16
	Housing clasp	1	1	1	2
Cylinder block	Fuel leakage	0	1	1	1
	Compression leakage	1	1	1	1
	Emulsion in the cylinder	0	1	1	1
	Cylinder block fuel leakage	1	2	2	3
Piston assembly	Piston damage	0	1	1	1
Initiation system	Guide valve breakage	0	1	1	1
	Guide valve blocked	0	2	2	3
Bloc-pump fuel	Fuel lath	0	0	0	1
Speed velocity regulator	Spring regulator breakage	0	0	0	1
Exhaust pipe	Emulsion leakage	0	1	1	1
	Torn screw	1	1	1	2
Injector	Nozzle burned	1	1	1	1
	Nozzle leakage	2	5	8	10
High pressure fuel pump	Fuel leakage	2	3	6	10
	Managing mechanism blocked	0	1	1	1
Total		10	35	49	69
$R_{300} = 0{,}85$ $\quad R_{775} = 0{,}50$ $\quad R_{882{,}37} = 0{,}43$ $\quad R_{1200} = 0{,}25$					

reliability, which are defined during conducted research based on collected empirical data collected.

Optimization of reliability will ensure retention of full operational ability of the high speed radial marine diesel engine and a reliability level of 0,85 over 2000 hours of operation or to the general revision of engines and at the same time extend the time until the general revision of the engine depending on the results of new research.

CONCLUSION / *Zaključak*

The operative demands of the everyday ship propulsion systems on warships are defined with the parameters of minimal mass and the volume with maximum usable power, maximum safety and durability, as greater autonomy, optimal possibilities for manoeuvre, minimum noise and vibration, short-term willingness to get underway, elasticity and drive optimal economy in all loads. Additionally, high resistance to malfunctions and expressed ecological component in the execution of the set tasks conditioned on the one hand easier and more cost-effective marine engines with the possibility of developing high-power, and on the other hand emphasized the need for high reliability. The number of hours without cancelling work of the engine is recognized as the basic demand while watching the reliability of a complex technical system.

In implementation of the researching of reliability of the high speed radial marine diesel engine the empirical data from the documentation which are led on the ship were used. The leading of the specifically defined documentation for all works and every reference of the engine is provided from the code of the ship service. All malfunctions on ship engines and all procedures of diverse form of maintenance are logged in The Diary of the machine and especially in the Failure book. The processing of empirical data on failures of marine engines obtained from the ship's documents, and calculating the reliability function and the function of intensity of ship engine failure is possible to predict the expected time of work without failure marine engine and to plan preventive maintenance processes.

The results of the obtained research of exploitation reliability are received using of the method of simulation and checked through the computer package Minitab 16 which allows us desired statistical analysis and confirms or rejects empirically received results. The whole exploitation reliability of the high speed radial marine diesel engine is defined on the basis of the empirically collected sample and statistically determined characteristics of the life span of the system, coming from the assumption based on the research as a life span of technical system in question belongs to the Weibull distribution with specifically determined parameters.

Results of the testing of the empirical data show that the Weibull distribution approximates the best the empirical function of reliability Re(t), because it is only then when the parameter p>0,05 is the most optimum result of the Anderson-Darling test.

Weibull distribution indicates ever growing failure intensity as a function of time of operation of a complex technical system which is very characteristic for the mechanical parts as opposed to the electronic parts which characteristically have a constant failure intensity. This kind of occurrence is caused by failure of the mechanical parts, and it is manifested as a consequent wear, creep and tear, corrosion, chemical changes, etc., i.e. the process that eventually, while the technical system works, only increases the possibility to cause a failure of a technical system. While researching, the reliability time was defined as a main parameter and a measure of efficiency of a technical system. That kind of operative ability and availability of the system as a unity increases the shorter time of jam, therefore, in terms of reliability and maintenance two facets are considered, preventive maintenance through capacity was maintained in operating condition prevention (preventing the occurrence of the fault) due to various processes and corrective maintenance as well as the ability to return to operating mode as soon as possible after the occurrence of the fault. Reliability of the technical system is defined as the ability to work without faults in a predefined period of time, while maintaining the convenience of the ability to maintain the technical system (through preventive maintenance) or return (through corrective maintenance) in proper operating condition and it is a structural feature of the technical system. Reported methodology for determining reliability, shown on a concrete example propulsion engine RTOP shows are undoubtedly applicable to similar technical systems.

Empirical data collected by the researching of exploitation of the high speed radial marine diesel engine are presented in this work, and the results achieved with their analysis are of great relevance for positioning critical components of characteristic technical system from the viewpoint of reliability and optimal intervals of preventive change for critical components, in order to ensure maximum reliability and retention of the required operational capabilities. In order to achieve that in further research, based on the results, it is necessary to define the revised intervals of preventive change for the critical parts or modify the procedures for preventive maintenance with respect to those defined by the engine manufacturer. It is important to emphasize that the usual procedure is that those intervals are prescribed considering the previous experiences, optimizing depending on the empirically collected data during the exploitation of the technical complex system such as definitely high speed radial marine diesel engine.

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