Ain Shams University
Faculty of Engineering
Electrical Power and Machines Department

Planning of the Electric Power Distribution Systems Securing Maximum Reliability at Constraint Budget

A thesis Submitted to the Faculty of Engineering, Ain Shams University in partial fulfillment of the requirements for the Degree of Master of Science in Electrical Engineering

Prepared by:
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STATEMENT

This thesis is submitted to Ain Shams University in partial fulfilment of the requirement for the M.Sc. degree in Electrical Engineering. The included work in this thesis has been carried out by the author at the Electrical Power and Machine Department, Ain-Shams University. No Part of this thesis has been submitted for a degree or a qualification at other university or institute.

Name: ***Shazly Nasser Fahmy Ahmed***

Signature: Shazly Nasser Fahmy

Date: / / **2016**

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Thanks to ALLAH who gives us the power and hope to succeed.

Thanks must go to Allah the creator of this universe who ordered us to study and explore his creations in order to know him better. However, as I come to understand more, I find that there is so much more knowledge to absorb and to get to grips.

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Shazly Nasser

ABSTRACT

It is evident that electric utilities all over world are facing an increasing number of complaints about distribution systems quality. High levels of continuity and quality are the two characteristics that customers expect and demand. Also, distribution systems reliability increase constitutes one of the most important issues in the studies of the power distribution systems.

The purpose of this thesis is to find an optimal system configuration in the planning process to enhance distribution systems reliability using a decision making process based on both incremental cost and incremental benefits criteria.

This thesis uses A Mathematical Programming Language (AMPL) software to build an algorithm for selection between given alternatives the optimal system configuration to optimize the customer oriented reliability indices, e.g. System Average Interruption Duration Index (SAIDI). Also, the objective function of AMPL software is to minimize SAIDI and point out the corresponding system configurations. The optimization is subjected to not exceeding the allocated budget. The procedure is applied on Feeder 4 of Bus 6 of Roy Billinton Test System (RBTS). Five alternatives are available for upgrading the distribution systems minimizing system reliability indices.

Minimal Cut Sets (MCSs) technique is applied for each load point and used in building both of the objective function and the constraints in the AMPL optimization model file.

Reliability Network Equivalent technique is applied to simplify the analytical optimization process. This was necessary to overcome the limited capacity of student version of AMPL software of handling limited

number of constraints and hence to make the AMPL software more or almost available for any complex distribution systems.

Pre-experimenting of robustness of proposed AMPL algorithm is achieved through comparing reliability indices obtained from NEPLAN software and from proposed AMPL software for base case and each configuration of alternatives for the test system.

Net Present Value (NPV) is used to capitalize the cost of energy interruption (ECOST), and added to capital budgeting to determine the total cost for the optimal investment.

Table of Contents

List of Figures

List of Tables

List of Symbols

λ_i, r_i	Failure rate and repair time for i^{th} component in a given distribution system
N_{comp}	Number of components in a given distribution system
λ_j, r_j, u_j	Average failure rate, outage duration and annual outage time of load point j
$Ncust_j$	Number of customers of each load point j
$\mathrm{N_{seclp}}$	The number of main feeder component sections corresponding to each load point
$\mathrm{N_{lp}}$	Number of load points in the system
$\lambda_{\mathrm{N_{seclp}}}$, $\mathrm{r}_{\mathrm{N_{seclp}}}$	The failure rate and repair time of main feeder component sections corresponding to each load point in MCSs technique
u_{LP}	The annual outage time of load points in MCSs technique
u_{LINE}	The annual outage time of main feeder corresponding to each load point in MCSs technique
u_{LD}	The annual outage time of lateral distribution feeder connecting to its load point in MCSs technique
λ_{LD}	The failure rate for lateral distribution feeder connecting to its load point in MCSs technique
r_{LD}	The repair time for lateral distribution feeder connecting to its load point in MCSs technique
λ_{ij}, $\mathrm{r_{ij}}$	Failure rate and outage duration (repair time or switching time) of the main section *i* in a general feeder