

MANAGMENT OF MAINTENANCE AND REPAIR FOR TRANSMISSION & DISTRIBUTION EQUIPMENT TO ENSURE OPERATIONAL RELIABILITY

PS 2 Rychagova Elena (Russia)

PS2 E.Rychagova (Russia)

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PARIS

2018

SC C1

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PROBLEMATICS



The normal operational condition of power system is interrupted by failures or emergency outages of equipment. It leads to:

• Not supplied energy to customers

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- Economic damages owing technological loses
- Incidental costs on the power equipment recovery





PROPOSED SOLUTION



Mathematical Reliability Model



where ω_0 - initial value of failure rate, b - coefficient, indicating the rate of equipment ageing, λ_{ij} $(j \neq i)$ - the transition rate from state i to state j, p_i $(i = \overline{1, n})$ - the probability of equipment state at time t.

Analytical solutions: Reliability Indexes

- $p_1(t)$ Failure-free operation probability
- K(t) Availability factor
- $\overline{w_{fail}}(t)$

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 Average frequency of failures C (outages)

Economic Indexes

- C_S(t) Total costs of maintenance during equipment operation
- $C_R(t)$ Total costs include risk of failures



OPTIMIZATION METHODOLOGY

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SIMULATION RESULTS

Power Transformers 35/6 kV



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The lower limit of decision-making area is formed by the criterions the maximum of failure-free operation probability.

The minimum of total costs include risk of failure forms the upper limit of decision-making area.

ECONOMY OR RELIABILITY?

$\Delta T_{optimal}$ (year)	1	2	3	4
$\Delta p_1(\%)$	- 0,01	- 0,013	- 0,017	- 0,02
$\Delta C_{\rm s}(\%)$	3	8	12	17





SIMULATION RESULTS



A part of Distribution Power System

 $Min(\overline{w}_{fail})$ - lower limit

 $Min(C_S), Min(C_R)$ - upper limits

Distribution	T _{optimal}			
system	$Min(\overline{w}_{fail})$	$Min(C_S)$	$Min(C_R)$	
L-1	1 30	4.80	3 10	
L-2	1.62	4.80	2.80	
L-3	2,30	5,40	2,65	
L-4	1,72	4,80	2,70	
L-5	1,00	4,95	3,48	
L-6	1,37	5,50	3,53	
L-7	1,86	4,80	2,60	
L-8	3,00	6,00	2,60	
L-9	1,86	6,10	3,48	







PROJECT FEATURES

- Developed mathematical reliability model allows obtain the reliability and economical indexes that form criterions for obtaining an optimal time of M&R
- The proposed methodology allows calculate the optimal values of the M&R management parameter for transmission and distribution equipment
- The optimization methodology has been tested during analysis the efficiency of M&R strategy in the real distribution grid company "Noyabrskenergoneft"

