NOWADAYS SITUATION IN OPERATIONAL RELIABILITY OF COMPLEX NETWORK IN THE CZECH REPUBLIC AND EU

Zbyněk Martínek, Veronika Královcová

ABSTRACT

The construction of power plant's blocks with bigger output, better parameters and with higher level of automation lay higher requirements on reliability of power blocks. The results from operation show that with increasing size of blocks the reliability goes down. This decrease is manifested by higher number of blackouts. This contribution deals with problems of current state of reliability in operation.

1. INTRODUCTION

The reliability of device in operation is one of the most important atribute which defines a quality. The precaution in increasing the reliability and quality is forefront in economical interests all over the world. One of the efficient means for increasing the quality are the reliability theory methods which are based on general physical theories linked with mathematical methods which can objectively evaluate the reliability of device. The real reliability of device or its part is measured by the level of performance capability, lifetime period, corrigibility, captive time, economy and others. These attributes must be calculated from equipollent data so the results from different equipment can be compared and used for controling, designing and constructing of new equipment and for improvement of production.

The appropriateness of theory of reliability to secure the reliability of complex device was proven by results. It shows that the reliability theory can be well aplicated on the theory of reliability in power engineering, especially in the field of power plants. Using electrical devices is characterized by many conditions which are similar in power plants, too. For example, complex equipment and continuous operating cycle, high standards for reliability and so on.

The application of theory of reliability is in nowadays in fast progress. There are high expectations and standards for reliability of power plant block because of higher level of regulation, high requests for reliability of power plants, blocks and whole networks. The experience shows that with growing size of blocks there is a lower reliability which is indicated by increasing number of stoppage and blackouts, lower captive time and lower lifetime period. Therefor there are a precaution whitch are focused on increasing the reliability. These precautions for increasing the reliability and economy must include all fields of activities, such as designing, costruction, production and service of device. It is possible to

apply the theory of reliability to calculate a reliability feature which directly influences the deliveries of power energy. When there are standards for reliability it is easier to arrange the contol of the network, power backup, service, time of repares and others. These aplications are profitable for a producer and for user of power equipment. One of the most used applications are those for prediction of indicators of reliability of new devices.

Basics for above mentioned applications are information about behaviour of power devices in operation. Models for prediction of operation of network if they use the probability utterance there are many simplified expression. In these models there is not used the real reliability characteristic of each power block, but for the evaluation of captive time is used the binomial distribution. Blocks are arranged to groups which have similar output and for these groups we calculate the probability of blackout *q*. We assume that the probabilities of blackout are same for all block in the group.

The probability that in group which has *n* devices will be *m* devices broken is set by binomial distribution.

$$P(m,n) = \binom{n}{m} \cdot q^m \cdot (1-q)^{n-m}$$

In models we often work with the mean time between failure $m_s = \frac{1}{\lambda}$, where λ is intensity of failure. We can use the Markov process model for simple devices, but for those more complex such as electrical network we rather use the simulation methods, for example Monte Carlo. For shortterm prediction isn't Monte Carlo method appropriate. In some countries are for shortterm prediction and operative management of electrical network used real reliability characteristic of individual power blocks with connection to diagram of power demand and power backup.

In dispatching in ČEPS-EU there were model for preparation of operation with determination of power backups that originated in avaradge brake-down rate then there were models based on division of power plants into groups and finaly nowadays model that is characterized by model of complex program for mediumterm and longterm preparation of operation of electrical network. This model uses the reliability characteristic and the analysis of reliability is calculated with method Monte Carlo.

In present practise is the preparation of daily operation done in classical way, it is the summation of disponible available power. The problem is that the data about the captive time of block is valid only in that moment, when it was recorded so it should be supplemented by the probability of abidance in that state for a fixed time.

In Research Institut for Power Engineering are the works focused mainly on the longterm prognosis. From the analysis of problems of shortterm prediction we can assume that there is no efficient model for operational management that can cover the daily power diagram and which would respect the real reliability characteristic of individual power blocks and consider the time that they have been already operational.

There is also no model for systematical monitoring of each power block in operation and prediction of following operation which will respect a number of hour that have pass from the last standdown with a different distribution of time between failure and time between working.

The main facts which are needed for another calculation or theoretical solution are included in the theory of reliability. These calculations can for example be continuous probability distribution and its evaluation, the model or reliability of power plant block with the main mechanism of failure. The block is in the beginning considered as nonrepairable, later it is generally considered as repariable dualstate system with exponential distribution. Than we generalize even futher, we say that the system has 3 or more states. After that we use the Weibull distribution and simplify further from the last standdown to final solution of mixed model. When we solve the calculation for one block we calculate new task where se have the system of cooperating power blocks in network.

2. REFERENCES AND BIBLIOGRAPHY

[1] Tůma, J., Martínek, Z., Tesařová, M., Chemišinec, I. : Security, Quality and Reliability of Electrical Energy (monografie v AJ), CONTE spol. s r.o., ČVUT Praha, ZČU v Plzni 2007, ISBN 978-80-239-9056-0 (+SW zpracování monografie pro PC)

[2] Tůma, J., Rusek, S., Martínek, Z., Chemišinec, I., Goňo, R.: Spolehlivost v elektroenergetice (monografie), CONTE spol. s r.o., ČVUT Praha 2006, ISBN 80-239-6483-6 (+SW zpracování monografie pro PC)

[3] Kolcun, M., Mészáros, A., Rusnák, J.: Active power losses optimisation for the voltage control in slovak transmission power system. In: Analele Universitatii din Oradea : Fascicola Electrotehnica. Oradea : Universitatea Oradea, 2003. s. 163-168, ISSN-1223-2106.

[4] Mészáros, A., Beňa, Ľ., Rusnák, J.: Challenges to optimization techniques in a deregulated environment. In: Distributed Power Generation Systems 2005. Plzeň: ZČU, 2005. s. 32 - 37. ISBN 80-7043-371-X.

[5] Noháčová L, Novák P.: Die Elektroenergie von dem Seawind auch für die Tschechische Republik möglich , article-16th International Expert Meeting "Power Engineering 2007", Maribor 2007, Slovenia Republic, 15.-17. 5. 2007 S. 1-6, University of Maribor ISBN: 978-961-248-018-9.

3. ACKNOWLEDGEMENT

This paper was written under solving science project GAČR 102/06/0132

Authors' Address

Doc. Ing. Zbyněk Martínek CSc.
University of West Bohemia in Pilsen
Faculty of Electrical Engineering
Department of Electric Power Engineering and Ecology
Establishment: Univerzitní 26,
306 14, Plzeň, Czech Republic
martinek@kee.zcu.cz
tel.: +420 37 763/4347

Ing. Veronika Královcová
University of West Bohemia in Pilsen
Faculty of Electrical Engineering
Department of Electric Power Engineering and Ecology
Establishment: Univerzitní 26,
306 14, Plzeň, Czech Republic
kralovco@kee.zcu.cz
tel.: +420 37 763/4399