THE PROBLEMS OF EFFICIENCY OF SERVICING POWER SYSTEMS

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The most crucial element of the way the operation process of power distribution companies is organized is to secure a reliable sort of operation of their power system equipment. The monitoring of power systems operation means, among other things, to secure the efficiency of their working mode and to locate fault situations emerging during their operation. Bearing in mind that any losses that are due to interruptions of power supply for consumers are often much higher than the cost of maintaining the operation of a complete distribution system company, it is necessary to carefully analyze the way any power system operation is organized, in order to optimize control over the distribution company's operation personnel. Because operation failures in power distribution systems are of a probability character, we propose to execute the modeling of the said distribution process by means of the theory of mass servicing, considering also application priorities, when individual kinds of applications are to be fulfilled.

It is well known that any emergency applications have to be fulfilled out of turn, and this means that the incoming flow of these applications has an absolute priority, i.e., the first-turn priority.

Applications to carry out an operation switchover, in view of the necessity to issue personnel work permissions for the execution of scheduled works in power systems, are dependent on the specific time for their execution.

Therefore, they are of the second-turn priority, because in the event of an emergency the power system will be switched over to the servicing of the first-turn applications.

The following algorithm is proposed to solve this problem: The intensity of applications reaching the service system during a certain period of time (one year) is determined in accordance with their priorities, on the basis of the following formula:

$$\lambda_i = \frac{1}{\bar{t}_{H_i}} \text{ or } \lambda_i = \frac{m_i}{T}, \ (i = 1, 2), \ 1/h,$$

where $\bar{t}_{H_i}$ is the average time interval between two adjacent applications reaching the service system, according to their priorities; i is the priority turn number; m_i is the number of received applications of the i_{th}-priority during the time interval under investigation; T is the duration of the time interval under investigation.

For the same time interval, the intensity of fulfilling the said applications is to be analyzed according to their priorities on the basis of the following formula:

$$\mu_i = \frac{1}{\bar{t}_i}, \ (i = 1, 2), \ 1/h,$$

where $\bar{t}_i$ is the average time of fulfilling the i_{th}-priority application.

Then the stationary nature of the service system operation will be determined. To this end, it is first necessary to determine the intensity of loading the service channel with applications according to their priorities, on the basis of the following formula:

$$\alpha_i = \frac{\lambda_i}{\mu_i}, \ (i = 1, 2)$$

The stationary nature of this mode depends on whether the following inequality holds:

$\alpha_1 + \alpha_2 < 1$.

This stationary mode will exist, if the said inequality is fulfilled.

If it happens to be so that the mode is of a stationary nature ($\alpha < 1$), then it means that the service system can basically service all the incoming applications, and if not, then the number of applications will keep on growing indefinitely and they will never be serviced at all.

Should it happen to be so that $\sum_i \alpha_i \geq 1$ (there is no stationary mode being present), then it will be necessary to put one more service channel into operation. Then the intensity of servicing will be determined by the following formula:

$\mu_i^* = \mu_i \cdot \nu$,

where ν is the number of service channels (ν = 1, 2, 3, ...).

In such a case this calculation should be made again every time, with due account taken of any new service intensity value, until the stationary operation mode is reached.

However, the stationary nature of the operation mode cannot guarantee the required efficiency of power supply system operation. Though basically all the applications are going to be fulfilled, yet one cannot be satisfied with the time an application will have to be held back before it is serviced. In this case, it is necessary to calculate the average number of applications on the waiting line $\bar{r}_1$, which have an absolute priority, on the basis of the following formula:

$$\bar{r}_1 = \frac{\alpha_1^2}{1-\alpha_1}.$$

Then the average time of waiting for servicing an application that has an absolute priority will be determined according to the following formula:

$$\bar{t}_{оч_1} = \frac{\bar{r}_1}{\lambda_1}.$$

If the time of waiting for servicing an application that has an absolute priority is longer than the permissible waiting time, then the number of channels will have to be increased by one and the calculation must be resumed (this cycle is to be repeated until the required time of waiting on the line is reached).

The average time of waiting for servicing an application that has no priority will be calculated according to the following formula:

$$\bar{t}\text{t2} = \frac{\frac{\mu_2}{\mu_1}\cdot\frac{\alpha_1}{1-\alpha_1}+\alpha_1+\alpha_2}{\mu_2(1-\alpha_1-\alpha_2)}$$, hours.

The average number of applications on the waiting line, which have no priority, $\bar{r}_2$ will be calculated according to this formula:

$\bar{r}_2 = \lambda_2 \cdot \bar{t}_{t_2}$, pieces.