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Load Flow Analysis and Transient System Analysis of a Cycle Combined Power Plant Using ETAP Software

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ABSTRACT-This paper dispenses an approach for keen evaluation of power supply trustability and quality of electrical network. In recent times power supply dependability and quality is a serious issue. Study of electrical power system is an indispensable element in power system planning and design. Studies of the power system are conducted for enabling the designed network is meeting the required specifications and quality with respect to safety and flexibility in operation. This paper majorly emphasises on performing load flow analysis, short circuit analysis and transient stability analysis. The analysis are done in this paper by using ETAP Software (Electrical Transient Analyser Program).

KEY WORDS: ETAP , Short circuit, Load flow, and Transient stability analysis.

I. INTRODUCTION

There is availability of different generation sources such as renewable and non-renewable sources. These sources has significant impact on the power flow and the voltage profile as well on the other parameters at customers and generation side. Electrical networks or installations are planned based on international and national standards depending on the type of the project and its needs. Additionally, some initial FEED i.e. (Front End Engineering Design) are being studied and taken before the single line diagram of the system is frozen. The study on power system are necessary to pre-confirm the parameters of different equipments and elements of the designed electrical facility. In electrical power system most of the electrical constants variation occurs vigorously due to sudden addition or tripping of generators. The faulted disturbance occurred part of the network is isolated by investigating the electrical power system.

Electrical power generation widely classified into two types depending on the utilization of power. The first one is captive power plants it points out to power generated from the plant set up by industries for its own exclusive consumption of power. Other one is utility power plant, which refers to those whose generated power is supplied or consume by various customers and not for its own use. Combined cycle power plant refers to the captive power plant and it is the combination of diesel turbine and steam turbine. Every captive power plant has to be made precisely to suit particular customer and industry needs. These include building , setting up and commissioning of generators, linking up with grids, catering to the power plant assistance as well as customer and industrial loads to ensure availability of sufficient reliable power supply to the industry.



II. DESIGNING OBJECTIVES OF THE POWER PLANT

While designing a captive power plant and delivering it for the business solution, the following criteria are to be fulfilled.

1. To ensure optimization in selection of equipments.
2. To identify and rectify the deficiencies in the system before it gets operational.
3. To analyse operation of different power plant plants scenarios for economic operation.
4. To establish system performance and guarantee the operation.
5. To ensure safe and reliable operation of the power plant.
6. To establish the provision for the system's future expansion plans.

III. SINGLE LINE DIAGRAM USING ETAP

Figure 1 shows the linked era power plant involving two energy device that drives a turbine generators (STG) with a volume of 36MW each, two gas turbine generator generators (GTG) accompanying an ability of 34.5MW each and it is affiliated to gridiron. Different loads are related at various bus levels (33KV, 6.6KV, 415V). various types of loads are lump loads, HT motors and LT motors. Lump loads are the mixture of 70% engine load and 30% non-engine load operating accompanying a power determinant of 0.88 delay. IEC standard ETAP spreadsheet book repository (software library) data is thought-out as default data for impedances of system components.

One-Line Diagram - OLV1 (Edit Mode)

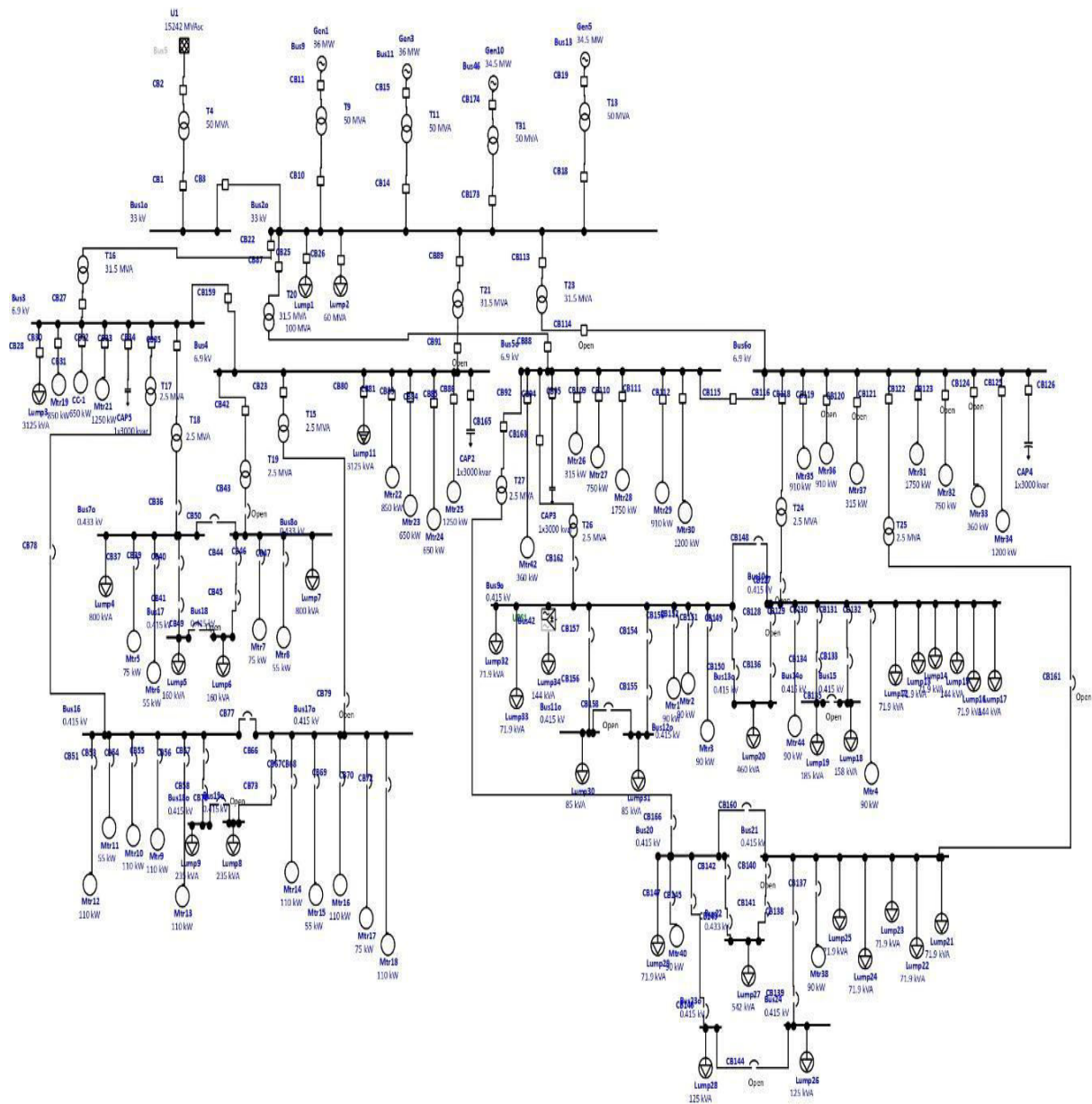


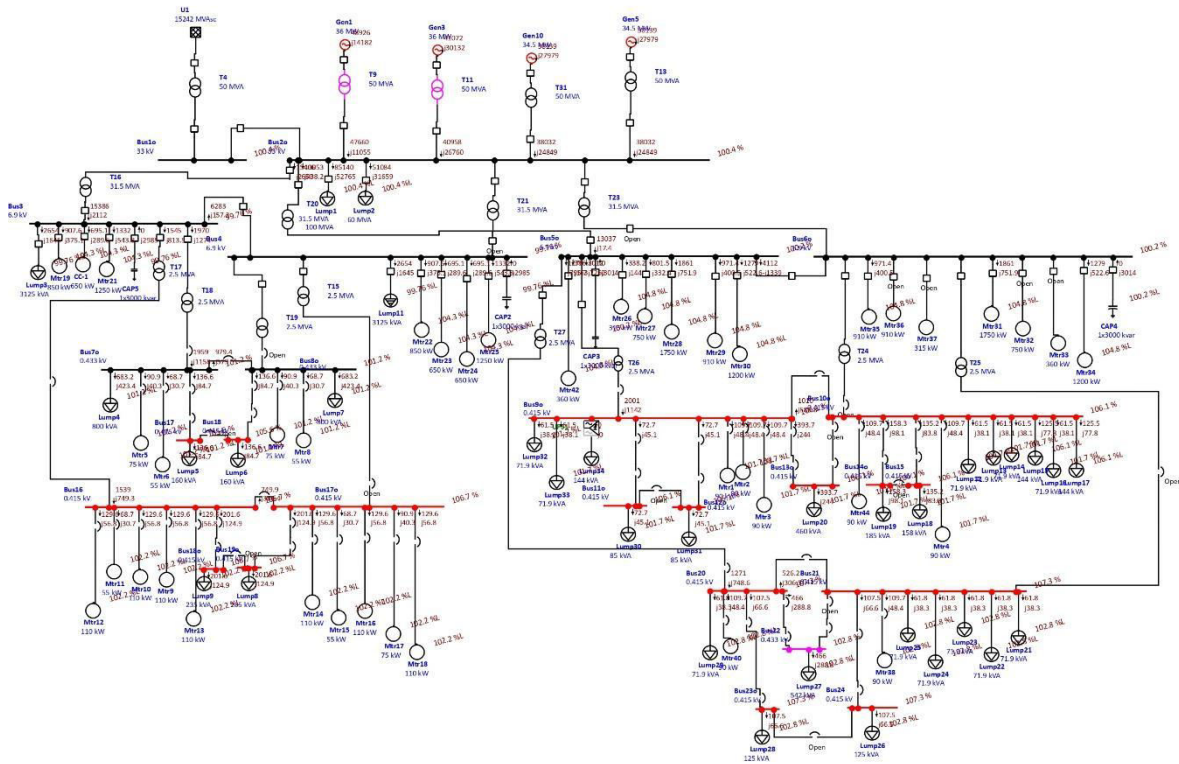
Fig... 1

IV. LOAD FLOW ANALYSIS AND ITS RESULTS

Checking of whole system efficiency that is, hindering of the ability of all whole component ratings, transformer sizes and their impedances and tap dealer scenes under a sort of operating environments containing possibility conditions . The main objective of the load flow analysis is decision of the steady state active and reactive power flows, current flows, system capacity determinant and voltage profile (magnitudes and chapter angles of load and alternator transport voltages). Figure 2 shows the load flow analysis results of a linked cycle power plant



One-Line Diagram - OLVI (Load Flow Analysis)



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Fig.. 2

V.ANALYSING SHORT CIRCUIT AND ITS FAULTS

Fault level analysis or commonly known as short circuit are used to control Both the maximum and minimum, all the three-phase faults and earth fault level across all the switch boards under fault make and fault break conditions which also includes the dc components [4]. The types of the short circuit faults are line to ground fault, line to line fault, double line to ground fault, three phase fault and three phase to ground fault.

IEC standards uses the following definitions, which are applicable in the calculations and outputs of ETAP for the Short circuit analysis.

Initial Symmetrical Short Circuit Current (I^{''}K): It's the RMS value of AC symmetrical component of an accessible short circuit current relevant at the instant of short circuit if the impedance remains at zero-time value.

Peak Short Circuit Current (Ip): It's the maximum feasible instantaneous value of the accessible short circuit current.

Symmetrical Short Circuit Breaking Current (Ib): It's the RMS value of an integral circle of the symmetrical AC components of the accessible short circuit current at the immediate of contact detachment of the first pole of a switching device.

Steady-State Short Circuit Current (Ik): It's the RMS gain of the short circuit current, which residue after the degradation of the transient event.

Voltage Factor (c): It's the part which is used to modify the value of the identical voltage source for minimum and maximum current estimations



VI.CALCULATION METHODS

Initial Symmetrical Short Circuit Current Calculation: Initial symmetrical short-circuit current (I_k'') is calculated using the following formula

$$I_k'' = \frac{cU_n}{\sqrt{3}Z_k} \quad \dots$$

Eqn (1)

Where, Z_k is the equivalent impedance at the fault location.

Peak Short Circuit Current Calculation: Peak short-circuits current (i_p) is calculated using the following formula:

$$I_p = \sqrt{2} K I_k''$$

Where, k is a function of the system R/X ratio at the fault location.

In this paper, we considered three faults i.e., LG, LLG and three phase faults at randomly considered buses. The following table-1 gives the short circuit fault current at different buses considering LG Fault.

Table-1: Fault currents at different buses considering LG Fault
Table-2: Fault currents at different buses considering LLG Fault

FAULTED BUS	VOLTAGE (KV)	FAULT CURRENT (KA)
33KV BUS-A	19.76	32.07
6.6KV BUS-A (BOARD 1)	6.55	0.63
415V BUS-A (BOARD 1)	0.26	41.09
415V BUS-B (BOARD 3)	0.25	37.97
415V BUS-B (BOARD 6)	0.25	38.32

FAULTED BUS	VOLTAGE (KV)	FAULT CURRENT (KA)
33KV BUS-A	19.67	31.9
6.6KV BUS-A (BOARD 1)	5.64	0.311
415V BUS-A (BOARD 1)	0.26	37.26
415V BUS-B (BOARD 3)	0.25	35.93
415V BUS-B (BOARD 6)	0.26	36.1

Table-3: Fault currents at different buses considering LLL Fault

FAULTED BUS	FAULT CURRENT (KA)
33KV BUS-A	33.1
6.6KV BUS-A (BOARD 1)	25.9
415V BUS-A (BOARD 1)	46.1
415V BUS-B (BOARD 3)	40.5
415V BUS-B (BOARD 6)	41.1

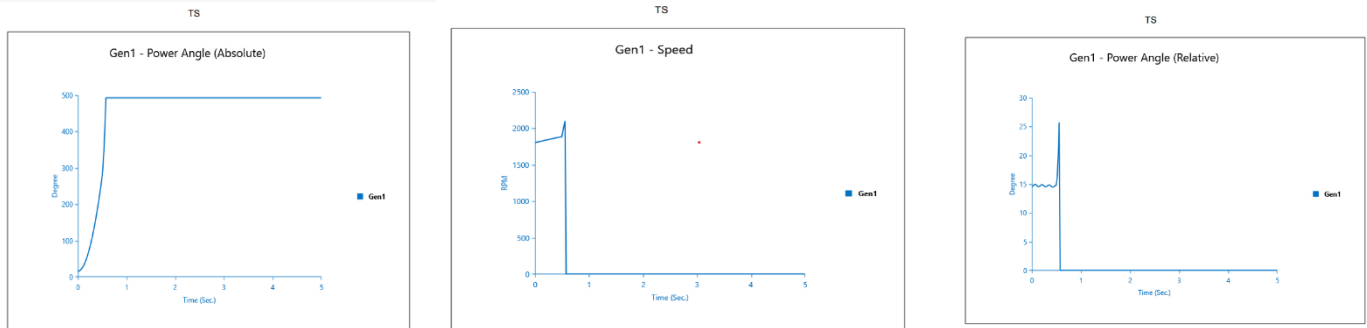
The following Table-2 and Table-3 gives the short circuit fault currents and voltages at different bus boards considering LLG Fault and three phase fault respectively

VII.TRANSIENT STABILITY ANALYSIS

The response of the system from the source of instability that leads to the loss of coevality or burden on alternators and motors. Along with malfunctioning circuit breakers and switches, switching of the capacitor bank and other frequently switched loads switching transients also occurs. We assumed that three-phase faults occurred at 5 sec on the



33kv bus. In this condition, the system can go into instability. We concluded that the critical clearing time is 0.750 sec. Thus, the system will be instability if the fault is being cleared before 0.5817 sec, beyond this the fault is created so the



system gets into an unstable condition. The power angle of the system and the speed of the alternator is shown below.
 Fig.. 3 (Power Angle Absolute) Fig.. 4(Speed) Fig..5 (Power Angle Relative)

Applying ground fault at 100 MVA AND 60 MVA Lump at 0.500 sec, the lump system goes into unstable condition. After making some trials we can conclude that the critical clearing time is 0.750 sec. The system is stable if the faults are cleared before 0.581 sec. The following are the graphs obtained which show the Current and the Mvar respectively.

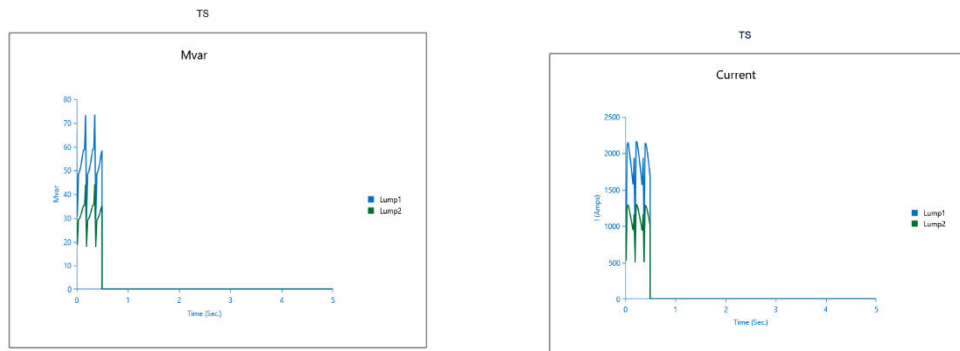


Fig.. 6(Current)

Fig.. 7(Mvar)

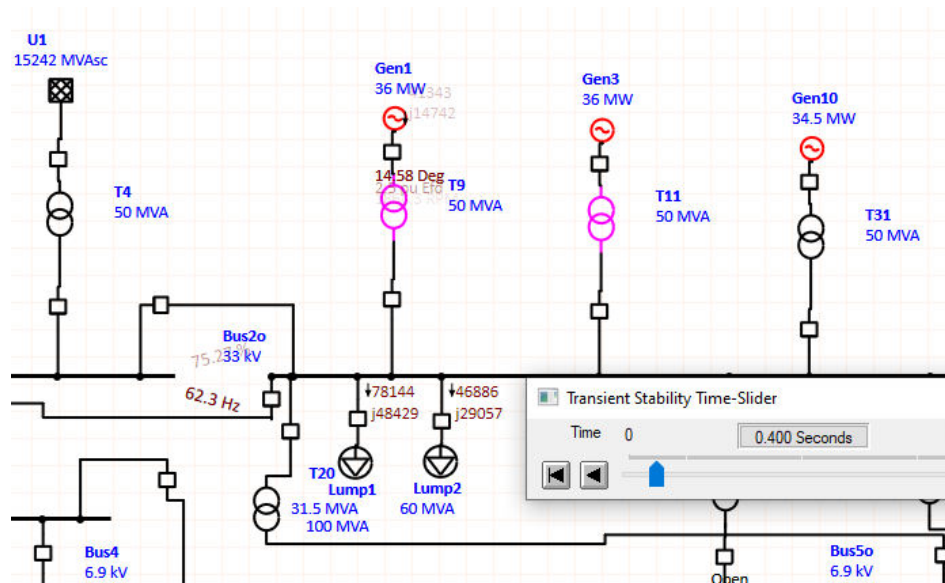


Fig.. 8 (Fault Gen1,Lamp1,Lamp 2,Bus 10)



VIII. CONCLUSION

The combined cycle power plant is modeled in the E tap software and different power system analysis are done on a single network. We have used E tap software because the network is very complicated and the calculations are impossible to do by hand. It also helped us reduce the malfunctioning of the network and it also increased the efficiency of the system by proper operating relay coordination immediately.

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