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Affect on forecasting reliability safety diesel power generators in the medical institutions

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Abstract— Many fundamentally important devices used in health care facilities require significant and uninterrupted supply of electricity. If a power outage occurs, significant generator to life support machines and all other necessary medical appliances that work in order to sustain human life, continue to operate unhindered. Unlike aggregates that people use in their homes, aggregates used in health care are of a different type, even unlike typical emergency power unit, the system aggregates spare you use the hospital must enter into operation almost immediately with full force. Hospitals are complex and sophisticated systems designed to provide current power supply. During a power outage, generator sets with diesel engine DEG (diesel electric generators) provide reliable, direct and full power of electricity. Forecasting reliability of diesel engines for generator used by medical institutions is one of the most important factors that will not reach the link. In this paper we analyse the state of the diesel engine as the most complex set of aggregate through an accidental condition. Properties accidental conditions are shown through: the exposure time, the coefficient of coverage and type of the original defect. Forecasting methods that will be used are: Analytical forecasting and statistical forecasting.

Keyword:Reliability, diesel power generators, medical institution, accidental conditions,

1 Introduction

The loss of the electricity grid because of the storm, bad weather, cold and ice, natural disasters, excessive spending, unplanned disorders like power line disrupting are becoming more common. With dependence on technology and connection of various systems, which rely on electricity, system reliability becomes more critical. Medical institutions, like hospitals, require a continuous supply of electricity to the maximal protection of public health and safety. Even a very short shutdown could have disastrous consequences for unprepared health facility. Power failures in the hospital, the patient's life may be in danger. Monitors, pumps, oxygen and other important equipment could stop working. The surgeons in the operating room even for a moment cannot remain without electricity. Most modern hospitals today are provided by a generator backup power.

There are two basic types of generators that are used for the hospital. The first is powered by natural gas. The second type, which is most commonly used to power the engine, it uses diesel fuel (DEG). Depending on the size of the hospital and the amount of fuel located in tanks, these generators can maintain the power supply for at least 24 hours. Unlike some other fuel and technology, diesel-powered generators provide a stable supply of high strength and superior performance due to its high torque characteristic of a diesel engine.
Diesel-engine generator (DEG) provides the most reliable form of emergency backup power. Many international construction codes and standards require an efficient diesel generator due to the need for fast response time, power, light fuel supply and reliability. One of the most unique features of engines with diesel-powered compared to other technologies is a very quick response, the power to start and absorbs a lot of electrical load within a few seconds of a power failure from the grid.

Aggregates are a combination of internal combustion engines, as well as drive machines, and electric generator to produce electricity. This means that the power generator induces an electrical current in a closed conductor, and thus converts mechanical energy into electrical energy. Driven machine i.e. combustion engine is commonly the diesel engine. This is a complex set of aggregates with a larger number of possible cancellation. Because, above mentioned, we are planning deal with the reliability of diesel engines for generator for medical facilities.

2 Balances engine

Internal combustion engines are complex dynamical systems consisting of a large number of inter-related parts and components. How engines fulfill important functions break in their work leads to major economic, technical and moral losses. For example, the cancellation element engine that costs five euros can cause an accident where they will be lost human lives.

It is therefore very important to know how to determine the condition of the engine and make timely measures to prevent downtime or to localize fine [1]. All internal engine performance, certain mutually related processes that are happening in the aggregate (in this case a diesel engine) at some point of time τ called the state. In general, the diesel engine can be placed in one of three states: the correct, accidental, and in a state of complete cancellation of labor - cancellation. Correct condition of the engine is characterized by overall properties that determine its exploitation, that is, when the engine meets all the needs of the given primary and second-instance parameters. Condition of cancellation is state of the engine when it does not meet the needs of its primary date and second instance parameters or when it becomes dangerous for exploitation. The state determines the cancellation of the unreliability of the engine. These two conditions are extreme and are examined in assessing the reliability of the engine. An accidental condition may be transient or central and is characterized by the fact that the engine occurred some changes, i.e. there have been a primary defect or fault for which changes the characteristics of the work process engine so that the engine still has the necessary operational efficiency. Yet if we do not take special measures to an accidental situation will inevitably move into cancellation. Correlation Engine crossing from one state to another is shown in Figure 1.

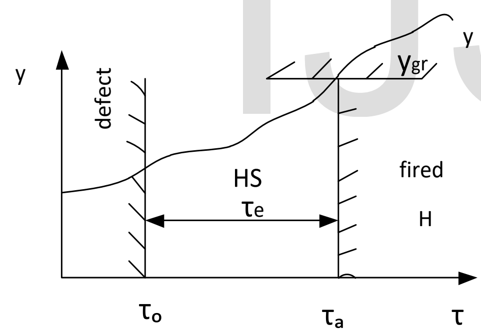


Fig. 1 Pass the fault condition

Where: y-the parameters of the working process;

I-period correct condition;

HS - period of accidental situation;

H - state cancellation (distress);

y_{gr}- The limit values of the parameters of the working process in which performs cancellation.

At some point of time τ_0 due to structural, technological or exploitation, appeared in a primary defect (failure of the main fuel supply, construction defect, etc.) which is why they began to change the parameters of the working process. If you do not take special measures parameters will reach their limit values y_{gr}, specified by the terms of the working capacity and the engine will go into a state of failure. Cancellations may occur in various forms. The principal ones are the following: the destruction of aggregates, off spontaneously, out of the working process parameters outside the permitted limits, the destruction of the engine. Accidental conditions can be divided into the following characteristics: exposure time, the coefficient of coverage, the type of the original malfunction or failure.

2.1. Exposure time

Time interval $\tau_e = \tau_a - \tau_0$, in which the engine is in a state of accidental is called the exposure time. Shutter speed plays an important role in the choice of measures to prevent engine failure or cancellation localization. (τ_e time - exposure).

To control the state of the engine can be applied to a system with sensors receiving information on changes of parameters of the working process in the case of approaching their limit values, with the help of automatic translation engine on safe mode or turn it off before the time of cancellation. It is obvious that the process control and implementation of inertial solutions.For its achievement with the help of a system (egg. τ_s - The time when the sensor is given specific information on changing parameters) takes time determines the ratio between τ_s and τ_e the control efficacy of accidental situation. Depending on the size τ_s and τ_e attitude of all the accidental states can be divided into two groups: controlled and uncontrolled. In respect of such failures can be predictable and unpredictable**.** If there is $\tau_s < \tau_e$, then is an accidental condition is controlled. In this case a special system can determine the exact beginning of the accidental situation and predict cancellation. If an emergency situation is uncontrollable $\tau_s > \tau_e$, a cancellation cannot be predicted. In such a case, the engine is also in a state of emergency, but the primary defect exceeds the cancellation in a short time. Technical system with finite time interval velocity action fails to record the changes of parameters. In this case, there is no basis for the application of the system to prevent failure. Two groups discussed the state of emergency and cancel them properly belong to the accepted classification of failures in reliability theory: gradual and sudden [1]**.**

2.2. Range coefficient accidental conditions

To the state of the engine control system had a practical goal, it is necessary to know the relationship between the controlled and uncontrolled accidental conditions, which is characteristic of the scope of the range coefficient accidental conditions**.** Let P_j - the probability that the system controls the accidental conditions, then

$$P_j = P\,(\tau_{ej} - \tau_{sj}) > 0 \qquad (1)$$

The probability that all accidental conditions are controlled in relation to their statistical independence is defined as follows:

$$P_k = \prod_{j-1}^{m} P_j \qquad (2)$$

Where is m - the number of accidental conditions.

Controlled and uncontrolled of accidental conditions in a given situation τ_s are independent, and is $P_k + P_{nk} = 1$, where is:

P_{nk}- the probability of uncontrolled accidental conditions

$P_{nk} = \prod_{j=1}^{m} P(\tau_{ej}\text{-}\tau_{sj} \leq 0)$.

Range coefficient accidental conditions is the same predicted probability of cancellation:$\alpha = P_k$ Theoretically, it is complex to determine α with a high degree of accuracy. Approximately can be determined by the results of data processing test engine when it is in accidental condition. Initial data for obtaining the coefficient α must be, τ_e,$\tau_s$andn_k, and n_k- the number of forecast and the overall number of accidental situation.

Then the frequency of accidental condition $\tilde{\alpha} = n_k/n$

2.3. Some types of the accidental conditions of diesel engines

The exploitation of the engine, there may be an infinite number of breakdowns the state of. Yet out of this number can be selected basic and most common of accidental conditions. Character occurrence of accidental condition and cancellation of some is this same primary defect is determined primarily scheme of the motor unit and the value of the parameters of the working process. The medical facilities are generally large aggregates SMAGA with conventional diesel engines because of the simplicity, safety and reliability. Medical institution that is one of the best equipped and most accomplished work in the toughest conditions (such as accidental conditions) in the Republic of Serbia, the Military Medical Academy (MMA). In order for this institution was safe and steady source of electricity MMA use ten diesel electric generators (DEG), which is a huge force [2].

The most commonly used types of these aggregates in medical institutions in general in the Balkan region are:

-GM tags TBD 232 V12 power of 227 kW,

-GM Tags TD 602 V12 power of 450 kW,

-GM Codes AGD 801TD 602 V12s of 450 kW,

-GM Codes AGD 602,8V396 TC 32 power of 460 kW,

-GM Mark 7083-7005 power 236 kW,

These generators deliver high power in a very short period of time and are characterized by high reliability. Since the planning engine reliability theme of this work a generator which is largely used in medical institutions have classic diesel engines. As an example, let's take the situation of accidental engine with conventional injection systems and air supply.

Disturbance of airtight highway fuel supply in conventional diesel engines

Reasons distortion may be different. Mainly due to the hermetic disrupts the construction and manufacturing defects, vibrations and high-frequency oscillations. First, in pipelines occur microscopic cracks, which eventually increase the surface due to mechanical and corrosive-erosive effects. The occurrence of hermetic components at high speed fuel leaks. Due to fluctuations in pressure in the pipeline engine failure. Leaking value (loss) components can be approximately determined by the dependence:

Gcu= $\mu F\sqrt{2\varrho\Delta p}$,

where: F - Surface cracks;

μ - coefficient for expenditure (spending);

$\Delta p = p_m - p_{ko}$ - Fluctuation of pressure;

p_m - The pressure in the pipeline, the main road from the high pressure pump to the nozzles;

p_{ko} - Pressure nozzles.

The main road which the motor is powered by fuel leaks may not have, because in addition to the unnecessary loss of fuel would lead to a loss of pressure in the nozzle and all parameters of the working process to change that leads after a while from accidental condition to state REF engine operation.

Violation of the engine air supply

Diesel engines with conventional air power we supply-air intake into the engine by pulling ("ordinary" diesel). It is known that when the motor has more of air, oxygen, runs better and better utilize energy. Clogging of the air filter is one of the basic problems of irregular engine running, and also mechanical damage to the air supply can cause problems (mechanical damage to the components of the dosage air).

The methods of forecasting

The basic elements of automation malfunctions include: incomplete opening or spontaneous activation valve malfunctions and braking of moving parts and others. Failures of elements of automation, depending on their purpose and place of mounting, leading to two forms of accidental condition:

- Destruction of aggregates engine for accelerated mode;
- Dimming mode and spontaneously switch off the engine.

Pump Failures

Pump malfunction occur due Constructors technological failures and defects of materials. The malfunctioning of pumps include: violation of airtight compression springs shooting, blocking beds, tearing special prefabricated parts and more. These defects result in a rule to the rapid destruction of the pump (pump high and low pressure) and have the character of destruction under the weight. The exposure time of such emergency situation is very short, so they are uncontrollable and cancellations - not forecasted.

High-frequency fluctuations (oscillations)

The emergence of high-frequency pressure fluctuations in the system for the supply of fuel and air motor causes vibration of structural elements. If the fluctuations in the motor event of the regular frequency and small amplitude, which does not exceed the limit value, then the destruction of the structure will not notice it. The destruction caused by the increased amplitude fluctuation limits. One case in the development of high-frequency oscillations is that when initially mild fluctuation occurs with regular frequency, low amplitude, and the amplitude of the fluctuations is growing rapidly.

Determination of quantitative parameters of emergency stocks (τ_{e}, α) is essential in order to create a system of protection. Theoretically, it is not possible to find the value of τ_{e} and α sufficiently precise. Therefore, the statistical analysis of test results only way of their determination. Primary defects and emergency conditions related to them a little dependent on the test conditions and dimensions of the engine. Therefore, to obtain statistical data necessary to use all the engine test, both in terms of sites for testing, as well as in service.

3 THE METHODS OF FORECASTING

Forming methods and means of controlling the state of the engine is part of a general technical problem of improving reliability. The engine consists of a large number of interrelated aggregates and elements. Direct control of the state of aggregate and motor is fully impossible. At the same time for each state are characteristic distinguishing features that appear in the corresponding modifications of parameters of the working process. Their registration, and a priori knowledge of the parameters depending on the working process of the engine conditions allow to establish the reasons for their changes, and consequently to predict working capacity of the engine. The parameters of the working process are interrelated, so that unambiguously define the state of the engine is very complex task. To increase the accuracy of forecasts it is necessary to criticize the characteristics which might be incidental to distinguish one from another condition of the engine.

Each class status should be given a sign (signal) to change the parameters of the working process, which will be different from signs of other conditions. Determination of such a set of parameters that characterize an emergency situation, the starting moment of forecasting. Suppose that each an emergency situation is characterized by a set of parameters of the working process. Then, looking at the controlled parameters as a function of time, it is possible (using a mathematical apparatus) to solve the task of forecasting the situation and anticipate the moment when there will be a cancellation. The mathematical apparatus for forecasting includes elements of numerical analysis and the theory of random functions.

Some of the controlled parameter y_i (τ) within a range 0-τ_n*, has a value of y (τ_0),y (τ_1), ... $y(\tau_n)$, which is recorded by the control apparatus. According to the known values y_i(τ) of previous control functions ($\tau_i \in$ τ*), it is necessary to predict the value of size

$y(\tau_{n+1}$, ... $\tau_{n+m})$, where in $\tau_{n+i} \in$ τ>τ*. In this way formulated principles of forecasting is called analytical forecasting.

Another solution of the task of forecasting is also in use. According to the available sizes $y(\tau_i)$, where $\tau_i \in$τ*, and i = 0,1, ..., n, it is necessary to determine the probability when the value of the function $y(\tau)$will go out the permissible limits:

$$\mathrm{R}\,\{\,|\,y_i(\,\tau_{n+1}\,)-y_n(\tau)\,|\le \varepsilon_\pi\},$$

Where is $y_i(\,\tau_{n+1}\,)$ - value controlled in the function point of time $\tau_{n+i} \in$ τ>τ*; y_n(τ) - changes required functions in the correct state of; this problem-solving forecasting is called statistical forecasting.

Analytical forecasting

If the controlled function changes monotonically, and a copy of the sign does not change, we can apply the analytical forecasting, whereby we determine the analytical expression, which in the best case describes a controlled function, where $\tau_i \in$ τ*. Let the function (τ) discrete data values y (τ_0), ... y(τ). It is necessary to choose such an analytical expression y(τ), to the point of time $\tau_i \in$ τ*, realized conditions:

$$\begin{Bmatrix} Y(\tau_0) = y(\tau_0) \\ Y(\tau_1) = y(\tau_1) \\ . \quad . \quad . \quad . \quad . \\ Y(\tau_n) = y(\tau_n) \end{Bmatrix} \tag{4}$$

A time at the moment of $\tau_j \in \tau > \tau *$

$$\begin{Bmatrix} Y(\tau_{n+1}) = y(\tau_{n+1}) + |\varepsilon_1| \\ Y(\tau_{n+2}) = y(\tau_{n+2}) + |\varepsilon_2| \\ . \quad . \quad . \quad . \quad . \quad . \\ Y(\tau_{n+k}) = y(\tau_{n+k}) + |\varepsilon_k| \end{Bmatrix} \tag{5}$$

It is $\varepsilon_i = (\varepsilon_i)\, min$. From the latest, we will determine the system of equations:

$$\begin{Bmatrix} y(y_{n+1}) = Y(\tau_{n+1}) \pm \varepsilon_1 \\ . \quad . \quad . \quad . \quad . \quad . \\ y(y_{n+k}) = Y(\tau_{n+k}) \pm \varepsilon_k \end{Bmatrix} \tag{6}$$

Sizes can $\varepsilon_i$be determined experimentally for the concrete realization y(τ). If we take that the intended function is selected polynomial Y(τ) form:

$$Y(\tau) = \mathrm{A_1F_1}(\tau) + \mathrm{A_2F_2}(\tau) + \cdots + \mathrm{A_kF_k}(\tau), \tag{7}$$

Where are they $F_i(\tau)$ is component functions;

The coefficients weight components function;

Prepared condition [3], $\sum_{i-1}^{m} A_i$ =1, which simplifies the calculation. As the value y (τ) known in level

0 - τ*, to F_i(τ), and A_i can be determined only in this range.

Range 0 -τ_n* breaks into several parts (areas).

For monotone functions are sufficient two parts: $T_1^{(1)} \epsilon T_1$ and $T_1^{(2)} \epsilon\, T_1$.

The first part $T_1^{(1)}$ determines the component functions, which in the common or general case has the form:

$$F\,(\tau) = a_0\varphi_0(\tau) + a_1\varphi_1(\tau)+\ldots+a_k\varphi_k(\tau) \qquad (8)$$

Where $\varphi(\tau)$ - function of the simplest form;

a_i - Unknown coefficients;

The task is reduced to the determination of the polynomial coefficient

$$a_i = f\,[y(\tau_i)]. \qquad (9)$$

At work $T_1^{(2)}$ is determined by the coefficient of mass A_i. If we take into account that the component F_i(τ) function of the current time, then the value A_i can be calculated on the work (in the field) $T_1^{(2)}$. Then the value of coefficient weight A_i determined based on the following system of equations:

$$\begin{Bmatrix} y(\tau_{n+1}) = \sum_i^m A_i F_i\,(\tau_{r+1}) \\ y(\tau_{n+2}) = \sum_i^m A_i F_i\,(\tau_{r+2}) \\ \cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\ y(\tau_{n+k}) = \sum_i^m A_i F_i\,(\tau_n) \end{Bmatrix} \qquad (10)$$

In this way, forecasted polynomial (7) is determined by solving the system (10). The advantage of the forecasted polynomial (7) consists in the fact that it can replace standard basic polynomials, and the weight coefficients to be corrected thereby increasing the accuracy of forecasting. As a basic polynomials used a series of mathematical polynomial as: Lagrange polynomial, Newton polynomials, least squares method, statistical prediction etc. [3].

Statistical forecasting

It is not always possible to apply the analytical methods we have considered because they are controlled by a complex function, but it cannot be established with sufficient precision to choose a projected polynomial. In addition, all controlled functions are random, and their value for each argument is random. In these cases, the law does not determine the control parameter changes for the future time, but it is estimated the probability at which the controlled function of the moment to go outside the permissible limits, or probability at which there will be a cancellation. Due to the limitations of the theorem of probability theory can be assumed that the values of the controlled function in every fixed point of time, subordinate to the normal law of distribution. These feature two statistical values [4]:

Mathematical expectation $m_y = \sum_1^n y(\,\tau_i)/n$ and

- Mean square deviation $\sigma_y = \sqrt{\frac{1}{n}}\,[y\,(\tau_i)\text{-}m_{y_i}\,]^2$,

where n - the number of measurement values $y$in point of time τ_i.

Virtually the size of mathematical expectation coincides with the nominal value of the controlled function at any point of time. It follows that the density distribution of controlled functions for a fixed moment of time τ takes the form[5]:

$$f(y) = \frac{1}{\sigma_y\sqrt{2\pi}}e^{\frac{(y-m_y)^2}{2\sigma_y^2}} \qquad (11)$$

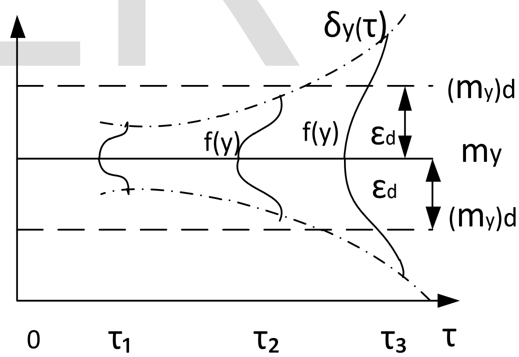
If it is a priori known to be m_y = const, i.e. the nominal value of the control parameter does not change, a change over time its dispersion (dispersion)σ_y, then the task of forecasting solves this. Given limit values of the controlled parameter y_1, y_2. The probability of transition y(τ) outside permissible limits is determined dependence (4).

$$P_y(y_1 < y < y_2) = \frac{1}{2}\left[\phi\left(\frac{y_2-m_y}{\sigma_y}\right) - \phi\left(\frac{y_1-m_y}{\sigma_y}\right)\right] \qquad (12)$$

If it is $y_1 = m_y$- ε_d; $y_2 = m_y + \varepsilon_d$; and Φ (Z) - i.e. odd function.

- Φ (Z) = Φ (- Z), equation (12) will be written in the form:

$$P_y\left(\left|y(\tau_i) - m_y\right| < \varepsilon_d\right) = \phi\left(\frac{\varepsilon_d}{\sigma_y}\right) \qquad (13)$$



Fig, 2 The statistical characteristics

Function y(τ) = var

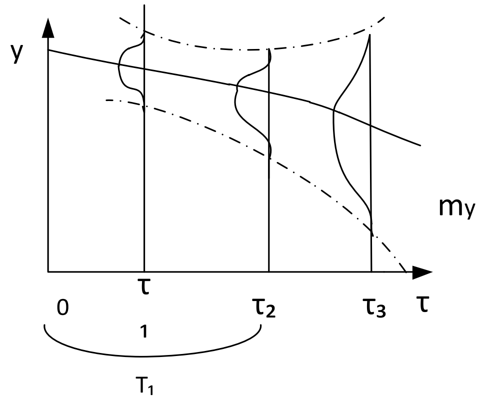


Fig. 3 The statistical characteristics functions y (τ) = const

The probabilityP_y is determined by the last measurement in the moment. Practically, the mathematical expectation and the mean square deviation as a function of time $m_y = m_y(\tau)$; $\sigma_y = \sigma_y(\tau)$. The tendency to shift controlled functions is determined by the character of its changes $m_y$and σ_y (Figure 3).

To explain the nature of the change moment in time it is necessary to assign the plane of (part of) the T_1 to k sub-areas, as in the analytical forecasting. Mean square deviation in the whole level $T_1$is defined as follows:

$$\sigma_y = \frac{1}{k}\sum_{\xi-1}^{k} \sigma_y^{\xi} \ ,$$

Where σ_y^{ξ} - the mean square deviation at different moments of time in the level. Normal distribution law for the controlled function with parameters $\sigma_y(\tau)$ and $\sigma_y(\tau)$ in the planeT_1has the form:

$$f(y)=\frac{k}{\sqrt{2\pi}\sum_1^k \sqrt{\frac{1}{z_\xi}\sum_{i=1}^{z}\left[y(\tau_i)-m_{y0}\right]^2}} \exp\left\{\frac{y-\frac{1}{k}\sum_1^k \frac{1}{r_\xi}\sum_{i=0}^{z_\xi} y(\tau_i)}{2\frac{1}{k}\sum_{i=1}^{z}\left[y(\tau_i)-m_{y0}\right]^2}\right\} \qquad (14)$$

According to formula (13) calculates the probability and direction of its changes. For statistical forecasting can be used polynomials, applied in the analytical forecasting. In order to determine trends shift $m_y(\tau)$ and $\sigma_y(\tau)$ in the plane $T_1$of the weather τ_{n+j}(j=1, 2, ..., m) are used F_{m_y}(m) andF_{σ_y}(m).

In general, these polynomials have the form:

$$F_{m_y}(\mathrm{m}) = \sum_{\lambda=1}^{M} A_\lambda \sum_{l=0}^{\lambda} a_l\, m^l \ ,$$

$$F_{\sigma_y}(\mathrm{m}) = \sum_{\lambda=1}^{M} A_\lambda \sum_{\eta=0}^{\lambda} a_\eta\, m^\eta \ ,$$

where is $a_{1=} f\ (m_y)$; $a_{\eta=} F(\sigma_y)$.

Probability in the field of forecasting T_2determined dependence:

$$P_y(y_1 < y(\tau) < y_2) = \frac{1}{2}\left[\phi\left(\frac{y_2-\sum_{\lambda=1}^{M} A_\lambda \sum_{l=0}^{\lambda} a_l m^l}{\sum_{\lambda=1}^{M} A_\lambda \sum_{\eta=0}^{\lambda} a_\eta m^\eta}\right) - \right.$$
$$\left. - \phi\left(\frac{y_1-\sum_{\lambda=1}^{M} A_\lambda \sum_{l=0}^{\lambda} a_l m^l}{\sum_{\lambda=1}^{M} A_\lambda \sum_{\eta=0}^{\lambda} a_\eta m^\eta}\right)\right] \qquad (15)$$

For statistical forecasting a special impact on the accuracy has a number of measurements n. For small copies (n<20), the best results are obtained if instead of the normal distribution of the benefits of Student's distribution [6].

4. PLANNING RELIABILITY MODELING EMERGENCY SITUATION

The parameters of the working process with the emergency condition of the engine are changed by certain laws, which depend on the primary defect. If we have two ways to change the parameters of the working process to properly condition for an emergency, then we comparing them to establish not only the fact of failure occurrence, but also its causes [7]. For the diagnosis and forecasting the state of the engine it is necessary to know the nature of changes in various parameters of the primary failure modes and choose one of them on the basis of which it may be possible to control. More occurrence of control parameters can be determined on the basis of the results of testing of the engines, in which there were reports of accidental conditions that ended with the failures.

As the number of accidental conditions tests can be small and usually does not cover all possible conditions and primary engine failure, it is not possible to determine experimentally controlled parameters. Engine response and changes the parameters of the working process in different emergency states, we can determine the solution of differential equations (describing the work processes in the primary defect occurs) with the help of computers, i.e. mathematical modeling. The basis of this method is the assumption that the engine is determined by the system, i.e. that each state corresponds to a specific engine outward manifestation in a particular character changes the parameters of the working process. In real conditions the engine is not determined by the system because the primary defect leading to accident conditions can be dependent and accidental. The task of modeling can be solved as follows. It is compiled mathematically functional model engine, which is a system of determinate equations. They describe the processes that occur in the aggregate, their mutual relations, and also depending on which link the parameters of the working process with the primary irregularities.

5. CONLUSION

It is important that medical institutions have reliable aggregates (DEA) because power outages are often unexpected and unpredictable. It is therefore necessary planning reliability aggregates and especially the reliability of the diesel engine as the complexity and sensitivity of aggregates like set preventive actions that will enable the safe and secure operation of the extraordinary conditions.

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