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Load Flow Analysis of 66 kV substation using ETAP Software

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Abstract - *Power is essentially required for the development of any country. To maintain the generation of electric power at adequate level the power has to be transmitted in proper form and quality to the consumer. This research paper deals with the simulation of 66 kV substation in Electrical Transient Analyzer Program (ETAP) with detailed load flow analysis and also to overcome the problem of an under voltage. The results are based on actual data received from 66 kV substation.*

Key Words: Capacitor bank placement, demand and Losses, Load Flow Analysis using ETAP software, need of Load Flow Analysis, reactive power transmission, the problem of an under voltage, voltage profile

1.INTRODUCTION

Load flow analysis using software is accurate and gives highly reliable results. This research makes effective use of Electrical Transient Analyzer Program (ETAP) to carry out load flow analysis of 66 kV substation [1],[2]. The actual ratings of Power Transformers, Circuit Breakers, Current Transformers, Potential Transformers and Isolating switches are taken and modelled accordingly in ETAP. This 66 kV substation is located in Trivandrum, Veli under Kerala State Electricity Board Limited (KSEB) which comprises of 3 Power Transformers, 13 Circuit Breakers, 13 Current Transformers, 3 Potential Transformers and 6 Isolating switches.

The major cause of almost all the major power system disturbance is under voltage. Reactive power (Vars) cannot be transmitted very far especially under heavy load conditions so it must be generated close to the point of consumption. This is because the difference in voltage causes reactive power (Vars) to flow and voltages on a power system are only +/- 5 percent of nominal and this small voltage difference does not cause substantial reactive power (Vars) to flow over long distances. So if that reactive power (Vars) is not available at the load centre, the voltage level go down. Chronic under voltages can cause excess wear and tear on certain devices like motor as they will tend to run overly hot if the voltage is low[4].

The single line diagram of the substation is simulated in ETAP based upon actual data and it is seen that at both the 11 kV feeder buses there is under voltage. To overcome the under voltage at both the 11 kV feeder buses capacitor bank of suitable ratings are placed in shunt.

Section 2 is the details of the components. Section 3 is the simulation of single line diagram of 66 kV substation in ETAP based upon practical data. Section 4 is the Load Flow Analysis of the substation. Section 5 contains the Alert summary report generated after load flow analysis. Section 6 is the load flow analysis of the substation with an improvement to surmount the problem of under voltage. Section 7 is the conclusion of this research work.

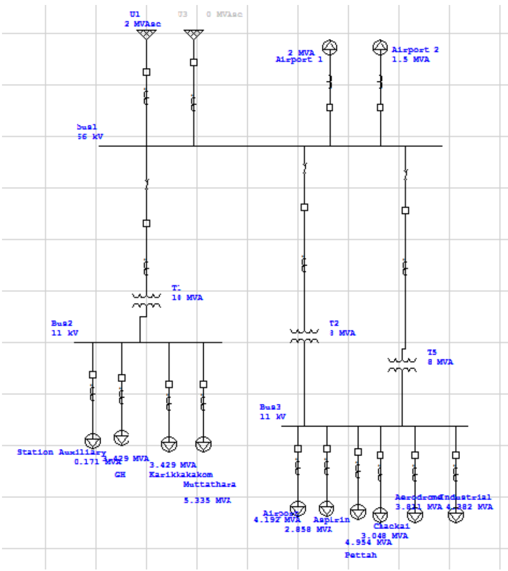
2. DETAILS OF COMPONENTS

TABLE 1

Component	Name	Rating
Power Transformer	T1	10MVA
	T2	8MVA
	T5	8MVA
Circuit Breaker	CB1-CB17	140kV/2500A
Current Transformer	CT1-CT14	400/200/100/ 50-1-1-1-1A
Potential Transformer	PT1-PT6	66kV/√3- 110V/√3
Feeders	Station Auxiliary	10A
	General Hospital	190A
	Karikkakom	180A
	Muttathara	280A
	Airport	220A
	Aspirin	150A
	Pettah	260A
	Chakkai	160A
	Aerodrome	200A
	Industrial	230A

3. SIMULATION OF 66 KV SUBSTATION IN ETAP

Fig. 1. Simulated diagram of 66 kV substation



4 LOAD FLOW ANALYSIS

Fig. 2 shows the Load Flow Analysis of the 66 kV substation carried out using ETAP in which Newton-Raphson method [5],[6] is used and it is observed that at the Bus 3 and Bus 4 there is under voltage which can be clearly seen from Fig. 2 (a) showing the sectional view of the feeders. At Bus 2 the voltage level is 92.70% and at bus 3 he voltage level is 93.30%.

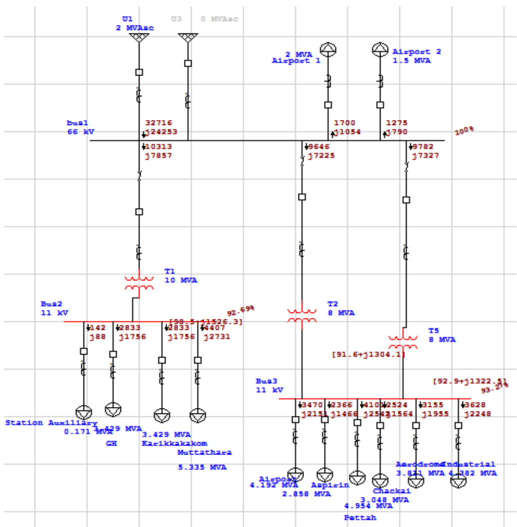


Fig. 2. Load Flow Analysis of 66 kV substation

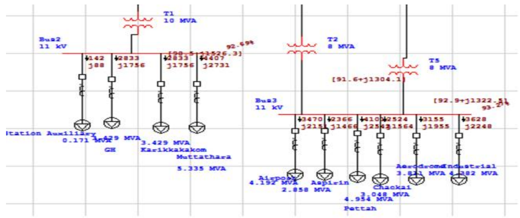


Fig. 3. Sectional View of the Feeders

TABLE 2 shows that the real power on swing bus i.e. BUS 1 is 24.463 MW and the reactive power is 16.088 Mvar and the power factor is 83.6% which is very low.

TABLE 2

Point	kV	MW	Mvar	%PF
Bus 2	11	10.214	6.33	81.022
Bus 3	11	19.244	11.926	86.211

TABLE 3 shows the Demand and Losses summary report which tells us about the total demand of the system and also about the losses that occurs in a system.

TABLE 3

Type	**MW**	**Mvar**
Load	32.433	20.1
Generation	32.716	24.253
Loss	0.283	4.153

5 ETAP ALERTS DURING LOAD FLOW ANALYSIS

TABLE 4 After carrying out load flow analysis using ETAP an alert summary report is generated which tells us which part of the system needs immediate attention and it can be clearly seen from the Table 4 that the Bus 2 and Bus 3 are operating at an under voltage.

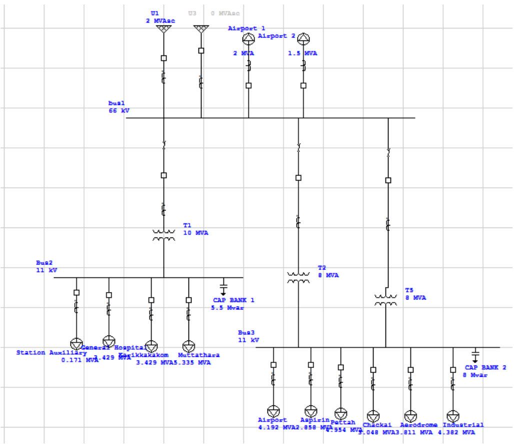
TABLE 4

Device	**Condition**	**Rating**	**Operating**	**%Operating**
Bus 2	UnderVoltage	11kV	10.196	92.7
Bus 3	UnderVoltage	11kV	10.259	93.3

6 LOAD FLOW ANALYSIS WITH AN IMPROVEMENT TO OVERCOME THE PROBLEM OF UNDER VOLTAGE

Fig. 4 The simulation of the 66 kV substation is carried out in ETAP by placing the capacitor banks in shunt with the feeders. The rating of capacitor bank 1 is 5.5 Mvar and that of capacitor bank 2 is 8 Mvar. Fig. 2 shows the load flow analysis of the substation. From Fig. 3 which shows the sectional view of the feeders it can be clearly seen that the operating voltage of Bus 2 has improved from 92.7% to 97.8% and that of Bus 3 from 93.3% (Fig.2) to 96.9%.

Fig. 4. Simulated diagram of 66 kV substation using



ETAP

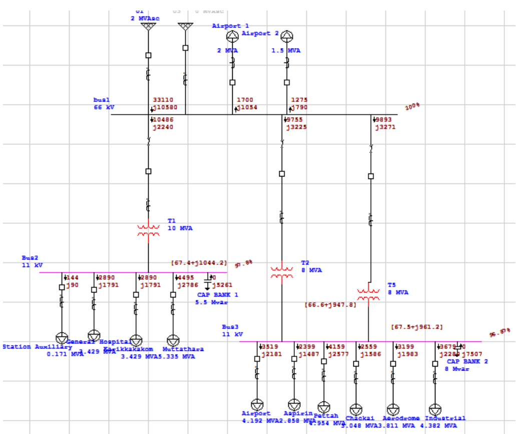


Fig. 5. Load Flow Analysis of 66 kV substation after placing capacitor banks

TABLE 5 shows the load flow results and by comparing it with TABLE 2 it can be clearly seen that there is an improvement in the power factor.

TABLE 5

Monitoring	kV	MW	MVar	%PF
Bus 2	11	10.419	6.457	84.34
Bus 3	11	19.514	12.094	86.26

TABLE 6 shows the Demand and Losses summary report and the losses are far less as compared to the losses shown in TABLE 3.

TABLE 6

Type	**MW**	**Mvar**
Load	32.908	7.627
Generation	33.11	10.58
Loss	0.202	2.953

By comparing TABLE 7 to TABLE 4 it can clearly be seen that the problem of an under voltage at both the buses is surmounted by the placement of capacitor banks in shunt to the feeders.

TABLE 7

Device	**Condition**	**Ratin g**	**Operating**	**%Operating**
Bus2	Under Voltage	11kV	10.758	97.8
Bus 3	Under Voltage	11kV	10.655	96.9

7 CONCLUSION

In this paper Load Flow study using ETAP software is carried out with an approach to overcome the problem of an under voltage. Load Flow Studies using ETAP Software is an excellent tool for system planning. A number of operating procedures can be analyzed such as the loss of generator, a transmission line, a transformer or a load. Load flow studies can be used to determine the optimum size and location of capacitors to surmount the problem of an under voltage.

Also, they are useful in determining the system voltages under conditions of suddenly applied or disconnected loads. Load flow studies determine if system voltages remain within specified limits under various contingency conditions, and whether equipment such as transformers and conductors are overloaded. Load-flow studies are often used to identify the need for additional generation, capacitive, or inductive VAR support, or the placement of capacitors and/or reactors to maintain system voltages within specified limits.

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