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NUMERICAL RESEARCH IN THE FIELD OF PREVENTIVE MAINTENANCE OF TECHNICAL SYSTEMS

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Abstract: Reliability-based maintenance is the set of actions and measures undertaken in order to establish the program and content of preventive maintenance works to be carried out in order to maintain and restore when necessary, the proper functioning of a technical system, in terms of maximum efficiency of use. Theoretical approaches to the premises of Preventive Maintenance based on reliability and develop practical research model of preventive actions on the influence of parameters of reliability in case of technical systems, regardless of these complexities. By practical character, metadata and the model developed can stay out of reach of any specialist working in the domain mentenability and reliability of technical systems with the idea of adopting the most appropriate strategies and action planning.

Key words: *Reliability, Maintainability, Equipment's reliability..*

1. INTRODUCTION

The frequency of preventive interventions in the framework of preventive Maintenance based on time is determined by the category and the technical condition of the system, suppliers of equipment, recommendations for safety standards, for deficiencies in the checks on a regular basis and the results of modern methods of diagnosis and/or interpretation of technical data obtained amterior [6].

Thus, through the combination of the intrinsic properties of the system-type wear and those of the intervention-type operations and moments of renewal, it follows its prophylactic strategy system. The two components are the defining elements of Preventive Maintenance based on Reliability.

2. SUMMERY

Or Ri (x) function of reliability of technical system within the range of the renewal of ' i-1 ' and ' i '. Depending on the system's behavior after a renewal (re-operation after a failure), we can distinguish the following types of renewals [2]:

A. *Renewals itself*, are those that bring the renewal system always in the same State, thus eliminating the accumulated wear from previous renewal.

$$R_1(x)= R_2(x)= R_3(x)...= Rn\ (x)= R\ (x) \qquad (1)$$

B. *Renewals are positive,* those renewals that contribute to improve the reliability of the system, their action being countered by the effect its wear and tear, so that after the renewal of the system reliability decreases.

$$R_1(x) > R_2(x) > R_3(x)... > R_n\ (x) >... \qquad (2)$$

C. *Negative,* renewal are those renewals that bring the system to a previous state of superior reliability. In this case the relationship is valid:

$$R_1(x) < R_2(x) < R_3(x)... < R_n\ (x) <... \qquad (3)$$

Referring to preventive, renewals that are found as a result of this renewal process, the system is completely transformed, so that after each renewal, we are dealing with a new improved indicators of reliability, but the same trend of reliability [2], [5].

It aims to analyze the hypothetical of a technological system, established as a flexible manufacturing robotic system, consisting of 3 machine tools NC, 2 robots handling and transfer system, a total of 6 functional technical units, viewed as repairable subsystems. For those functional units, 6 notations used are: MU1 – Tool machine 1; R1 – Robot 1; MU2 - Tool machine 2; R2 - Robot 2; M3 - Tool machine 3; ST – Transfer System.

It accepts that the repairabile system is composed of simple elements repairable-what are dependent on fiabilistic (the failure of an element influencing the functioning of the whole system) with negligible recovery time, or: $t_{ri} \rightarrow 0. \mid i = 1, n$. In this case the availability will depend only on the overall reliability of the system.

For virtual system chosen for the analysis, it recalls the following fiabilistic data, monitoring for each of the functional systems of the complete menu tree, plunging the following marking:

- *Time moments*, t_i (in days) in which it was interrupted for technical operation of the system, considering only those switches that were followed by corrective actions aimed at restoring the operation of the system; string value's tag are:

  tj=[155 210 350 385 420 505 610 702 775 802 825 850 910 992 1020 1104 1170 1240 1265 1295 1310 1365 1390 1475 1510 1590 1620 1685 1710 1765 1795 1812 1868 1905 1930 1970 1990 2010 2065 2095 2140 2165 2198 2214 2245 2275 2305 2332 2380 2436];
- Number of registrations: n=50;
- *J* the current number of registrations.
- *Duration of the corrective actions*, $\mathbf{T_{ri}}$ (expressed in minutes), for reinstatement in the operation of the system; string values Tr_j is:

  Trj=[15 22 124 420 520 12 42 75 540 60 15 22 480 68 60 48 12 15 220 320 110 480 60 480 32 48 12 30 45 120 360 480 24 30 115 30 120 15 45 25 240 30 45 90 90 36 48 60 120 360];
- The duration in days of each intervention is equivalent to the relationship:

  $Tr(k)=w* Tr_j =(1/60)*(1/24)$;
- Within the framework of the follow-up of 8 years were taken into account in working days only, approximately 2400 equivalent days.

As a result of the proposed numerical data in the work [3] have completed the following steps:

- Determining the distribution of operating time and repair time for each intervention and plotting histograms for two variables;
- Modelling of technical system reliability based on Weibull distribution function;
- Determining the parameters λ_w and β of functional reliability, proven to be the type of the Weibull distribution;
- Trace functions, reliability and function of technical system for nefiabilitate;
- Modeling of mentenabilitatii according to the components and trace reliability charts globally-compared to each subsystem component reliability.

2.1 System reliability indicators

For the determination of system reliability indicators, based indicators listed in the paper [3], will proceed in the following theoretical magazine [1]:

a) **P** – <u>the probability of success (operating)-</u> the probability that the system to accomplish the specified function*:*

$$P = \frac{\mu_e}{\lambda_e + \mu_e} = 1 - q_e \;, \qquad (4)$$

b) **Q –** <u>the probability of failure (refused)-</u> *the probability that the system does not carry out the function specified:*

$$Q = \frac{\lambda_e}{\lambda_e + \mu_e} = q_e \;; \quad Q = 1 - P \qquad (5)$$

c) $M[\alpha(T)]$ – <u>the average total length of success-</u> *the average amount of total operating time (0, T), also called reference period T [operating hours/year]*

$$M[\alpha(T)] = P \cdot T \quad \text{[ore /an]}; \qquad (6)$$

d) $M[\beta(T)]$ – <u>the average total length of failure-</u> *the average amount of total downtime within the time (0, T), also called reference period T [hours downtime per annum]*

$$M[\beta(T)] = Q \cdot T \quad \text{[hours /year]}; \qquad (7)$$

e) $M[\nu_R(T)]$ – The <u>average number of interuptions removed by repair,</u> *on a duartă T time [hours/year (years)]; -the* *average number of trips of operating conditions in States of downtime in the interval [0, T],* return status success making the repairs and/or replacement. [number of outages/year]

$$M[\nu_R(T)] = P \cdot \lambda_e \cdot T = (1-Q) \cdot \lambda_e \cdot T \qquad (8)$$

or:

$$M[\nu_R(T)] = Q \cdot \mu_e \cdot T = (1-P) \cdot \mu_e \cdot T \qquad (9)$$

f) $M[T_f]$ - <u>average duration of a State of success during the time T-</u> *the average value of the run time of a system from commissioning until the first flaw.*

$$M[T_f] = \frac{M[\alpha(T)]}{M[\nu_R(T)]} = \frac{P \cdot T}{P \cdot \lambda_e \cdot T} = \frac{1}{\lambda_e} \quad \text{[hours]} \qquad (10)$$

g) - <u>average duration of a state of failure,</u> eliminated by repair and/or replacement - *the average amount of time between two consecutive operating conditions durrepairedich the system repair (or replace element)*

$$M[T_d] = \frac{M[\beta(T)]}{M[\nu_R(T)]} = \frac{Q \cdot T}{Q \cdot \mu_e \cdot T} = \frac{1}{\mu_e} \qquad (11)$$

h) $R(t, t+t_f)$ - <u>the likelihood of continuous operation</u> on a given interval of time $(t, t+t_f)$ - the probability that a system is in working order at time t to rămană in this State in the time interval $(t, t+t_f)$ - actually represents *"the function of reliability interval".*

$$R(t, t+t_f) = \frac{\mu_e}{\lambda_e + \mu_e} \cdot e^{-\lambda_e \cdot t_f} = P \cdot e^{-\frac{t_f}{M[T_f]}} \qquad (12)$$

i) $M[\nu_{tc}(T)]$ - <u>the average number of faults removed</u> by repair-and/or replacement during the reference period T, the duration of which exceeds a critical t_c.

$$M[\nu_{tc}(T)] = M[\nu_R(T)] \cdot e^{-\frac{t_f}{M[T_f]}} \qquad (13)$$

or: $$M[\nu_{tc}(T)] = M[\nu_R(T)] \cdot e^{-\lambda_e \cdot t_f} \qquad (14)$$

Technical review system has gone further in the calculation of the operating indicators based on MATLAB, spreadsheet program below [1].

The calculation of the operating times

```
tj=[155 210 350 385 420 505 610 702 775 802 825 850 910 992 1020 1104 1170 1240 1265 1295 1310 1365 1390 1475 1510 1590 1620 1685 1710 1765 1795 1812 1868 1905 1930 1970 1990 2010 2065 2095 2140 2165 2198 2214 2245 2275 2305 2332 2380 2436];
Trj=[15 22 124 420 520 12 42 75 540 60 15 22 480 68 60 48 12 15 220 320 110 480 60  480 32 48 12 30 45 120 360 480 24 30 115 30 120 15 45 25 240 30 45 90 90 36 48 60 120 360];
n-50;
Ltf=1:1:n;
Ltf(1)=tj(1);
for k=2:n
Ltf(k)=tj(k)-tj(k-1);
end
MUT=sum(Ltf)/n %[ Total days of operation]
Ltr=1:1:n;
w=(1/60)*(1/24); %[ conversion minutes to days]
for k=1:n
Ltr(k)=w*Trj(k); %[zile]
End
MDT=sum(Ltr)/(n-1) %[ Total days of repairs]
LAMBDA = 1/MUT
MIU=1/MDT
p=MIU/(LAMBDA+MIU)
q=LAMBDA/(LAMBDA+MIU)
Beta =1.4631;
Landa =2.6270e-005;
Qs=1:1:n; Ds=1:1:n;
for k=1:n
Ds(k)=p*exp(-(Landa)*(tj(k)^Beta));
Qs(k)=q*(1-exp(-(Landa)*(tj(k)^Beta)));
end
subplot (2,1,1); plot(tj,Ds,'b'); axis([0 2400 0 1.]);grid
legend('  AVAILABILITY OF TECHNOLOGICAL SYSTEM’);
subplot (2,1,2); plot(tj,Qs,'r'); grid
legend(AVAILABILITY  OF  TECHNOLOGICAL SYSTEM’);
```

As a result of numerical calculation were obtained the following data:

- MUT = 48.7200 - average days of operation between the two falls;
- MDT=0.0974 - average days of repairs between the two falls;
- LAMDA=0.0205 - intensity of the falls [zile^{-1}];
- MIU=10.2707 - the intensity of the repair on the system [days^{-1}];
- P=0.9980 - the probability of success (System reliability);
- Q=0.0020 - the probability of failure (nefiabilitatea);

On the basis of the same file for calculating function was determined by the availability and unavailability of the system function, rendered graphically in Figure 1.

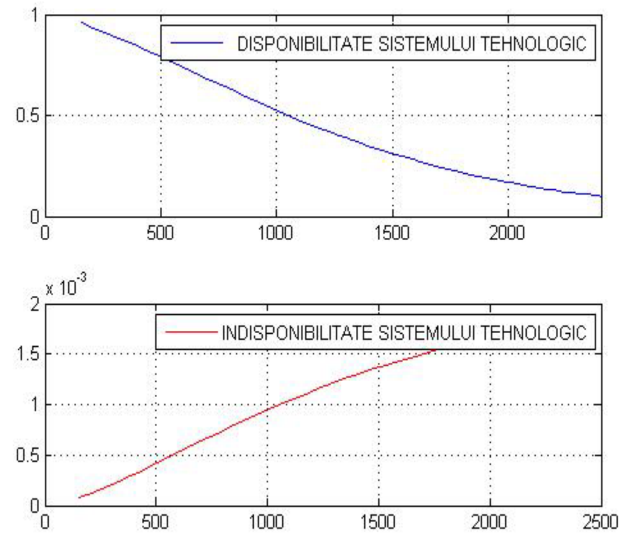

Fig. 1. Graphical representation of the function of availability and unavailability of the system function review

2.2 Mentainability modeling based on the number of renewals

In the presence of preventive maintenance, under the action of renewals-reliability function takes the form:

$$R_r(t) = e^{-\lambda\cdot(r+1)^{(1-\beta)}\cdot t^{\beta}} \qquad (15)$$

where:

r - the number of renewals of the preventive system.

It was studied the influence of the number of renewals, r, on the variation in time of the reliability function (15) for a period of time.

It has initiated this study for different values of the number of renewal at the same time made and amount of time, in the range t_i [155 ¸ 2400 days], at all 6 functional subsystems of technological system:

r =0 , 5, 10, 20, in interval:

t_i [155 ¸ 2400 days]:

β - Beta = 1.4631; % [days]

λ_0 - LAMDA = 2.6270e-005; %[days]

P_0 = 0. 9980,

What parameters were determined in the previous stages.

MATLAB program shown below resulted graphs tool reliability $R_r(t)$ Depending on the number of renewals, shown in Figure 2. From the analysis of the obtained results it is observed clearly increase reliability of technical system with the increase in the number of renewals, considering the system as a whole.

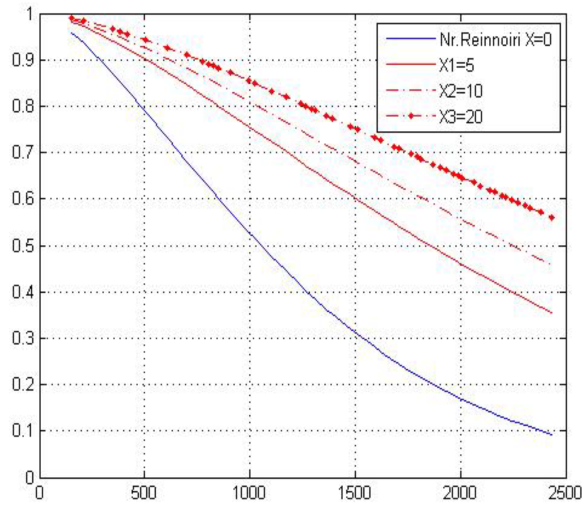

Fig. 2. Influence on the number of renewals over the reliability of the system

The calculation of the number of renewals of the reliability

```
tj=[155 210 350 385 420 505 610 702 775 802 825 850 910
992 1020 1104 1170 1240 1265 1295 1310 1365 1390 1475
1510 1590 1620 1685 1710 1765 1795 1812 1868 1905
1930 1970 1990 2010 2065 2095 2140 2165 2198 2214
2245 2275 2305 2332 2380 2436];
n=50;
LAMDA =  2.6270e-005; %[zile]
Beta =    1.4631; % [zile]
p0 =    0. 9980;
X=0; X1=5; X2=10; X3=20;
for k=1:n
RN(k)=p0*exp(-LAMDA*(tj(k)^Beta));
RM1(k)=p0*exp(-(LAMDA)*((X1+1)^(1-
Beta))*(tj(k)^Beta));
RM2(k)=p0*exp(-(LAMDA)*((X2+1)^(1-
Beta))*(tj(k)^Beta));
RM3(k)=p0*exp(-(LAMDA)*((X3+1)^(1-
Beta))*(tj(k)^Beta));
end
plot(tj,RN,'b',tj,RM1,'r',tj,RM2,'r-.',tj,RM3,'r-..')
% axis([0 2920 0. 1. 0 1750 0. 1. 0 1750 0. 1.])
legend('Nr.Reinnoiri X=0','X1=5','X2=10','X3=20')
grid
```

If, at the moment $t=T_0$ the system is in operation, the likelihood of functioning for a period of time $T_1 = T_0 + \Delta T_1$, involves taking into account simultaneously of two independent events: at the time of operation $t=T_0$ and uninterrupted operation ΔT_1 zile – thus:

$$P_1(T_1) = P_1(T_0, T_0+\Delta T_1) = P_0(T_0) * P_1(\Delta T_1) \qquad (16)$$

or:

$P_2(T_2) = P_2(T_1, T_1+\Delta T_2) = P_1(T_1) * P_2(\Delta T_2) = P_0(T_0) * P_1(\Delta T_1) * P_2(\Delta T_2)$

………………………………………………… ………………………………

$P_n(T_n) = \ldots\ldots\ldots = P_0(T_0) * P_1(\Delta T_1) * P_2(\Delta T_2) * \ldots\ldots\ldots P_n(\Delta T_n)$

or:

$$Pn(Tn) = P0(T0) \prod_{i=1}^{n} Pi(\Delta Ti) \quad (17)$$

where:

$P_i(\Delta T_i) = \exp[- \lambda_i (r_i +1)(1 - \beta) *\Delta T_i^{\beta}]$

| i=1,n (18)

Replacing the relationship (18) to (17), shows the probability of the operation of the system on the time interval: $T_n = T_{n-1} + \Delta T_n$, depending on the number of renewals per time interval ' ri | i=1,n ' :

$$P_n(T_n) = P_0(T_0) \prod_{i=1}^{n} exp\, [-\lambda_{i-1}(r_i + 11-\beta*\Delta Ti\beta] \ | \ i=1,n \quad (19)$$

$$\text{for:} \quad \lambda_i = \lambda_0 \prod_{j=1}^{i} (r_j + 1)^{(1-\beta)} \quad (20)$$

and expending the product 'π exp(…)', results the following recurrence relation for calculation of probability of P_n, of the system with:

ΔT_i - time periods, each with a number of r_i – renewals for | i=1,n

$$P_n = P_0 \exp\{-\lambda_0 \sum_{i=1}^{n} [\prod_{j=1}^{i} (r_j + 1)^{1-\beta} * \Delta Tj\beta]\}$$

(21)

Based on analysis of data from each functional unit: exploatara Machine Tool 1 (MU1), Robot R1, Machine Tool 2 (MU2), Robot R2, Machine Tool 3 (MU3) and the Transfer System (ST) and the assumption that each component element has a function of reliability that follow a Weibull distribution shape:

$$R_i(t) = e^{-\lambda_i^{\beta i} \cdot t} \quad \text{i=1,2,..,6} \quad (22)$$

The statistical processing of data on the basis of the above models, it follows the parameters of reliability and scale coefficients/shape of components, nominated by table 1.

Parameter values for the Weibull function 6 functional units of the system **Tab. 1**

UNITS	P_0	Beta	Landa
MU1	0.947	1.3285	6.6997e-005
R1	0.832	1.3315	5.8791e-005
MU2	0.815	1.5388	1.4137e-005
R2	0.925	1.3474	5.7769e-005
MU3	0.859	1.4709	2.3862e-005
ST	0.876	1.4888	2.1559e-005

On the hypothesis, a maintenance function on each functional unit of the system, form (22), you can write the relationship:

$$R_i(t) = \exp\left[-\lambda_i (r_i + 1)^{(1-\beta_i)} \cdot t^{\beta_i}\right] \ | \ i = 1,2,...,6 \quad (23)$$

with : r_i - the number of renewals per component i = 1,2,...,6

Thus, it was possible to calculate the parameters of the reliability and availability of the system at a given time or time interval, based on the number of renewals per functional unit of the system.

In the hypothesis in which are known:

P_{10} ; P_{20}; P_{30} ; P_{40} ; P_{50}; P_{60} - *probabilities fiecăreii units operating at the time of* $T_0 = 0$,

λ_i ; β_i | i=1,2,...,6 - the parameters of the Weibull distribution unit;

You can calculate the probabilities of operation P_i, each functional unit and full system at the end of a period of time Δt ', depending on the number of renewals 'r_i' each functional unit 'i ', with relations:

$$P_i(\Delta t) = P_{i_0} \cdot \exp\left[-\lambda_i (r_i + 1)^{(1-\beta_i)} \cdot (\Delta t)^{\beta_i}\right] \ | \ i = 1,2,...,6 \quad (24)$$

or:

$$P_L(\Delta t) = \prod_{i=1}^{3} P_i(\Delta t) = \prod_{i=1}^{3} P_{i_0} \cdot exp\left[-\lambda_i (r_i + 1)^{(1-\beta_i)} \cdot (\Delta t)^{\beta_i}\right] \quad (25)$$

with: r_i – variabil

All based on relationships (24) and (25) could study these parameters and the variance at the end of a range Δt , or the range Δt = [t_1... t_n] .It is observed that the function of reliability in the range (0, t) depends only on the intrinsic characteristics of reliability of system [4]. Reliability function in the interval (t, t, Δt) depends on both the intrinsic reliability of the system, as well as those of its maintenance service. The function of reliability within system capacity expressed to fulfill a mission well located in time.

To be able to meet the technical system availability analysis and its components, on the basis of relationships (24) and (25) was calculated reliability parameters of the functional unit for a time interval ΔT = 600 days (2 years), under the assumption of a different number of interventions (renews) 'r_i '- preventive maintenance i = 0, 2, 6, 12 on components-results are presented in table 2.

The reliability of components and overall system depending on the number of renewals at the end of a reference period of 600 days **Tab. 2**

UNITS	P0	R1 ri=0/0/0/0/0/0	R2 ri=2/2/2/2/2/2	R3 ri=6/6/6/6/6/6	R4 ri=12/12/12/12/12/12
MU1	0.947	0.4148	0.4907	0.5326	0.5989
R1	0.832	0.3970	0.4976	0.5390	0.5821
MU2	0.815	0.3759	0.5649	0.6431	0.6711
R2	0.925	0.4099	0.5977	0.6493	0.6824
MU3	0.859	0.3833	0.6448	0.6749	0.7086
St	0.876	0.3828	0.6779	0.7120	0.7403
P		0.0037	0.0360	0.0576	0.0837

The graphics of the influence of the system components and renewals on the total system, the following: a preventive maintenance-free and b-with preventive maintenance, with 12 renewals, respectively, are shown in Figure 3 and 4.

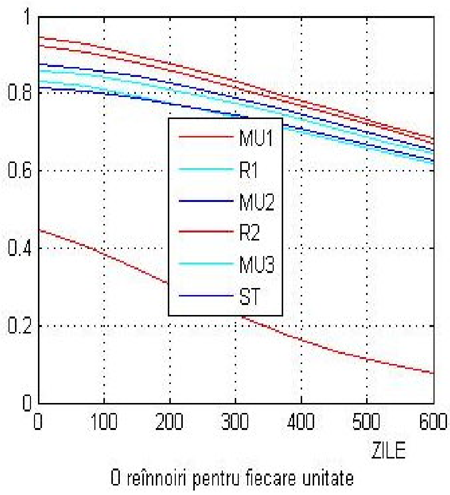

Fig. 3. Variation in reliability and global system components, if no preventive renewals

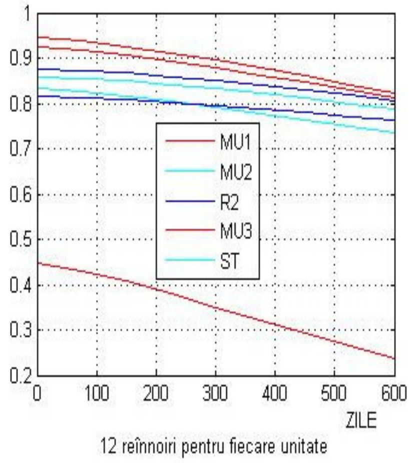

Fig. 4. The variation system reliability and global components in the case of 12 preventive renewals

The calculation of the number of rough system renewals **Tab. 3.**

```
P10=0.947; % MU1
P20=0.832; % R1
P30=0.815; % MU2
P40=0.925; % R2
P50=0.859; % MU3
P60=0.876; % ST
% Weibull parameters
L1=6.6997e-005; B1=1.3285; % MU1
L2=5.8791e-005; B2=1.3315; % R1
L3=1.4137e-005; B3=1.5388; % MU2
L4=5.7769e-005; B4=1.3474; % R2
L5=2.3862e-005; B5=1.4709; % MU3
L6=2.1559e-005; B6=1.4888; % ST
% Reinnoiri
%Varianta I
r11=0; r21=0; r31=0; r41=0; r51=0; r61=0;
%Varianta II
r12=2; r22=2; r32=2; r42=2; r52=2; r62=2;
%Varianta III
r13=6; r23=6; r33=6; r43=6; r53=6; r63=6;
%Varianta IV
r14=12; r24=12; r34=12; r44=12; r54=12; r64=12;
t=[0 75 150 225 300 375 450 525 600]; % zile
%Varianta I
for k=1:9
   P11(k)=P10*exp(-L1*((r11+1)^(1-B1))*(t(k)^B1));
   P21(k)=P20*exp(-L2*((r21+1)^(1-B2))*(t(k)^B2));
   P31(k)=P30*exp(-L3*((r31+1)^(1-B3))*(t(k)^B3));
   P41(k)=P40*exp(-L4*((r41+1)^(1-B4))*(t(k)^B4));
   P51(k)=P50*exp(-L5*((r51+1)^(1-B5))*(t(k)^B5));
   P61(k)=P60*exp(-L6*((r61+1)^(1-B6))*(t(k)^B6));
   P1(k)=P11(k)*P21(k)*P31(k)*P41(k)*P51(k)*P61(k);
End
% Varianta II
for k=1:9
   P12(k)=P10*exp(-L1*((r12+1)^(1-B1))*(t(k)^B1));
   P22(k)=P20*exp(-L2*((r22+1)^(1-B2))*(t(k)^B2));
   P32(k)=P30*exp(-L3*((r32+1)^(1-B3))*(t(k)^B3));
   P42(k)=P40*exp(-L4*((r42+1)^(1-B4))*(t(k)^B4));
   P52(k)=P50*exp(-L5*((r52+1)^(1-B5))*(t(k)^B5));
   P62(k)=P60*exp(-L6*((r62+1)^(1-B6))*(t(k)^B6));
   P2(k)=P12(k)*P22(k)*P32(k)*P42(k)*P52(k)*P62(k);
end
% Varianta III
```

```
for k=1:9
   P13(k)=P10*exp(-L1*((r13+1)^(1-B1))*(t(k)^B1));
   P23(k)=P20*exp(-L2*((r23+1)^(1-B2))*(t(k)^B2));
   P33(k)=P30*exp(-L3*((r33+1)^(1-B3))*(t(k)^B3));
   P43(k)=P40*exp(-L4*((r43+1)^(1-B4))*(t(k)^B4));
   P53(k)=P50*exp(-L5*((r53+1)^(1-B5))*(t(k)^B5));
   P63(k)=P60*exp(-L6*((r63+1)^(1-B6))*(t(k)^B6));
   P3(k)=P13(k)*P23(k)*P33(k)*P43(k)*P53(k)*P63(k);
end
% Varianta IV
for k=1:9
   P14(k)=P10*exp(-L1*((r14+1)^(1-B1))*(t(k)^B1));
   P24(k)=P20*exp(-L2*((r24+1)^(1-B2))*(t(k)^B2));
   P34(k)=P30*exp(-L3*((r34+1)^(1-B3))*(t(k)^B3));
   P44(k)=P40*exp(-L4*((r44+1)^(1-B4))*(t(k)^B4));
   P54(k)=P50*exp(-L5*((r54+1)^(1-B5))*(t(k)^B5));
   P64(k)=P60*exp(-L6*((r64+1)^(1-B6))*(t(k)^B6));
   P4(k)=P14(k)*P24(k)*P34(k)*P44(k)*P54(k)*P64(k);
end
figure % reprezentare grafica
subplot(2,2,1)
plot(t,P11,'r',t,P21,'c',t,P31,'b',t,P41,'r',t,P51,'c',t,P61,'b',t,P1,'r')
grid
legend('MU1','R1','MU2','R2','MU3','ST')
subplot(2,2,2)
plot(t,P12,'r',t,P22,'c',t,P32,'b',t,P42,'r',t,P52,'c',t,P62,'b'')
grid
legend('MU1','MU2','R2','MU3','ST')
subplot(2,2,3)
plot(t,P13,'r',t,P23,'c',t,P33,'b',t,P43,'r',t,P53,'c',t,P63,'b'')
grid
legend('MU1','MU2','R2','MU3','ST')
subplot(2,2,4)
plot(t,P14,'r',t,P24,'c',t,P34,'b',t,P44,'r',t,P54,'c',t,P64,'b',t,P4,'r')
grid
legend('MU1','MU2','R2','MU3','ST')
```

In data analysis, one notices at the end of the 600 days, a growing likelihood of operation-by increasing the number of preventive interventions on its components.

3. CONCLUSION

Through the combination of the intrinsic properties of the every system technology-type wear and those of the intervention-type operations and moments of renewal, it follows the strategy for prophylactic system, the two components being the defining elements of Preventive Maintenance based on Reliability.

Starting from the determination of reliable indicators of a virtual system technology, developed at the level of numerical programs in MATLAB environment, the model of the research and analysis of the influence of applied preventive maintenance actions, in order to increase their efficiency and reliability of the system.

The proposed analysis method and model of calculation developments make it possible to determine, depending on the number of renewals per functional unit of the system, the most important of reliability parameters and the variation of reliability and availability functions of the system.

By dint of practically metadata and the model developed can stay out of reach of any specialist working in the manteinability and the reliability domain of technical systems with the idea of adoption of the most appropriate strategies and action planning.

4. ACKNOWLEDGMEND

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CERCETARI NUMERICE IN DOMENIUL MENTENANTEI PREVENTIVE A SISTEMELOR TEHNICE

Rezumat: Mentenanța bazată pe fiabilitate reprezintă ansamblu de acțiuni şi măsuri realizate cu scopul de a stabili programul şi conținutul lucrărilor de mentenanță preventivă ce trebuie executate pentru a menține şi eventual restabili, atunci când este necesar, starea de bună funcționare a unui sistem tehnic, în condițiile eficienței maxime a utilizării lui. Lucrarea abordează teoretic premisele *Mentenanței Preventive Bazate pe Fiabilitate* şi dezvoltă modelul practic de cercetare a influenței acțiunilor preventive asupra parametrilor de fiabilitate în cazul sistemelor tehnice, indiferent de complexitatea acestora. Metoda de analiza propusa şi modelul de calcul elaborat fac posibil determinarea, în funcție de numărul de reînnoiri, pe fiecare unitate funcțională a sistemului, a celor mai importanți *parametri de fiabilitate* şi a variației funcțiilor: *fiabilitate* şi *disponibilitate* a sistemului. Prin caracterul practic, metoda şi modelul elaborate pot sta la îndemâna oricărui specialist ce activează în domeniul mentenabilității şi fiabilității sistemelor tehnice, în ideea adoptării celei mai adecvate strategii de planificare şi acțiune.

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