Load Flow Studies of 33/11KV Harbour Substation Ratnagiri Using ETAP

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Abstract: - Power flow calculation is very important for power system operation, economic scheduling and planning. This paper presents gives information about a development of Power System Load Flow Analysis tool based on the Newton Raphson method. This tool introduces a simple interface for the user to perform load flow analysis. It is also designed for a user to view power flow results for each iteration and thus will facilitate especially undergraduate electrical students to verify their manual calculation of load flow solution. By just point and click, the students will easily get the required solution. The load flow tool is evaluated by solving the load flow of several test systems including IEEE bus system. For every required calculation steps for Newton Raphson load flow are successfully verified with the manual calculation and load flow solution in Power World Simulator and VBA Excel. Thus, this tool helps student and lecturer to learn and verify their manual calculation and at the same time reduce their calculation time.

Key Words: — *Power systems, Load flow analysis, Newton Raphson method.*

I. INTRODUCTION

Load flow analysis is one of the most important analyses to be performed on the power system. Load flow result helps in maintaining proper operation of a power system, and also to design and extend the existing power system. ETAP is one of the leading software uses for various analyses on simulated power network. Load flow analysis 33KV substation is carried out on this software. This substation is located in Ratnagiri district. The rating of protective device, transformer is after the major cause of fault or disturbance in power system is due to overvoltage and under voltage condition. Overvoltage condition occur due to various factors such as tree falling on the line causes sudden rise in voltage, lighting strokes towards the line, due to operating of protective devices creates arc for Short duration, two conductors touching each other creates spark. Another cause of disturbance in the System is under voltage condition, when average voltage of a three phase power system drops below Intended levels, if the devices like motors, pumps are allowed to operate at reduced voltage levels they will draw higher currents. The increases in current causes increased heat in the winding and coils of the equipment. Damaging the critical insulation protecting them... Operating in under voltage condition can drastically reduce the life of electromechanical equipment and lead to premature failure.

The single line diagram of the substation is simulated in ETAP based upon actual data collected directly from substation. It is seen that, at Three 11KV feeder there is overvoltage and under voltage problems.

Table.1. Details of components

Component	Type	Rating	
Power Transformer	Transformer 1	5MVA	
	Transformer 2	5MVA	
	Transformer 3	5MVA	
Circuit Breaker	CB 5/7/8	12KV/800A	
	CB 1-4	12KV/400A	
	CB 6	12KV/800A	
Current Transformer		Primary	secondary
	CT-1	100A	5A
	CT-2	100A	5A
	CT-3	100A	5A
Potential Transformer	PT-1	19KV	63V
Isolating Switches	SW 1,2	33KV	
Feeders	SAI	800A	
	ZADGAON	800A	
	RAMNAKA	400A	
	BHAGAWATI	400A	
	MIRYA	400A	
	SPARE	400A	
	INDUSTRIAL	800A	

II. Methodology

The Newton Raphson method was used to perform load flow analysis. This method is has a faster solution for load flow analysis. It requires an initial condition and work well for heavily load system when compared to another method. The expected results for load flow are voltage magnitude, phase angle, real and reactive power. To design the tool, it requires a depth understanding on the concepts of Newton Raphson Load Flow.

Main steps:

- Determine the type of the bus
- Formation of Bus Admittance Matrix
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- Identifying power mismatch
- Jacobian formation.
- New estimation for complex bus voltage

III. 33/11kv Substation Layout Diagram

Below fig shows the schematic representation of 33/11 substation, which is located at Ratnagiri district. After visiting that substation for project purpose we have seen that there is one 33KV supply line coming from kuwarbao to the three incoming lines (Henkel, Rahataghar & Mirkarwada) one common bus is implemented at this three lines along with CT, PT & single pole switch in between bus & each of the three lines. This 33KV supply is further stepped down to 11KV for the local supply distribution. Vacuum circuit breaker is provided for protection purpose & it is installed before 33/11KV transformer, also CT is used to measure large value of current. Total 8 feeders load is given to this 3 lines. Substation is near to the load center. VCB is used for each feeder for overcurrent protection. Out of 8 feeders 7 feeders feed supply for domestic consumer and one feeder feeds supply for industrial consumer.

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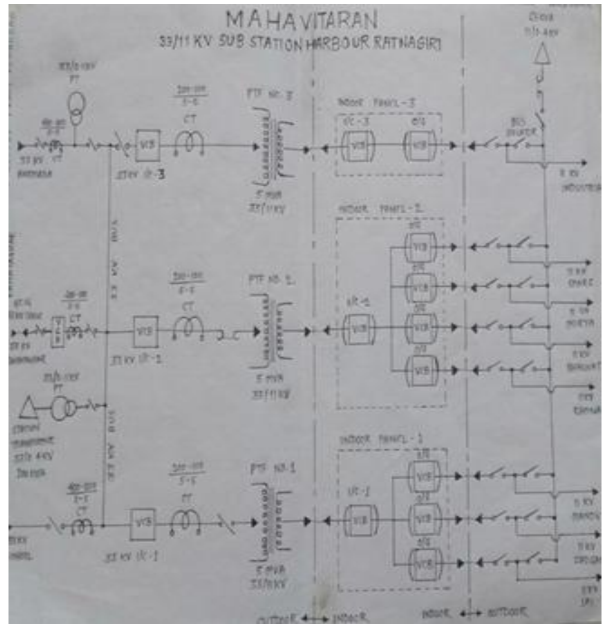

Fig.1. Single line substation diagram 33/11KV substation

IV. Simulation Of 33/11kv Substation Using ETAP

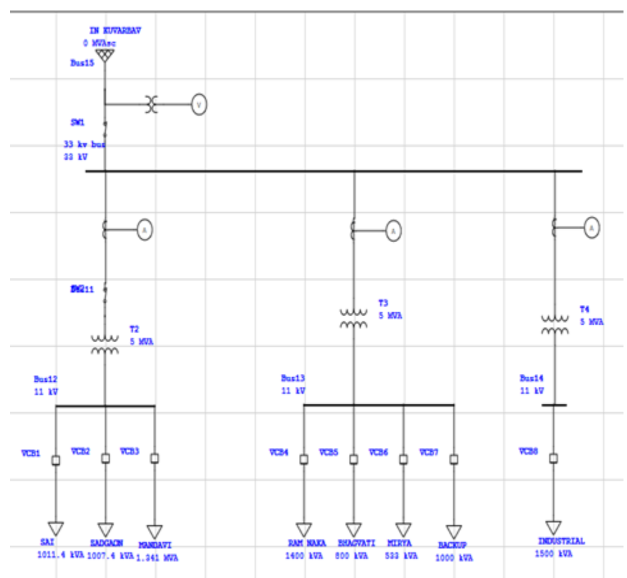

Fig.2. Simulation diagram of 33/11KV

Following diagram is 33/11KV substation simulation in harbor substation.

A. Load Flow Analysis

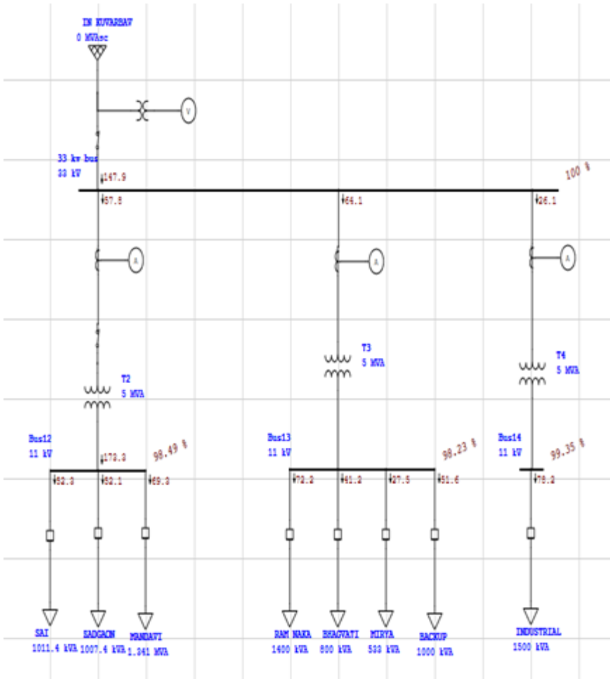

Fig.3. Load flow analysis of 33/11KV substation

Table.2. Real Power on Swing Bus

Monitoring point	KV	MW	MVAR	%PF
Bus 1	33	24.18	12.45	96.78
Bus 2	11	17.17	9.59	96
Bus 3	11	16.77	8.5	98
Bus 4	11	9.55	5.15	98

Table.2. shows that the real power on swing bus i.e. Bus 1 is 8.18 MW & reactive power is 3.48 MVAR & the power factor is 96.78% which is very low.

Tabel.3. shows the demand & losses summary report which tell us about the total demand of the system and also about the losses that occurs in system.

Table.3. Demand & losses summary report

Type	MW	MVAR	MVA	%PF
Swing bus	8.18	24.45	12.46	96.78
Transformer 1	3.198	0.821	5	
Transformer 2	3.531	0.98	5	
Transformer 3	3.198	0.328	5	

B. 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, Bus 3 and bus 4 are operating at an under voltage.

Table.4. load flow analysis using ETAP

Device Id	Condition	Rating	Operating
Bus 2	Under voltage	11 KV	10.83 KV
Bus 3	Under voltage	11 KV	10.81 KV
Bus 4	Under voltage	11 KV	10,93 KV

Study case scenarios are created in ETAP to analyse the power flow under the following operation

- Normal operation (all the generators and transformers are working)
- Maximum load operation (some generator, transformer and grid are not working)
- No load operation (all the loads and capacitors are not connected to switchgear).

Load flow analysis under normal operation is performed to find voltage, current, power factor, etc. under normal operation. Load flow analysis under maximum load operation is performed to find maximum load on transformers, generators, switchgear buses, worst case power factor etc. Since transformers are loaded to the maximum in maximum load operation therefore the voltage across the switchgear bus will be minimum. Hence worst case minimum voltage of switchgear can be calculated in maximum load operation. Load flow under no load condition is performed to find the maximum voltage across the switchgear. The switchgear bus voltage depends on transformer loading. When transformers are operating under no load, maximum voltage occurs in switchgear bus because voltage drop across transformer will be zero (due to no current flows through transformer). But switchgear bus voltage doesn't depend on generator or grid loading because load flow calculation doesn't depend on generator or grid impedance.

V. Conclusion

In this paper load flow studies using ETAP software is carried out with on approach to overcome the problem such as, overload, under voltage and short-circuit. Load flow studies using ETAP software is excellent tool for system planning, designing & rebuilding current system with new ideas and expansion. A simulation of complex plant can be easily done using this software. The accuracy and precision in the output readings gives the ideas about the correct system planning by installing rated protective equipment such as (VCB, Relay, isolator) the relay setting plays important role for this protection system purpose because it gives command to CB to trip, wrong setting is harmful for all the protective device. Most of the time consumers are not aware about this. It also gives idea about placement of capacitor or reactors to maintain system voltage with in specified limit. Can correct size of cable can find out using this study software.

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