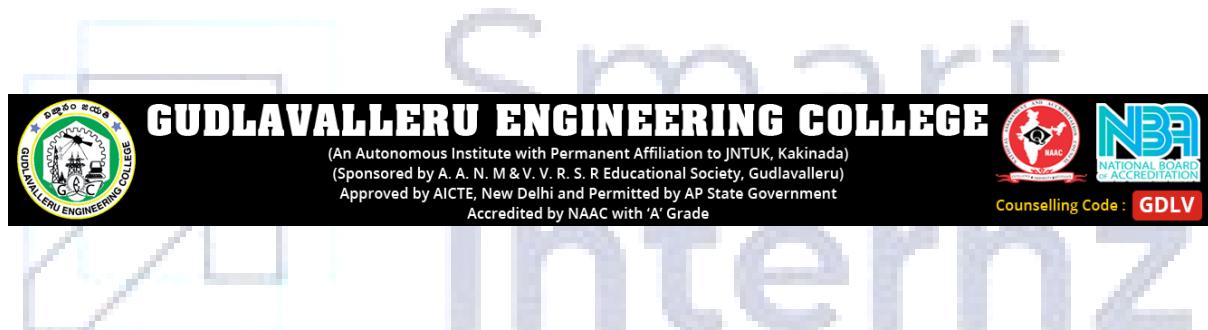


# **Internship Program Report**

**By**

**ALIBILLI BHAVANI - 19485A0216**



**In association with**



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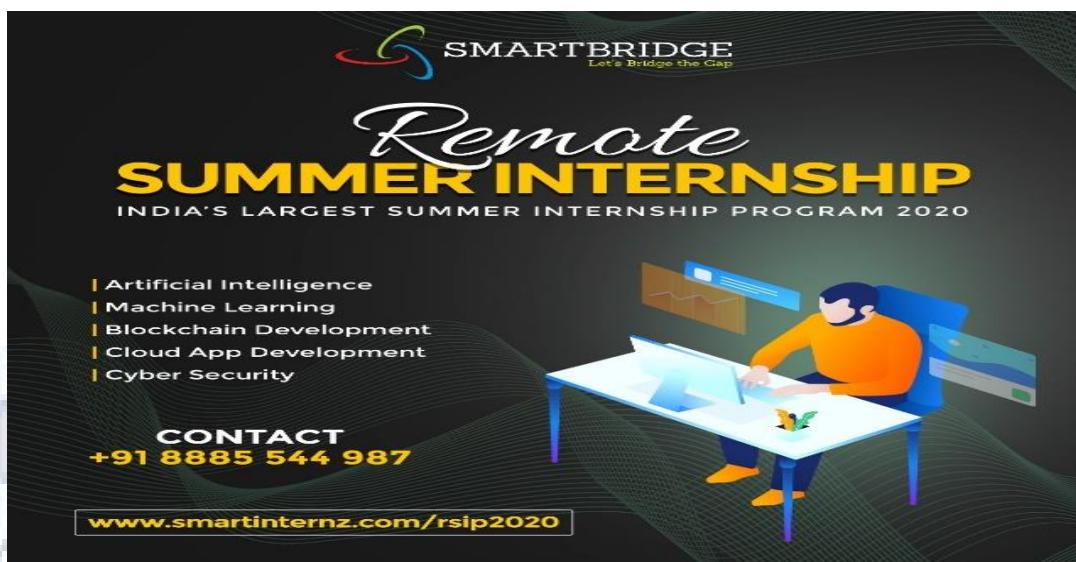
## Introduction

Internship program arranged by GUDLAVALLERU ENGINEERING COLLEGE in association with Smart Internz, Hyderabad for the benefit of 3<sup>rd</sup> /4<sup>th</sup> year EEE batch 2018-2022 on Electrical Detailed design Engineering for Oil& Gas, Power and Utility industrial sectors.

## Program organiser

Smart Bridge, Hyderabad.

Pioneer in organising Internships, knowledge workshops, debates, hackathons, Technical sessions and Industrial Automation projects.



Courtesy

Dr. Sri B. Dasu – HOD – EEE, GEC

Mr. Rama Krishna –

Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Softwar/Technical Support

## Program details

Smart Internz program schedule: 4 weeks starting from 3<sup>rd</sup> May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: On line through ZOOM

Presenter: Mr Ramesh V

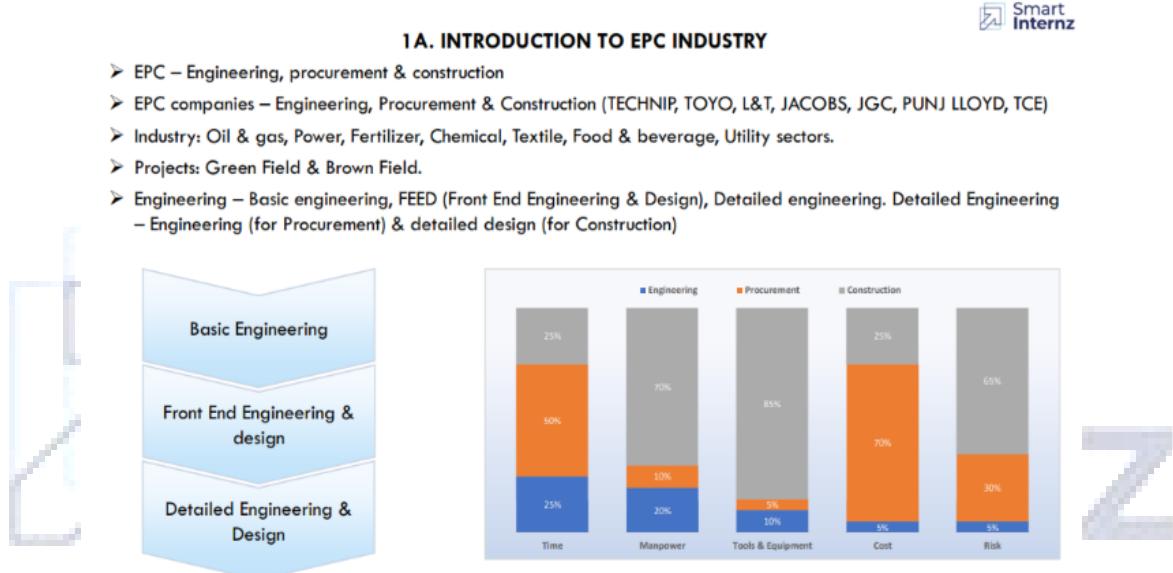
## Internship program

We have been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

### 3<sup>rd</sup> May2021: Introduction to EPC Industry

1	EPC Industry & Electrical Detailed Engineering	EPC Industry Engineering Procurement Construction	Introduction Types of Engineering Engineering role in procurement Engineering role during construction
---	--	---	---

Topic details:



Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineer role at various phases of project.

### 4<sup>th</sup> May2021: Engineering documentation for EPC projects

2	Electrical Design Documentation	Engineering Deliverables list Detailed Engineering work flow Document transmission Deliverables types	Sequence of deliverables Detailed engineering process Document submission and info exchange Different types of deliverables
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Topic details:

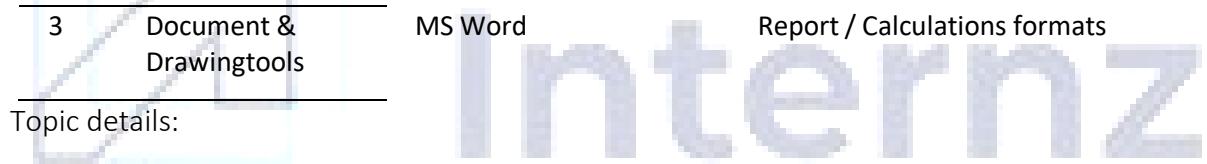
## 2B. ELECTRICAL DETAILED ENGINEERING DELIVERABLES



- ❖ Electrical Consumer List (Excel or SPEL or ETAP)
- ❖ Single Line Diagram: Power Distribution concept, Detailed Metering & Protection Diagram (ACAD)
- ❖ Network calculations: Load flow, short circuit, motor starting, internal arc (Word/Excel/ETAP)
- ❖ Power Balance: Transformer Sizing (Excel or SPEL or ETAP)
- ❖ UPS, DC Charger & Battery sizing (Excel or ETAP)
- ❖ Cable Sizing, Tray sizing (Excel or SPEL)
- ❖ Grounding calculations (Excel/ETAP)
- ❖ Lightning Protection calculations (Excel)
- ❖ Illumination calculation (3D modeling based using DIALUX)
- ❖ 3D Modeling (PDS/PDMS/Smart Plant 3D)
- ❖ Lists/Schedules: LCS lists, cable schedules, DCS Signal Exchange (Excel or SPEL)
- ❖ Layouts: SS / CR, Haz. Class, Earthing / Lightning protection, Cable routing, Illumination (ACAD)
- ❖ BOQs or Material Take-offs (Excel or SPEL)
- ❖ Cable termination details / Inter-connection Diagrams (Excel or SPEL)
- ❖ Electrical equipment Installation details (ACAD)
- ❖ Relay Co-ordination & Selectivity Studies (Excel or ETAP)

Here we observed that how to do a project and sequence of approach, Approach to detail design and overall plant distribution system

5<sup>th</sup> May 2021: Engineering documentation for commands and formulae



### 3A. MS WORD COMMANDS



Word Shortcut Keys

Command Name	Keys
All Caps	Ctrl+Shift+A
Apply List Bullet	Ctrl+Shift+L
Auto Format	Alt+Ctr+K
Auto Text	F3
Bold	Ctrl+B
Cancel	ESC
Center Para	Ctrl+E
Change Case	Shift+F3
Clear	Del
Close or Exit	Alt+F4
Copy	Ctrl+C
Create Auto Text	Alt+F3
Cut	Ctrl+X
Double Underline	Ctrl+Shift+D
Find	Ctrl+F
Help	F1
Hyperlink	Ctrl+K
Indent	Ctrl+M
Italic	Ctrl+I
Justify Para	Ctrl+J
Merge Field	Alt+Shift+F
New Document	Ctrl+N
Open	Ctrl+O
Outline	Alt+Ctrl+O
Overtype	Insert
Page	Alt+Ctrl+P
Page Break	Ctrl+Return
Paste	Ctrl+V
Paste Format	Ctrl+Shift+V
Print	Ctrl+P
Print Preview	Ctrl+F2
Redo	Alt+Shift+Backspace
Redo or Repeat	Ctrl+Y
Save	Ctrl+S
Select All	Ctrl+A
Small Caps	Ctrl+Shift+K
Style	Ctrl+Shift+S
Subscript	Ctrl+=
Superscript	Ctrl+Shift+=
Task Pane	Ctrl+F1
Time Field	Alt+Shift+T

Underline	Ctrl+U
Undo	Ctrl+Z
Update Fields	F9
Word Count List	Ctrl+Shift+G

Function Keys	
F1	Get Help or visit Microsoft Office Online.
F2	Move text or graphics.
F3	Insert an AutoText (AutoText: A storage location for text or graphics you want to use again, such as a standard contract clause or a long distribution list. Each selection of text or graphics is recorded as an AutoText entry and is assigned a unique name.) entry (after Microsoft Word displays the entry).
F4	Repeat the last action.
F5	Choose the Go To command (Edit menu).
F6	Go to the next pane or frame.
F7	Choose the Spelling command (Tools menu).
F8	Extend a selection.
F9	Update selected fields.
F10	Activate the menu bar.
F11	Go to the next field.
F12	Choose the Save As command (File menu).

#### Checks to be done:

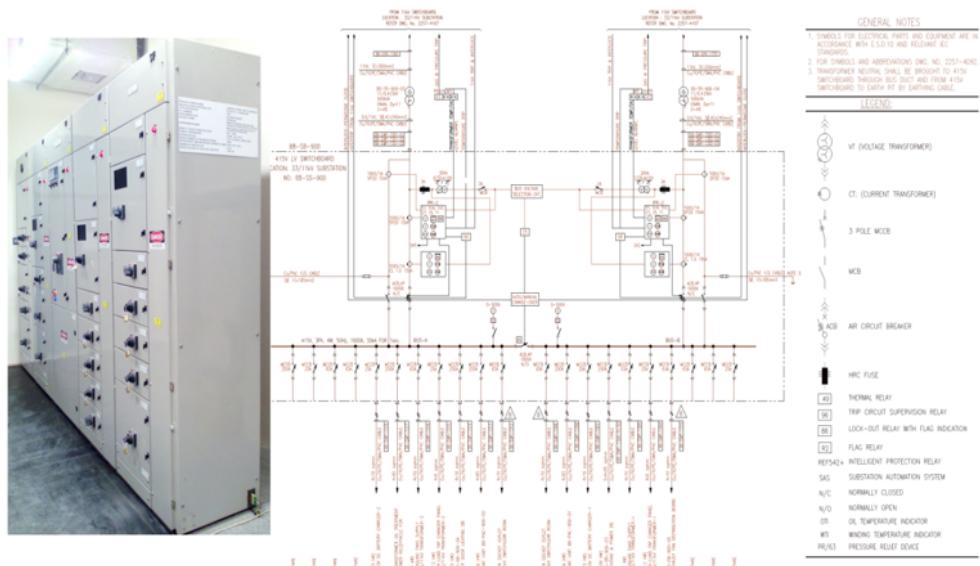
- Page setup
- Spelling
- Grammar
- Punctuation
- Paragraphs
- Overall presentations
- Tables & pictures to be numbered and titled
- Document name & date of versions

Here we need to check the Page setup, spelling, Grammer, Punctuation, Paragraphs, Overall presentations, Tables & pictures to be numbered and titled at last we check the Document name & date of versions.

## 10<sup>th</sup> May 2021: Electrical documentation for Typical diagrams

4	Electrical documentation for typical diagrams	Single line diagram	Overall plant description

### 4B. SINGLE LINE DIAGRAM



Here we observed that how to do a project and Sequence of approach, Approach to detail design and Overall plant distribution system.

### 11<sup>th</sup> May 2021: Classification of transformers and Generators

5	Classification of transformer and generators	Transformers	Sizing & Selection
		Generator	Diesel generator set,DG set selection

Topic details:

Transformer shall include a primary disconnect on the incoming power source. The disconnect means shall be either a breaker or a load break primary switch that is fused.

#### 5A. TRANSFORMERS



1 Ph. Pad mounted Residential lighting



3 Ph Pole mounted Commercial/  
Residential/ street lighting



3 Ph Oil filled (ONAN) Distribution type for industrial & commercial



3 Ph Oil filled (ONAF) Power transformer for industrial



3 Ph. Auto transformer for large  
motor starting & line regulation



3 Ph. Servo Stabilizer for hospital  
and critical equipment



3 Ph. Dry type indoor for  
commercial/industrial/data centers

#### Diesel generator set

The packaged combination of a diesel engine, an alternator and various ancillary devices such as base, canopy, sound attenuation, control systems, circuit breakers, jacket water heaters, starting systems etc., is referred to as a Diesel Generating Set or a DG Set in short.

DG sets are selected based on the load they are intended to supply power for, taking into account the type of load, ie emergency (stand by) or for continuous power (prime), and the size of the load, and size of any motors to be started which is normally the critical parameter.



11kV/6.6kV Diesel generator sets for standby /  
Emergency power supply



415V Diesel generator sets for standby /  
Emergency power supply



240V 1 ph diesel generator set for  
lighting and & small power only

## 12<sup>th</sup> May 2021: Classification of Switchgear construction and power factor improvement

6	Classification of switchgear construction and power factor	switchgear	Types
		Power factor improvement	Description

Topic details:

### Switchgear

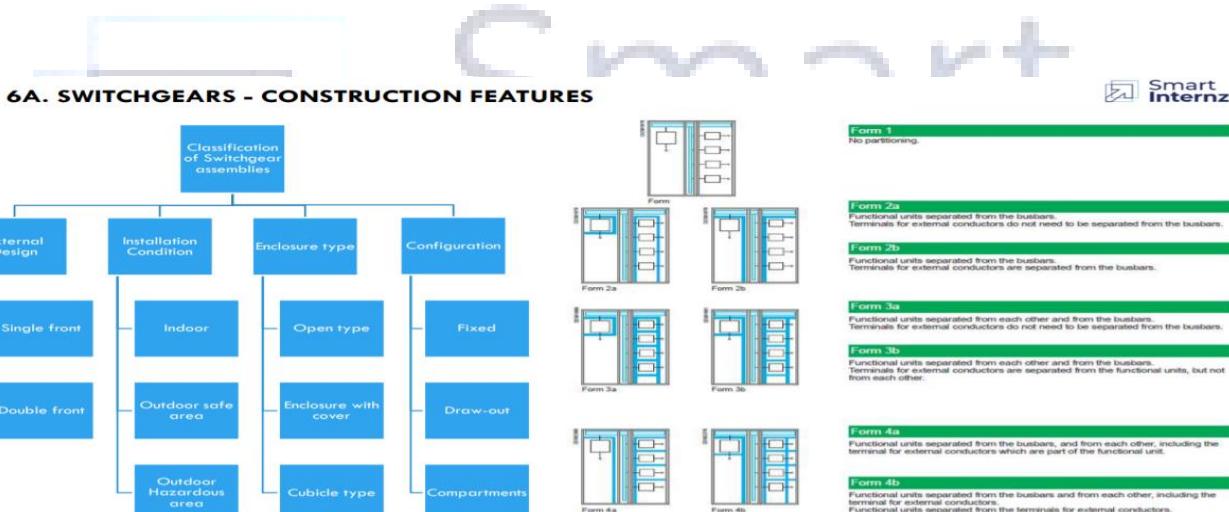
Switchgear includes switching & protecting devices like fuses, switches, CTs, VTs, relays, circuit breakers, etc. This device allows operating devices like electrical equipment, generators, distributors, transmission lines, etc.

There are three types of switch gears namely

LV (Low voltage),

MV (Medium voltage) and

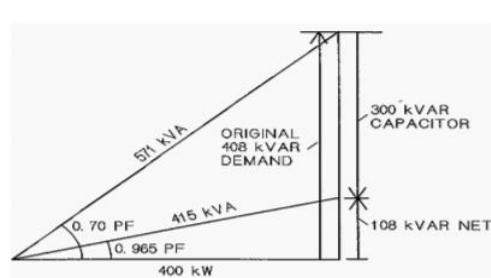
HV (High voltage) Switchgear.



### POWER FACTOR IMPROVEMENT

Power factor defined as the ratio of real power to volt-amperes and is the cosine of the phase angle between the voltage and current in an AC circuit.

Power factor penalties on demand charges range from none to a factor of 2 on the peak power demand.



## 17<sup>th</sup> May 2021: Detailing about UPS system and Busducts

7	Detailing about UPS system and Busducts	UPS system	Types
		Busducts	Applications

Topic details:

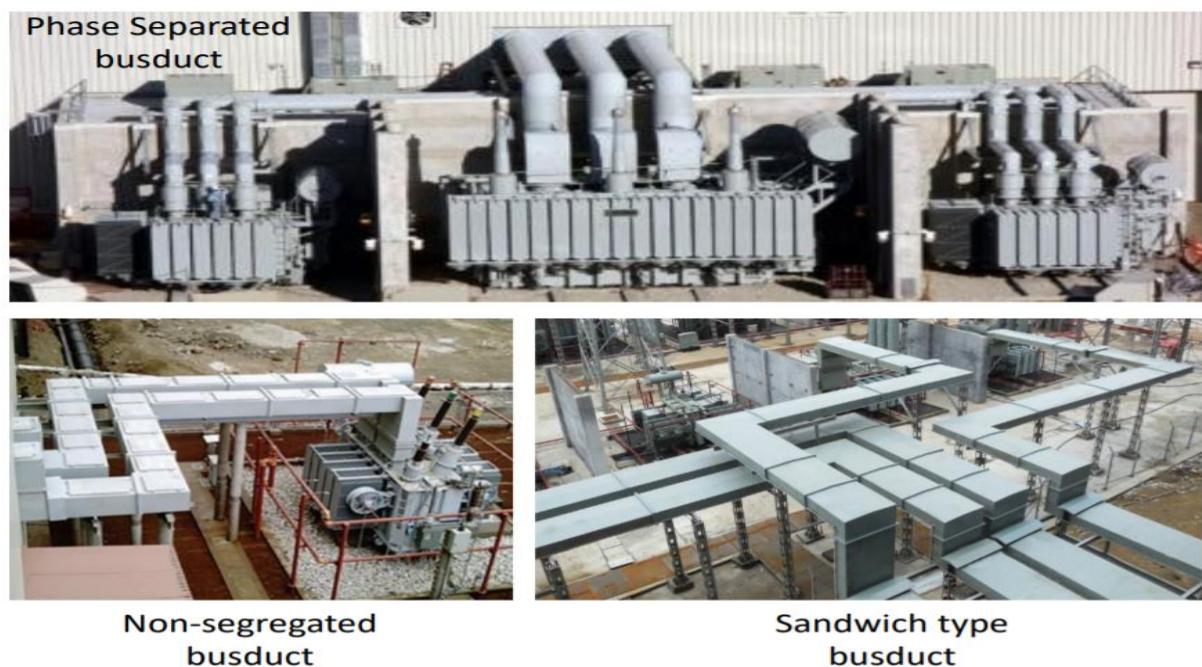
### UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEMS

Power disturbances occur in the electrical system environment and critical applications like plant control systems, computer-based operations, telecommunications or any other system critical for operations shall have uninterruptible power supply.



### Busducts

A sheet metal duct with aluminium or copper bus bars as conductor, and used as a reliable link for transferring power from one equipment to other at desired voltage levels, used as an alternate means for conducting electricity to cable bus and power cables.



18<sup>th</sup> May 2021: Detailing about Motor Starters and Sizing of motors

8	Detailing about Motor starters and sizing of motors	Motor starters	Methods
		Sizing of motors	Sizing selection

Topic details:

### Motor Starters

The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is missing in a relay. So a starter has two main roles - to switch the power automatically or manually to a motor and at the same time protect the motor from overload or faults.

- Direct-On-Line Starter
- Rotor Resistance Starter
- Stator Resistance Starter
- Auto Transformer Starter
- Star Delta Starter

### Motor Sizing

LV motors – based on driven equipment shaft power + 10-15% margin to select nearest standard size. MV Motors - based on driven equipment shaft power + 5-10% margin and rounded off to nearest 10s. Voltage: 0.18 to 160kW LV, 200 to 1800kW 3.3/6.6KV, >2000 11kV also depends on availability

### Selection after sizing

Type - Synchronous or Induction motor

Environment – hazardous area, dusty, saliferous, altitude,

Application – Pump, Compressor, fan, Lift/Hoist/Crane etc.

Duty – based on application S1, S2, S3, S4, S5, S6

Ingress protection – Dust & water, Enclosure – Explosion proof, industrial

Mounting – Horizontal, Vertical

Bearings – Single Ball, Double Ball, Roller, Sleeve.

Cooling – TEFC, TENV, TEWC

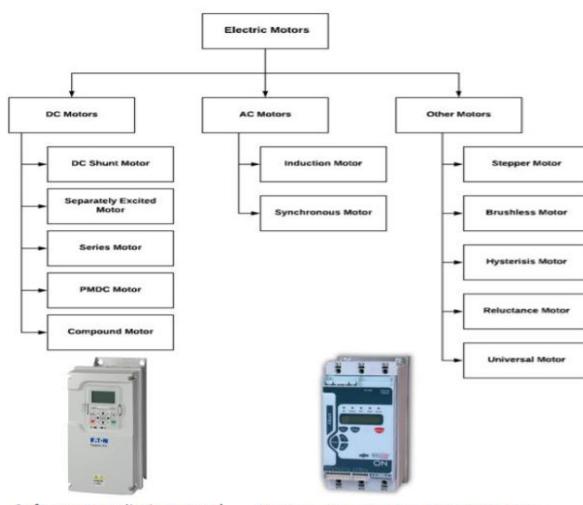
Temperature detectors – Winding (6 nos.) & Bearing (2 nos.)

Starting & running torque – Based application

Load factor – 10 – 15 %

Efficiency – Energy efficient motors

## 8B. MOTORS



### After selection

Starting method – soft starter, Auto transformer, Star/Delta  
 Speed variation – Constant speed, variable speed for VFD  
 Frame Size – 56 to 280  
 Insulation class & Temp rise – A, E, B, F & H  
 Protection – Protection based on voltage & KW rating  
 Cable entry, size & termination – Cable sizing based on starting/running voltage drop and short circuit current  
 Vibration – monitoring based on KW rating  
 Lube oil system – Lube oil system based on KW rating  
 Differential CT's - based on KW rating  
 Cost – 4pole motor cheapest



9

## 19<sup>th</sup> May 2021: Describing about Earthing system and Lightening Protection

9	Describing about Earthing system and lightening protection	Earthing system	Methods
		Lightening protection	Description

Topic details:

### EARTHING SYSTEM

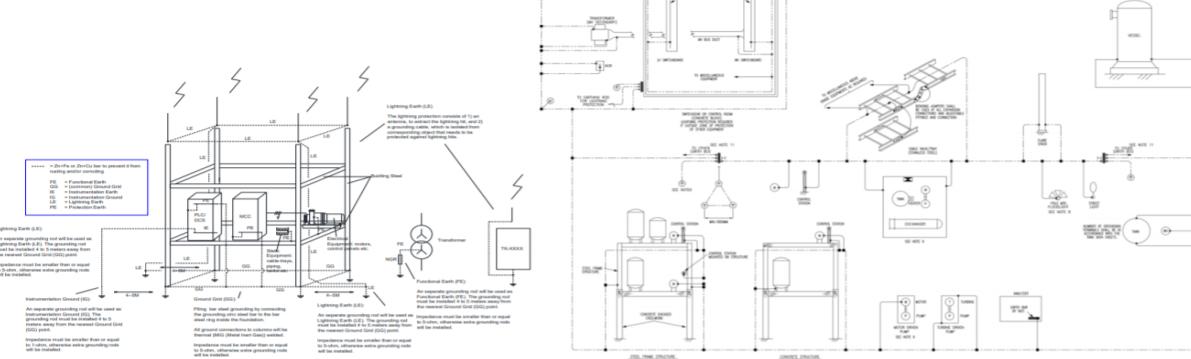
The purpose of earthing is to prevent damage to people and prevent or limit plant damage. Various earthing systems are provided with each earthing system is isolated from the other.

System earthing (usually copper material), body earthing (also called dirty earth, usually GI/copper material), earthing for lightning protection (usually GI/copper material), Clean earth system for instrumentation (usually copper material) and Telecom earthing system (usually copper material).

### 9A. TYPICAL PLANT EARTHING SYSTEM

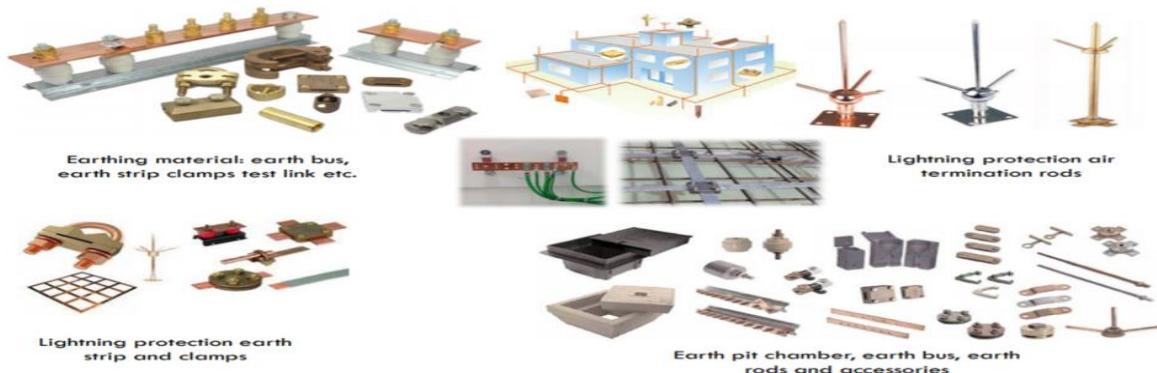
All metallic parts shall be earthed based on size and volume. Bolted metallic parts shall have continuity of adequate size.

Typical earthing schemes:



### LIGHTNING PROTECTION SYSTEM

Lightning protection required for high rise structures and important buildings against lightning currents during thunder storms . Primarily Lightning protection system calculations are done based on soil resistivity, conductor material, coverage structure / Building to determine whether lightning protection is required or not . Earthing calculation for lightning protection system shall be same as described in previous chapter. Lightning protection layouts are prepared for showing lightning protection to tall structures/buildings, important/heritage buildings, Buildings with electrical & instrumentation control panels etc .



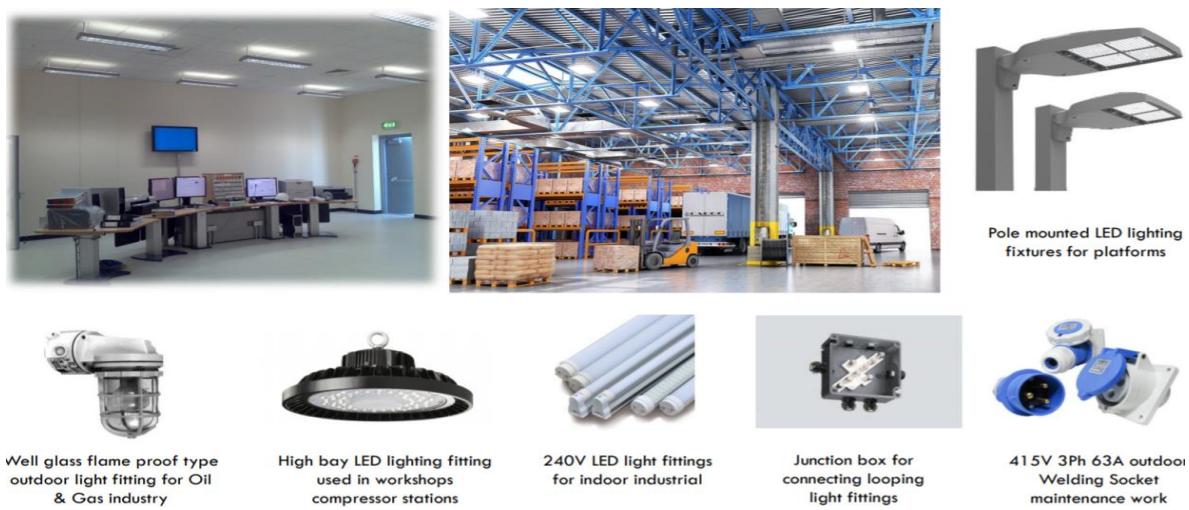
## 20<sup>th</sup> May 2021:Lightening or illumination system and calculations

10	Lightening or illumination system and calculations	Illumination system
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Topic details:

### LIGHTING OR ILLUMINATION

Lighting or Illumination systems are designed based purpose, color rendering, criticality. Industrial lighting load shall be grouped as normal, emergency and critical. Separate lighting DBs shall be provided for critical and emergency lighting load. Emergency lighting shall be 30% of total lighting fittings as per calculations. However the circuiting shall be done such that the emergency lights shall also be switched on during normal condition.



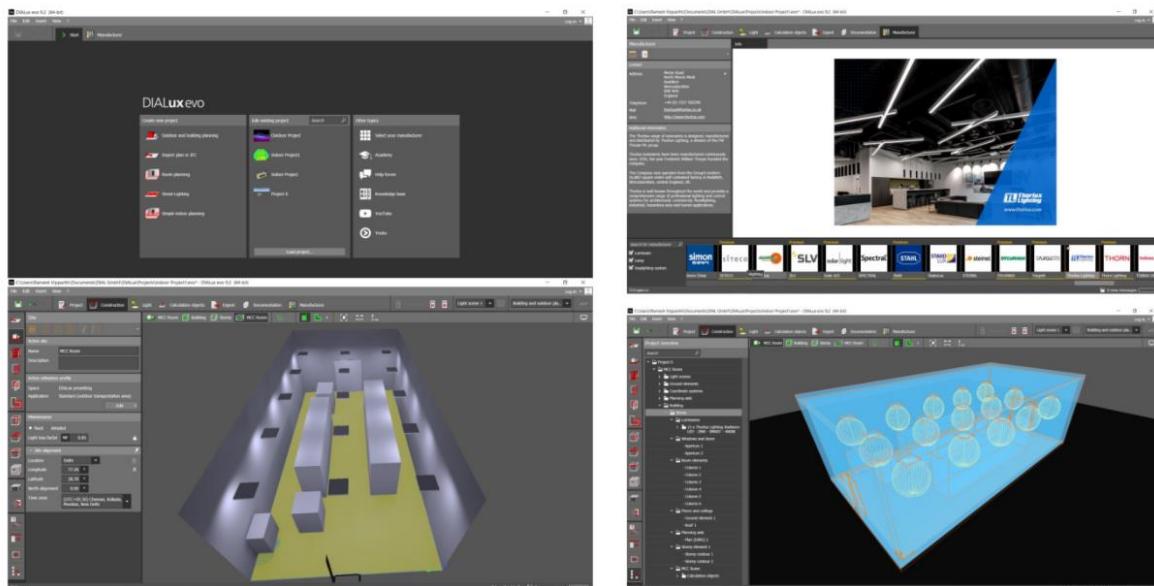
21<sup>st</sup> May 2021:Lightening or illumination systems using DIALUX software

11	Lightening or illumination system using DIALUX software	Illumination system	DIALUX software
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Topic details:

### 11A. LIGHTING OR ILLUMINATION CALCULATIONS USING DIALUX SOFTWARE

Dialux evo 5.9.2 software windows



24<sup>th</sup> May 2021:Cabling and their calculations and types

12	Cabling and their calculations and types	cable	Cabling specifications
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Topic details:

### 12A. CABLING – CABLE SPECIFICATIONS



Electrical Power cables:

Sizes: 3Cx2.5, 4Cx16, 3.5Cx95, 1Cx400 sq mm

Types: Al/PVC/SWA/PVC, Cu/XLPE/SWA/PVC, Cu/XLPE/AWA/PVC

Control Cables:

Sizes: 3Cx2.5, 7Cx2.5, 19Cx2.5, 24Cx2.5 sq mm

Types: Cu/XLPE/SWA/PVC

Instrumentation cables:

Sizes: 3Cx1.5, 2Px1.0, 5Tx1.0, 24Cx2.5 sq mm

Types: Cu/XLPE/I & C SCR/SWA/PVC

Telecom cables:

Sizes: Jelly filled 50Px0.4, 200Px0.4 sq mm

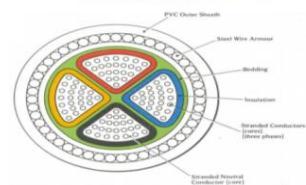
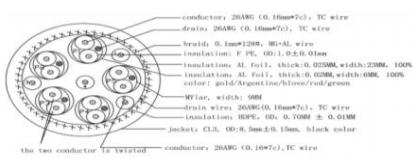
Types: Cu/twisted pair/PVC

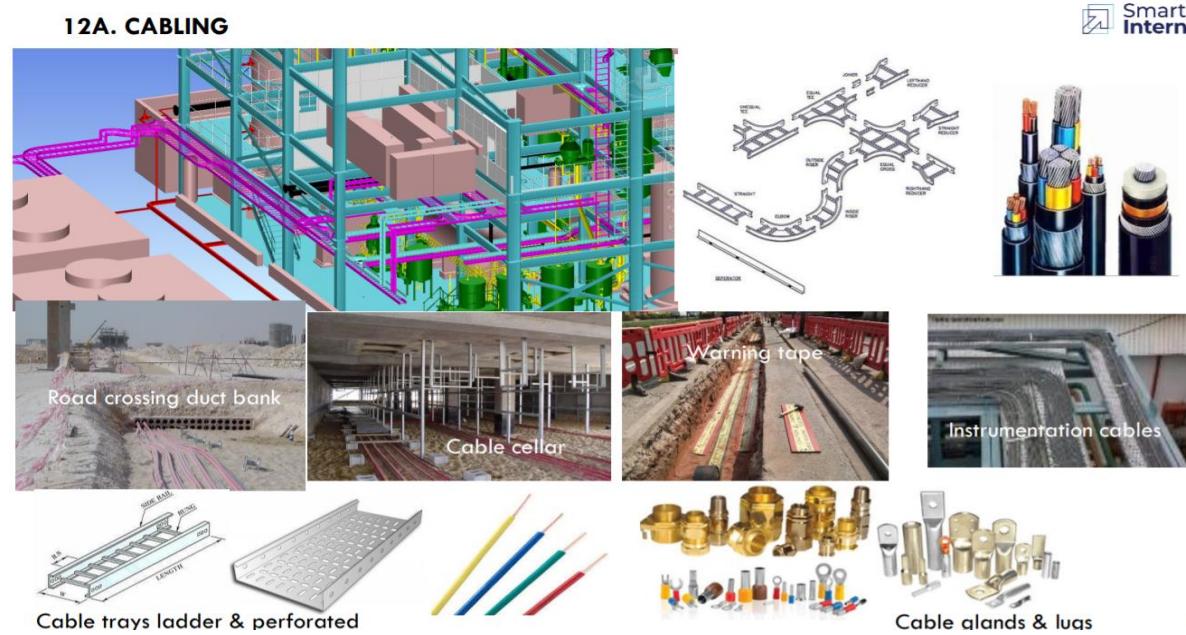
Fire Alarm cables

Sizes: 3Cx1.5, 3Cx2.5 sq mm

Types: Cu/LSZH/PVC

Cables are generally supplied in wooden drums or returnable steel drums. Depending on size and weight of the cable, the standard drum lengths are 250, 350, 500, 750, 1000, meters 2000 etc. cable shall be laid in cable trenches or overhead cable trays using vertical drum rollers.





## 25<sup>th</sup> May 2021:Cabling calculations and cable gland selection

13	Cabling calculations and cable gland selection	Cable sizing	Cable glands
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Topic details:

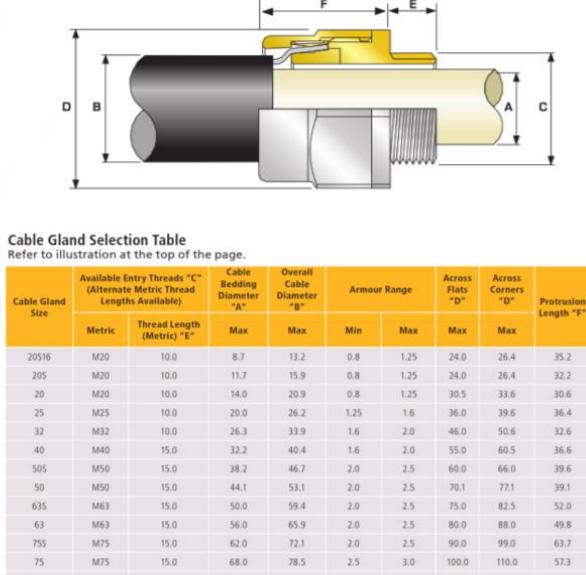
### 13C. CABLE GLAND SELECTION

Cable glands are mechanical cable entry devices and can be constructed from metallic or non-metallic materials. Cable glands are used on all types of electrical power, control, instrumentation, data and telecommunications cables. They are used as a sealing and termination device to ensure that the characteristics of the enclosure which the cable enters can be maintained adequately.

Cable glands are made from Plastic, Brass Nickle plated, Aluminium & Stainless steel and they are Single compression type & Double compression type.

Important specifications for cable glands:

- The hole diameter is the maximum diameter of a cable.
- The cable diameter specifies the diameter of the cable that can be through the cable gland.
- The mounting hole diameter refers to the diameter of the barrier on which the gland is to be installed.



## 28<sup>th</sup> May 2021:Load calculations and Transformer sizing calculations

14		Load calculations	Calculations,procedure
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	Load calculations and Transformer sizing calculations	Transformer sizing calculations	Calculations,procedure
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Topic details:

## Load calculations

### ELECTRICAL LOAD CALCULATIONS LV MCC

Sl. No.	Equipment No.	Equipment Description	Breaker Rating	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load	Motor / Load Rating	Load Factor [A] / [B]	Efficiency at Load Factor [C]	Power Factor at Load Factor [D]	kW = [A] / [D]	Consumed Load		kVAR = kW x tan φ		Remarks	
													[A] mA	[B] kW	[C] decimal	[D] decimal	cos φ	
1	PU2315	Silica filter feed pump					21.80	30.00	0.73	0.91	0.73	23.98	22.43					
2	PU 2314-A	Absorbent/Neutral oil pump (W)					6.33	7.50	0.84	0.85	0.73	7.4	7.0					
3	PU 2314-B	Absorbent/Neutral oil pump (S)					5.45	7.50	0.73	0.85	0.73						6.4 6.0	
4	PU2305	Feed Pump (Separator)					22.01	30.00	0.73	0.91	0.78	24.2	19.4					
5	MX2305	MIXER (W)					22.18	30.00	0.74	0.91	0.78	24.4	19.6					
6	MX 2308	MIXER (S)					22.18	30.00	0.74	0.91	0.78						24.4 19.6	
7	PU2313	Agitator					9.53	11.00	0.73	0.85	0.73	11.2	10.5					
8	Regulating valve	TK 2310B (I)					0.03	0.05	0.62	0.85	0.73							
9	SC2314	Screw conveyor (I)					2.14	3.00	0.71	0.85	0.72						1.1 1.0	
10	AG 2324A	Citric acid tank agitator (W)					1.60	3.00	0.53	0.85	0.73	1.88	1.76					
11	AG 2324B	Citric acid tank agitator (S)					1.60	3.00	0.53	0.85	0.73						2.52 2.36	
12	AG 2305	Citric oil reaction vessel agitator					5.84	7.50	0.78	0.85	0.73	6.87	6.43					
13	AG 2309	Lye oil reaction vessel agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34					
14	AG 2310	Lye oil reaction vessel agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34					
15	AG 2314	Soap Adsorbant Tank Agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
Maximum of normal running plant load : (Est. x%E + y%F)												TOTAL	109.28	95.81	3.61	3.38	32.67	27.32
Peak Load : (Est. x%E + y%F + z%G)												KVA	145.33		4.95		42.59	
<b>Assumptions</b>																		
1) Load factor, Efficiency and Power factor.																		
Load Rating (kW)																		
<= 20																		
> 20 - <= 45																		
> 45 - < 150																		
>= 150																		
2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for continuous, intermittent and standby load.																		

### Calculation for Transformer Capacity

#### 1.0 Example of calculation for Transformer Capacity

##### 1.1 Calculation for consumed load

Consumed loads used for this example are as follows :

	kW	kVar	kVA	
a. Continuous load	109.28	95.81	145.33	--- (i)
b. Intermittent load / Diversity Factor	3.61	3.4	4.95	--- (ii)
c. Stand-by load required as consumed load	32.67	27.3	42.59	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	113.6	99.6	151.07	
Future expansion load (20% capacity)	22.7	19.9	30.21	
Total Load =	136.4	119.5	181.29	

##### 1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

$$\begin{aligned} \text{Max. Consumed load} &= 151.1 \text{ kVA} \\ \text{Spare capacity} &= 30.2 \text{ kVA} \\ \text{Required capacity} &= 181.3 \text{ kVA} \\ \text{Transformer rated capacity} &= 190 \text{ kVA} \end{aligned}$$

##### 1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW), while all the other loads running, the voltage regulation is as follows :

$$\begin{aligned} P_T &= 190 \text{ KVA} & (\%) &= 4 & \text{Ratio X/R} &= 3.3 \\ \text{Hence, \%R} &= & & & = 1.173 \% \\ \%X &= & & = 3.82 \% \\ P_M &= 30 \text{ KW having } K = 6 & C = 1 & \text{Cos } \theta = 0.78 & \text{Eff.} \eta = 0.91 & \text{Cos } \theta_S = 0.25 \\ P_S &= & & = 253.5926 \text{ KVA} & & \\ \text{Cos } \theta_S &= 0.25, \text{ Corresponding to Angle } \theta_S = 75.52249 \text{ Degrees for which } \sin \theta_S = 0.97 \\ P_B &= 70.81 \text{ KVA} & & & = 60.1885 & \& \text{P}_B \text{ in Kvar} = 11.94 \therefore \text{Cos } \theta_B = 0.850 \\ \text{Cos } \theta_B &= 0.85, \text{ Corresponding to Angle } \theta_B = 31.78833 \text{ Degrees, for which } \sin \theta_B = 0.53 \\ P_{CP} &= & & = 123.5866 \text{ KW} \\ P_{CO} &= & & = 257.4799 \text{ KVAR} \\ P_C &= & & = 285.6039 \text{ KVA} \\ \text{Cos } \theta_C &= 0.43272, \text{ where as } \sin \theta_C = & & & = 0.902 \end{aligned}$$

$$\text{Voltage Regulation } \varepsilon = 5.9 \%$$

**Result:** During starting of max. capacity motor, while all other loads are running, the voltage regulation at Transformer secondary terminals is approx. 5.3%, which meets the criteria to maintain less than 15% voltage regulation.

##### 1.4 Selection of rated capacity

120 kVA transformer selected.

## 29<sup>th</sup> May 2021: DG set calculations

15	DG set calculations	DG set	Calculations, procedure
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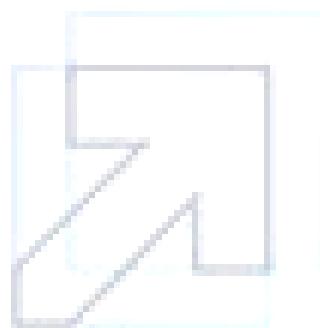
Topic details:

DG SIZING CALCULATIONS			
<b>Design Data</b>			
Rated Voltage	415	KV	
Power factor ( $\cos\phi$ )	0.78	Avg	
Efficiency	0.91	Avg	
Err:509	146.8		
Largest motor to start in the sequence - load in KW	30	KW	
Running kVA of last motor ( $\cos\phi=0.91$ )	42	KVA	
Starting current ratio of motor	6	(Considering starting method as Soft starter)	
Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	254	KVA	
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	105	KVA	
<b>A Continuous operation under load -P1</b>			
Capacity of DG set based on continuous operation under load P1	105	KVA	
<b>B Transient Voltage dip during starting of Last motor P2</b>			
Total momentary load in KVA	358	KVA	
(Starting KVA of the last motor+Base load of DG set in KVA)			
Subtransient Reactance of Generator ( $X_d''$ )	7.91%	(Assumed)	
Transient Reactance of Generator ( $X_d'$ )	10.065%	(Assumed)	
$X_d''' = (X_d'' + X_d')/2$	0.089875		
Transient Voltage Dip	15%	(Max)	
Transient Voltage dip during Soft starter starting of Last motor $P_2 = \text{Total momentary load in KVA} \times X_d''' \times [1 - \text{Transient Voltage Dip}]$ (Transient Voltage Dip)	182	KVA	
<b>C Overload capacity P3</b>			
Capacity of DG set required considering overload capacity			
Total momentary load in KVA	358	KVA	
overcurrent capacity of DG (K)	150%		
(Ref: IS/IEC 60034-1, Clause 9.3.2)			
Capacity of DG set required considering overload capacity (P3) = $\frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	239	KVA	
<b>Considering the last value amongst P1, P2 and P3</b>			
Continuous operation under load -P1	105	KVA	
Transient Voltage dip during Soft starter starting of Last motor P2	182	KVA	
Overload capacity P3	239	KVA	
Considering the last value amongst P1, P2 and P3	239	KVA	
selected rating	315	KVA	
Hence, DG set 239 KVA is adequate to cater the loads as per re-scheduled loads			
NOTE: VOLTAGE DIP CONSIDERED - 15%			

**2<sup>nd</sup> June 2021: Calculations of Earthing and Lightening protection**

16	Calculations of Earthing and Lightening protection	Earthing calculations	Calculations,procedure
		Lightening protection calculations	Calculations,procedure

Topic details:



# Smart Internz

**EARTHING CALCULATIONS**

Maximum line-to-ground fault in kA for 1 sec	11
Earthing material (Earth rod & earth strip)	GI
Depth of earth flat buried in meter	0.5
Average depth / length of Earth rod in meters	3.5
Soil resistivity $\Omega\text{-meter}$	7.5
Ambient temperature in deg C	45
Plot dimensions (earth grid) Lx B in meters	85 145
Number of earth rods in nos.	6

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

$$I_{eg} = A_c X \sqrt{\frac{TCAP \times 10^{-4}}{t_c \sigma g_e T_a}} \ln \left[ \frac{K_0 + T_m}{K_0 + T_a} \right]$$

 $\sigma$  - Thermal co-efficient of resistivity, at 20 oC 0.0032 $\rho$  - Resistivity of ground conductor at 20 oC 20.10 $T_a$  - Ambient Temperature in °C 50 $I_{eg}$  - RMS fault current in kA = 50 KA 11 $t_c$  - Short circuit current duration sec 1Thermal capacity factor, TCAP  $\text{A}/(\text{cm}^2\text{oC})$  3.93 $T_m$  - Maximum allowable temperature for copper conductor, in oC 419 $K_0$  - Factor at oC 293

The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:

 $11 = Ac *$  0.123

Ac - Required conductor cross section in sq.mm 90

Earth rod dia in mm 11

Earth rod dia (including 25% corrosion allowance) in mm 13

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

$$I_{ef} = A_c X \sqrt{\frac{TCAP \times 10^{-4}}{t_c \sigma g_e T_a}} \ln \left[ \frac{K_0 + T_m}{K_0 + T_a} \right]$$

 $\sigma$  - Thermal co-efficient of resistivity, at 20 oC 0.0032 $\rho$  - Resistivity of ground conductor at 20 oC 20.10 $T_a$  - Ambient Temperature in °C 50 $I_{ef}$  - RMS fault current in kA = 50 KA 14 $t_c$  - Short circuit current duration sec 1Thermal capacity factor, TCAP  $\text{A}/(\text{cm}^2\text{oC})$  3.93 $T_m$  - Maximum allowable temperature for copper conductor, in oC 419 $K_0$  - Factor at oC 293

The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:

 $14 = Ac *$  0.123

Ac - Required conductor cross section in sq.mm 134

Earth flat area in mm 12

Earth flat area (Including 25% corrosion allowance) in mm 15

Selected flat size W \* Thk in sq mm 20

 $R_g$  - Grid resistance

Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left\{ \frac{1}{L} + \frac{1}{\sqrt{20 \times A}} \left[ 1 + \frac{1}{1 + h \sqrt{20/A}} \right] \right\}$$

 $\rho$  - Soil resistivity in  $\Omega\text{-meter}$  7.5 $L$  - Total buried length of ground conductor in meter 480 $h$  - Depth of burial in meter 0.5

A - Grid area in sq. meter 12325

 $R_g$  - Grid resistance 0.046 $R_e$  - Earth Electrode resistance

Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_e = \frac{\rho}{2 \times \pi \times n_r \times L_r} \left\{ \ln \left[ \frac{4 \times L_r}{b} \right] - 1 + \frac{2 \times k_2 \times L_r}{\sqrt{A}} \left( \sqrt{n_r} - 1 \right)^2 \right\}$$

 $\rho$  - Soil resistivity in  $\Omega\text{-meter}$ , 16.96 7.5 $n$  - No of earth electrodes 6 $L_r$  - Length of earth electrode in meter 3.5 $b$  - Diameter of earth electrode in meter 0.020 $k_2$  - co-efficient 1

A - Area of grid in square metre 12325

 $R_e$  - Earth Electrode resistance 3.239016

Grounding system resistance

Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \times R_2 - R_m^2}{R_g + R_2 - 2R_m}$$

 $R_s$  - Mutual ground resistance between the group of ground conductors,  $R_g$  and group of electrodes,  $R_2$  in  $\Omega$ . Neglected  $R_m$  since this is for homogenous soil $R_s$  - Total earthing system resistance 0.046 OhmsThe calculated resistance grounding system is less than the allowable 1  $\Omega$  value.

**lightening calculations**

Location	Jaipur
Building	Srtuctural, Industrial
Type of Building	Triangle Roofs (c)
Building Length (L)	19
Building breadth (W)	7
Building Height (H)	7

**Risk Factor Calculation****1 Collection Area ( $A_c$ )**

$$A_c = \frac{3.14 * H * H + (2 * H * L)}{419.86}$$

**2 Probability of Being Struck (P)**

$$P = \frac{A_c * N_e * 10^6}{0.001175608}$$

**3 Overall weighing factor**

a) Use of structure (A)	=	1.0
b) Type of construction (B)	=	0.8
c) Contents or consequential effects (C)	=	0.8
d) Degree of isolation (D)	=	1.0
e) Type of country (E)	=	0.3
Wo - Overall weighing factor	=	$A * B * C * D * E$
	=	0.192

**4 Overall Risk Factor**

$$\begin{aligned} P_o &= P * Wo \\ P_o &= 0.0002257167 \\ P_a &= 10^{-5} \end{aligned}$$

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor (  $P_o$  ) has been taken as  $10^{-5}$   
Since  $P_o > P_a$  lightning protection required.

**5 Air Terminations**

$$\begin{aligned} \text{Perimeter of the building} &= 2(L+W) \\ &= 52 \quad \text{Mts.} \end{aligned}$$

**6 Down Conductors**

$$\begin{aligned} \text{Perimeter of building} &= 52 \quad \text{Mts.} \\ \text{No. of down conductors based on perimeter} &= 3 \quad \text{Nos.} \end{aligned}$$

Hence 3 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Galvanized Steel Strip

(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

### 5<sup>th</sup> June 2021:Cable sizing and cable tray sizing calculations

17	Cable sizing and cable tray sizing calculations	Cable sizing	Calculations, procedure
		Cable traying calculations	Calculations, procedure

Topic details:



### Conclusion

We have been taught many aspects of engineering activities during the EPC stages for all electrical and related other disciplines also.

### Feedback

#### Smart Bridge

They conduct summer internships, work shops, debates, hackthons, technical sessions.

#### Method of conducting program

Online virtual program with presentation slides and explanation on the topic and practical usage of topic and with some examples.

#### Program highlights

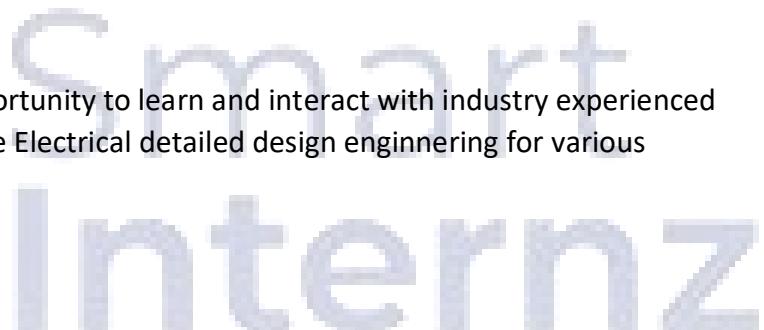
It is for the detailed design of any industrial sectors.

#### Material

The material was good.

#### Benefits

It has been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design enginnering for various industrial sectors.



## **ASSIGNMENT-1**

## ELECTRICAL LOAD CALCULATIONS LV MCC

## load calculations.xls

### 1) Load factor, Efficiency and Power factor.

110.4 kW

96.8 kVAR

$$\text{sqrt}(\text{kW}^2 + \text{kVAR}^2) = 146.8$$

TOE

10

95.81

3.61

32.67 | 2

Peak Load :

(Est. x%E + y%F + z%G)

1

1

1

— 1 —

### 2) Coincidence

10.000-15.000 m²

## ASSIGNMENT-2

### Calculation for Transformer Capacity

#### 1.0 Example of calculation for Transformer Capacity

##### 1.1 Calculation for consumed load

Consumed loads used for this example are as follows :

	kW	kVar	kVA	
a. Continuous load	109.28	95.8	145.33	--- (i)
b. Intermittent load / Diversity Factor	3.61	3.4	4.95	--- (ii)
c. Stand-by load required as consumed load	32.67	27.3	42.59	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	113.6	99.6	151.07	
Future expansion load (20% capacity)	22.7	19.9	30.21	
Total Load =	136.4	119.5	181.29	

#### 1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

$$\begin{aligned} \text{Max. Consumed load} &= 151.1 \text{ kVA} \\ \text{Spare capacity} &= 30.2 \text{ kVA} \\ \text{Required capacity} &= 181.3 \text{ kVA} \\ \text{Transformer rated capacity} &= 190 \text{ kVA} \end{aligned}$$

#### 1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW), while all the other loads running, the voltage regulation is as follows :

$$\begin{aligned} P_T &= 190 \text{ kVA} & (\%Z) &= 4 & \text{& Ratio } X/R &= 3.3 \\ \text{Hence, \%R} &= & & & = 1.173\% \\ \%X &= & & = & 3.82\% \\ P_M &= 30 \text{ kW having (K} & = 6 & \text{& C} & = 1 & \text{& Cos } \theta = 0.78 \text{ & Eff.} \eta = 0.91 & \text{& Cos } \Theta_s = 0.25 \\ P_s &= & & = & 253.5926 \text{ kVA} & & \\ \cos \theta_s &= 0.25, \text{ Corresponding to Angle } \theta_s = & & & 75.52249 \text{ Degrees for which } \sin \theta_s & = 0.97 \\ P_B &= 70.81 \text{ kVA} & & & 60.1885 & \text{ & } P_B \text{ in Kvar} = 11.94 \therefore \cos \theta_B = 0.850 \\ \cos \theta_B &= 0.85, \text{ Corresponding to Angle } \theta_s = & & & 31.78833 \text{ Degrees, for which } \sin \theta_s & = 0.53 \\ P_{CP} &= & & = & 123.5866 \text{ kW} & \\ P_{CQ} &= & & = & 257.4799 \text{ KVAR} & \\ P_c &= & & = & 285.6039 \text{ KVA} & \\ \cos \theta_c &= 0.43272, \text{ where as } \sin \theta_c & & & & = 0.902 \\ \text{Voltage Regulation } \varepsilon &= & & = & 5.9\% & \end{aligned}$$

**Result:** During starting of max. capacity motor, while all other loads are running, the voltage regulation at Transformer secondary terminals is approx. 5.3%, which meets the criteria to maintain less than 15% voltage regulation.

#### 1.4 Selection of rated capacity

120 kVA transformer selected.

### ASSIGNMENT-3

<b>DG SIZING CALCULATIONS</b>		
<b>Design Data</b>		
Rated Voltage	415	KV
Power factor ( $\cos\phi$ )	0.78	Avg
Efficiency	0.91	Avg
Err:509	146.8	
Largest motor to start in the sequence - load in KW	30	KW
Running kVA of last motor ( $\cos\phi = 0.91$ )	42	KVA
Starting current ratio of motor	6	(Considering starting method as Soft starter)
Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	254	KVA
Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	105	KVA
<b>A Continous operation under load -P1</b>		
Capacity of DG set based on continuous operation under load P1	105	KVA
<b>B Transient Voltage dip during starting of Last motor P2</b>		
Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA)	358	KVA
Subtransient Reactance of Generator ( $X_d''$ )	7.91%	(Assumed)
Transient Reactance of Generator ( $X_d'$ )	10.065%	(Assumed)
$X_d''' = (X_d'' + X_d')/2$	0.089875	
Transient Voltage Dip	15%	(Max)
Transient Voltage dip during Soft starter starting of Last motor $P_2 = \text{Total momentary load in KVA} \times X_d''' \times \frac{(1-\text{Transient Voltage Dip})}{(\text{Transient Voltage Dip})}$	182	KVA
<b>C Overload capacity P3</b>		
Capacity of DG set required considering overload capacity		
Total momentary load in KVA	358	KVA
overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
Capacity of DG set required considering overload capacity $(P_3) = \frac{\text{Total momentary load in KVA}}{\text{overcurrent capacity of DG (K)}}$	239	KVA
<b>Considering the last value amongst P1, P2 and P3</b>		
Continous operation under load -P1	105	KVA
Transient Voltage dip during Soft starter starting of Last motor P2	182	KVA
Overload capacity P3	239	KVA
Considering the last value amongst P1, P2 and P3	239	KVA
selected rating	315	KVA
Hence, DG set 239 KVA is adequate to cater the loads as per re-scheduled loads		
NOTE: VOLTAGE DIP CONSIDERED - 15%		

#### ASSIGNMENT-4

##### EARTHING CALCULATIONS

Maximum line-to-ground fault in kA for 1 sec	11		
Earthing material (Earth rod & earth strip)	GI		
Depth of earth flat burial in meter	0.5		
Average depth / length of Earth rod in meters	3.5		
Soil resistivity $\Omega\text{-meter}$	7.5		
Ambient temperature in deg C	45		
Plot dimensions (earth grid) L x B in meters	85	145	
Number of earth rods in nos.	6		

Earth electrode sizing:  
Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c x \sqrt{\left[ \frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r} \right] x l_n \left[ \frac{K_0 + T_m}{K_0 + T_a} \right]}$$

ar - Thermal co-efficient of resistivity, at 20 oC	0.0032		
pr - Resistivity of ground conductor at 20 oC	20.10		
Ta - Ambient Temperature is °C	50		
$I_{lg}$ - RMS fault current in kA = 50 KA	11		
tc - Short circuit current duration sec	1		
Thermal capacity factor, TCAP J/(cm3.oC)	3.93		
Tm - Maximum allowable temperature for copper conductor, in oC	419		
K0 - Factor at oC	293		
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:			
11 = Ac *	0.123		
Ac - Required conductor cross section in sq.mm	90		
Earth rod dia in mm	11		
Earth rod dia (including 25% corrosion allowance) in mm	13		

Earth flat sizing:  
Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c x \sqrt{\left[ \frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r} \right] x l_n \left[ \frac{K_0 + T_m}{K_0 + T_a} \right]}$$

ar - Thermal co-efficient of resistivity, at 20 oC	0.0032		
pr - Resistivity of ground conductor at 20 oC	20.10		
Ta - Ambient Temperature is °C	50		
$I_{lg}$ - RMS fault current in kA = 50 KA	14		
tc - Short circuit current duration sec	1		
Thermal capacity factor, TCAP J/(cm3.oC)	3.93		
Tm - Maximum allowable temperature for copper conductor, in oC	419		
K0 - Factor at oC	293		
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:			
14 = Ac *	0.123		
Ac - Required conductor cross section in sq.mm	114		

Rg - Grid resistance  
Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left\{ \frac{1}{L} + \frac{1}{\sqrt{20} \times A} \left[ 1 + \frac{1}{1 + h \sqrt{20/A}} \right] \right\}$$

$\rho$  - Soil resistivity in  $\Omega\text{-meter}$  7.5  
L - Total buried length of ground conductor in meter 460  
h - Depth of burial in meter 0.5  
A - Grid area in sq. meter 12325

Rg - Grid resistance 0.046

Rr - Earth Electrode resistance  
Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_r = \frac{\rho}{2 \times \pi \times n_r \times L_r} \left\{ l_n \left[ \frac{4 \times L_r}{b} \right] - 1 + \frac{2 \times k_1 \times L_r (\sqrt{n_r} - 1)^2}{\sqrt{A}} \right\}$$

$\rho$  - Soil resistivity in  $\Omega\text{-meter}$ , 16.96  
n - No of earth electrodes 6  
Lr - Length of earth electrode in meter 3.5  
b - Diameter of earth electrode in meter 0.020  
k1 - co-efficient 1  
A - Area of grid in square metre 12325

Rr - Earth Electrode resistance 3.239016

Grounding system resistance  
Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \times R_2 - R_m^2}{R_g + R_2 - 2R_m}$$

$R_m$  - Mutual ground resistance between the group of ground conductors,  $R_g$  and group of electrodes,  $R_e$  in  $\Omega$ . Neglected  $R_m$  since this is for homogenous soil

Rs - Total earthing system resistance 0.046 Ohms  
The calculated resistance grounding system is less than the allowable 1  $\Omega$  value.

## ASSIGNMENT-5

### lightening calculations

Location	Jaipur
Building	Srtuctural, Industrial
Type of Building	Triangle Roofs (c)
Building Length (L)	19
Building breadth (W)	7
Building Height (H)	7

#### Risk Factor Calculation

##### 1 Collection Area ( $A_c$ )

$$A_c = \frac{3.14 * H * H + (2 * H * L)}{419.86}$$

##### 2 Probability of Being Struck (P)

$$P = \frac{A_c * N_g * 10^{-6}}{0.001175608}$$

##### 3 Overall weighing factor

a) Use of structure (A)	=	1.0
b) Type of construction (B)	=	0.8
c) Contents or consequential effects (C)	=	0.8
d) Degree of isolation (D)	=	1.0
e) Type of country (E)	=	0.3
Wo - Overall weighing factor	=	$A * B * C * D * E$
	=	0.192

##### 4 Overall Risk Factor

$$\begin{aligned} Po &= P * Wo \\ Po &= 0.0002257167 \\ Pa &= 10^{-5} \end{aligned}$$

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor ( Po) has been taken as  $10^{-5}$   
Since Po > Pa lightning protection required.

##### 5 Air Terminations

$$\begin{aligned} \text{Perimeter of the building} &= 2(L+W) \\ &= 52 \quad \text{Mts.} \end{aligned}$$

##### 6 Down Conductors

$$\begin{aligned} \text{Perimeter of building} &= 52 \quad \text{Mts.} \\ \text{No. of down conductors based on perimeter} &= 3 \quad \text{Nos.} \end{aligned}$$

Hence 3 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Galvanized Steel Strip  
(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

## ASSIGNMENT-6

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating (V)	No. of Phases	Full Load Current (A)	Load P.F	RIN & Running Motor P.F	Motor P.F Starting	Stn & Starting Motor P.F	Type	No. of Runs	No. of Cores	Size (mm <sup>2</sup> )	Current Rating (A)	Derating factor k4	Derating factor k2	Derating factor k3	Derating factor k5	Overall Derating factor k4	Derated Current (A)	Cable Length (m)	Cable Resistance (Ohms)	Cable Resistance (mΩ)	Voltage drop (Running) (V)	Voltage drop (Starting) (V)	Voltage drop (Standby) (V)	Cable size (mm <sup>2</sup> )	Qd of Cable (mm)	Gnd size		
1	LV MCC	PU2315	Sikar filter feed pump	21.90	3.00	415	3	0.9	22.51	0.8	0.6	0.8	0.5	2	1	4.0	35	146	0.98	0.9	1	0.882	130.5	95	0.6710	0.0794	0.08	11.58	1.22	OK	24	20	
2	LV MCC	PU 2314A	Absorbent/Neutral oil pump (W)	5.48	7.0	415	3	0.9	57.13	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	0.882	45.0	95	3.9400	0.0902	5.02	1.21	30.0	7.24	OK	18	20
3	LV MCC	PU 2314-B	Absorbent/Neutral oil pump (S)	5.48	7.0	415	3	0.9	57.13	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	0.882	24.7	60	9.4900	0.1007	7.56	1.82	45.32	10.92	OK	16	20s
4	LV MCC	PU2305	Feed Pump (Separator)	23.40	30.0	415	3	0.9	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	146	0.98	0.9	1	0.882	130.5	85	0.6710	0.0794	3.50	0.84	20.72	4.99	OK	24	20s
5	LV MCC	AG 2309	MXV(R)	23.40	30.0	415	3	0.9	22.51	0.8	0.6	0.8	0.5	2	1	4.0	35	146	0.98	0.9	1	0.882	130.5	70	0.6710	0.0794	3.00	0.74	19.50	4.41	OK	24	20s
6	LV MCC	MX 2308	MXV(R) (S)	23.40	30.0	415	3	0.9	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	146	0.98	0.9	1	0.882	130.5	105	0.6710	0.0794	4.33	1.04	25.60	6.17	OK	24	20s
7	LV MCC	BW2313	Blower	8.03	11.00	415	3	14.0	83.79	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	0.882	75.0	100	1.4700	0.0815	2.96	0.71	17.66	4.25	OK	21	20s
8	LV MCC	Rotary valve	KX 2313B (R)	1.10	1.50	415	3	1.9	11.43	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	0.882	33.5	100	5.9000	0.0947	1.58	0.38	9.43	2.27	OK	18	20s
9	LV MCC	LG 2304	Spool valve (R)	2.19	3.0	415	3	0.9	22.51	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	0.882	75.0	100	0.6710	0.0794	1.00	0.38	9.43	2.27	OK	18	20s
10	LV MCC	AG 2324A	Citr acid tank agitator (W)	2.19	3.0	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	0.882	24.7	110	9.4900	0.1007	5.55	1.34	33.24	8.01	OK	16	20s
11	LV MCC	AG 2324B	Citr acid tank agitator (S)	2.19	3.0	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	0.882	45.0	75	3.9400	0.0902	1.59	0.38	9.49	2.29	OK	18	20
12	LV MCC	AG 2305	Citr oil reactor vessel agitator	5.48	7.0	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	0.882	45.0	105	3.9400	0.0902	5.55	1.34	33.22	8.00	OK	18	20
13	LV MCC	AG 2309	Live oil reactor vessel agitator	2.19	3.0	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	0.882	24.7	80	0.6710	0.0794	0.84	0.71	13.60	3.22	OK	16	20s
14	LV MCC	AG 2310	Live oil reactor vessel agitator	2.19	3.0	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	0.882	24.7	95	9.4900	0.1007	4.79	1.15	28.70	6.92	OK	16	20s
15	LV MCC	AG 2314	Soap Adiabatic Tank Agitator	3.43	4.70	415	3	6.0	35.80	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	0.882	24.7	65	9.4900	0.1007	5.14	1.24	30.77	7.41	OK	16	20s

Basis:

I. Overall derating factor k = k1 x k2 x k3 x k4

K1=Rating factor for variation in air/ground temperature

K2=Rating factor for depth of laying

K3=Rating factor for spacing between two circuits

K4=Rating factor for variation in thermal resistivity of the soil

2. LT Motors : Running Voltage Drop = 3%, Starting Voltage Drop = 15%

3. Cable type

TYPE 1: Al Conductor, XLPE Insulated, Armoured, PVC outer sheathed

TYPE 2: Cu Conductor, XLPE Insulated, Armored, PVC outer sheathed

4. Effect of Frequency Variation ± 5%

5. Combined Effect of Voltage &amp; Frequency Variation ±10%

ASSIGNMENT-7									
LT CABLES		CABLE TRAY: FROM		TO		LT-5			
Sr. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm <sup>2</sup> )	No. of Cable	Overall Diameter of each Cable (mm)	Sum of Cable OD (mm)	Self Weight of Cable (Kg/Mt)	Total Weight of Cable (Kg/Mt)	Remarks
1	LV MCC	4	35	1	24	24	1.8	1.8	
2	PU2315- VFD	4	35	1	24	24	1.8	1.8	
3	PU2315- VFD	5	1.5	1	15	15	0.4	0.4	
4	LV MCC	4	6	1	18	18	0.7	0.7	
5	LV MCC	5	1.5	1	15	15	0.4	0.4	
6	LV MCC	4	2.5	1	16	16	0.5	0.5	
7	PU 2314 -B- VFD	4	2.5	1	16	16	0.5	0.5	
8	PU 2314 -B- VFD	5	1.5	1	15	15	0.4	0.4	
9	LV MCC	4	35	1	24	24	1.8	1.8	
10	PU2305- VFD	4	35	1	24	24	1.8	1.8	
11	PU2305- VFD	5	1.5	1	15	15	0.4	0.4	
12	LV MCC	4	35	1	24	24	1.8	1.8	
13	LV MCC	5	1.5	1	15	15	0.4	0.4	
14	LV MCC	4	35	1	24	24	1.8	1.8	
15	LV MCC	5	1.5	1	15	15	0.4	0.4	
16	LV MCC	4	16	1	21	21	1	1	
17	BW2313- VFD	4	16	1	21	21	1	1	
18	BW2313- VFD	5	1.5	1	15	15	0.4	0.4	
19	LV MCC	4	4	1	17	17	0.6	0.6	
20	LV MCC	5	1.5	1	15	15	0.4	0.4	
21	LV MCC	4	6	1	18	18	0.7	0.7	
Total				21		391	19	19	
<b>Calculation</b>									
Maximum Cable Diameter:		24	mm						
Consider Spare Capacity of Cable Tray:		30%							
Distance between each Cable:		0	mm						
Calculated Width of Cable Tray:		508	mm						
Calculated Area of Cable Tray:		12199	Sq.mm						
No of Layer of Cables in Cable Tray:	2								
Selected No of Cable Tray:	1	Nos.							
Selected Cable Tray Width:	300	mm							
Selected Cable Tray Depth:	150	mm							
Selected Cable Tray Weight Capacity:	50	Kg/Meter							
Type of Cable Tray:	Ladder								
Total Area of Cable Tray:	45000	Sq.mm							
<b>Result</b>									
Selected Cable Tray width:		O.K							
Selected Cable Tray Depth:		O.K							
Selected Cable Tray Weight:		O.K							Including Spare Capacity
Selected Cable Tray Size:		O.K							Including Spare Capacity
Required Cable Tray Size:	300 x 150	mm							
Required Nos of Cable Tray:	1	No							
Required Cable Tray Weight:	50.00	Kg/Meter/Tray							
Type of Cable Tray:	Ladder								
Cable Tray Width Area Remaining:		15%							
Cable Tray Area Remaining:		73%							