CHAPTER 1
INTRODUCTION

The main requirements of consumers are to receive uninterrupted reliable power supply on demand. Various researchers have published their views but still there are more research works needed in this domain to satisfy these requirements. Haida et al (1994) indicated that both positive and negative load forecasting errors resulted in increased operating costs. Hobb et al (1999) quantified saving of thousands of dollars for reduction of 1 % error in load forecasting. Short term load forecasting can estimate load flows for taking timely decisions, which leads to the improvement of network reliability due to reduced occurrences of equipment failures avoiding blackouts.

The application of short term load forecasting using Supervisory Control And Data Acquisition (SCADA) system in this dissertation work has a significant role in network management, load dispatch and network reconfiguration under the constraints to maintain quality of reliable power supply. An algorithm is developed based on similar day and similar weather for half an hour before forecasting of loads. In addition, a frequency is estimated before half an hour. Mean Absolute Percentage Error shows improved performance compared to existing method.

Further, the recent trend in urban area is to improve the system reliability by adjustment of substation bus bar configuration with hybrid switchgear within the same space constraint. The single bus bar substation, sectionalized bus bar substation, breaker and a half bus bar substation and
double bus bar double breaker substation are analyzed for estimating reliability with Successful Path Method (SPM).

A success tree provides assurances that the desired event will occur. The success tree is a valuable tool from success view point that provides equivalent information to the fault tree. A success tree can be transformed into its logical inverse, a fault tree. A fault tree is the logical compliment of success tree. The fault tree starts with an undesired event and then deduces its causes using backward stepping process. Thus, the fault tree is a deductive approach.

A path set is said to be minimal if it can not be reduced without loosing its status as a path set. The success tree identifies the minimal success sets of basic events that need to be successful in order to assure that the top event occurs. A set theory is used for indicating the success path. The success mode uses basic two gates, AND gate and OR gate.

The proposed method of SPM gives better results than the existing method for reliability assessment of various substation configurations.

1.1 LITERATURE SURVEY

Load forecasts can be divided into three categories. Srinivasan et al (1995) classified load forecasting based on durations. Short term load forecasting duration is up to one day, medium term load forecasting is from one day to one year and long term forecasting is from 1 year to 10 years.

Various methods are developed for short term load forecasting. These are similar day approach, time series regression models. Some methods use tools such as neural networks, fuzzy logic, artificial intelligence and
expert systems for forecasting loads. The accuracy of load forecasting depends upon the accuracy of available input information.

Electric load forecasting uses regression methods to model the relationship between load and other variables such as type of the day, either working or holiday. Mbamalu et al. (1993) computed regression coefficients by equal or exponential weighted least squares estimation using the historical data. Varadan et al. (1996) presented a least squares method to quantify various types of loads at power system. Barakat et al. (1990) determined the seasonal variation using the regression model. Hyde et al. (1997) determined a weather load model using regression analysis of historical load and weather data. Al fares et al. (1999) used regression based method to forecast load throughout the year with different seasonal factors. Average wind chill factor is added as an explanatory variable in winter and average temperature, humidity factor is added as an explanatory variable in summer. Badran et al. (2008) examined the short term load forecasting deterministic, probabilistic and stochastic forecast models. Asbury et al. (1975) used a method which is based on a regression analysis of historical load and weather information. Taylor et al. (2003) have shown that the electricity consumption is affected by climate variables particularly temperature.

Short term load forecasting using Gaussian process model is a probabilistic non parameter model that provides the prediction and the variance value of the prediction. The prediction value variance that depends on the data density and noise can be viewed as the prediction level of confidence. A major disadvantage of the Gaussian process model is the computational load associated with the need to invert the covariance matrix, whose dimensions depend on the size of the data set and the number of regresses at every iteration of the optimization algorithm.


Neural networks are non linear circuits having the capability to learn. There are number of neural network architectures such as Hop field, back
propagation and Bottzmann machine. The most used architecture for electric load forecasting is back propagation since it uses continuously the estimated functions with supervised learning. The numerical weights assigned to element input are derived by matching historical time and weather data to the desired historical loads in a pre operational training programme. Khotanzad et al (1997) presented Artificial Neural Network (ANN) for short term load forecasting method that selects various trends in load data. There are various types of neural networks. These are multilayer perception network and self organizing network. There are many neurons in each hidden layer. Inputs are multiplied by weights and then added to a threshold to form the net function. Khotanzad et al (1998) made improvement by adding ANN for forecasting base load and change in load. The effect of wind speed and humidity are considered through a linear transformation of temperature and relative humidity on the load. The method used multilayer perception which was trained by back propagation algorithm. Choueiki et al (1997) presented weighted least square method in training a neural network for short term load forecasting. An input under Fuzzy logic may associate with it a certain qualitative range. The load may be low, medium or high load. The drawbacks of these models are that their accuracies are affected if an abrupt change in temperature takes place due to change in load.

Vapnic (1995) had introduced a statistical learning theory, which is known as support vector machines for solving regression problems. Support vector machines uses kernel functions to perform non linear mapping of load data. Christiani (2000) also introduces support vector and kernel based learning methods. Mohandes (2002) presents support vector machine method and shows better performance against the auto regression methods.

Expert system uses human expert rules and procedures in load forecasting software, which has ability to automatically make forecast. Rahman et al (1996) presented a site independent expert system for short term load forecasting. An expert system is a computer program that has the ability to explain, reason and its knowledge base gets expanded as new load data gets input. Knowledge engineer extracts load forecasting knowledge from field experts. This knowledge consists of the set of relationship which is used as rule. This rule base gives load forecast. Mohamad et al (1996) used a combination of neural network and expert system for hourly load forecasting in Egypt Reis et al (2005) had described a methodology of feature extraction via multi resolution analysis for short term load forecasting.


Valor et al (2001) used temperature data in 30 minute intervals for 8 years for predicting load. Osczevski et al (2005) had devised the wind chill equivalent temperature chart. Similarly, humidex that measures heat and
humidity is used for summer, which causes high level of discomfort. Masterton et al (1979) had described humidex, a method of quantifying human discomfort due to excessive heat and humidity. The scatter plot of the load versus wind chill temperature in winter and the load versus humidex in summer is plotted to select the forecast load.

The drawback of all the above works is that these have not accounted for frequency variation effects due to variation of loads and generation. This dissertation work develops a short term initial load forecast for a day by fixing the maximum and minimum forecast from weather based historical data for the similar day. The final load forecast before 30 minute is estimated by correcting the difference between initial load forecast and actual load recorded by Supervisory Control and Data Acquisition (SCADA) system at every minute interval using regression. The frequency forecast is based on final forecast demand, at every minute interval taking into consideration the power number of the system and the variation in generation.

All the above works deals with FTA where as this work develops a method of reliability estimation by Successful Path Method (SPM) for substation configuration, which has improved the accuracy in reliability estimation of various bus bar configurations compared to existing method.

1.2 ORGANIZATION OF THE THESIS

This thesis comprises of five chapters. Chapter 2 gives an analytical overview of SCADA reliability and the utility of evaluating a reliability of component during its operation rather than depending on the old data base provided by the manufacture. A recent trend in the application of SCADA in the power system including its utility in load forecasting is presented. Existing SCADA systems are vender specific devices. The monopolies of the specific supplier do not give scope to other suppliers to integrate and upgrade the existing system. They are hardwired systems known as legacy systems. The trend is changing towards the network platform concept due to technological development in communication field hence the solutions offered by the International Electro technical Commission (IEC-61850) Global standard is presented . Chapter 3 deals with development of proposed algorithm based on similar day load forecast. The similar day load forecast and frequency variation is estimated with the proposed algorithm initially by Profile Based Load Forecast (PBLF) for an interval of one hour using Mat lab. The improved result is achieved with the application of the proposed algorithm with the Weather Based Load Forecast (WBLF) for an interval of one minute. Chapter 4 deals with a proposed method of successful path method (SPM). A comparison of conventional method and the proposed Successful Path Methods (SPM) and the results are presented and the results are discussed. Chapter 5 deals with the conclusions and suggestions for future works.