PREFACE

Data is precious because it can identify the chronological changes in the performance and, therefore helps to determine weak areas where the reinforcement/modification is needed. It helps in the computation of indices which serve as a guide for acceptable value in reliability estimation and enables predicted values to be compared with actual values. In the present work, data is collected from AP TRANs. Co, and APSPDCL operation and maintenance. This thesis has been organized into ‘seven’ chapters. Based on the critical analysis of the results obtained from the programs written for “Studies on Reliability Evaluation of Electrical Transmission System” are presented.

Chapter I presents the general fundamental background of reliability engineering and their applications. Four probability functions such as the Reliability function \( R(t) \), Cumulative Distribution function \( Q(t) \), Probability Density function \( f(t) \) and Hazard rate function \( \lambda(t) \) are described. Four time dependent and independent probability models such as Exponential, Weibull, Normal and Log Normal Distribution are presented. Network modelling reduction procedure for evaluation of complex systems in reliability engineering was discussed.

The background of power systems fundamental and deregulation, planning of Electrical Transmission Systems and factors affecting the planning are presented. Here some basic power system reliability evaluation techniques such as probabilistic and deterministic methods are also discussed. The possibility to explore the reliability evaluation of electrical transmission system is presented in Chapter II. The literature review with research objectives and problem statement is presented.

Chapter III mainly focuses on two categories among which one is the establishment of new reliability index framework that meets the developing power market and integrates reliability assessment called Expected Energy Not Supplied (EENS). The generation adequacy can also be calculated based on the statistical analysis of discrete distribution like Binomial Distribution for Loss of Load Probability (LOLP), Loss of Load Energy (LOLE). The other is the reliability assessment of bulk power system based on sensitivity analysis called Expected Load Curtailment (ELC). In this chapter, IEEE
Reliability Test System is investigated for evaluation of above indices for the operation/planning of the power system.

Chapter IV presents an overview of assessment of various EHT AC Sub-Station. Minimal Cut-Set and Monte Carlo Simulation Methods are used for the computation of indices. With the knowledge of computation of sub-station reliability indices, an engineer would analyze the best possible system reliability for different substation configurations. Determination of the reliability of a sub-station is a significant parameter for existing installations as it can help to locate weak points which may be contributing to overall system unreliability and security.

The 220kV sub-station at Nellore district is considered as a realtime case study for reliability assessment of various configurations of reliability indices through these the results so obtained for standard test case is compared. The data is collected for reliability assessment for different failure data of various components like line, transformer, and Circuit breakers etc. of 220kV sub-station at Nellore. The high value of reliability index (annual outage U) is an indication of weak points in the EHT AC Sub-Station and may lead to unreliable operation. Sub-stations are to be reconfigured based on the assessments of reliability index obtained for various sub-station configurations. This improves the overall system’s reliability and would be more useful in the design of new sub-station layouts in future.

Electricity distribution is the middle stage in the delivery (before retail) of electricity to end users. These days’ major interruptions take place at the distribution level, due to its peculiar characteristics and structure. Hence, it becomes immensely imperative for distribution expansion planning models include reliability issues.

Chapters V and VI emphasise the objective of improving the distribution system reliability of a realtime system. The distribution system reliability can be improved in two ways:

- By placing capacitors at weak voltage nodes and thereby improving the voltage profiles.
- By providing protective components in the feeder for improvement of reliability indices.
Since consumer load demand is not constant throughout the day and it varies from
time to time, the study in carried out by considering the terms Diversity Factor (DF) and
Power Factor (PF) for five combinations. The load data is framing for performing load
flow analysis.
The five conditions are as follows
1. Average DF Good PF
2. High DF High PF
3. High DF Low PF
4. Low DF High PF
5. Low DF low PF

Average peak load demand covered over a month, by considering the terms Load
Factor (LF) and Loss Load Factor (LLF), the real time losses of a feeder from substation
are calculated for comparison with load flow losses. Distribution system reliability
assessment is able to predict the interruption profile of a distribution system based on
system topology and interruption profile. Distribution system reliability indices are a
measure of system continuity and quality of power supply to consumers. Utilities
commonly use these indices as benchmark of reliability. The most common distribution
indices are
1. System Average Interruption Frequency Index (SAIFI)
2. System Average Interruption Duration Index (SAIDI)
3. Customer Average Interruption Duration Index (CAIDI)
4. Average Service Availability (ASAI)
5. Average Service Unavailability (ASUI)
6. Average Energy Not Supplied (AENS)
7. Average Customer Curtailment Index (ACCI)

The above indices are determined for realtime radial distribution feeders (both
urban and rural) considering the interruption profiles data over a year from the interruption
records of APSPDCL. AENS reflects the reliability of the distribution system in terms of
Average Energy Not Supplied per customer in KWH. For the purpose of performing the
distribution reliability, the following three stage methodology is used.

- The load flow of realtime radial distribution system is carried out to find out
  voltages at all the nodes and total losses of the system. These losses are compared
with real time losses from substation. The nodes having voltage less than 0.95 p.u are identified.

- On the basis of load flow solutions, the low voltage nodes are compensated by placing capacitor at single or multiple nodes for improvement of voltage profiles and also for reduction of total losses. Placement of capacitor at multiple nodes is done by using Particle Swarm Optimization (PSO).

- Based on interruption data over a calendar year, distribution system reliability indices are calculated.

- By incorporating the single protective component such as the isolator for enhancements of distribution system, reliability indices are evaluated.

Chapter VII summarizes the thesis and concludes the reliability evaluation of ETS and scope for future work.