Trakia Journal of Sciences, Vol. 4, No. 4, pp 70-75, 2006

Available online at:
http://www.uni-sz.bg
ISSN 1312-1723

***Original Contribution***

# RESEARCH OF DATA DISTRIBUTION

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**ABSTRACT**

Using of risk technical systems is connected to the investigation of the distribution of the values from the measured parameters. That is defined by the technical impossibility for their complete recovery. As a result the average value $\overline{\Pi}_j = \overline{\Pi}_j(t)$ of the parameters values is function of the period of technical usage. Analogical to that process, the values from the dispersion measurements $D = D(t)$ and its root-mean square diversion $\sigma = \sqrt{D(t)}$ are functions of the period of technical exploitation. The present article is investigated a real exploitation distribution of the power of the transmitter of a communication information system.

**Key words**: technical usage, risk technical systems, data distribution

## INTRODUCTION

At the control measurements of risk technical systems (RTS) we determine the inevitable aging process of the running values of their parameters $\Pi_j$. They change around average value $\overline{\Pi}_j$ at transverse section of the current time $t$. As a result the average values of the measured parameters $\overline{\Pi}_j = \overline{\Pi}_j(t)$ are functions of the time of technical usage (TU). Analogical are the processes at the used measurement instruments for control of RTS. At them the disperse of relative error of each periodic series of control measurements $D = D(t)$ and its root-mean square $\sigma = \sigma(t) = \sqrt{D(t)}$ are also functions of the current exploitation time $t$. The normal work of RTS is influenced also by many human factors [5, 6]. In that sense in the present work is proposed investigation of concrete data for RTS.

## PROBLEM FORMULATION

According to theory of errors, the low of distribution for measurement values on parameter $\Pi_j$ for every series periodicals controls measurements (in transverse section) stiffly is approximated from the normal law of distribution [1, 2]. For report of time dependences $\Pi_j$ and $\sigma$ of current time $t$, this low has aspect [4]:

$$y(\Pi, t) = \frac{1}{\sigma(t)\sqrt{2\pi}} . \exp\left\{ -\frac{\left[\Pi - \overline{\Pi}(t)\right]^2}{2\sigma^2(t)} \right\} \qquad (1)$$

where: $y(\Pi, t)$ - density of distribution of measurement values on parameter $\Pi(t)$.

The density of distribution $y(\Pi, t)$ of controlled parameter $\Pi(t)$ with the time variable $\overline{\Pi}(t)$ and $\sigma(t)$ will have theoretical form as it shown in Fig.1.

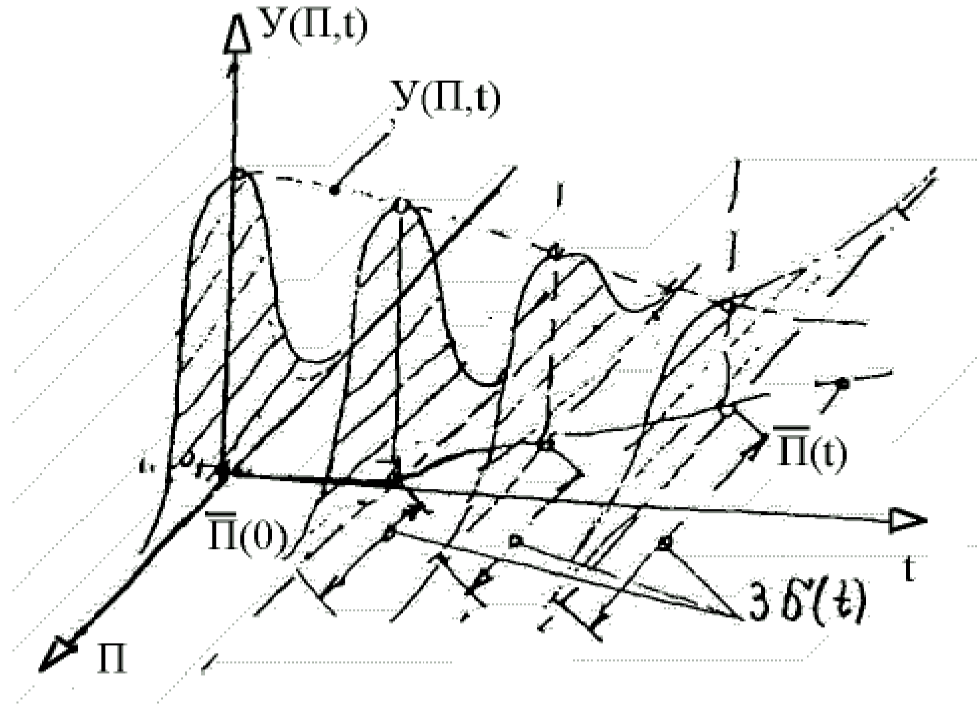


***Fig. 1.** Theoretical density of distribution* $У\left(\Pi,t\right)$ *of measurement values on parameter* $\Pi\left(t\right)$

In connection of studying of temporary (in transverse section) differential structure of variation of nominal of parameters and confiding intervals on dispersion of nominal values for every series measurement in a process of exploitation and their prognosis in this work is offered an algorithm for decomposing of the density of distribution from equation (1), based on following interpolation correlations:

$$\overline{\Pi}(t)=\lim_{\Delta t_i\to 0}\left[\frac{\sum_{i=1}^{n}\Delta t_i.\overline{\Pi}_i\left(\Delta t_i\right)}{\sum_{i=1}^{n}\Delta t_i}\right], \quad (2)$$

$$\sigma(t)=\lim_{\Delta t_i\to 0}\left[\frac{\sum_{i=1}^{n}\Delta t_i.\sigma_i\left(\Delta t_i\right)}{\sum_{i=1}^{n}\Delta t_i}\right], \quad (3)$$

$$\sum_{i=1}^{n}\Delta t_i=T_{\Sigma TE}, \quad (4)$$

where: $\overline{\Pi}_i\left(\Delta t_i\right),\sigma_i\left(\Delta t_i\right)$ nominal (averag e) values of parameters $\Pi(t)$ and his root-mean square for $i$ –th series measurements; $T_{\Sigma TE}$ - continuous time for TU in interval of observation.

**PROBLEM SOLUTION**

In realization of decomposition (2) and (3), each of the function $\overline{\Pi}_i\left(\Delta t_i\right),\ \sigma_i\left(\Delta t_i\right)$ from formula (1) is represented through holomorphic functions of the time from polynomial type [2]:

$$\overline{\Pi}(t)=a_0+a_1.t+a_2.t^2+...+a_r.t^r,$$
$$\sigma(t)=b_0+b_1.t+b_2.t^2+...+b_S.t^S, \quad (5)$$

where: $a_0,a_1,a_2,...,a_r,b_0,b_1,b_2,...,b_S$ - are constant coefficients determined by systems algebraic equations respective regarding to $\overline{\Pi}(t),\sigma(t)$ in a priory known statistical coordinates $\Pi_K,t_K\ (k=1,2,...,r)$, $\sigma_m,t_m\ (m=1,2,...,s)$. The ranks of the polynomials (5) are determined by the conditions:

$$a_{r+1}.t^{r+1}\le 10^{-2}.\left[\overline{\Pi}(t)-a_{r+1}.t^{r+1}\right],$$
$$b_{s+1}.t^{s+1}\le 10^{-2}.\left[\sigma(t)-b_{s-1}.t^{s+1}\right], \quad (6)$$

ensuring insignificance from second order respective to $(r+1),(s+1)$

members. Substituting the functions $\overline{\Pi}(t), \sigma(t)$ from equations (5) in equation (1), we obtain ***nontrivial parametric distribution***, depended from the time of technical exploitation. In [2, 4] this distribution is studied for elementary case $\overline{\Pi}(t) = a_0 + a_1.t$.

Let we do an investigation of this distribution with $\overline{\Pi}(t)$ having more complex general form (5) and arbitrary approximating function for $\sigma(t)$. At these conditions an equation (1) is transformed in the other form. In the presented article is done an investigation of this distribution with $\overline{\Pi}(t)$ which have more complex general presentation (5) and arbitrary approximation function for $\sigma(t)$. However is obtained inequality from the type:

$$У(\Pi,t) = \frac{1}{\sigma(t)\sqrt{2\pi}}.\exp\left\{-\frac{\Pi^2 - 2\Pi\overline{\Pi}(t) + \left(\overline{\Pi}(t)\right)^2}{2\sigma^2(t)}\right\}, \tag{7}$$

We are an logarithmating equation (7) and doing respective mathematical transformations from which is obtained:

$$\begin{aligned}
\ln У(\Pi,t) &= \ln\frac{1}{\sigma(t)\sqrt{2\pi}} + \ln\exp\left\{-\frac{\Pi^2 - 2\Pi\overline{\Pi}(t) + \left(\overline{\Pi}(t)\right)^2}{2\sigma^2(t)}\right\} = \\
&= -\ln\sigma(t) - 0{,}5.\ln 2\pi - 0{,}5.(\sigma(t))^{-2}.\left[\Pi^2 - 2\Pi\overline{\Pi}(t) + \left(\overline{\Pi}(t)\right)^2\right] = \\
&= -\ln\sigma(t) - 0{,}5.\ln 2\pi - 0{,}5.(\sigma(t))^{-2}.\begin{bmatrix}\Pi^2 - 2\Pi\left(a_0 + a_1 t + \ldots + a_r t^r\right) + \\ + \left(a_0 + a_1 t + \ldots + a_r t^r\right)^2\end{bmatrix} = \\
&= -\ln\sigma(t) - 0{,}5.\ln 2\pi - 0{,}5.(\sigma(t))^{-2}.\begin{bmatrix}\sum_{k=0}^{r}\left(\Pi - a_K t^K\right)^2 + 2\sum_{i=0}^{r-1}\sum_{k=i+1}^{r} a_i a_k t^{i+k} - \\ -(r-1)\Pi^2\end{bmatrix}.
\end{aligned}$$

We are doing an antilogaritmation of an above mathematical expression and after a respective mathematical transformations [3] is obtained:

$$\begin{aligned}
У(\Pi,t) &= \frac{1}{\sigma(t)\sqrt{2\pi}}\cdot\exp\left\{-\frac{1}{2\sigma^2}\sum_{k=0}^{r}\left(\Pi - a_k t_k\right)^2\right\}\cdot \\
&\cdot\exp\left\{-\frac{1}{\sigma^2}\sum_{i=0}^{r-1}\sum_{k=i+1}^{r} a_i a_k t^{i+k}\right\}.\exp\left\{\frac{(r-1)}{2\sigma^2}\Pi^2\right\}.
\end{aligned} \tag{8}$$

An equation (8) cam be presented in general mode:

$$У(П,t)=\frac{1}{\sigma(t)\sqrt{2\pi}}\cdot\prod_{k=0}^{r}\exp\left\{-\frac{\left(П-a_k t^k\right)^2}{2\sigma^2}\right\}\cdot$$
$$\cdot\prod_{i=0}^{r-1}\prod_{k=i+1}^{r}\exp\left\{-\frac{a_i a_k t^{i+k}}{2\sigma^2}\right\}.\exp\left\{\frac{(r-1)}{2\sigma^2}П^2\right\}. \quad (9)$$

Equation (9) represents nontrivial parametrical distribution, appearing in transverse section time function for technical exploitation of relevant RTS. The dispersing of it's values in the confidential interval with probability, higher or equal to 0,9973 is $\pm 3\sigma(t)$.

For doing of investigation of equation (9) for distribution law, it is presented in the form:

$$У(П,t)=\frac{1}{\sigma(t_m+T_П)\sqrt{2\pi}}\cdot\prod_{k=0}^{r}\exp\left\{-\frac{\left(П-a_k\left(t_m+T_П\right)^k\right)^2}{2\sigma^2}\right\}\cdot$$
$$\cdot\prod_{i=0}^{r-1}\prod_{k=i+1}^{r}\exp\left\{-\frac{a_i a_k\left(t_m+T_П\right)^{i+k}}{2\sigma^2}\right\}.\exp\left\{\frac{(r-1)}{2\sigma^2}П^2\right\}. \quad (10)$$

The investigation of (10) is accomplished by the program „Mathematics", in which is obtained the distribution in transverse section of parameter $У(П,t)$. For concrete investigating risk technical system is shown the presented example.

**Example**
for investigating a distribution of power of the transmitter of
communication information system P-862
Technical exploitation of communication information system P-862 has begun in 1995 year. The variation of the sensibility of a receiver and the power of the transmitter is shown on fig. 2 and fig.3. By tactics-technical data the examining system P-862 has frequency range (100,000-149,975) MHz and from (220,000-399,975) MHz. The sensibility of a receiver is not worse by $3\,\mu V$. The power of a transmitter is not worse by $25\,W$ [7]. An investigation of serial number 10 corresponds to the beginning of 2001 year. An investigation of serial number 20 corresponds to the beginning of 2002 year. An investigation of serial number 30 corresponds to the beginning of 2003 year. An investigation of serial number 40 corresponds to the beginning of 2004 year and so forth.

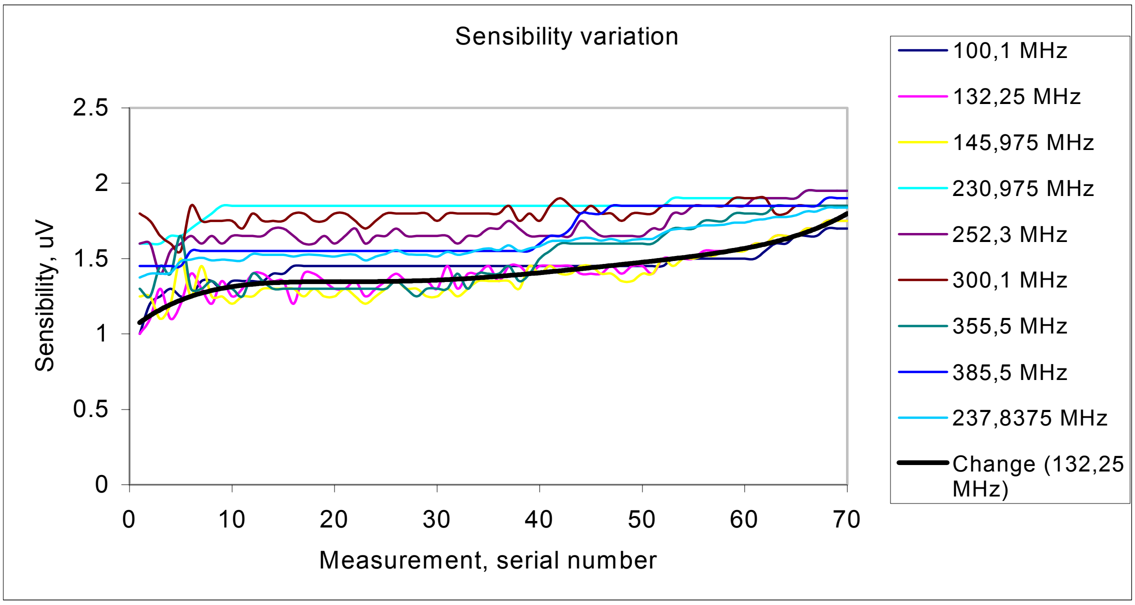


***Fig. 2.** The sensibility's variation of P-862 for measurements leading in 7 years period (2000 – 2007 year)*

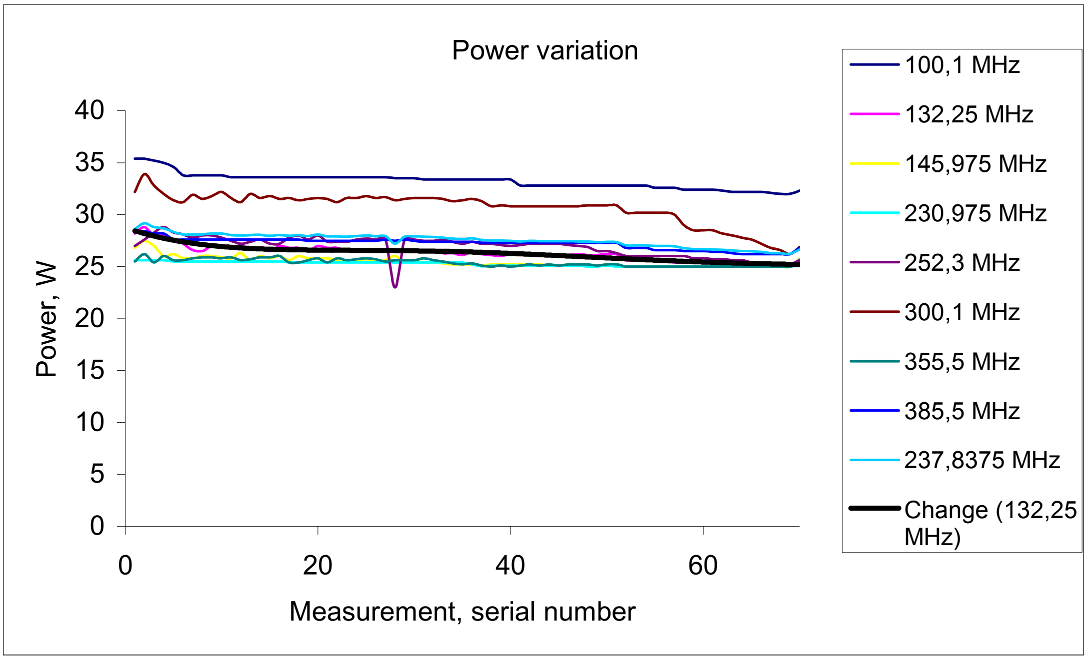


***Fig. 3.*** *The power's variation of transmitting station P-862 at measurements leading in 7 years period (2000 – 2007 year)*

On fig.4 is shown the real exploitation distribution of the power of transmitter of the investigated system P-862.

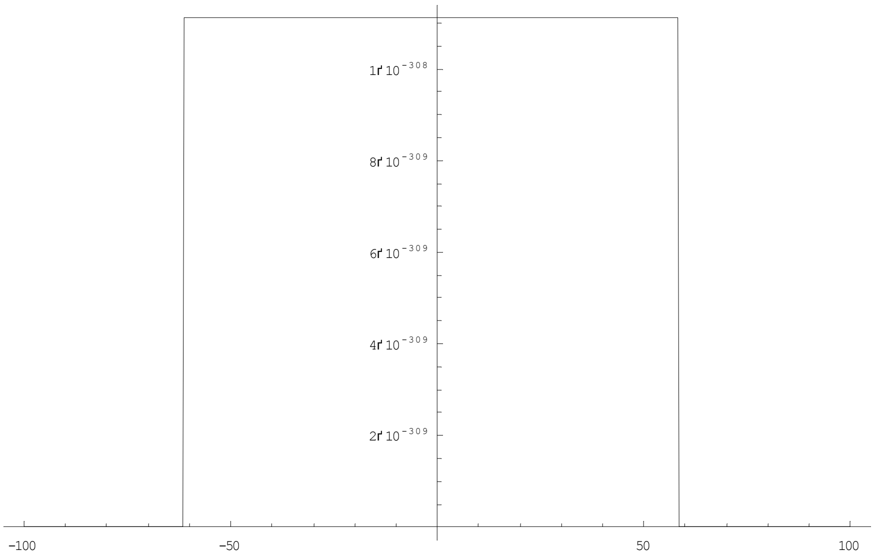


***Fig. 4.*** *The real exploitation distribution of the power of the transmitter of communication-information system P-862 around its nominal value determined by the producer*

## CONCLUSIONS

As a result of the making investigations in this paper could be formulated the following conclusions:

1. There is obtained nontrivial parametrical law of distribution of parameters of the risk technical systems with rendering of account evolutions of nominal values and their root-mean square deviations.

2. It got a real exploitation distribution of capacity of transmitter of communication information system P-862.

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