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66/11 Kv Distribution Substation Design

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***Abstract*— Over the decades, electricity demand has increased considerably. Electric energy is produced in power plants that are located far away from consumers. It is given for consumption through a vast network of transmission and distribution lines. In many places on the power grid, it may be desirable and necessary to modify some features of the power supply. This is accomplished by a suitable device assembly called a substation. Some characteristics of the power supply include voltage level, power factor, frequency, AC to DC, etc. are included. It is a major challenge to design such a modern complex structure keeping in mind all the design parameters.**

Key words: Substation design, Autocad design,earthing

I. INTRODUCTION

Substations are an important part of the electrical system. The continuity of supply depends to a large extent on the proper functioning of substations. Therefore it is important to take great care while constructing substation and designing. Important points to keep in mind while planning the substation are as follows:

It should be located at the appropriate site. If possible, it should be located near the load center.
It should provide a safe and reliable system.
For safety reasons, compliance with regulatory authorities is required to be taken into account.
It should be easy to use and maintain.
This should include a minimum capital cost.

Bus bars are important components of substations. There are many repeated arrangements
a. Single bus bar diagram
b. There are simple bus bars
c. main bus and transfer bar diagrams with sectioning diagrams.
d. Double busbar diagram
e. Diagram of main double bus and transfer bus
f. Half circuit breaker system

II. DESIGN OF 66/11KV, SUB-STATION

Before choosing the nominal values of different devices in the substation and deciding their location in the substation, it is necessary to draw a single line diagram, also called a key diagram.

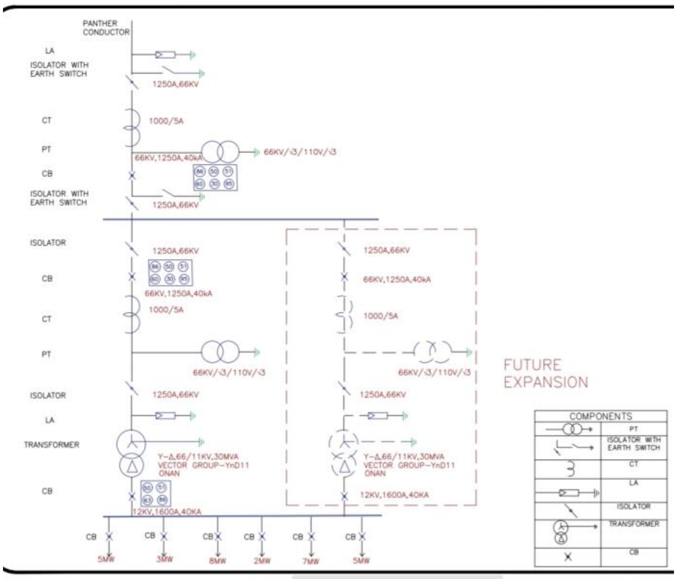

Fig1-sld of 66Kv/11Kv Substation

Here, the unique busbar arrangement with sectioning scheme is described in SLD. All images are created in AutoCAD software. Once the key diagram p is repaired, the configuration diagrams are drawn to show the actual state of each instrument's PLAN & SECTION configuration.

This provision will reveal the physical condition of each piece of equipment. Distance between different devices.

- Phase separation distance.
- Phase – land separation distance (horizontal).
- Ground clearance phase (vertical).

Interconnection between lines of the same voltage level, this allows the stations to distribute the power of different lines. Change of electrical energy, processors can switch between voltage levels to another. Thus, we can classify MV / LV substations on the networks on which they are used as well as the tasks they complete. Prior knowledge is required to obtain MV / LV stations:

- Reference standard and regulator equipment (voltage, power quality, short-circuit power, etc.)
- Linked to specific usage requirements
- Obstacles, installation and environment; Second.

III. 11/0.433 KV SUBSTATION

The decision on MV or LV supply will depend on local conditions and considerations such as those mentioned above, and will usually be imposed by the utility. When it has been

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decided to provide power to MT, there are two widely followed procedures:

- The electricity supplier builds a standard substation near the consumer's premises, but near the MV / LV transformer load center, the premises. Inside the transformer is located in the room.
- The consumer builds and furnishes his substation in his own premises, from which the electricity supplier makes MV connection.

A. Choice of job site:

The consumer has to provide some data for public service from the first phase of the project. (Maximum expected power demand (KVA), site planning and elevation indicate the location of the proposed substation, the degree of continuity of supply required from the information provided by the consumer), the electricity supplier should indicate:

- The type of supply proposed and defines the type of supply system: On a cable or underground network, a description of the service connection: service on a line, main ring installation or parallel feeder, and power limit (KVA) and fault current .
- Nominal voltage and nominal voltage (the highest voltage for the device) Metering details that define: the cost and tariff details of the connection to the power network (consumption and fixed costs).

B. The request for approval should include the following information, broadly based on the above preliminary discussions:

- the location of the proposed post;
- single-line diagrams of power circuits and connections, as well as proposed earthing circuits;
- to establish all details of electrical equipment, including performance characteristics;
- Arrangement of equipment and measurement components;
- Provision to improve the power factor if necessary;
- Provision of an emergency power plant (MV or LV) if necessary.

C. For 66/11 kV substations, the following minimum electrical and safety clearances are required.

Nominal System Voltage (kV)	Highest System	Phase And Earth (mm)	Between Phases (mm)	Safety Clearance (mm)	Ground Clearance (mm)
11	12.1	178	230	2600	3700
66	72.5	1970	1830	3660	6400

Table 1.1

The design of the substation cannot be finalized without all selection and the design calculations for the equipment to be performed should be postponed and postponed until different items have been ordered and dimensions. Are not obtained from equipment suppliers.

Technical specification of General Equipments	
Sr. No.	**Description**
1	Type
2	Service
3	Reference Standard
4	System Details
4.1	Rated Voltage
4.2	Nos. of phase s
4.3	Frequency
4.4	System Neutral Earthing
5	Insulation Level
5.1	HV terminal & earth kVp
5.2	Lightning Impulse withstand Voltage (1.2/50 μs kVp)
5.3	Rated current KA rms
5.4	Number of secondary winding
6	Temperature rise
6.1	Design Ambient Temperature
6.2	Maximum temperature rise
7	Short-time Withstand Current
7.1	Rated 1 or 3-second Current KA rms
7.2	Rated dynamic Current KA peak
8	Auxilia ry System
8.1	Motor
8.2	Control & Interloc k
9	Mounting
10	Terminal Connector type
11	Partial discharge level in pC
12	Creepage distance mm (based on 31mm/kV)
13	Basic Impulsee level (B.I.L.) kV peak

IV. EARTHING SCHEME DESIGN

The current earthing system in a substation takes the form of a grid or a mat consisting of several sections or rectangular traps of horizontally buried earthing conductors that are connected to multiple electrodes controlled at intervals. As shown in Fig.

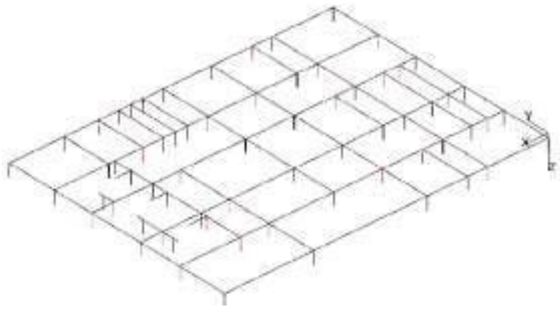

Fig 2- model of earthing grid

The purpose of the earthing system is to provide as much surface as possible under and around a station, at a uniform potential and on a potential ground as close to or as absolute as possible. Ensure that:

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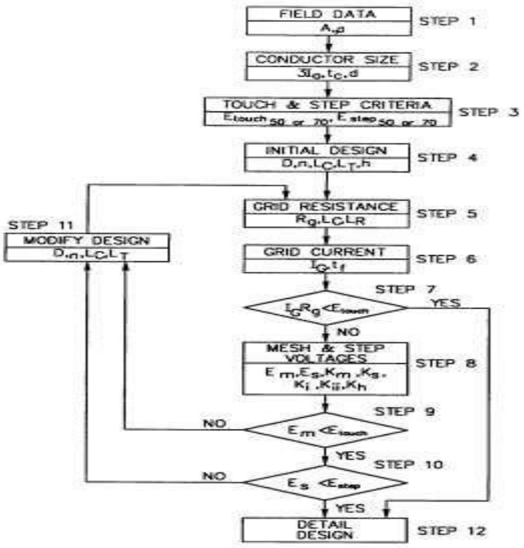
The most affected parameters for the design of earthing grids are:

- fault current and duration.
- Soil and surface resistivity in place of substation (soil structure and soil model).
- Property and cross section of material used for conductors of earth mat.
- Geometry of grounding mats (area covered by ground mats).
- Touch and phase capability allowed



The flow diagram and calculation sample for earthing is described above and below in which all the required parameters are represented by the design of earthing mats of substation 66. K. V.

Design Input Data		
Descripiton	Notation	Unit
Symmetrical fault current in substation	I_g	A
Duration of Shock for determining allowable body current	t_s	Sec.
Duration of fault current for sizing ground conductor	t_c	Sec.
Surface layer resistivity	ρ_s	Ω-m
Surface layer thickness	h_s	M
Grid reference Depth	h_0	M
Soil resistivity	P	Ω-m
Depth of ground Grid Conductors	H	M
Length of Grid conductor in X Direction	L_x	M
Length of Grid conductor in Y direction	L_y	M
No. of Grid conductor in X Direction	N_x	Nos.
No. of Grid conductor in Y direction	N_y	Nos.
Spacing between parallel Conductors	D	M
Length of Ground rod at each Location	L_r	M
Number of rods placed in area	n_R	Nos.
Decrement factor for determining IG	D_f	---
Equivalent earthing mat area	A	m2
Total length of Buried Conductor=(LX X NY)+(LY X NX)+(Lr X Nr)	L	M
Total length of ground rods	L_R	M
Equivalent impedance Zeq	Zeq	Ω
Total length of conductor in horizontal grid	L_c	M
Peripheral length of grid	L_p	M
RMS Current	I	Ka
Maximum Allowable Temperature	T_m	°C
Ambient Temperature	T_a	°C
Reference Temperature for material constants	T_r	°C
Thermal coefficient of resistivity at 0°C	α_0	1/°C
Thermal coefficient of resistivity at reference temperature Tr	α_r	1/°C
Resistivity of the ground Conductor at reference temperature Tr	ρ_r	μΩ.c m
1/α0 or (1/αr) –Tr	K_0	°C
Duration of Current	t_c	Sec.
Thermal capacity per unit volume	TCAP	J/(cm ³.°C)

➢ Earthing grid conductor Area,

$$Amm^2 = 1 \Big/ \sqrt{\left(\frac{TCAP\ x\ 10^{-4}}{t_c\ \alpha_r\ \rho_r}\right)}\ \ln\left(\frac{K_{0+T_m}}{K_{0+T_a}}\right)$$

➢ Cs Surface layer derating factor,

$$c_s = 1 - \frac{0.09(1-\frac{\rho}{\rho_s})}{2h_s + 0.009}$$

$$E_{touch50} = (1000 + 1.5C_s \times \rho_s)\frac{0.116}{\sqrt{t_s}}$$

➢ This is tolerable touch voltage of grid considering 50 kg person.

$$E_{step50} = (1000 + 6C_s \times \rho_s)\frac{0.116}{\sqrt{t_s}}$$

➢ This is tolerable step voltage of grid considering 50 kg people.

➢ Grid Resistance

$$R_x = \rho\left[\frac{1}{L_T} + \frac{1}{\sqrt{20A}}\left(1 + \frac{1}{1 + h\sqrt{20/A}}\right)\right]$$

Typically, the site engineer specifies a grid resistance. Earth resistance should be as low as possible and should not exceed the following limits:

- Power Stations-0.5 Ω.
- EHT Substations -1.0 Ω.
- 66/11 kV Stations -2.0 Ω.

If the ground resistivity is 800 ohm-meters or more, it will be difficult to obtain the desired low resistance of 1 to 2 ohm for a network station with a single grounding band. In such cases, it becomes necessary to increase the area of the grounding network. Simply increasing the amount of grounding tape may not help much to reduce the resistance of the grounding system, and the use of deeply driven rods may be unavoidable.

Ground Potential rise (GPR) = (Maximum grid current Ig * Grid resistance Rg)

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Now compare GPR < E touch tolerable voltage

If yes then DESIGN IS SAFE.

If GPR > E touch
Then Find (Estimated E mesh and E step)

Estimated Mesh voltage,

$$E_m = \frac{\rho \cdot I_G \cdot K_m \cdot K_i}{L_c + \left[1.55 + 1.22 \cdot \left(\frac{L_r}{\left(\sqrt{Lx^2 + Ly^2}\right)}\right)\right] \cdot L_R}$$

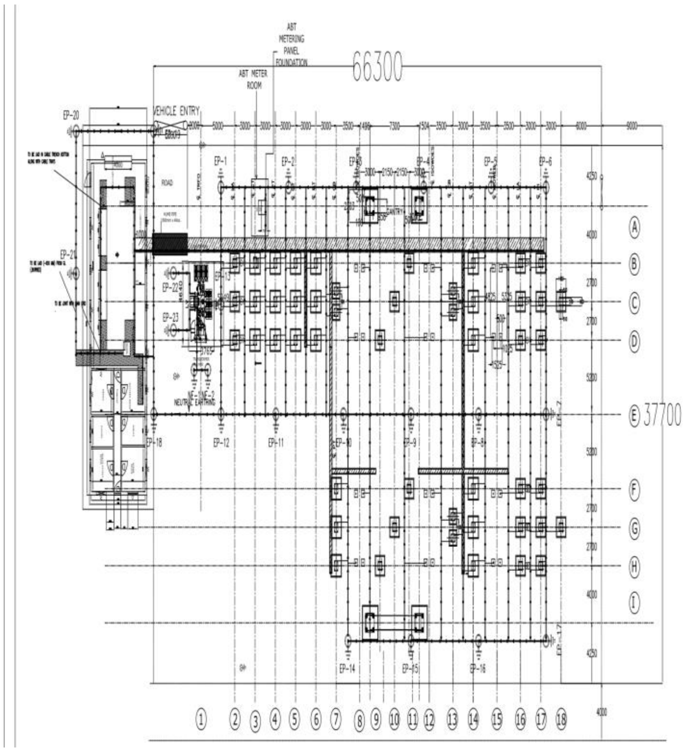

Fig 3:- Earthing grid design

- Estimated step Voltage:

$$E_s = \frac{\rho \cdot I_G \cdot K_s \cdot K_i}{0.75 \cdot L_c + 0.85 \cdot L_{rR}}$$

Compare E mesh estimated < E touch tolerable,

If yes then Compare E step estimated < E step tolerable, if yes then DESIGN IS SAFE.

Otherwise, modify by increasing or decreasing spacing of conductor, Length of conductors or by increasing or decreasing number of rods and Calculate design parameter again.

V. CONCLUSION

The Power Netvo RX will continue to grow and develop, so that the design of the substation evolves to meet the new requirements. The use of a grounding grid with specific spacing and the use of a lightning rod with shielding wire will reduce accidents and at the same time reduce post costs and protection against lightning strikes without affecting the safety of working personnel. Post respectively Therefore, the goal of lower installation and assembly costs, the ability to extend future loads, safer operation and easier maintenance, more reliability can be achieved with optimal design and performance. The substation can be improved.

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