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Simulation of Cable Overloading Problem on a University Distribution System

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Abstract

This paper presents the cable overloading analysis on the distribution system of the Amity University, Noida campus. The MiPower software was used in modelling the distribution components and simulating the process of load flow analysis. The simulation results were analysed and compared with relevant standards for evaluating the problem of cable overloading in distribution system.

Keywords: Distribution system; cable overloading; system modelling and simulation.

1. Introduction

The evaluation of the suitability of electric power cables and the overload protection are very important. In reference to the prospective actual load profile of each circuit, this feeling is very useful for the designer to presuppose how much the power cable size will be allowable and for the maintenance operator to presume during the life of the circuits .The objective of this paper is to formulate the model of University distribution system components and simulate several processes related to cable overloading problems with the help of MiPower software. The power distribution system of the Amity University consists of one 33kv and two 11 kV substations, approximately 8 km of underground power cable with a maximum load level of 4MW with total backup capacity 8200 KVA. The distribution system is supplied by the local utility UPPCL through a 33KV substation, which is located on the University campus.

2. Component Models

One of the typical feeders in the distribution system was chosen for this study, which involve Substations 1 and 2.The load pattern of the distribution system mainly includes- air conditioners, fluorescent lighting, PC'S, heaters, motors, etc. Some power cable overloading disturbances were reported in the University distribution system over the past few years mainly due to tripping of motors in the central chillers plant. To find the location of cable overloading this simulation is performed.

2.1 Transformer Model

The transformer is modelled with series impedance for the windings together with a shunt magnetising branch of the core. For a overloading study, the resistance and leakage inductance of the transformer windings are frequency-dependent, modelling them as constant R and L is generally acceptable for typical overloading studies. Basic transformer parameters (as supplied by a local manufacturer) used to generate input data for transformer models are shown in Table 1.

Table 1: Transformer basic parameters.

Sr No	Trans Rating (kV)	Capacity (kVA)	I_o (%)	ΔP_{nl} (kW)	ΔP_{sh} (kW)	Z (%)
1	33/11	3,000	0.25	10.0	75.0	6.25
2	33/0.415	3,000	0.25	10.0	9.0	5.0
3	33/0.415	1,500	0.85	0.8	7.1	5.0
4	11/0.415	1,500	0.80	0.25	0.85	4.0

2.2 Underground power cable model

A cable equivalent circuit with PI circuit was used to construct the three-phase underground cable models. First, the unit-length series impedance and shunt admittance parameters are computed according to the geometrical and physical arrangement of the cable with the earth return effect is taken into account. Underground line parameters are on the basis of single line diagrams provided by Quality department of campus which are shown in Table 2.

Table 2: Underground Cable Line parameters.

Name of Block	Length of Cable (in meters)	Cable size (in sq mm)	Current Rating (in amperes)	Electricity consumed (in KW)	Name of Block	Length of Cable (in meters	Cable size (in sq mm)	Current Rating (in amperes)	Electricity consumed (in KW)
A Block	140	3.5x185	235	24.83	AC Chillers	230	3.5x300	305	16.22

B Block	250	3.5x185	235	27.91	F3 Block	150	3.5x240	275	14.27
C Block AC	285	3.5x185	235	0.161	Hostel 2	140	3.5x95	165	40.53
C Power	230	3.5x185	235	2.03	I Block	120	3.5x185	235	39.51
G Block	70	3.5x50	100	8.07	Feeder Pillars	180	3.5x185	235	22.36
D Block AC	180	3.5x185	235	0.32	Chillers	200	3.5x240	275	33.12
D Block + Canteen	180	3.5x300	305	31.37	Agricultural Farm	50	3.5x35	92	45.72
D Power	285	3.5x185	235	66.31	Sports	75	3.5x95	165	21.9
E1 Block	300	3.5x300	305	96.62	Swimming Pool	70	3.5x150	210	16.12
E2 Block	380	3.5x240	275	56.66	STP (1 + 2)	40	3.5x150	210	19.71
F1 Block	230	3.5x185	235	13.34	RO Water System	150	3.5x95	165	17.79
F2 Block	210	3.5x240	275	29.02	Hostel 1	280	3.5x185	235	49.09

2.3 Generalised linear load model

Linear loads are represented by parallel R and L elements. The value of R and L can be computed by the active power P and reactive power Q of the load according to the following formula and monthly consumption block wise shown in Table 2.

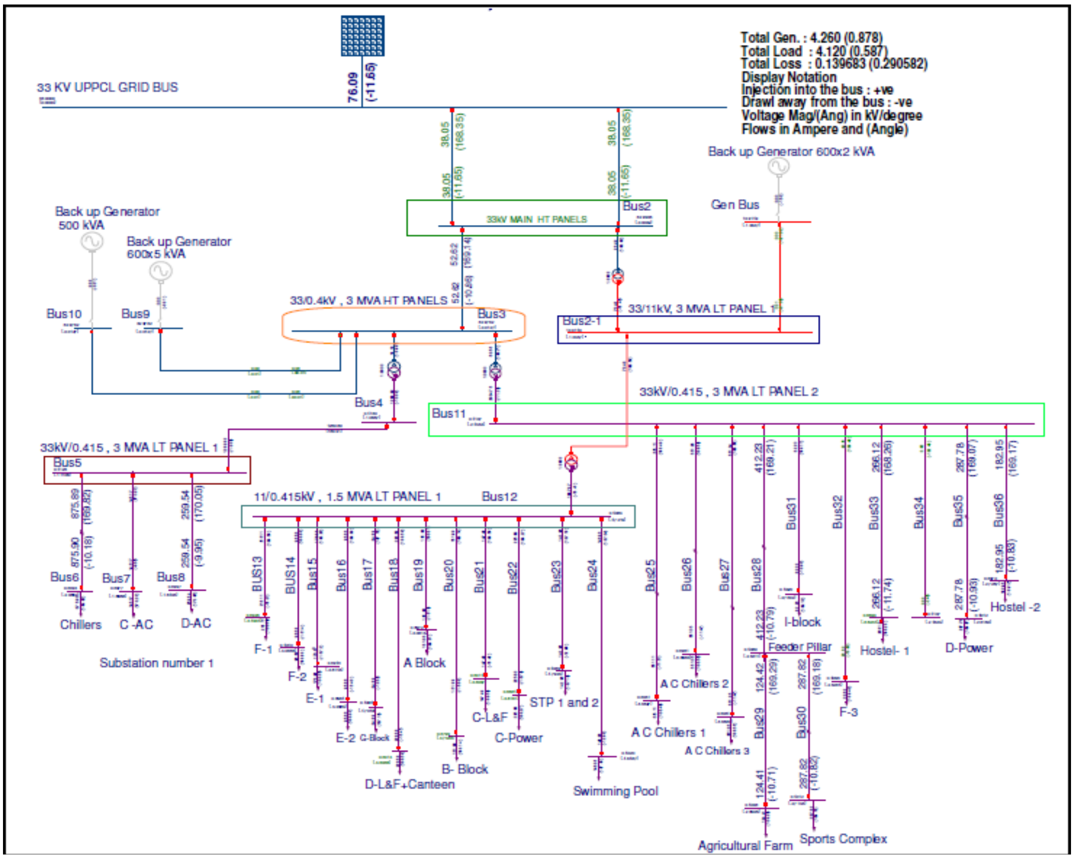
$$R=V^2/P;\ L=V^2/(2\pi f_0 Q)$$

2.4 System source and capacitor bank model

The 33kV system source is modelled as a standard voltage source with the equivalent system impedance, which is converted from the three-phase short circuit strength at the 33kV bus. The capacitor bank is represented by a standard EMTP capacitor component with the three phase kVAR rating converted to mF value.

3. Simulation Results

Based on the collected data model which is shown below was drawn using the software we had conducted a general load flow analysis on the system to check the voltage drops, current flows through the line/cable feeders and have found that some of the cable were carrying the more Amps based on the existing capacity. This showed that the cables were not having sufficient amount of power to carry for the load. An improvement in the system was suggested to overcome the problem. The issues on the cables such as overloading had to be cleared by proposing a change in such a way that once their is a load increase it should be able to carry sufficient amount of power so that the insulation remains intact and also for future growth of loads.The simulation results show that at substation 1 bus no 6 and at substation 2 bus 28, bus 33 and bus 35 are facing cable overloading problem.



4. Lt Power Cable Sizing Criteria

Comparing the simulation result of cable overloading with IEC standard, the cable sizing reqirements were not meeting and line loading limit was found to exceed the IEC requirements at bus 6, 28, 33 and bus 35. One commonly used method for limiting the cable overloading is to use LT power cable sizing criteria. Some calculations are performed for the buses facing overloading problem as per method of cable sizing given below and improvements were suggested to quality department.

Step - 1 : Inputs (Load Data)
Connected Load Power = 90 KW
System Voltage = 415 Volts
Length of the load from panel = 250 Mtrs.

Step - 2 : Caculation for Full load current (IFL)
Full Load current (Amps) = $\frac{\text{Connected load power}}{\text{1.732 x System voltage x power factor}}$ = 156.515 Amps

Step - 3 : Inputs from Cable catalogue
Current carrying capacity of the cable = 257Amps
Resistance of the cable = 0.324 Ω / km
Reactance of the cable = 0.0712 Ω / km

Step - 4 : Calculation of Derated Current of the cable
De-rated current of the cable = Current carrying capacity of the cable x de-rating factor
De-rated current of the cable = 154.2 Amps

Step - 5 : Calculation of Number of cable runs required
Number of runs = $\frac{\text{Connected load power}}{\text{1.732 x System voltage x power factor}}$ = 1.015
Actual Number of cable runs required = 2

Step - 6 : Calculation of %Voltage drop

% Voltage drop at Starting = $\frac{1.732 \times \mathrm{IFL} \times 6 \times ((\mathrm{R} \times \mathrm{cospi}) + (\mathrm{X} \times \mathrm{sinpi}))}{\text{Actual number of cable runs x System voltage}} \times 100$ = 6.593

% Voltage drop at Running = $\frac{1.732 \times \mathrm{IFL} \times ((\mathrm{R} \times \mathrm{cospi}) + (\mathrm{X} \times \mathrm{sinpi}))}{\text{Actual number of cable runs x System voltage}} \times 100$ = 2.465

Result: Number of cables runs required is 2 or 3. The suggestions for increasing number of cable runs at bus 2, 28, 33 and bus 35 were given to the existing maintenance engineers who will later on test it according to the loadings.

5. Conclusion

The failure of underground cables due to heating caused by long term overload conditions is easily prevented by proper cable sizing. This is based on information provided by cable manufacturers, circuit configuration, and operating conditions. When combined with a SCADA system, can be used to track the amount of time the cable is exposed to overload, allowing for estimates of the remaining life of the cable. Load shedding, operation, rated capacity operation of transformer is must needed for efficient operation of lines. In this paper, the capacity of overloaded cable is increased by using double circuit line. Double circuits can carry more power. Also, double circuits introduce a level of redundancy, so that if a single circuit (half of the double circuit) fails, the other half is still intact.

References

[1] Technical Document on Power System Studies, MiPowe Software, PRDC Bangalore
[2] Present worth analysis by “MiPower Software”, PRDC Bangalore
[3] “Electrical Safety Hazards of Overloading Cable” from www.osha.gov
[4] “A Primer on Cable Damage and Related Failure of Cables” from www.AmerCable.com
[5] “XLPE Land Cable Systems User´s Guide” from www.abb.com/cable