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Availability Analysis of Electric Power Substation 33/11 kV, Supaul- A Case Study

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Abstract

Electric Power Substation 33/11 kV, Supaul, Bihar is under NBPDCL (North Bihar Power Distribution Company Ltd Government of Bihar). The entire organization of the Bihar State Power Holding Company Ltd. has been set up keeping in view the functions entrusted to it i.e., co-ordinated development of generation, transmission, and distribution of electricity in the State. In this electric power substation where maximum failures are due to loss of unexpected failures and downtime associated also maintenance costs. This study deals with the analytical evaluation of the reliability,availability aspects of electric power substations. In this study reliability and availability of power equipment of electric power substations 33/11 kV is analyzed using collected available five years of data on Fault Frequency and Downtime of associated main power equipment for 2017 to 2021.

Keywords: Reliability, Availability, Maintainability

Availability Analysis

This analysis can be used to estimate the availability metrics of a wide variety of manufacturing processes and production equipment. It is versatile enough to be used in all sizes of manufacturing facilities and can be specified to processes or equipment, individually or in groups.

Availability is a performance criterion of both maintainability and reliability. It is possible to define three types of availability depending on the elements we have taken into consideration. Operational achieved and inherent availability is three types of availability (2). A system is not failed undergoing a repair action/ maintenance job as a matter of fact availability is the probability that when it needs to be used. So, the estimation of availability plays a vital role in both reliability and maintainability aspects. These are considered for a system or a component performing under investigation.

4.10.1 Classification of Availability

The definition of availability is to performance of inherent availability and operational availability is the probability of the equipment being used satisfactorily under a stated condition with an actual support

environment. The solid-state availability is when given only the corrective downtime of the system under inherent availability. Mathematically (20),

Ain = MTBF/ (MTBF +MTTR-------- (4.1)

The mean availability over a specific period is calculated on operational availability and it contains all qualified basis of such as administrative downtime, logistic downtime, downtime, etc. Mathematically (2);

Aop= MTBF / (MTBF+MDT) ---- (4.2)

The following relationship has been used in availability analysis (18):

MTBF (Mean Time Between Failure) = Up time / No. of failures--------- (4.3)

MTTR (Mean Time to Repair) = Taken as 30% of MDT---------- (4.4)

MDT (Mean Down Time) = Down Time / No. of Failure---------- (4.5)

Hazard Rate = No. of failures / Up time---------- (4.6)

The availability of the various components of electric power substation [table 4.6 to 4.20] has been estimated for sixty months (Jan 2017 to December 2021)

Each of the tables gives the operational as well as inherent availability of different components of the electric power substation based on their uptime, downtime, and number of failures.

Corresponding estimation of availability for Feeder-I, Hardi, Feeder-II, Beena, Feeder-III, Laukha, Feeder-IV, Chughara, CB1 (Circuit Breaker), CB2 (Circuit Breaker), T1
(Transformer), and T2 (Transformer). All tables (Table 4.9 to 4.14) are given in Appendix-A.

And related graphs are obtained from those tables, so graphs are presented in fig 4. 6 To 4.21.

Table 4.5 Availability of different components of the electric power substation

SL NO.	Name of the differen components	Average operationa Availability	Inherent Availability
A	Feeder-I, Hardi	0.9977 0.9964 0.9984	1.0000 0.9988 0.9999
B	Feeder-II, Beena	0.9994 0.9991 0.9948	1.0000 0.9992 0.9984
C	Feeder-III, Laukha	1.0000 0.9744 0.9798	1.0000 0.9777 0.9899

D	Feeder-IV, Chughara	0.9961 0.9946 1.0000	0.9998 0.9977 1.0000
E	CB1(Circuit Breaker)	0.99781 0.99820 1.00000	0.9988 0.9994 1.0000
F	CB2(Circuit Breaker)	0.99677 0.99666 0.99944	0.9990 0.9984 0.9999
G	T1(Transformer)	0.99944 0.99933 0.99873	0.9994 0.9994 0.9989
H	T2(Transformer)	0.99788 0.99711 0.99944	0.9988 1.0000 0.9994

Here, the below graphs are considering operational availability and inherent availability versus the period for the electric power substation components are shown in the figures [Fig. 4.19 to 4.21] which shows the availability of the electric power substation during the period under study (Jan 17 to Dec 21).

Here X -the axis - Time & Y-axis - operational availability and inherent availability.

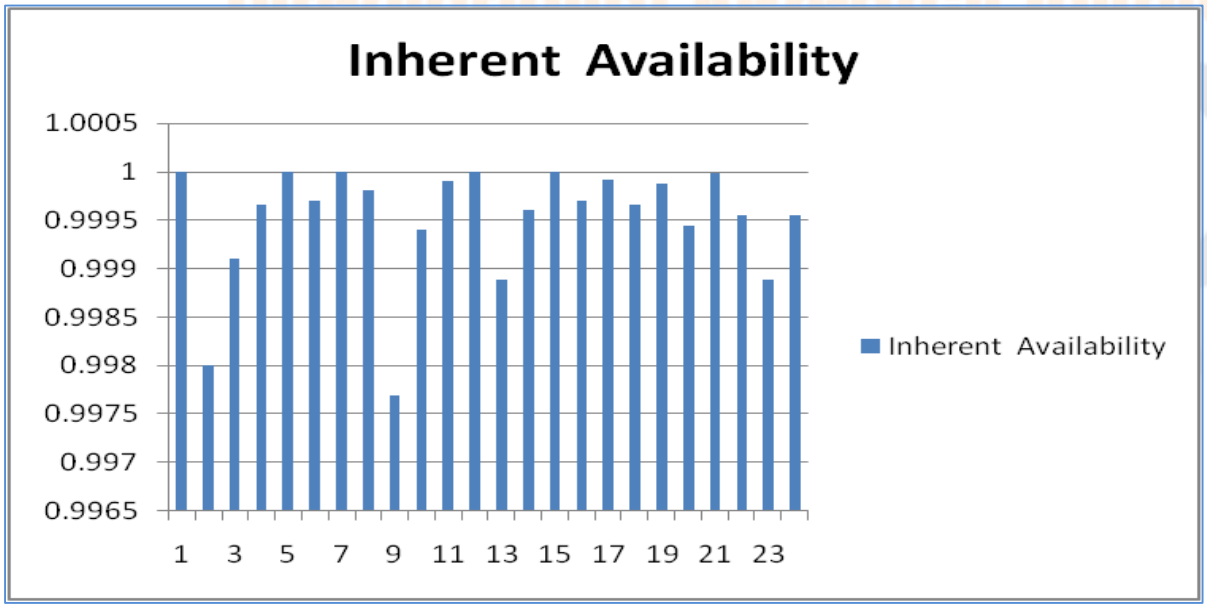

Fig .4 .19 Inherent availability chart

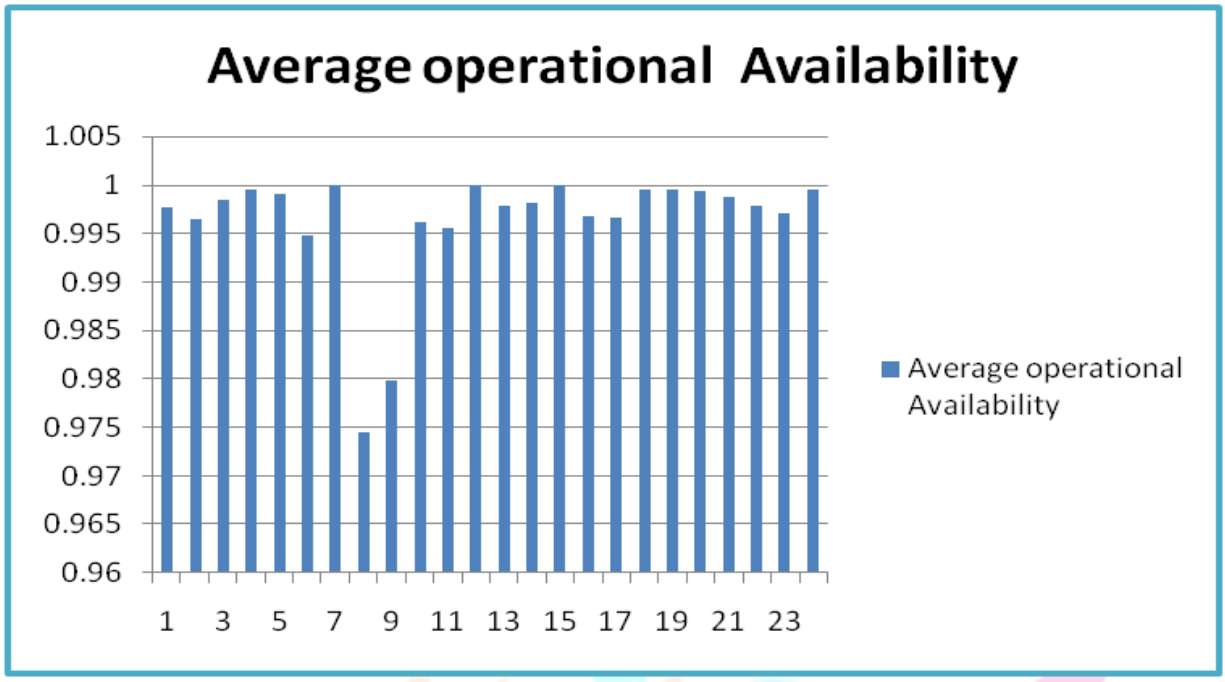

Fig 4.20 Average operational availability chart

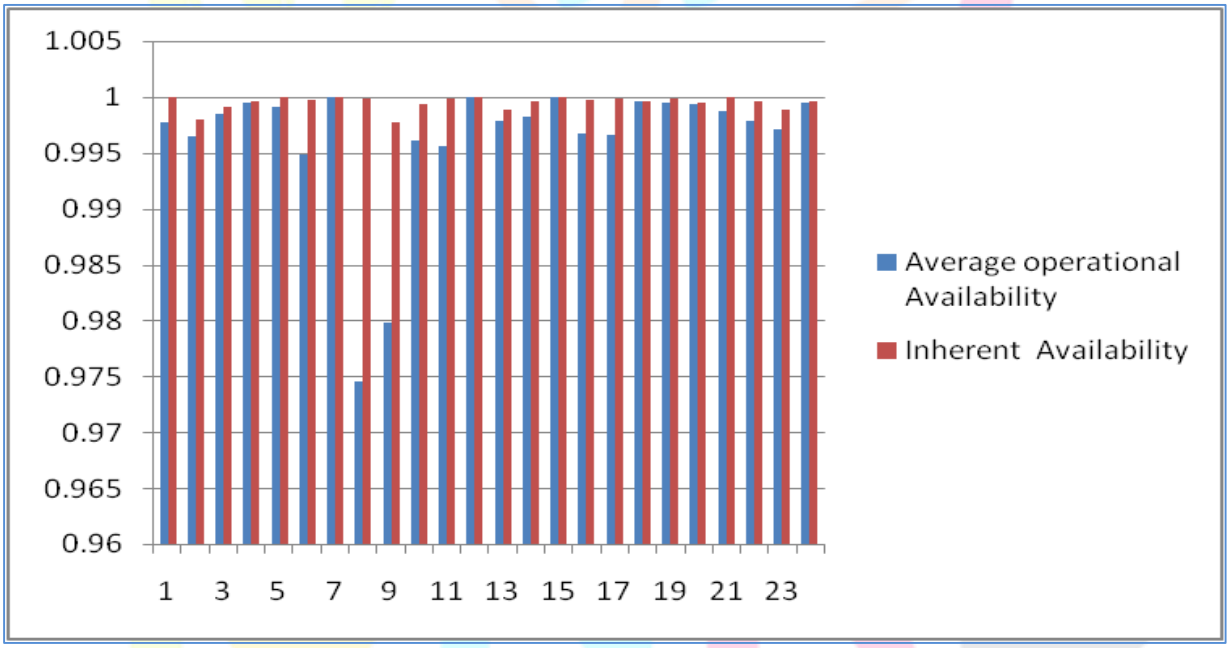

Fig.4.21 Operational Availability vs Inherent availability

4.10.2 Availability patterns

Graphs are considering operational availability and inherent availability versus the time for the electric power substation and their components are shown in figures [Fig. 4.22 To 4.29] which show the availability patterns of electric power substation components during the period under study (Jan 17 to Dec 21).

Here, X -the axis - Time Y-axis - operational availability and inherent availability

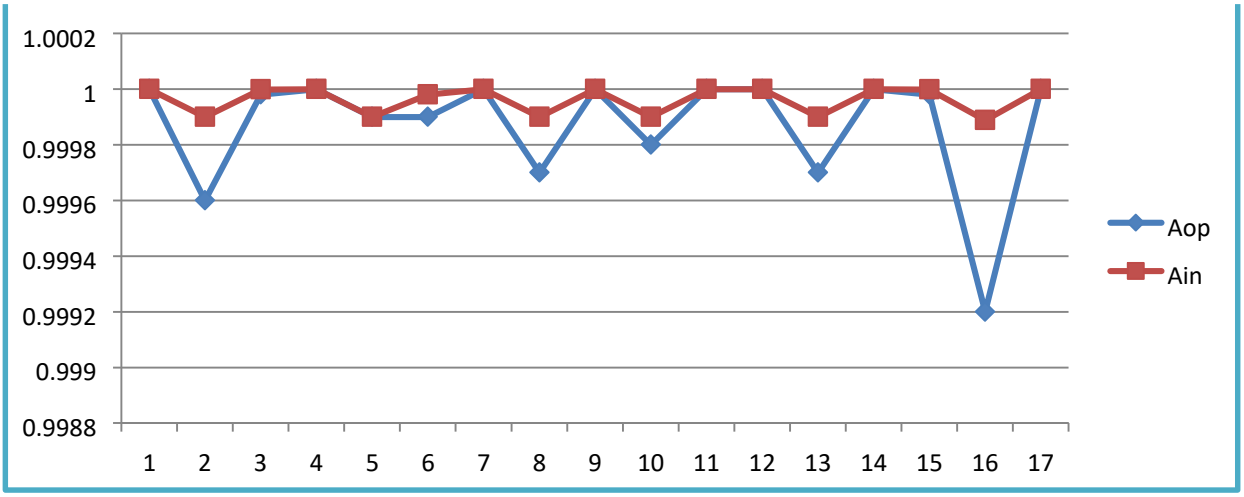

Fig.4.22 Availability of Feeder-I, Hardi

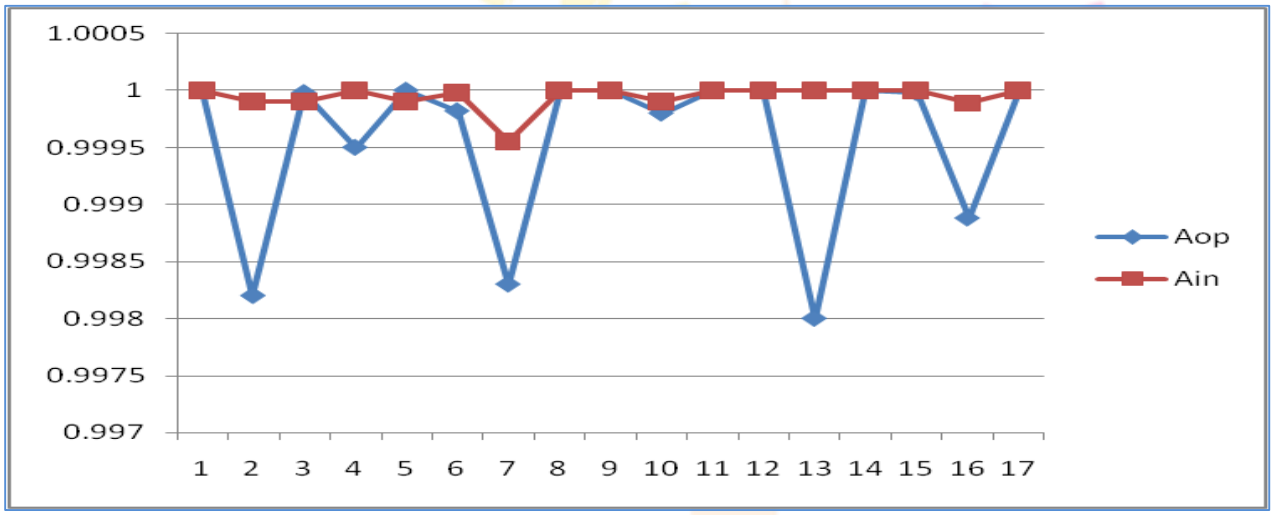

Fig.4.2 3 Availability of Feeder -II, Beena

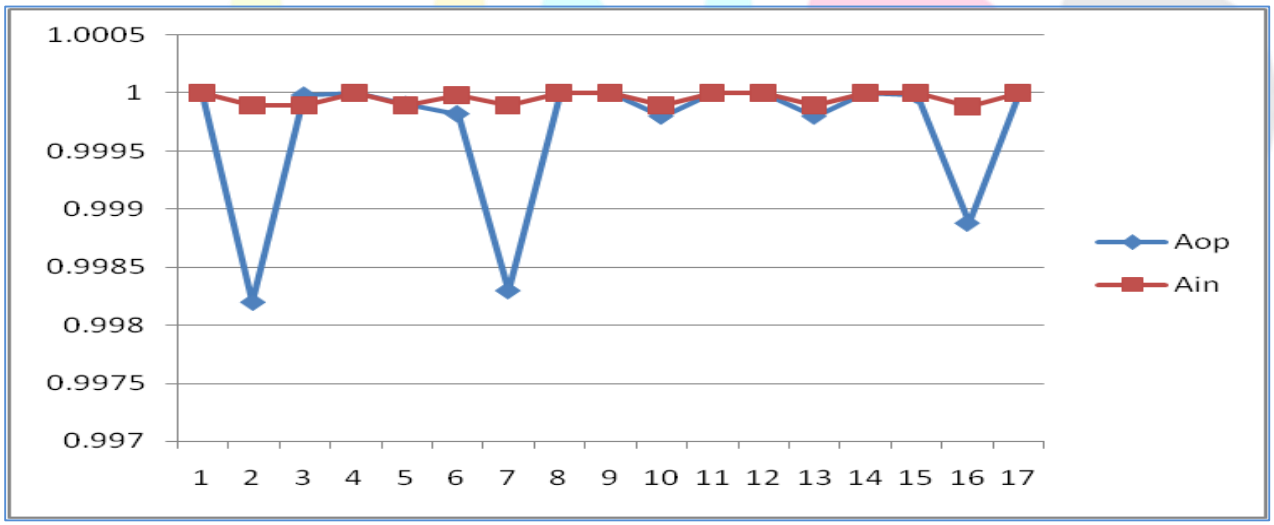

Fig.4 .24 Availability of Feeder -III, Laukha

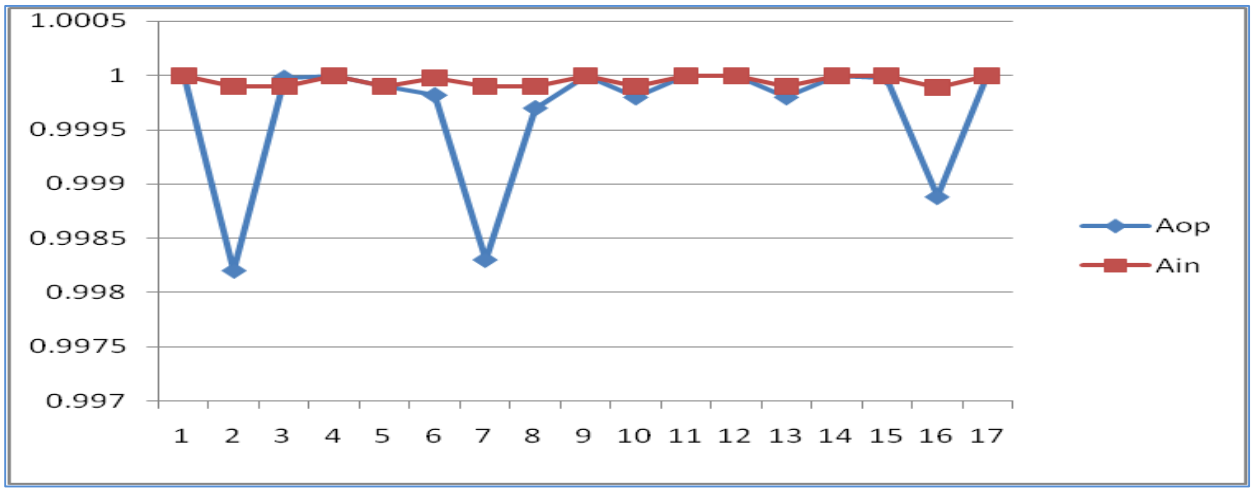

Fig.4 .25 Availability of Feeder -IV, Chughara

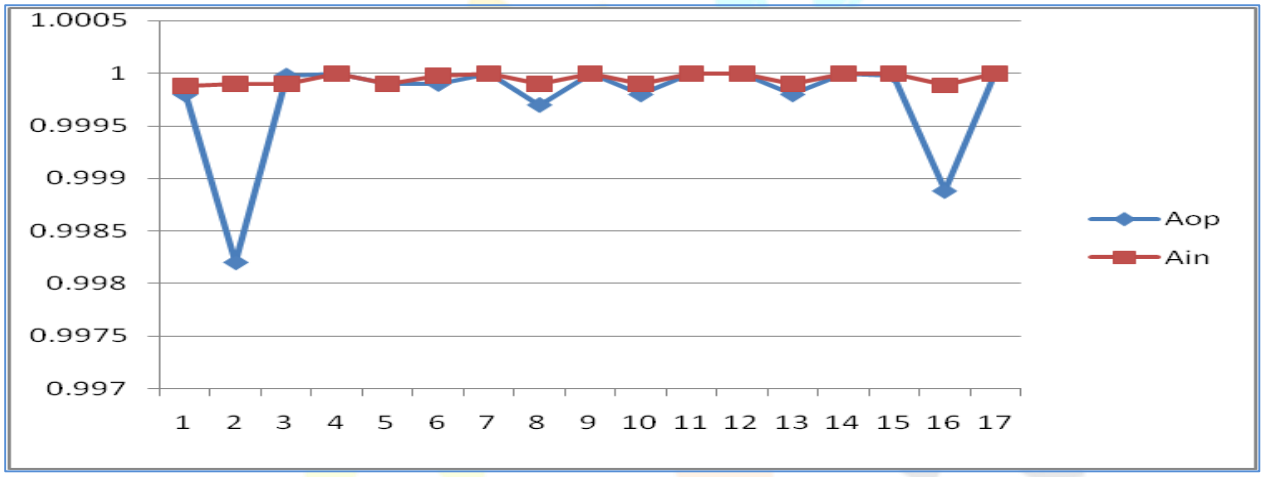

Fig.4.26 Availability of CB1 (Circuit Breaker)

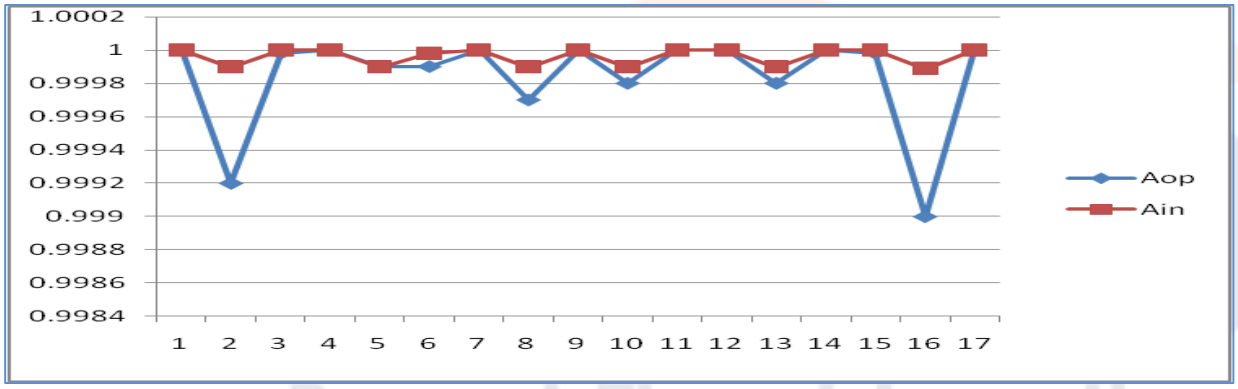

Fig.4 .27 Availability of CB2 (Circuit Breaker)

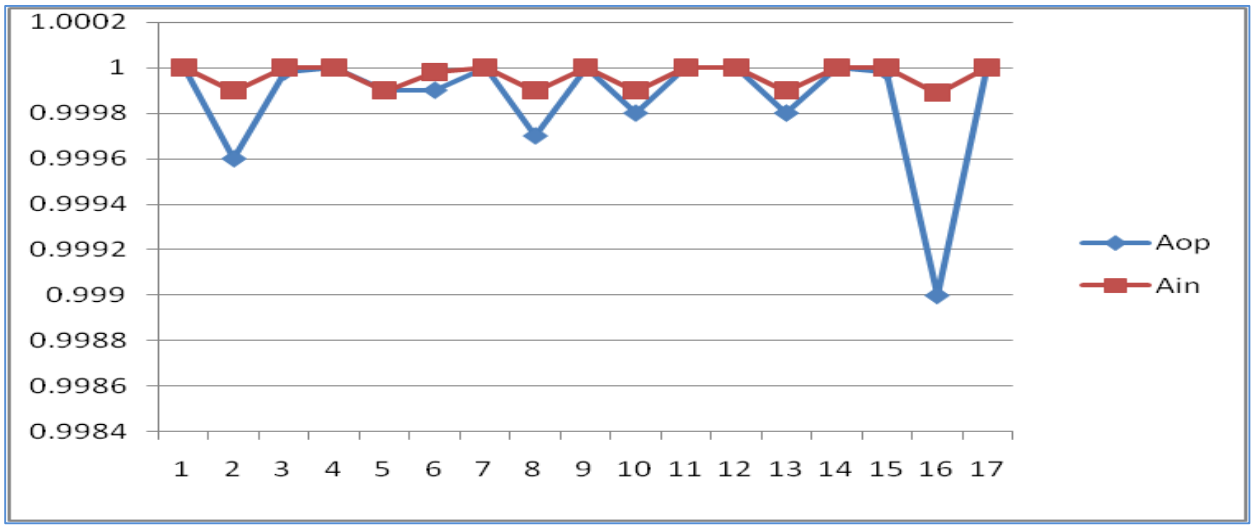

Fig.4 .28 Availability of T1 (Transformer)

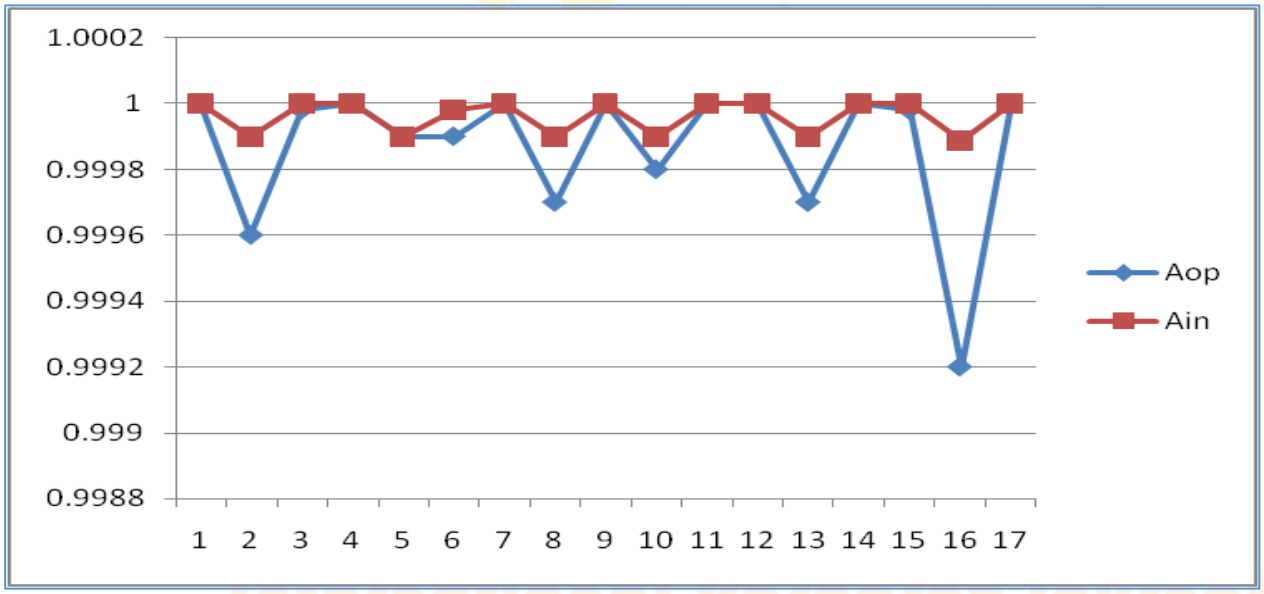

Fig.4.29 Availability of T2 (Transformer

Conclusion

This study on Electric Power Substation 33/11 kV, Supaul, and Bihar is under NBPDCL (North Bihar Power Distribution Company Ltd Government of Bihar). This is a field application of the Risk-based Reliability, Availability, and Maintainability Analysis of Electric Power Substation 33/11 kV. The data collected for the last five years is the main focus of the thesis work. The data is collected for reliability, availability, and maintainability analysis. It also describes the performance criteria of the major components of the electric power substation and computes maintenance strategy.

The availability patterns describe the performance of the electric power substation's major components and also show the unavailability of the major components .

This maintenance strategy helps in increasing the availability of the components as well as reducing the maintenance cost. It also develops the reliability of the electric power substation components.

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