Optimized Protective Devices Allocation in Electric Power Distribution Systems Based on the Current Conditions of the Devices

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Abstract— This paper proposed the new method to carry out the optimized allocation of the protection devices to improve SAIFI based on the current placement of devices. Genetic algorithm (GA) is used to optimize the objective function. Advantages of the method used in this paper are minimal risk to change the protection devices, cost minimization of change the location of the devices and system reliability improvement. In order to illustrate the application of this method, an actual electric power distribution feeder, 20 kV, overhead lines, three-wire with a delta-grounded wye connection substation transformer is used.

Keyword- distribution systems, protection, reliability, optimization

I. INTRODUCTION

THE fundamental purpose of the electric utilities is to service their customers with a reliable and appropriate cost power supply. In the recent studies, the most common indices used about the power quality and reliability of the distribution systems are customer oriented indices. These customer oriented indices are system average interruption frequency index (SAIFI), system average interruption duration index (SAIDI), average system interruption frequency index (ASIFI), average system interruption duration index (ASIDI), customer average interruption duration index (CAIDI) and average system availability index (ASAI). These indices have been detailed in several relevant papers with the reliability of the distribution systems [1,2].

Optimized and safe designing of distribution systems concludes the protective and switching devices in strategic places of the distribution networks to improve the reliability and power quality indices. Several papers are found in literature dealt with the optimized placement of protective and switching devices. References [3-7] survey separately the optimal switch allocation for network energy restoration. Other references have analyzed the optimized allocation of the protective devices in distribution systems [1,8-10]. Also several papers proposed different methods to optimally place both switches and protective devices [11-14].

In the model proposed in [3], the objective function includes outage, capital cost and maintenance to find the optimal placement of the switches. In other reference [4], the proposed method has dealt with the comparison between cost of the non- supplied energy and cost of the sectionalizing switches. The algorithm used to solve the optimization problem is genetic algorithm. [8]. Binary linear programming model is used for the placement of protection devices, fault locators and other sensors in the distribution networks [1,9]. In References [11,13], the problem of the optimized switches and protective devices is modeled through non- linear programming (MINLP) with real and binary variables. The reactive tabu search algorithm (RTS) is used to solve the optimized problem. Ref [14] has presented a multi objective optimization methodology to optimally place of the switches and protective devices to improve the system reliability indices. The multi objective ant colony optimization (MACO) has been applied to solve the problem. The proposed placement of switches and protective devices leads to minimize the total cost while simultaneously minimize two distribution network reliability indices including SAIFI and SAIDI.

This paper proposed the new method to carry out the optimized allocation of the protection devices to improve SAIFI based on the current placement of devices. Genetic algorithm (GA) is used to optimize the objective function. Advantages of the method used in this paper are minimal risk to change the protection devices, cost minimization of change the location of the devices and system reliability improvement. In order to illustrate the application of this method, an actual electric power distribution feeder, 20 kV, overhead lines, three-wire with a delta-grounded wye connection substation transformer is used.

II. PROPOSED ALGORITHM

In the proposed method, in process of optimization, the algorithm checks the suggested places for install the protective devices and compares the proposed placement of the devices by the current conditions of the feeder. Each proposed device placement that is different from the placement of the devices imposes a penalty factor to value of the objective. Although in the end of the each step of the optimization, the algorithm compares the total number of the protective devices with the total number of the protective devices. Other value is added to objective in order to the additional devices needed.

In this method, SAIFI is determined to minimize. According to the above explanation, it is reasonable to write the objective function in expression as same as the available