Reliability evaluation of radial distribution system – A case study

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Abstract

Reliability evaluation of a system or component or element is very important in order to predict its availability and other relevant indices. Reliability is the parameter which tells about the availability of the system under proper working conditions for a given period of time. In this paper reliability evaluation of an electrical power distribution system is done and different parameter are evaluated. The electrical power distribution system taken for study is radial distribution system in nature.

Keywords: Reliability, Availability, Radial distribution system, Electrical power system.

I. Introduction

Reliability evaluation of a system or component or element is very important in order to predict its availability and other relevant indices. Reliability is the parameter which tells about the availability of the system under proper working conditions for a given period of time. A Markov cut-set composite approach to the reliability evaluation of transmission and distribution systems involving dependent failures was proposed by Singh et al. [1]. The reliability indices have been determined at any point of composite system by conditional probability approach by Billinton et al. [2]. Wojczynski et al. [3] discussed distribution system simulation studies which investigate the effect of interruption duration distributions and cost curve shapes on interruption cost estimates. New indices to reflect the integration of probabilistic models and fuzzy concepts was proposed by Verma et al. [4]. Zheng et al. [5] developed a model for a single unit and derived expression for availability of a component accounting tolerable repair time. Distributions of reliability indices resulting from two sampling techniques are presented and analyzed along with those from MCS by Jirutitijaroen and Singh [6]. Dzobe et al. [7] investigated the use of probability distribution function in reliability worth analysis of electric power system. Bae and Kim [8] presented an analytical technique to evaluate the reliability of customers in a microgrid including distribution generations. Reliability network equivalent approach to distribution system reliability assessment is proposed by Billinton and Wang [9].

Evaluation of Reliability indices accounting omission of random repair time for distribution systems using Monte Carlo simulation [10]. Determination of Optimum period between Inspections for Distribution system based on Availability Accounting Uncertainties in

Inspection Time and Repair Time, Tiwary et al. [11]. Jirutitijaroen et al. [12] developed a comparison of simulation methods for power system reliability indexes and their distribution. Determination of reliability indices for distribution system using a state transition sampling technique accounting random down time omission Tiwary et al. [13]. Tiwary et al. [14] proposed a methodology based on inspection repair based availability optimization of distribution systems using Teaching Learning based Optimization. Bootstrapping based technique for evaluating reliability indices of RBTS distribution system neglecting random down time was evaluated [15]. Volkanavski et al. [16] proposed application of fault tree analysis for assessment of the power system reliability. Li et al. [17] studies the impact of covered overhead conductors on distribution reliability and safety. Reliability enhancement of distribution system using Teaching Learning based optimization considering customer and energy based indices was obtained in Tiwary et al. [18]. Self-Adaptive Multi-Population Jaya Algorithm based Reactive Power Reserve Optimization Considering Voltage Stability Margin Constraints was obtained in Tiwary et al. [19]. A smooth bootstrapping based technique for evaluating distribution system reliability indices neglecting random interruption duration is developed [20]. The impact of covered overhead conductors on distribution reliability and safety is discussed [21]. Sarantakos et al. [22] introduced a method to include component condition and substation reliability into distribution system reconfiguration. Battu et al. [23] discussed a method for reliability compliant distribution system planning using Monte Carlo simulation.

II. Reliability evaluation of series system and its implementation

Physically a system configuration will be a series reliability network if system fails even if a single component fails or system survives if all the components are working successfully.

If one assumes time independent reliability r1,r2…rn, then reliability of series system is given as

$$R_s = \prod_{i=1}^{n} r_i$$

Fig. 1, [20] consists of 7 distributor segments and 7 load points from LP-2 to LP-8. For each and every load point series path is considered from source to that load point.

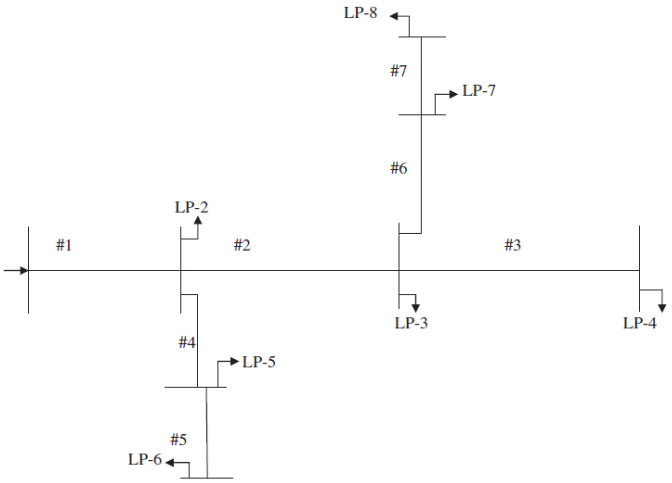

Figure 1: Eightnode distribution system

III. Results and Discussion

Table 1 shows the initial data for the radial distribution system. There are seven distribution section and the initial data for the reliability are 0.4, 0.3, 0.5, 0.7, 0.2, 0.6, 0.8 respectively. Table 2 provides the evaluated reliability for each of the load points separately. For LP-2 to LP-8 evaluated reliability value is 0.4, 0.12, 0.06, 0.28, 0.056, 0.072, 0.0576 respectively. Fig. 2 provides the magnitude of evaluated reliability at different load points.

Table 1: Initial data for the radial distribution system.

Distribution section	1	2	3	4	5	6	7
Reliability value	0.4	0.3	0.5	0.7	0.2	0.6	0.8

Table 2: Evaluated reliability for each of the load points.

Load Point	2	3	4	5	6	7	8
Evaluated Reliability	0.4	0.12	0.06	0.28	0.056	0.072	0.0576

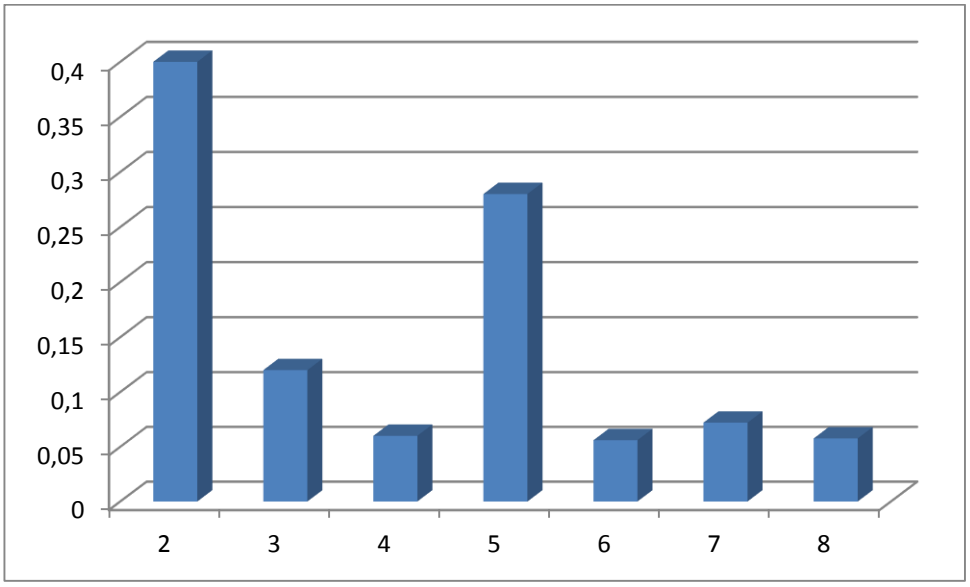

Figure 2: Magnitude of Reliability at different load points.

IV. Conclusion

Reliability evaluation of a system or component or element is very important in order to predict its availability and other relevant indices. In this paper reliability evaluation of an electrical power distribution system is evaluated. The electrical power distribution system taken for study is radial distribution system in nature. The parameter obtained is shown in Table-2 for the different Load points LP-2 to LP-8 respectively.

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