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TECHNIQUES TO ACHIEVE THE PROCEDURES AND SCHEDULING STRUCTURE OF DISTRIBUTION SYSTEM

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ABSTRACT:

The Elementary Reliability Assessment Technique (ERAT) is needed to assess the reliability of distribution systems. These techniques are adopted into the distribution system to achieve the operations and planning construction of distribution system. In this paper we propose six different strategies, which are examined on distribution system. In generally the study of reliability can also help to predict the system's performance of the reliability, after measuring the impact on adding new components to the distribution system. The newly added components data (i.e., number of devices and their locations) is needed to improve the reliability indices, and certain limits can be identified and studied for the improvement in performance of the ERAT.

Keywords: Elementary reliability assessment technique (ERAT), Distribution systems, Reliability evaluation, Customer interruption costs.

1. INTRODUCTION:

The basic function of an electrical power system is to meet its customer's requirements by maintaining standard levels quality and continuity in power supply [1]. In this context, the term "reliability" has a broad and general meaning. It includes load/demand measures such as quality and continuity of service. Since, the primary objective of the power system is to satisfy customer requirements, which need the proper functioning and efficiency of the system in order to customer satisfaction. It is also to be noted that, the distribution system is a link among the bulk power system and its customers. In many cases, these links are radial in nature that makes them vulnerable to customer interruptions due to a single outage event. A radial distribution circuit generally uses main feeders, and distributors to supply customer energy requirements. Earlier, the distribution segment of a power system has given considerably less importance in terms of reliability planning compared to generation and transmission segments, due to generation and transmission segments are very expensive, and outages in these segments can cause widespread catastrophic economic consequences for society. An electric power system comprises generation, transmission and distribution, and ensures a reasonable balance in the reliability [2]. Electric power distribution systems constitute the interrupted power supply. It has been studied that more than 80% of all customer interruptions occurs due to the failure of distribution system. And, the distribution segment has been the weakest link among the source of supply and the customer load points. Hence, a single distribution system reinforcement scheme is relatively inexpensive when compared with generation or transmission improvement scheme. An electric unit spends a large amount of capital and maintenance budget collectively on a huge number of distribution improvement projects. Distribution utilities are required only to furnish historical distribution system performance indices to regulatory agencies. Reliability evaluation and maintenance planning techniques have separately been well developed. The reliability study can also help to predict the reliability performance of the system, in expansion and quantify the impact of adding new components to the system. The number and locations of new components needed to improve the reliability indices up to certain limits can be identified and studied.

Customer satisfaction is important in the new deregulated electric utility environment in terms of reliable electric supply. Customer outage costs due to electric supply failures are big concern in both utilities and customers. Customer outage cost assessments have been conducted in many countries and the results applied using both analytical and simulation techniques to assess reliability worth. The magnitude of the interruption cost associated with a specific delivery point will depend up on many factors such as the load curtailed, the type of customers involved, and the duration of the outage, and also the time of day, day of the week and time of year have an effect on magnitude of the interruption cost. In order to make the estimation of delivery point interruption costs there should be a reasonable method need to develop an approximate technique that uses a load point topology and customer demographic data and provides acceptable interruption cost estimations. The object of this paper is to present the Elementary Reliability Assessment Technique (ERAT) to evaluate the reliability of distribution systems.

II. ERAT DISTRIBUTION SYSTEM ANALYSIS

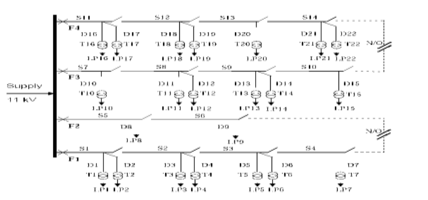

Fig 1.ERAT system

III.RELIABILITY INDICES

A distribution system is segment in a power system which links the bulk system to the individual customers. The basic distribution system reliability indices are the three load point indices are: i) average failure rate; ii) the average outage duration r; iii) the annual outage duration U. These indices are important individual load point parameters. The system indices of SAIFI, SAIDI, CAIDI, ASAI and ASUI can be calculated from these indices. Also, the reliability cost worth indices of expected energy not supplied (EENS), expected interruption cost (ECOST), and interrupted energy assessment rate (IEAR) measured using these three basic load point indices.

ERATDATA

Thereliabilityparameters are asfollows:

- Average failure rate foreach section and distributor=0.065 failures/yr-km
- Average repairtime foreach section and distributor=5 hours
- Average failure rate foratransformer=0.015 failures/year
- Average replacement time fora transformer=10hours
- Averageswitchingtime=1 hour.

The circuit breakers and fuses are assumed to be 100% reliable. The failure rate of a transformer is considered to be unaffected by the weather conditions. A faulted transformer is replaced by a mobile transformer instead of repairing it.

Length	Feeder sections	Lateral distributors
0.60 km	S4, S6, S9, S14	D1, D4, D10, D15, D17, D18
0.75 km	S1, S2, S3, S5, S7, S10, S12, S13	D6, D11, D13, D16, D21
0.80 km	S8, S11	D2, D3, D5, D7, D8, D9, D12, D14, D19, D20, D22

Table.1.feeder section and lateral distributor lengths

Load point	Average load (MW)	Peak load (MW)	Number of customers	Customertype
1,2,3,10,1	0.535	0.866	21	Residenti
12,17,18,	0.450	0.729	20	Residenti
8	1.000	1.627	1	Small
9	1.150	1.872	1	Small
4,5, 13,	0.566	0.916	1	Institutio
6,7,15,16,	0.454	0.750	1	Commerc

Table.2.load point data

Feeder	Load points	Averageload (MW)	Peak load (MW)	Number of Customers
F	1	3.645	5.934	6
F	8	2.150	3.500	2
F	10–15	3.106	5.057	6
F	16–22	3.390	5.509	6
To	2	12.291	20.00	19

Table.3.Feeder data

IV. CONVENTIONAL APPROACH

Approximate equation method is used to calculate primary indices**.** The fundamental reliability indices for any load point K of a feeder **[3]** are as follows:

$$\lambda_K = \lambda_T + \lambda_{DK} + \sum \lambda_{Si} - - - (1)$$

$$U_K = \lambda_T r_T + \lambda_{DK} r_{DK} + \sum \lambda_{Si} r_{Si} - - - (2)$$

$$R_K = \frac{U_K}{\lambda_K} - - - - (3)$$

Where:

λ_T = average failure rate of a transformer

λ_{DK} =average failure rate of distributor k

λ_{Si} =average failure rate of feeder section *i*

r_T = average repair time of a transformer

r_{DK} =average repair time of distributor k

r_{Si} = average repair time of feeder section *i*

The load point indices λ_k and U_k computed using **Equations 1and 2** are used to obtain the feeder or system indices (SAIFI, SAIDI and CAIDI) given by equations below:

$$SAIFI = \sum_{k=1}^{lp} \lambda_K N_K / N - - - \textbf{(4)}$$

$$SAIDI = \sum_{K=1}^{lp} U_K N_K / N - - - \textbf{(5)}$$

$$CAIDI = \frac{SAIDI}{SAIFI} - - - \textbf{(6)}$$

Where, *lp*denotes the number of load points connected to the feeder/system and N_K is the number of customers at load point k, and N is the total number of customers in the system. The indices, SAIFI SAIDI and CAIDI, can be determined for different levels in the system. The cost worth indices of a feeder or a load point can be calculated by using the following equations:

$$ECOST = \sum_{k=1}^{lp} L_{avgk} CDF_{rk} \lambda_k \quad \text{--- (7)}$$

$$EENS = \sum_{k=1}^{lp} L_{avgk} U_k \quad \text{--- (8)}$$

$$IEAR = \frac{ECOST}{EENS} \quad \text{--- (9)}$$

Where L_{avgk} denotes the average load in MW connected at a load point k. λ_k, U_k are the failure rate and unavailability of a load point k.The customer interruption cost (CDF) associated with a particular interruption depends on the composition of the load point. CDF_{rk} in the above equation denotes the customer damage function for an interruption duration r(hrs) of load point k. The sector CDFs used in this paper are shown as demand normalized values (Rs/kW) in T**able 4.**The load point indices of average failure rate, average annual outage time (unavailability) and average outage duration obtained without considering weather conditions using **Equations 1-3** are shown in **Table 2.**We consider six variant possible alternativesand are applied to a typical ERAT distribution system. These are as follows:

1. Base Case:

Here, the assumption is no fuse gears, disconnects on the feeder

2. Effect of lateral distributor protection:

To install fuse gear at the tee-point in each lateral distributor, a short circuit on a lateral distributor causes its appropriate fuse to blow and causes disconnection of its load point until the failure is repaired, but it does not affect or cause the disconnection of other load point.

3. Effect of disconnects

Here, the arrangement of disconnects or isolators at appropriate points along with the main feeder is described.

4. Effect of protection failures

The arrangement of fuses in the lateral distributor operated whenever a failure occurred on the distributor which are supposed to protecting by assuming that the fuse gear operates with a probability of 0.9, i.e. the fuses operate successfully 9 times out of 10 when required. The contribution of the failure rate can be evaluated using the concept of expectation.

Failure rate = (failure rate | fuse operates) x ***p*** *(fuse operates) + (failure rate | fuse fails) x P (fuse fails)*

5. Effect of transferring loads without restrictions on transfer:

Here, assuming that there is no restriction on the amount of load that can be transferred through the back feed, in which the failure rate of each load point does not change. Therefore, the indices of load points do not change because load transfer cannot recover.

6. Effect of transferring loads with restrictions on transfer

In this case the outage time associated with a failure event is equal to the isolation time if the load can be transferred, or equal to the repair time if the load cannot be transferred. The average of these values can be evaluated using the concept of expectation.

Outage time = (outage time | transfer) x P (of transfer) + (outage time no transfer) x P (of no transfer)

V. APPLICABILITY TO ERAT SYSTEM

A. Analytical Reliability Network Equivalent Technique: The analytical techniques required for distribution system reliability evaluation are highly developed. The proposed oneis an inductive method that systematically approach on a component-by-component basis in all possible failure modes and identifies their resulting effects on the system. Possible failure events or malfunctions of each component in the distribution system are identified and analyzed to determine the effect on surrounding load points. A final list of failure events is formed to evaluate the basic load point indices. The FMEA technique has been used to evaluate a wide range of radial distribution systems. In systems with complicated configurations and a wide variety of components and element operating modes, the list of basic failure events can become quite lengthy and can include thousands of basic failure events. This requires considerable analysis when the FMEA technique is used. It is therefore difficult to directly use FMEA to evaluate a complex radial distribution system. A reliability network equivalent approach is introduced in this section to simplify the analytical process. The main objective in this strategy is using an equivalent element to replace a portion of the distribution network and therefore decompose a large distribution system into a series of simpler distribution systems. This approach provides a repetitive and sequential process to evaluate the individual load point reliability indices.

B. Basic Formulas for a General Feeder

Based on the element data (λi, λk, λs , ri , rk, rs, pk) and the configuration of the general feeder, a set of general formulas for calculating the three basic load point indices of load point failure rate λ_j , average outage duration r_j and average annual outage time U_j for load point j of a general feeder is as follows:

$$\lambda_j = \lambda_{sj} + \sum_{i=1}^{n} \lambda_{ij} + \sum_{k=1}^{n} P_{kj} \lambda_{kj} \quad \text{....... (10)}$$

$$U_j = \lambda_{sj} r_{sj} + \sum_{i=1}^{n} \lambda_{ij} r_{ij} + \sum_{k=1}^{n} P_{kj} \lambda_{kj} r_{kj} \quad \text{....... (11)}$$

$$r_j = \frac{U_j}{\lambda_j} \quad \text{...... (12)}$$

The control parameter of lateral section k that depends on the fuse operating model. It can be 1 or 0 corresponding to no fuse or a 100%reliable fuse respectively and a value between 0 and 1 for a fuse which has a probability of unsuccessful operation of pkj. The parameters λij, λkj, and λsj are the failure rates of the main section i, lateral section k and series element s respectively, and $r$ij ,$r$kj , and $r$sj are the outage durations (switching time or repair time) for the three elements respectively.The $r$ij, $r$kj, and $r$sj data have different values for different load points when different alternate supply operating modes are used and disconnect switches are installed in different locations on the feeder. This is illustrated in the following three cases.The basic Formulas for a General Feeder are deduced to conventional approach approximate equations. These are given as

$$\lambda_K = \lambda_T + \lambda_{DK} + \sum \lambda_{Si} - - - (13)$$

$$U_K = \lambda_T r_T + \lambda_{DK} r_{DK} + \sum \lambda_{Si} r_{Si} - - - (14)$$

$$R_K = \frac{U_K}{\lambda_K} - - - (15)$$

Where:

λ_T = average failure rate of a transformer

λ_{DK} =average failure rate of distributor k

λ_{Si} =average failure rate of feeder section *i*

r_T = average repair time of a transformer

r_{DK} =average repair time of distributor k

r_{Si} = average repair time of feeder section *i*

Case 1: No Alternate Supply:

In this case, r_s is the repair time of the series element s and r_i is the switching time for those load points that can be isolated by disconnection from the failured main section i or the repair time for those load points that cannot be isolated from a failure of the main section i, r_k is the switching time for those load points that can be isolated by disconnection from a failure on a lateral section k or the repair time for those load points that cannot be isolated from a failure on a lateral section k.

Case 2: 100%Reliable Alternate Supply:

In this r_i and r_k take the same values as in Case 1. The parameter r_s is the switching time for those load points that are isolated from the failure of a series element by disconnection or the repair time for those load points not isolated from the failure of a series elements.

Case-3: Alternate Supply with Availability:

In this case, r_i is the repair time (r1) for those load points not isolated by disconnection from the failure of main section i, the switching time (r_2) for those load points supplied by the main supply and isolated from the failure of the main section i, or r_2p_a+ (1-p_a) r1 for those load points supplied by an alternate supply and isolated from the failure of the main section i. The parameter r_k is the repair time r_1 for those load points not isolated by disconnection from the failure of lateral section k, the switching time r_2 for those load points supplied by the main supply and isolated from the failure of lateral section k or $r_2$pa + (1-p_a) r1 for those load points supplied by an alternate supply and isolated from the failure of a lateral section k. r_s is the same as in Case 2.

VI.CONCLUSION

This paper has presented different techniques for improving the reliability in radial distribution system. In this paper above mentioned all techniques examined on considerable system and finally calculated cost/worth indices values. These values decrease with increasing in the investment on radial distribution system. And also introduced six cases for the assessment of reliability of ERAT distribution system and relationship between characteristics and policy have been presented using case studies.

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