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A STATISTICAL APPROACH FOR IMPROVING THE AVAILABILITY OF A 220 KV EXTRA HIGH-TENSION FEEDER NETWORK

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ABSTRACT

An electrical power utility is expected to maintain power quality and reliability. Electrical power reaches the consumer through a network of 400, 220, 132, 33 and 11 kV feeders. An electrical power utility is responsible for minimizing the number of interruption of these feeders. A regression based statistical method has been developed to forecast the number of interruptions. This approach utilizes historical data for evolving a strategy to take corrective actions to minimize the number of future interruptions. This paper proposes a scientific way for facilitating uninterrupted power supply to consumers.

Keywords: *Regression based statistical method, high-tension feeder network, kV feeders, uninterrupted power supply*

INTRODUCTION

Energy is the prime mover of economic growth and development. There is a direct correlation between the degree of economic growth and per capita consumption of energy. The countries with abundant supply of energy have realized substantially higher rates of industrial growth and corresponding increase in the gross national product. As energy sets the basic foundation for the economic development of a country, the energy consumption is bound to grow over the years. A reliable extra high-tension (EHT) power network (Power Grid) is essential for uninterrupted supply of electrical power.

Andhra Pradesh power grid has around eight 400 kV, sixty-five 220 kV and one-hundred-and-seventy 132 kV EHT substations. Electrical power reaches the consumer through the network of these substations. Availability and reliability of these EHT feeders is of paramount importance for ensuring continuous electrical power to the end user.

Limited amount of research is done in forecasting the availability of electrical power network due to the feeder network redundancy (standby feeders) in the power grid. This paper presents a scientific approach based on regression analysis for forecasting EHT feeder interruptions. Bulk power system planning and operation procedures include reliability as one of the essential measures of system requirements [1].Quantitative reliability invariably leads to the consideration of the data available and data required to support such studies. Data collection and reliability evaluation must evolve together. Such data can be used for both assessment of past performance and prediction of future performance [2].

REGRESSION APPROACH

A number of statistical approaches including extrapolation, field surveys, exponential smoothing, time-series analysis and regression analysis, are available for forecasting purposes. Regression analysis was chosen since it is believed to be the best method for medium- and short-term forecasting. Also, regression approach is a potent device for establishing relationships between variables (interruption of EHT feeders and time) from the given data. In this study, historical data on Nellore EHT feeder interruptions were used in regression approach for forecasting future feeder interruptions.

The outage rates of the transmission lines can be estimated by using regression analysis method. The following regression equations are used for forecasting the feeder tripping.

The associated regression equation is given by

$$Y = mX + b$$

where m and b are the slope and intercept of the regression line and can be obtained with the help of the following equations.

$$m = \frac{n\sum_{i=1} Xi\, Yi - \sum_{i=1} Xi \sum_{i=1} Yi}{n\sum_{i-1} Xi^2 - \left(\sum_{i-1} Xi\right)^2}$$

$$\text{And } b = \frac{\sum_{i=1} Yi - m\sum_{i=1} Xi}{n}$$

NETWORK AVAILABILITY

An electrical power network is said to be available if the feeder interruptions are minimal or none. Power emanating from various generating stations flows through a network of EHT feeders before reaching the customer. A number of generating stations are feeding a number of substations with the help of essential and standby (redundant) feeders. The present paper utilizes the feeder-interruption data of Nellore 220 kV substation to demonstrate the efficacy of the proposed statistical approach.

Feeder interruption data of Nellore 220 kV substation feeders, viz., Nellore-Ongole and Nellore-Sullurpet are collected tabulated (Table 1) and utilized for medium-term forecasting of interruptions.

Quarter Number	Feeder 1 (Nellore-Ongole)		Feeder 2 (Nellore – Sullurpet)	
1	7		1	
2	9		9	
3	5		4	
4	7		3	
5	3		4	
6	7		1	
7	4		3	
8	4		0	
9	4		0	
10	8		4	
	Actual	Predicted	Actual	Predicted
11	9	5	3	1
12	7	4	3	1
13	2	4	1	0
14	3	4	2	0
15	8	4	3	0

Table 1. Summary of feeder interruption data

RESULTS AND CONCLUSIONS

Figures 1&2 present the actual and predicted feeder interruptions. It can be seen from the figures that the predictions match the actual data with reasonable accuracy. The discrepancy between actual and predicted data may be attributable to varying climatic conditions and non-adherence to stipulated preventive maintenance schedules from quarter to quarter.

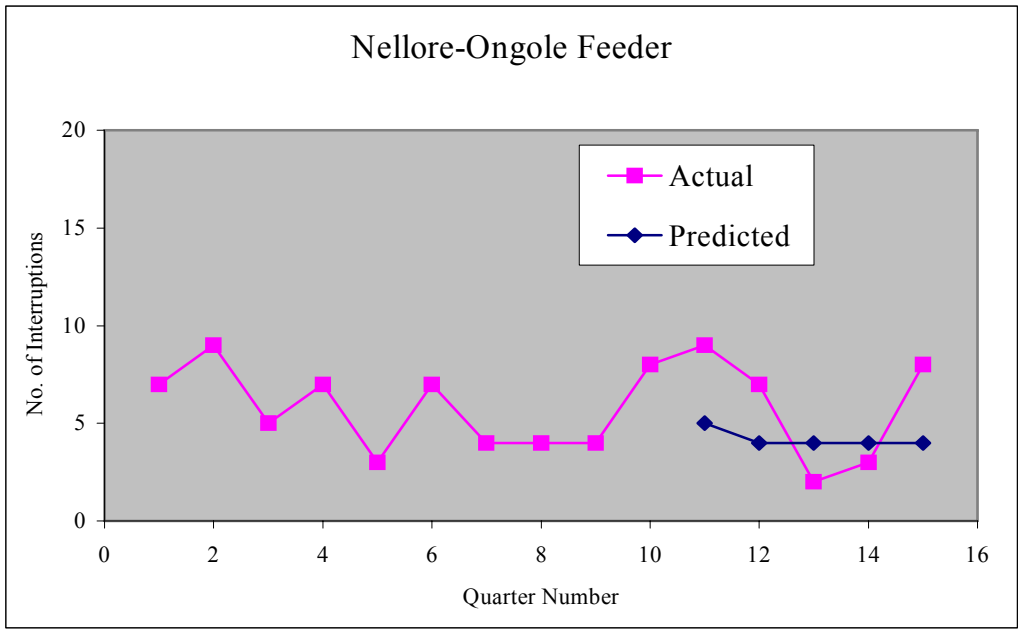

Figure 1. Graphical representation of Nellore-Ongole feeder interruption data

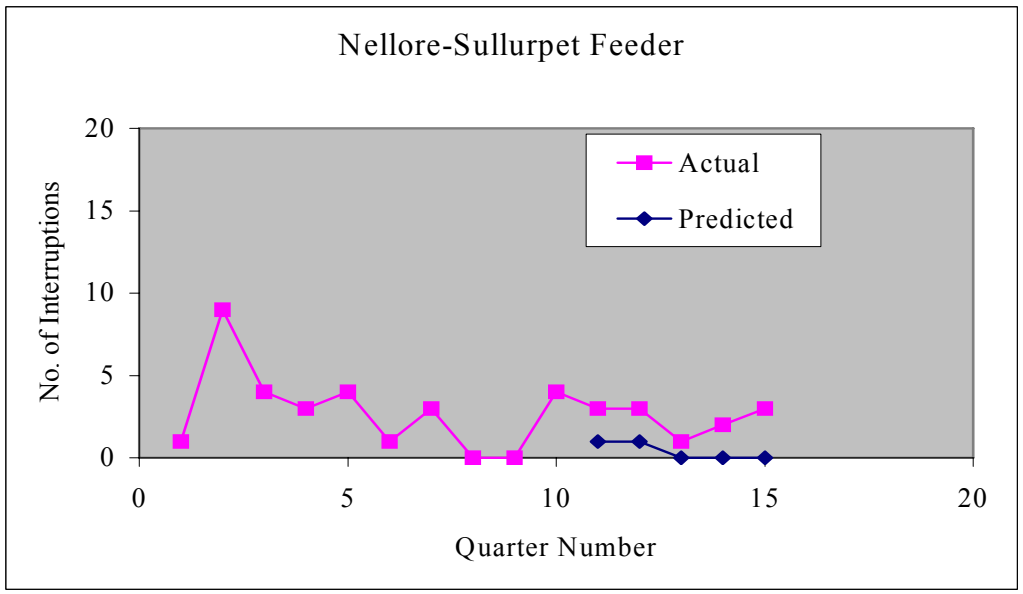

Figure 2. Graphical representation of Nellore-Sullurpet feeder interruption data

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