GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
(Sponsored by A. A. N. M & V. V. R. S. R Educational Society, Gudlavalleru)
Approved by AICTE, New Delhi and Permitted by AP State Government
Accredited by NAAC with 'A' Grade

Counselling Code : GDLV

INTERNSHIP REPORT

BY

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19485A0210

In association with

Smart Internz

SMARTBRIDGE
Let's Bridge the Gap

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Contents

Introduction

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

Program organizer

Smart Bridge, Hyderabad.

Pioneer in organizing Internships, knowledge workshops, debates, hackathons, technical sessions and Industrial Automation projects.

Courtesy

Dr. B. Dasu (HOD of EEE), GEC
Dr. G. Srinivasa Rao (Internship coordinator)
Mr. Ramesh V – Mentor of internship Program
Mr. Vinay Kumar - System Support
Mr. Harikanth – Software/Technical Support

Program details

Smart Internz program schedule: 4 weeks starting 3rdMay2021

Daily schedule time shall be 4PM to 6PM

Mode of classes: Online through ZOOM App

Internship program

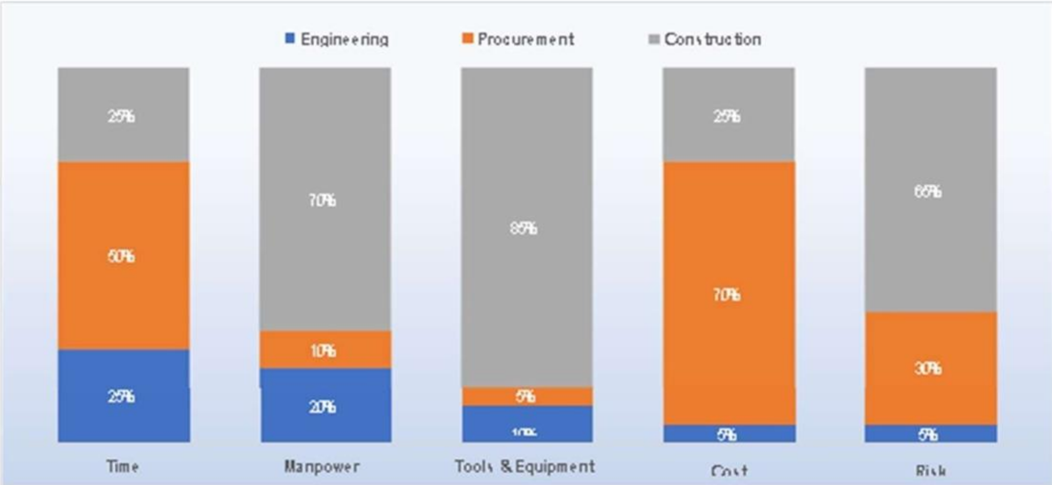
We have been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

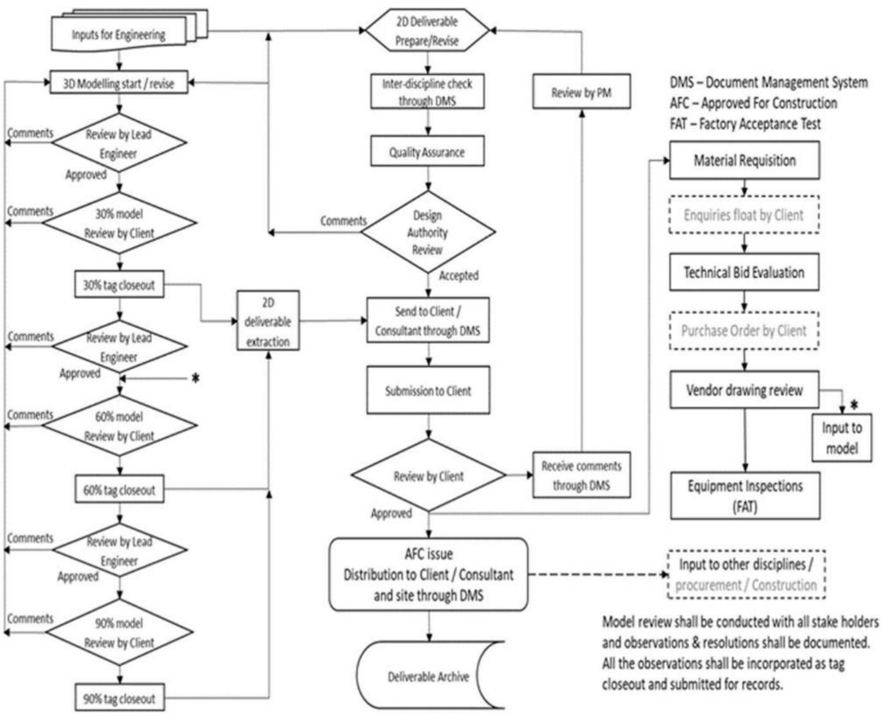
3rd May2021: Introduction to EPC Industry

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

TOPIC DETAILS:

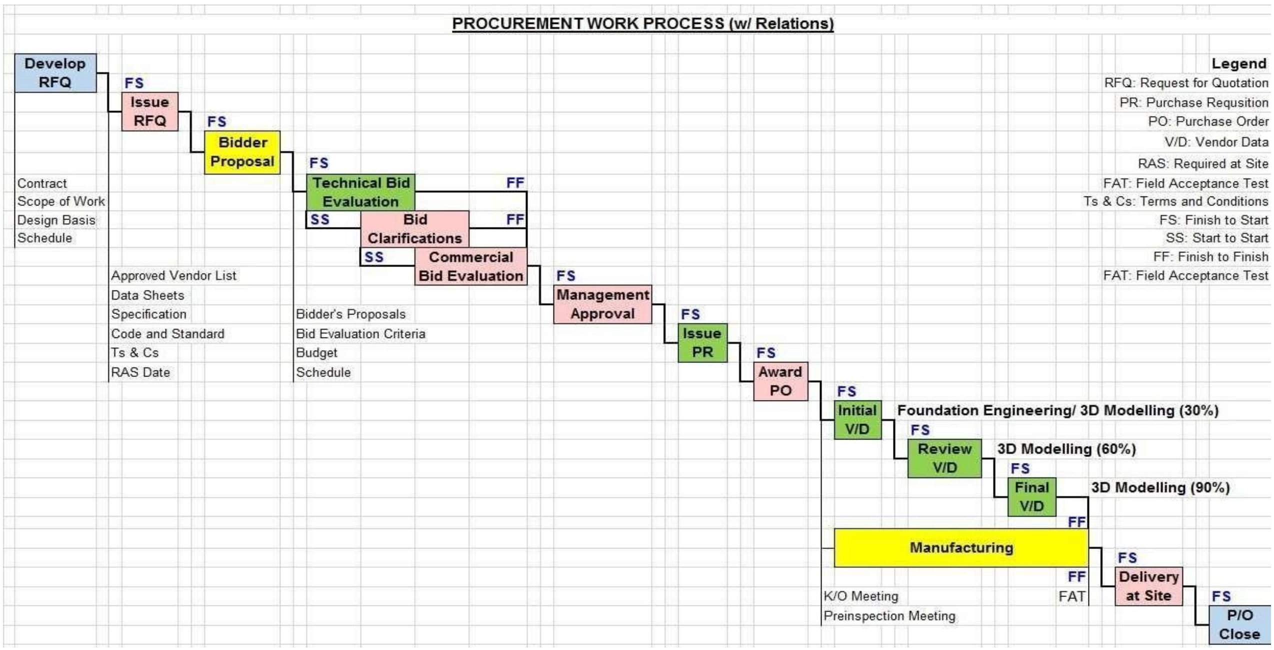
ENGINEERING:





Engineering Design & Detailed Engineering Process

PROCURMENT:



ENGINEERING SUPPORT TO PROCURMENT

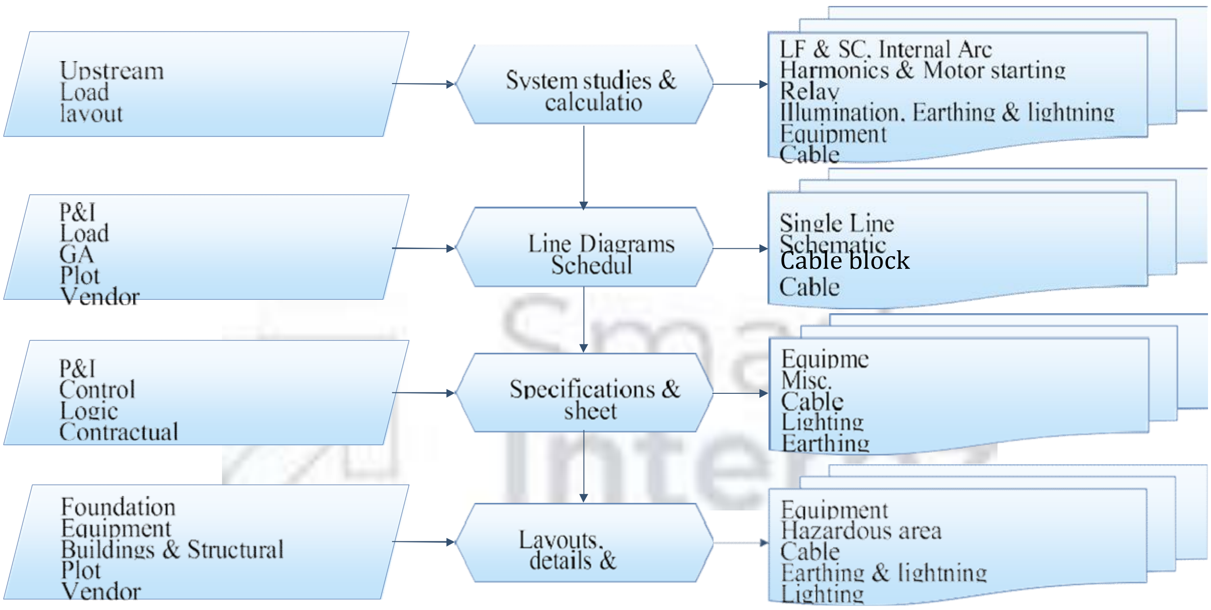
CONSRUCTION:

This brief applies to engineering support for engineering-procurement-construction projects, also known as design-bid-build projects, with construction management by others. This brief is intended to be used as an aid to determining the level of engineering support required during construction, from the office and in the field. For purposes of this brief, when the term “engineer” is used, it applies to the engineering firm or its representatives, that were responsible for the design of the project. Engineering support is typically required for any industrial construction project. The roles of the construction manager and the owner are usually well understood. The role of the engineer during construction needs to complement the roles of the construction manager and the owner. This is not clear cut as the owner and construction manager often have capabilities that overlap with those of the engineer. What divisions of responsibilities represent the best use of resources and best promotes the timely and successful completion of the project. Further, when owners are looking for ways to control construction costs, one option considered is to reduce costs by restricting or eliminating on-site representation from engineering.

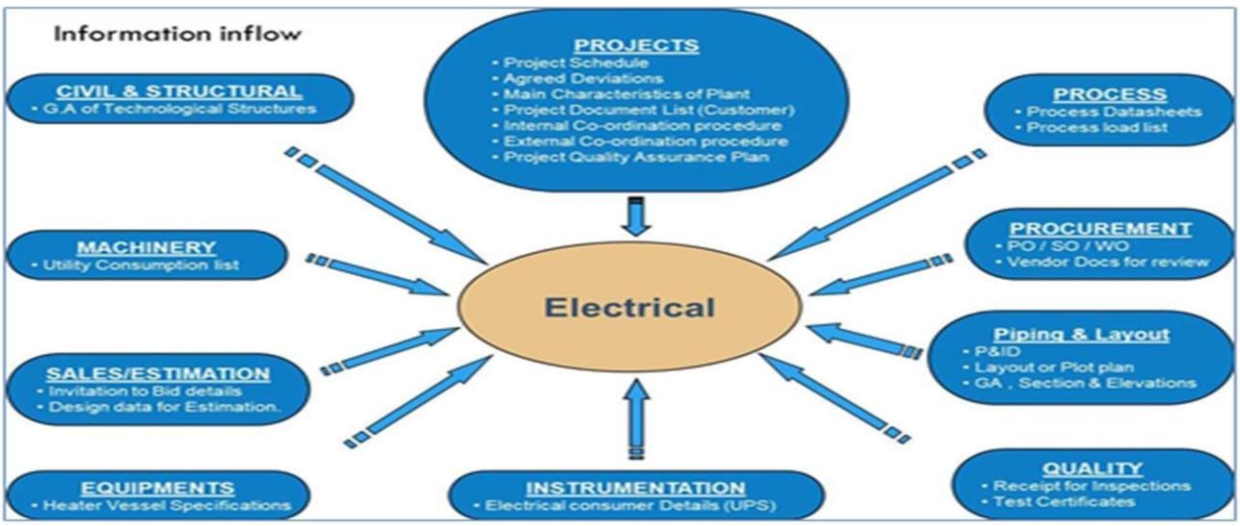
4th May2021: Engineering documentation for EPC projects

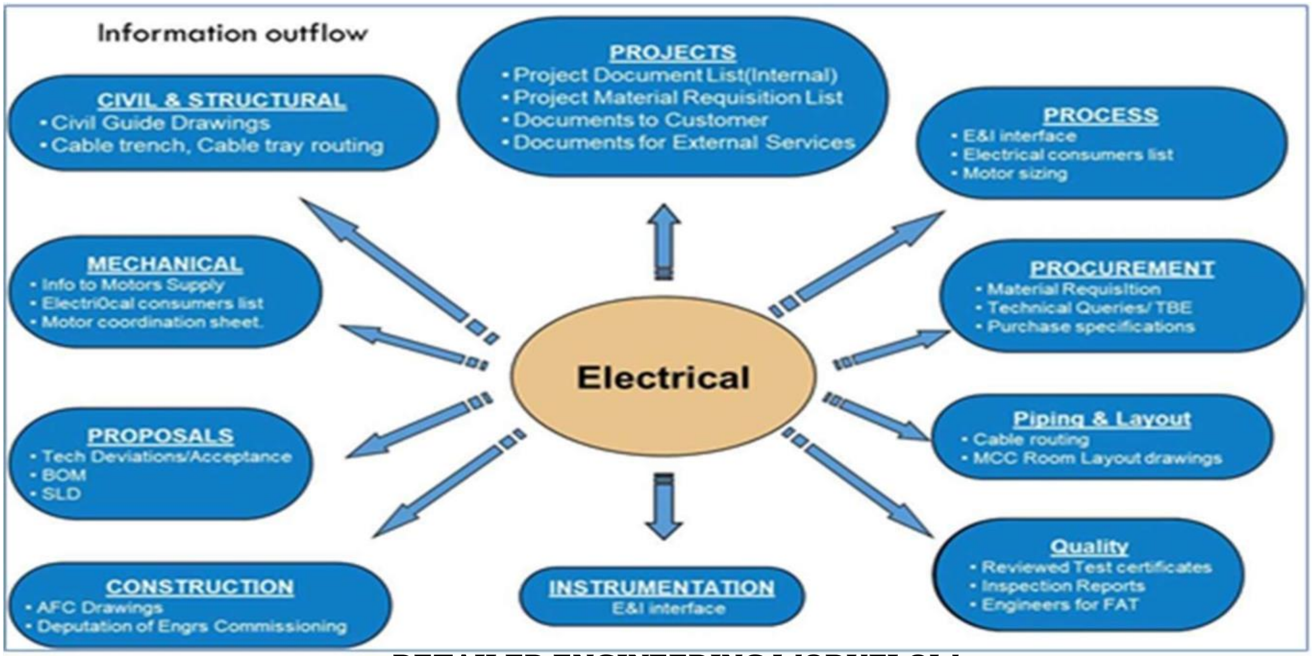
2	Electrical Design Documentation	Engineering Deliverables list	Sequence of deliverables
		Detailed Engineering work flow	Detailed engineering process
		Document transmission info	Document submission and exchange
		Deliverables types	Different types of deliverables

Topic details:



SEQUENCE OF DELIVERABLES





DETAILED ENGINEERING WORKFLOW

IS no.	Description	Equivalent IEC no.
IS:1885	Electrotechnical Vocabulary	IEC 60050
IS:2206	Flameproof electric lighting fittings	
IS:3646	Code of practice for interior illumination	
IS:6665	Code of practice for industrial lighting	
IS:10322	Luminaires	IEC 60598
IS:3043	Code of practice for earthing	IEC 60364
IS: 2309	Code of practice for the protection of buildings and allied structures against lightning	IEC 62305
IS:10118	Code of Practice for Selection, Installation and Maintenance	IEC 60092
IS:13234	Guide for Short-circuit Current Calculation in Three-phase A.C. Systems	IEC Pub 909
IS:1180	Outdoor type three-phase distribution transformers	
IS:2026	Power transformers	IEC 60076
IS:325	Three-phase induction motors	IEC 60034
IS:1554	PVC Insulated (Heavy Duty) Electric Cables	IEC 60502
IS:7098	XLPE insulated PVC sheathed cables	IEC 60502
IS: 10810	Tests on Electric and Optical Fibre cables under fire conditions	IEC 60332
IS:8623	Low-Voltage Switchgear and Control gear	IEC Pub 439 & IEC 60947
IS:10918	Vented type nickel cadmium batteries	IEC 60623
IS:5571	Guide for Selection and installation of Electrical Equipment for Hazardous Areas	IEC 60079
IS:5572	Classification ofhazardous areas(other thanmines)havingflammablegasesandvapoursfor electrical installation	IEC 60079
IS:2705	Current transformers	IEC 60185
IS:3156	Voltage transformers	IEC 60186
IS:398	Aluminium conductors for overhead transmission purposes	IEC 60889
	Electric Heat Tracing for Safe Industrial locations	IEC62395
	Electric Heat Tracing for Hazardous locations	IEC60079-30

Fig: RELAVANT NATIONAL & INTERNATIONAL STANDARDS

5th May2021: Engineering documentation for commands and formulae

3	Electrical Design Documentation	MS word commands MS excel formulae Auto cad basic commands

Topic details:

MS Word, Excel and Auto cad COMMANDS.

Word Shortcut Keys

Command Name	Keys
All Caps	Ctrl+Shift+A
Apply List Bullet	Ctrl+Shift+L
Auto Format	Alt+Ctrl+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).

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

AUTOCAD BASIC KEYS							
STANDARD		DRAW		MODIFY		FORMAT	
NEW	Ctrl+N	LINE	L	ERASE	E	PROPERTIES	MO
OPEN	Ctrl+O	RAY	RAY	COPY	CO	SELECT COLOR	COL
SAVE	Ctrl+S	PLINE	PL	MIRROR	MI	LAYER	LA
PLOT	Ctrl+P	3DPOLY	3P	OFFSET	O	LINETYPE	LT
PLOT PREVIEW	PRE	POLIGONE	POL	ARRAY	AR	LINEWEIGHTS	LW
CUT	Ctrl+X	RECTANGLE	REC	MOVE	M	LT SCALE	LTS
COPY	Ctrl+C	ARC	A	ROTATE	RO	LIST	LI
PASTE	Ctrl+V	CIRCLE	C	SCALE	SC	DIMEN. STYLE	D
MATCH PROPE.	MA	SPLINE	SPL	STRECH	S	RENAME	REN
CLOSE	Ctrl+F4	ELLIPSE	EL	TRIM	TR	OPTION	OP
EXIT	Ctrl+Q	BLOCK	B	EXTENED	EX		
		POINT	PO	BRAKE	BR		
		HATCH	H	CHAMFER	CHA		
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		REGION	REG	EXPLODE	X		
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		DONUT	DO				

EXTRA				DRAFTING		PAPER SIZE
UNIT	UN	UCS	UCS	ORTHO	F8, Ctrl+L	A4=210*297
LIMITS	LIMITS	SINGLE TEXT	DT	OSNAP	F3, Ctrl+F	A3=297*420
(0,0; 1000,1000)		MULTILINE TEXT	MT	POLAR	F10, Ctrl+U	A2=420*594
ZOOM	Z	EDIT TEXT	ED	GRID	F7, Ctrl+G	A1=594*841
ALL	A	OBJECT SNAP	OB	OTRACK	F11	A0=841*1189
PAN	P	DIMENTION	DIM	SNAP	F9	
CLEAN SCREEN	Ctrl+0	HORIZONTAL	HOR			
COMMAMD WIN	Ctrl+9	VERTICAL	VER			

Fig: AUTOCAD KEYS

Excel Formulas

Basic math

Function	Formula	Example
To add up the total	=SUM(cell range)	=SUM(B2:B9)
To add individual items	=Value1 + Value 2	=B2+C2
Subtract	=Value1 - Value 2	=B2-C2
Multiply	=Value1 * Value2	=B2*C2
Divide	=Value1 / Value2	=B2/C2
Exponents	=Value1 ^ Value2	=B2^C2
Average	=AVERAGE(cell range)	=AVERAGE(B2:B9)
Median	=MEDIAN(cell range)	=MEDIAN(B2:B9)
Max	=MAX(cell range)	=MAX(B2:B9)
Min	=MIN(cell range)	=MIN(B2:B9)

Simple formatting tricks

Function	Formula	Example
To change a cell to proper case	=PROPER(cell)	=PROPER(A2)
To change a cell to upper case	=UPPER(cell)	=UPPER(A2)
To change a cell to lower case	=LOWER(cell)	=LOWER(A2)

Conditional statements

Function	Formula	Example
If statement	=IF(logical test, "result if the test answer is true", "result if the test answer is false")	=IF(B2>69,"Pass","Fail")
Exact	=EXACT(Value1, value2)	=EXACT(B2, C2)

Absolute cell references

When a formula contains an absolute reference, no matter which cell the formula occupies the cell reference does not change: if you copy or move the formula, it refers to the same cell as it did in its original location. In an absolute reference, each part of the reference (the letter that refers to the row and the number that refers to the column) is preceded by a "$" – for example, **$A$1** is an absolute reference to cell A1. Wherever the formula is copied or moved, it always refers to cell A1.

Pulling things apart

Function	Formula	Example
To select a certain number of characters from the left	=LEFT(cellwithtext, number of characters to be returned)	=LEFT(A2, 6)
To select a certain number of characters from the right	=RIGHT(cellwithtext, number of characters to be returned)	=RIGHT(A2, 6)
Find text in a field	=SEARCH("text you want to find", where you want to find it)	=SEARCH(",", A2)
Extract information from the middle	=MID(cellwithtext, start position, number of characters you want returned)	=MID(A2, 9, 4)
Separate a last name (Example: Smith, Jane)	LEFT and SEARCH functions	=LEFT(A2, SEARCH(",", A2)-1)
Separate a first name (Example: Smith, Jane)	MID and SEARCH functions	=MID(A2, SEARCH(",", A2)+2, 20)

Putting things together

Function	Formula	Example
To combine cells with a space in-between	=CONCATENATE(text, " ", text)	=CONCATENATE(A2, " ", B2)
To combine cells with a space in-between (second option)	=text & " " & text	=A2 & " " & B2

Dealing with dates

Function	Formula	Example
Return the year	=YEAR(datefield)	=YEAR(A2)
Return the month	=MONTH(datefield)	=MONTH(A2)
Return the day	=DAY(datefield)	=DAY(A2)
Return the day of the week (1 = Sunday, 2 = Monday, 3 = Tuesday, etc.)	=WEEKDAY(datefield)	=WEEKDAY(A2)
To create a date from year, month, and day	=DATE(year, month, day)	=DATE(B2, C2, D2)

7th May2021: Engineering documentation for Electrical system design

4	Electrical system design for a small small project	Overall plant description Sequence of approach Approach to detailed design

Topic details: Overall plant description, approach to detailed design.

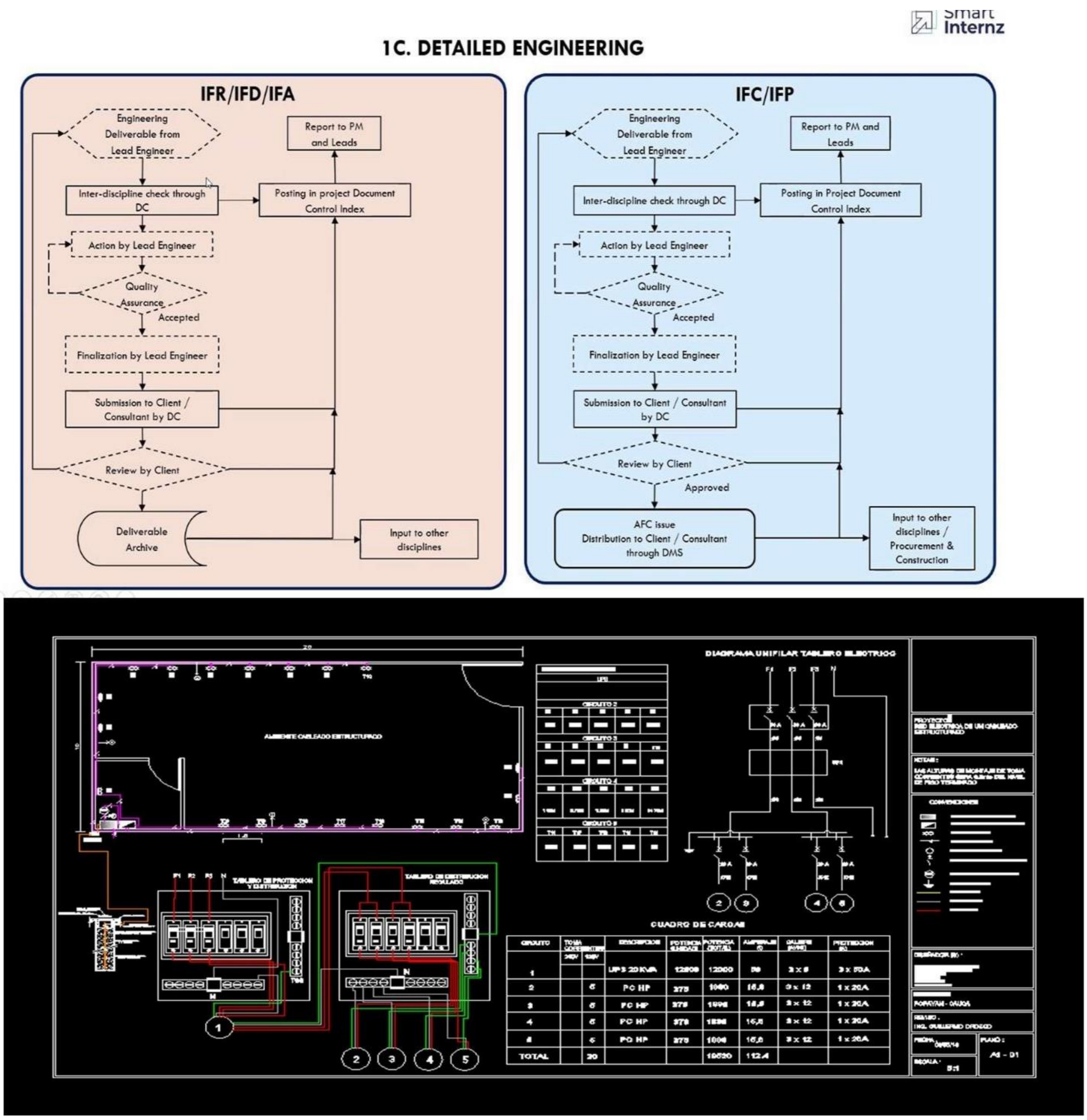


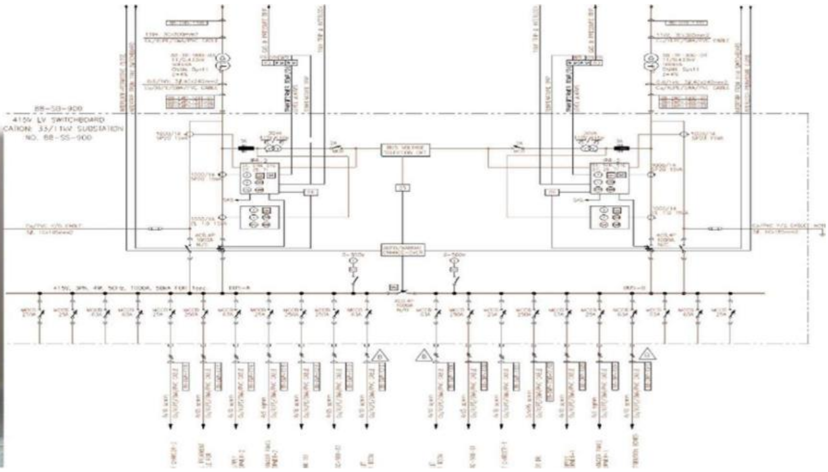
Fig: ELECTRICAL SYSTEM DESIGN

10th May2021: Engineering documentation for Typical diagrams

5	Electrical system design for typical diagrams	Loadlistsschedule Singlelinediagram	Power flow diagram Typical schematic diagram

Topic details:

Single line Diagram:



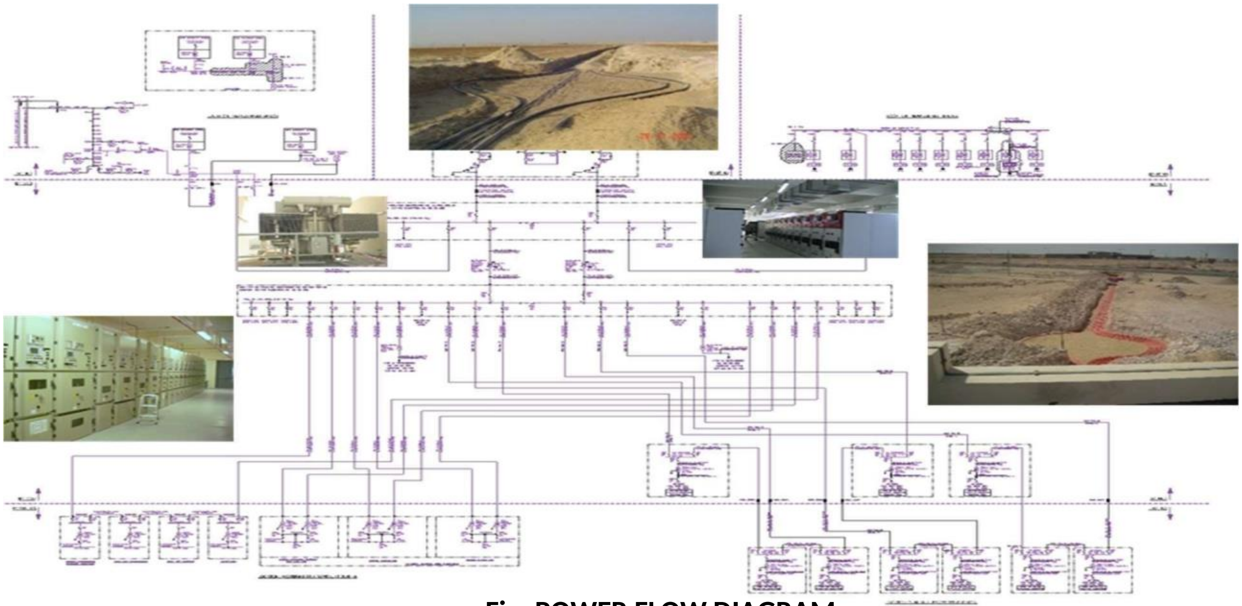


Fig: POWER FLOW DIAGRAM

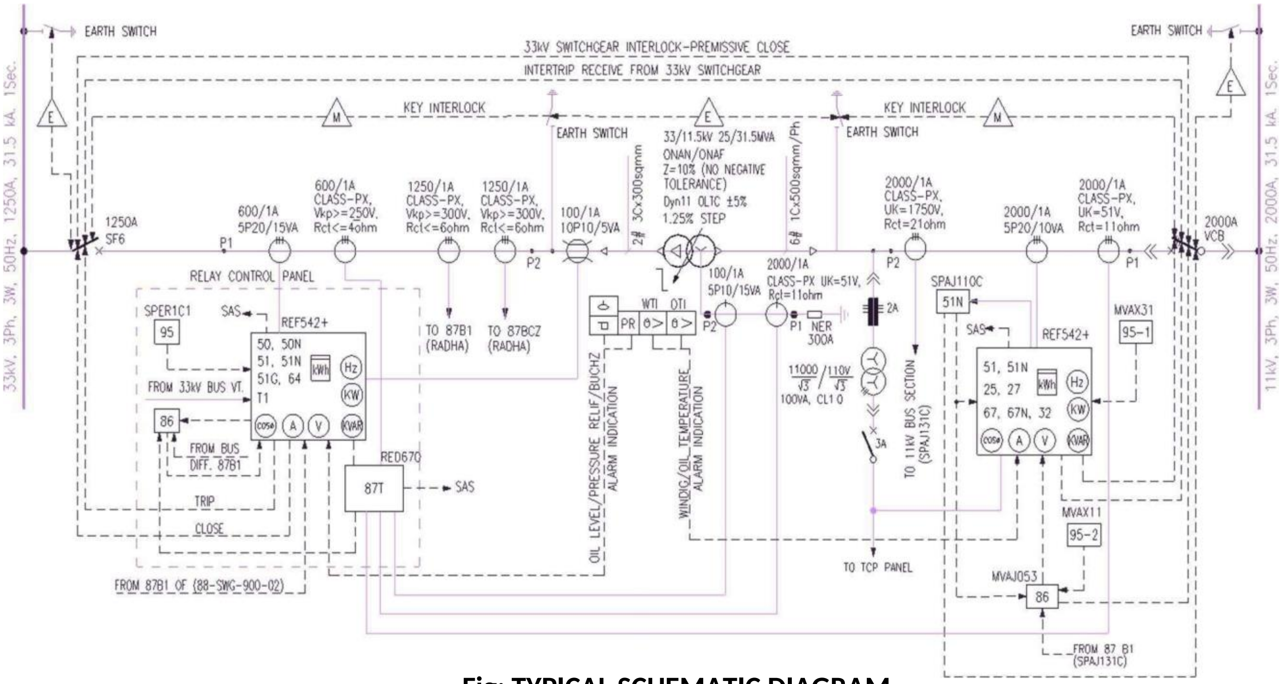
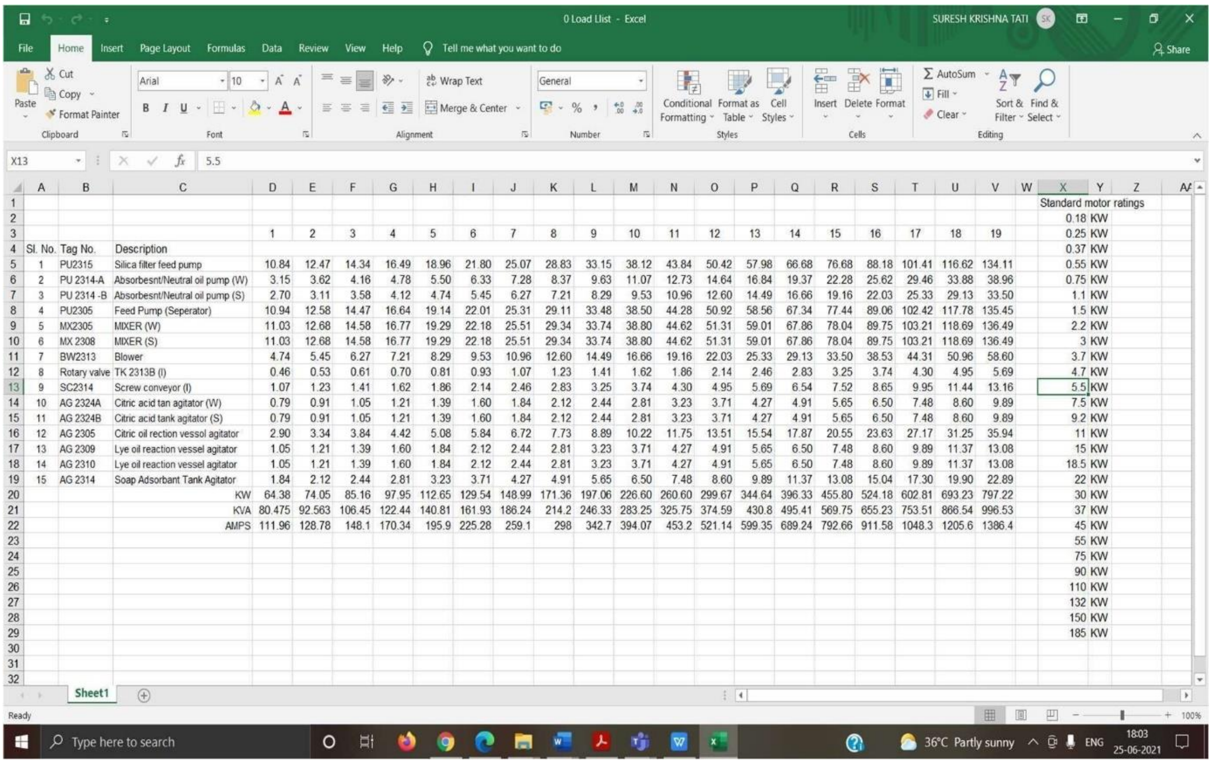


Fig: TYPICAL SCHEMATIC DIAGRAM



Sl. No.	Tag No.	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Standard motor ratings
																						0.18 KW
																						0.25 KW
																						0.37 KW
1	PU2315	Silica filter feed pump	10.84	12.47	14.34	16.49	18.96	21.80	25.07	28.83	33.15	38.12	43.84	50.42	57.98	66.68	76.68	88.18	101.41	116.62	134.11	0.55 KW
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)	3.15	3.62	4.16	4.78	5.50	6.33	7.28	8.37	9.63	11.07	12.73	14.64	16.84	19.37	22.28	25.62	29.46	33.88	38.96	0.75 KW
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)	2.70	3.11	3.58	4.12	4.74	5.45	6.27	7.21	8.29	9.53	10.96	12.60	14.49	16.66	19.16	22.03	25.33	29.13	33.50	1.1 KW
4	PU2305	Feed Pump (Seperator)	10.94	12.58	14.47	16.64	19.14	22.01	25.31	29.11	33.48	38.50	44.28	50.92	58.56	67.34	77.44	89.06	102.42	117.78	135.45	1.5 KW
5	MX2305	MIXER (W)	11.03	12.68	14.58	16.77	19.29	22.18	25.51	29.34	33.74	38.80	44.62	51.31	59.01	67.86	78.04	89.75	103.21	118.69	136.49	2.2 KW
6	MX 2308	MIXER (S)	11.03	12.68	14.58	16.77	19.29	22.18	25.51	29.34	33.74	38.80	44.62	51.31	59.01	67.86	78.04	89.75	103.21	118.69	136.49	3 KW
7	BW2313	Blower	4.74	5.45	6.27	7.21	8.29	9.53	10.96	12.60	14.49	16.66	19.16	22.03	25.33	29.13	33.50	38.53	44.31	50.96	58.60	3.7 KW
8	Rotary valve	TK 2313B (I)	0.46	0.53	0.61	0.70	0.81	0.93	1.07	1.23	1.41	1.62	1.86	2.14	2.46	2.83	3.25	3.74	4.30	4.95	5.69	4.7 KW
9	SC2314	Screw conveyor (I)	1.07	1.23	1.41	1.62	1.86	2.14	2.46	2.83	3.25	3.74	4.30	4.95	5.69	6.54	7.52	8.65	9.95	11.44	13.16	5.5 KW
10	AG 2324A	Citric acid tan agitator (W)	0.79	0.91	1.05	1.21	1.39	1.60	1.84	2.12	2.44	2.81	3.23	3.71	4.27	4.91	5.65	6.50	7.48	8.60	9.89	7.5 KW
11	AG 2324B	Citric acid tank agitator (S)	0.79	0.91	1.05	1.21	1.39	1.60	1.84	2.12	2.44	2.81	3.23	3.71	4.27	4.91	5.65	6.50	7.48	8.60	9.89	9.2 KW
12	AG 2305	Citric oil rection vessol agitator	2.90	3.34	3.84	4.42	5.08	5.84	6.72	7.73	8.89	10.22	11.75	13.51	15.54	17.87	20.55	23.63	27.17	31.25	35.94	11 KW
13	AG 2309	Lye oil reaction vessel agitator	1.05	1.21	1.39	1.60	1.84	2.12	2.44	2.81	3.23	3.71	4.27	4.91	5.65	6.50	7.48	8.60	9.89	11.37	13.08	15 KW
14	AG 2310	Lye oil reaction vessel agitator	1.05	1.21	1.39	1.60	1.84	2.12	2.44	2.81	3.23	3.71	4.27	4.91	5.65	6.50	7.48	8.60	9.89	11.37	13.08	18.5 KW
15	AG 2314	Soap Adsorbant Tank Agitator	1.84	2.12	2.44	2.81	3.23	3.71	4.27	4.91	5.65	6.50	7.48	8.60	9.89	11.37	13.08	15.04	17.30	19.90	22.89	22 KW
		KW	64.38	74.05	85.16	97.95	112.65	129.54	148.99	171.36	197.06	226.60	260.60	299.67	344.64	396.33	455.80	524.18	602.81	693.23	797.22	30 KW
		KVA	80.475	92.563	106.45	122.44	140.81	161.93	186.24	214.2	246.33	283.25	325.75	374.59	430.8	495.41	569.75	655.23	753.51	866.54	996.53	37 KW
		AMPS	111.96	128.78	148.1	170.34	195.9	225.28	259.1	298	342.7	394.07	453.2	521.14	599.35	689.24	792.66	911.58	1048.3	1205.6	1386.4	45 KW
																						55 KW
																						75 KW
																						90 KW
																						110 KW
																						132 KW
																						150 KW
																						185 KW

Fig: LOAD LIST SCHEDULE

11th May2021: Classification of Transformers and Generators

6	Classification of Transformers and Generators	Different types of Transformers Different types of Generators

Topic Details: Classification of Transformers and Generators.

Transformers can be classified on different basis, like types of construction, types of cooling etc.

- On the basis of construction, transformers can be classified into two types as;
  - (I) Core type transformer and
  - (ii) Shell type transformer, which are described below.
- On the basis of their purpose
  - Step up transformer: Voltage increases (with subsequent decrease in current) at secondary.
  - Step down transformer: Voltage decreases (with subsequent increase in current) at secondary.
- On the basis of type of supply
  - Single phase transformer
  - Three phase transformers
- On the basis of cooling employed
  - Oil-filled self-cooled type (ONAN - Oil Natural Air Natural)
  - Oil-filled Forced Air Cooling (ONAF – Oil Natural Air Forced)
  - Oil-filled Forced Air Cooling (OFAF – Oil Forced Air Forced)
  - Oil-Filled water-cooled type (ONWF - Oil Natural Water Forced)
  - Dry Type resin cast with natural cooling

<u>TYPES OF TRANSFORMERS:</u>

Pole Mounted Commercial

Oil Filled Distribution Type

Oil Filled Power Transformer Commercial

TYPES OF DG GENARATORS:

11kV/6.6kVDieselgeneratorsetsforstandby/ Emergency powersupply

415VDieselgenerator sets for standby/ Emergencypowersupply

TRANSFORMERS AND DG GENERATORS:

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. On a single feed radial system, the distribution transformer base rating shall be sized for the total connected load and 125% of the largest motor; in addition, the transformer may have 20% spare capacity as per design basis. Also, the transformer shall be sized to allow starting the large motor on the system. Load diversities shall be taken into account when calculating the total connected load. Load calculations shall be completed and approved before final sizing of the transformers. When twotransformers are connectedto buses with a tie breaker, each transformer shall have its rating sized to handle the total connected load from both buses with the tie breaker closed and the other transformer out of service. Also, each transformer needs to be sized to allow starting the largest motor on the system. When two transformers are connected to buses with a tie breaker, the fault study must include the condition of havingthe shortcircuit MVA contribution from one transformer duringa fault and the switchgear shall be sized appropriately to be able to withstand rating of both transformers during a short period defined in the standards. Transformers are sized to carry the peak running load of all busses connected to them. In addition, feeders to and from power transformers shall be rated to carry full current at the maximum rating.

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 systemsetc., isreferredto asa Diesel Generating Setora DGSetinshort. DGsetsareselectedbased 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.

Depending upon the projected growth, availability of space etc. projected expansion to be considered. Diversity factor of load will determine the optimum size of DG set. Quantities & ratings of motors with their starting methods and largest size motor, influence the Right sizing of the DG set. CPCB (Central Pollution Control Board) norms to be followed for DG sets up to 1000 KVA rating with acoustic enclosures and pollution norms for larger sizes.

12th May2021: Classification of Switchgear construction and power factor improvement

7	Classification of Switchgear construction and power factor improvement	Different types of Switchgear assemble	Power factor improvement

Topic details: Switchgear construction and Power Factor Improvement.

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. Once the short circuit occurs within the power system, then a huge current will flow through the devices. So that the equipment can be damaged & the interruption will occur to the operators. To overcome this problem, it is used to detect the fault in the power system to protect humans and equipment. There are three types of switch gears namely LV (Low voltage), MV (Medium voltage) and HV (High voltage) Switchgear.

Low Voltage Switchgear (LV): The power system which deals up to 1KV is called as LV or low voltage switchgear consists switches, LV circuit breakers, HRC fuses, earth leakage (EL) circuit breakers, offload electrical isolators, MCBs (miniature circuit breakers) and MCCBs (molded case circuit breakers), etc.

Medium Voltage Switchgear (MV): The power system which deals up to 36 kV is called MV (medium voltage switchgear). These are available in different types like without metal enclosure outdoor type, metal-enclosed indoor & outdoor type, etc. consisting devices like minimum oil CBs, bulk oil CBs, SF6 gas-insulated, air magnetic, gas-insulated, vacuum, etc. The disruption medium of this type of switchgear can be vacuum or SF6. The main condition of this type of power network is to break off current throughout faulty conditions in this system. This is capable of ON/OFF operation, interruption of short circuit current, capacitive current switching, inductive current switching and used in some special applications.

High Voltage Switchgear (HV):

Switch the most fundamental device in making or isolating a circuit from the supply manually. It shall not protect the connected circuit from short circuit. Switches/ or Disconnect switches in outdoor EHV switchyard are manual and/ or motor operated for ease of routine operation. Required electrical clearances, 'safety clearances' required for maintenance personnel to safely work in the adjacent bays in the switchyard. These switches need to be of the snap action type while making/ breaking to prevent arc induced contact welding.

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 can be improved by adding capacitors on the power line to draw a leading current and supply lagging vars to the system. Capacitors can be switched in and out as necessary to maintain var and voltage control. Many utilities charge industrial customers a certain rate for kilowatt-hours of energy consumed in a month, and another charge related to the infrastructure necessary to supply that power under the customer's conditions of operation. If the customer is operating with a low power factor load, the demand charge is higher, because the current requirement is higher. Power factor penalties on demand charges range from none to a factor of 2 on the peak power demand.

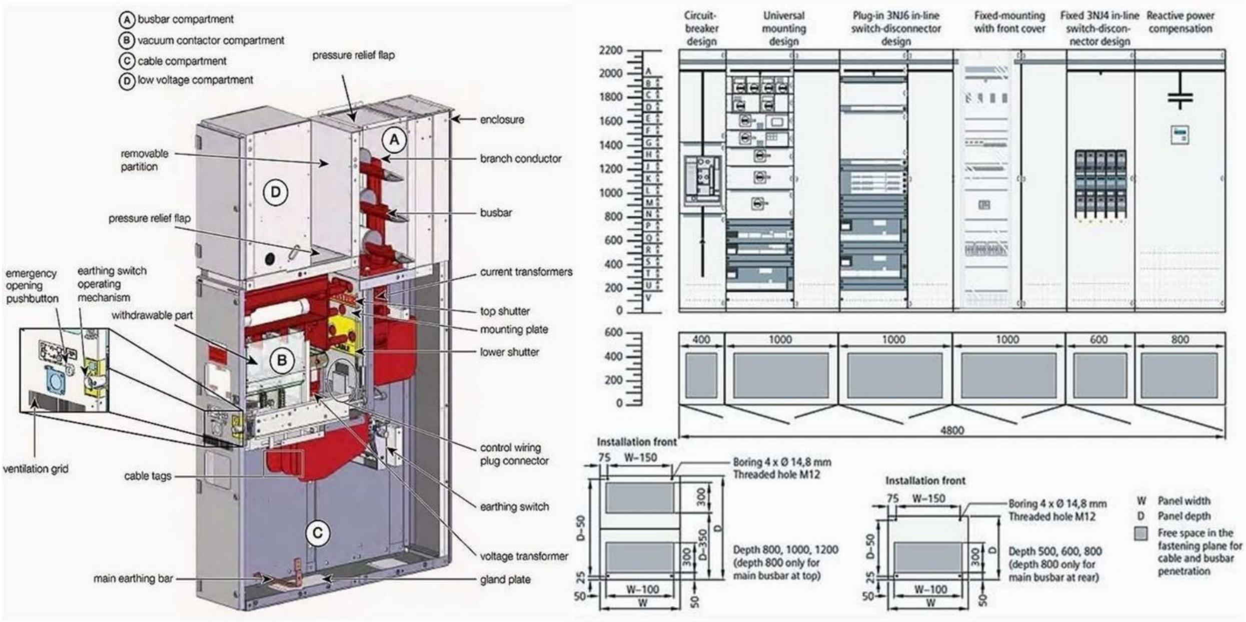


Fig: SWITCHGEAR CONSRTUCTIONAL FEATURES

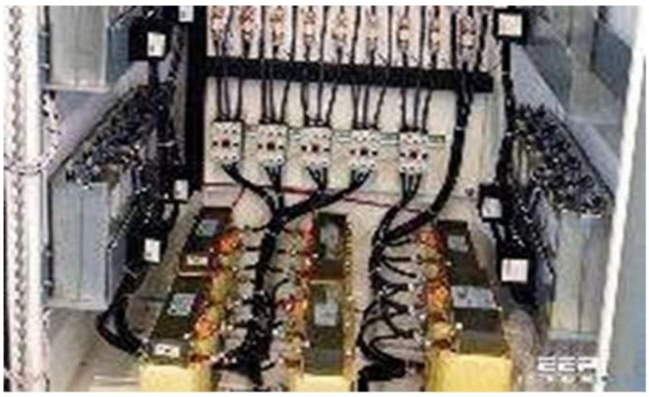
TYPES OF SWITCH GEARS:

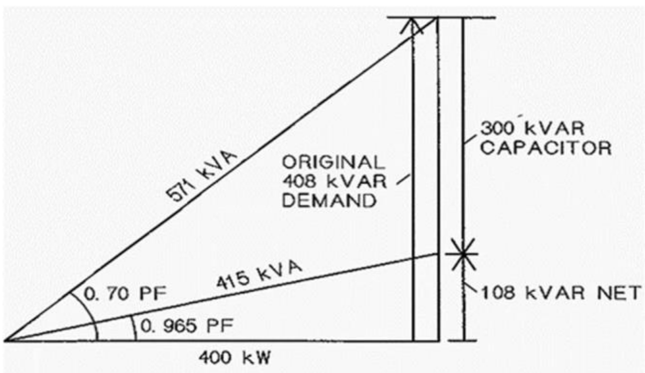
LV 415V Indoor Air Insulated Switchgear for Industrial /

HV 33kV or 220kV Outdoor Switchgear for large Industries & substations

220V DC power supply for emergency application s

POWER FACTOR IMPROVEMENT:





17th May2021: Detailing about UPS system and Busducts.

8	Detailing about UPS system and Busducts	Uninterruptible power supply system	Busducts of the system

Topic details: UPS system and Busducts.

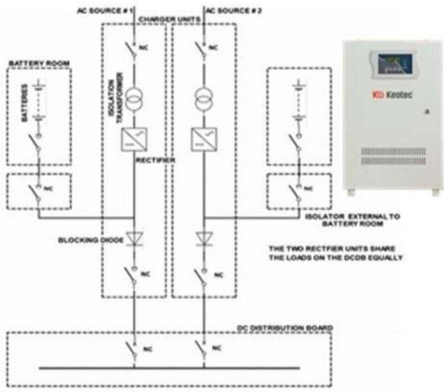
UPS SYSTEMS:

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. UPS systems are designed to provide continuous power to a load, even with an interruption or loss of utility supply power. UPS generally involves a balance of cost Vs need.

UPS systems shall be two types:

AC UPS – 48V, 110V, 230V Single phase & 415V three phase AC UPS power is required to feed power without any interruption to critical consumers in a facility during loss of normal power to critical plant loads like plant control systems, Emergency shut down systems. AC UPS derives its power from batteries. It also provides stabilized quality power even if it is from normal sources.

DC UPS – 24V 48V, 110V, 220V DC Uninterrupted Power Supply System (DC UPS) always available to the identified loads fed from a DC Distribution board that fed from the AC mains via a rectifier and when sourcesupplyoutage charged batteriesshallsupplytotheloads. These arerequiredmainlyfor the Electrical Control & Protection system loads apart from a few other loads in certain plants like Switchgear closing/Tripping operation on lossof power supply, critical DC lighting, DG starting.



DCUPSSYSTEM **AC UPSSYSTEM**

BUSDUCT OF SYSTEM:

A sheet metal duct with aluminum or copper bus bars as conductor, and used as a reliable link for transferringpowerfromoneequipmenttootheratdesiredvoltagelevels, usedasan alternatemeans for conducting electricity to cable bus and power cables. Busducts are classified into various types depending on its application viz phase separated Busducts, segregated phase busducts, non-segregated phase busducts.

Segregated Phase Busduct

These are metal enclosed busducts wherein all the three phase busbars are enclosed in a common enclosureandthe all the phases are segregatedby means of non-magnetic metalbarriers preferably made of the same materials as that of the bus enclosure with degree of protection IP65. Busbars are generally mounted on high creep porcelain insulators are high quality epoxy resin cast insulators of suitable rated voltage. These Segregated phase busducts are commonly used in medium voltage applications with rated voltages from 3.3KV to 33KV and with rated continuous currents up to 5000 Amps with short circuit fault currents of 50 KA for 1 or 3 seconds.

Non-segregated Phase Busduct

Non-segregated busduct, on the other hand, is almost similar to the above in construction wherein all the phase/ neutral conductors are enclosed in a common enclosure with airas medium of insulation between phases. As the name implies, there is no metallic barriers between phases. These busducts are relatively compact in comparison with segregated phase bus since the same are generally used for low voltage applications and thus needing much lower electrical clearances between phases and phase to earth. These non-segregated phase busducts are offered in two variants-one with RYBN

NON-SEGRAGETEDBUSKET **SANDWITCH TYPEBUSKET**

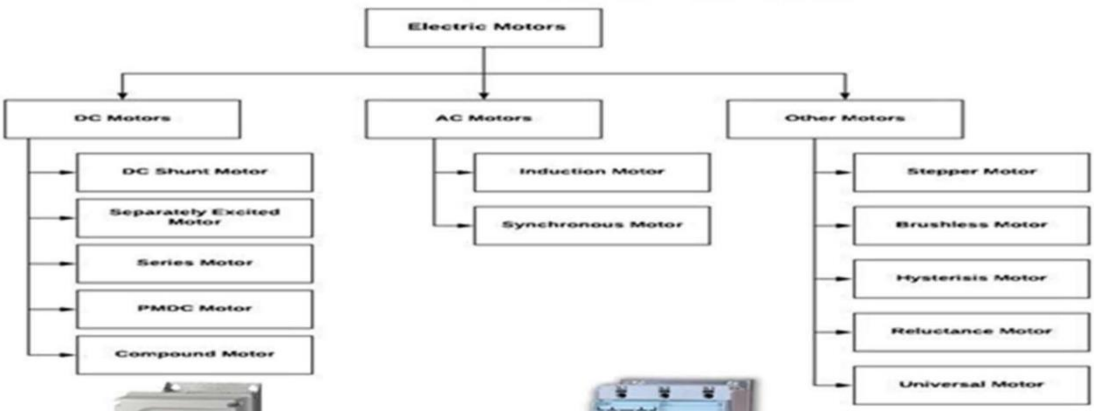
18th May2021: Detailing about Motor Starters and Sizing of motors.

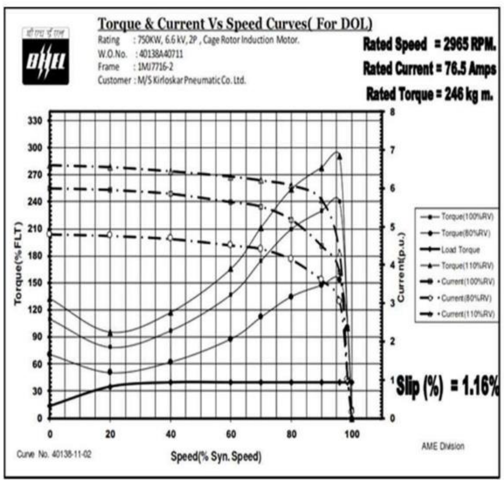
9	Detailing about Motor Starters and Sizing of motors	Motor starters and drives	Sizing and selection of motors

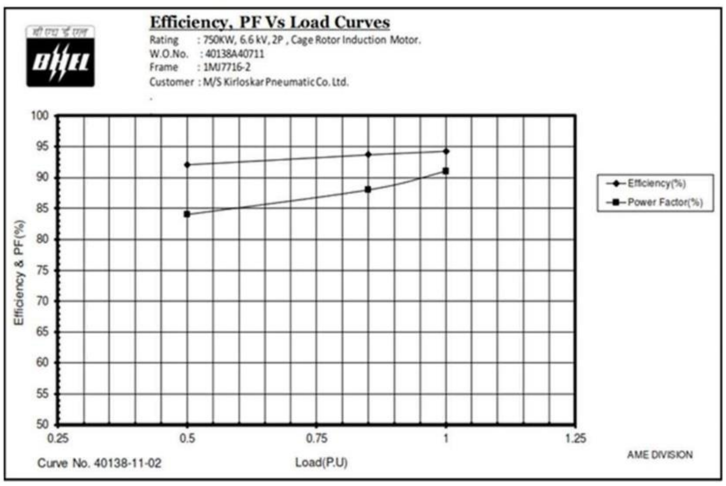
Topic details: Detailing about Motor Starter and Sizing of motors and their selection.

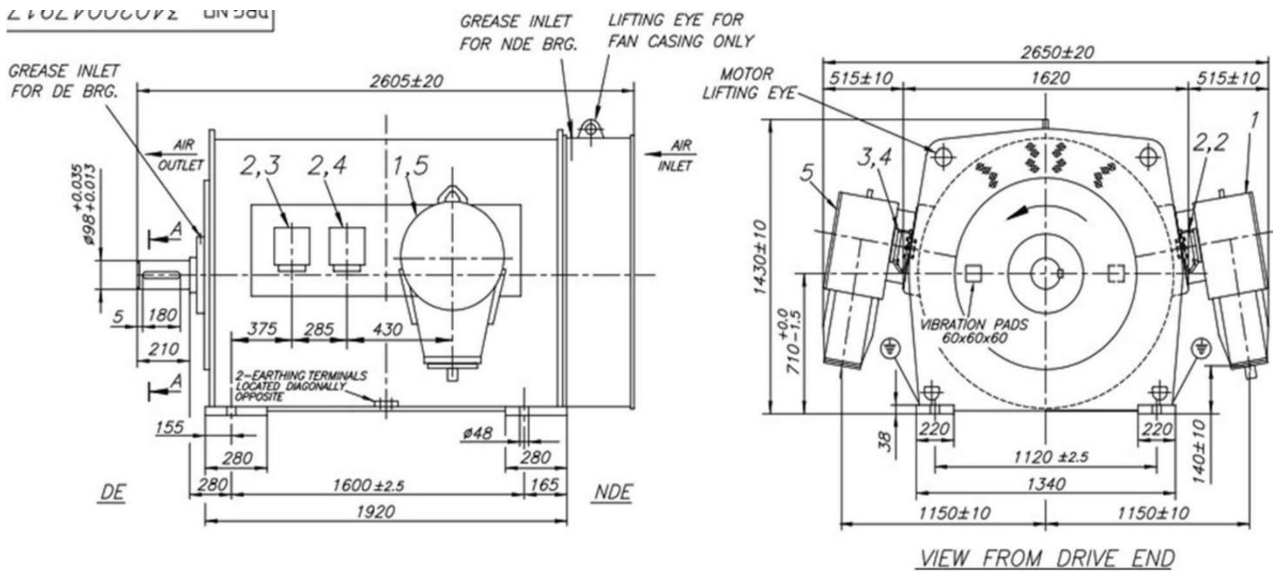
The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is 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.

1. DOL STARTER
2. ROTOR RESISTANCE STARTER
3. STATOR RESISTANCE STARTER
4. AUTO TRANSFORMER STARTER
5. STAR- DELTA STARTER









Large capacity MV motor for heavy industrial applications

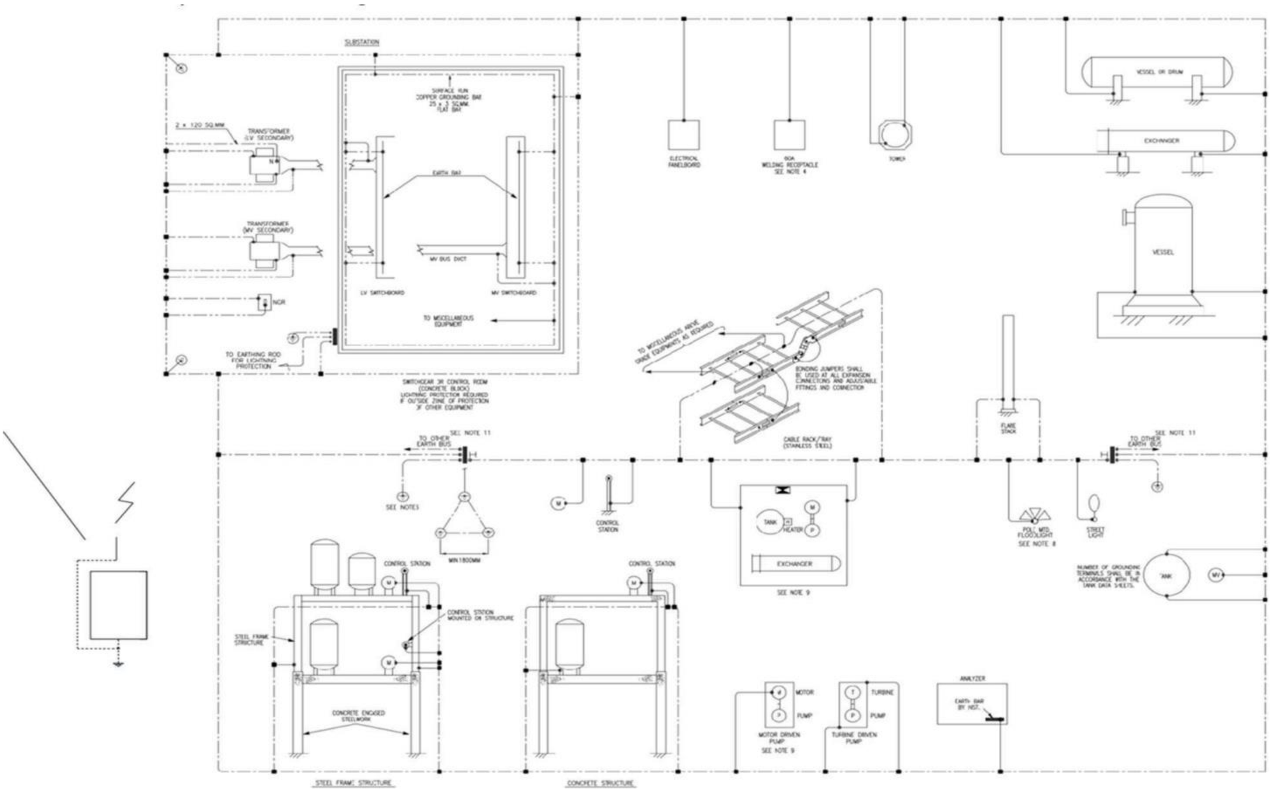
415V LV motors for industrial applications, Pumps, fans, agitators

19th May2021: Discribing about Earthing system and Lighting Protection.

10	Discribing about Earthing system and Lighting Protection.	Plant Earthing system	Lighting Protection materials

Topicdetails: Discribing about Earthing system and LightingProtection.

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). Earth pits are back- filled with earthing compound - Bentonite or Marcionite. Bentonite is a moisture retaining clay used as an earth electrode back-fill to help lower soil resistivity. Marcionite is a conductive compound mixed with cement. The Bentonite clay is a sodium activated montmorillonite which when mixed with water swells to many times its original volume.



TYPICAL PLANT EARTHING SYSTEM

LIGHTING 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 lighting protection to tall structures/buildings, important/heritage buildings, Buildings with electrical & instrumentation control panels etc.

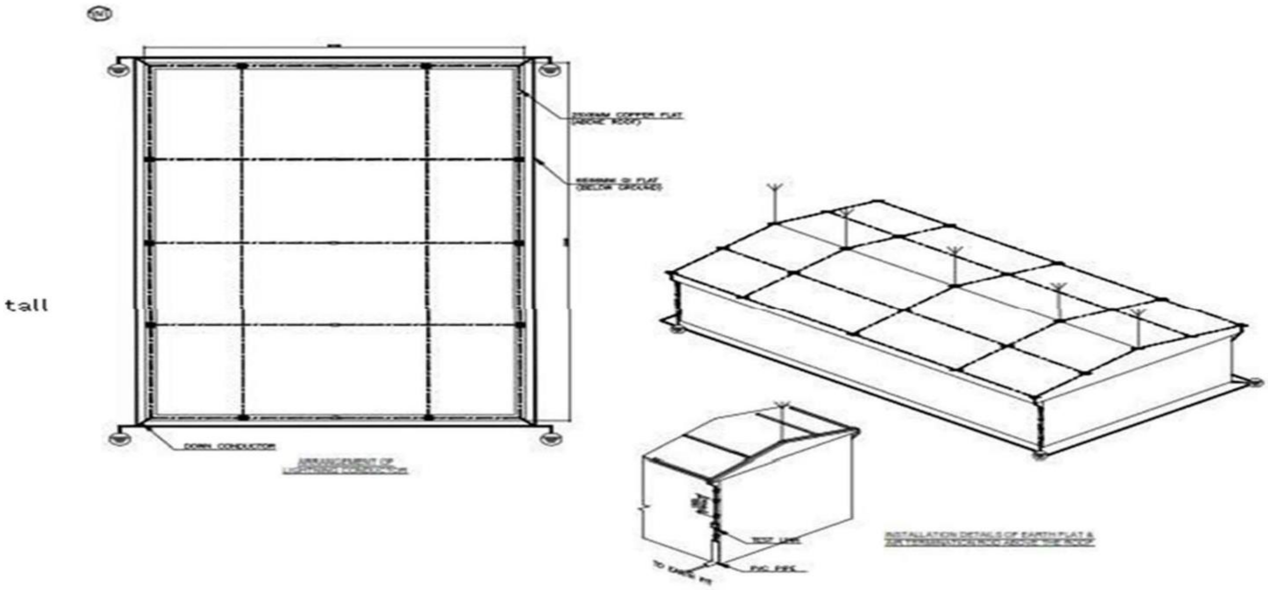
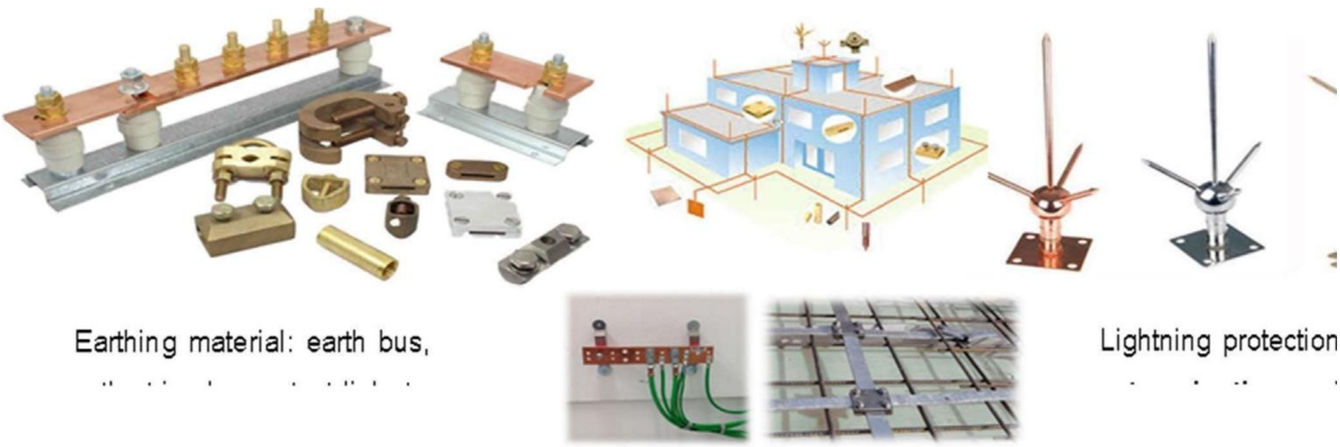


Fig: LIGHTING PROTECTION SYSTEM



20th May2021: Lighting or illumination systems and calculations.

11	Lighting or Illumination systems and Calculations	Lighting or illumination systems	Lighting calculations

Topic details: Lighting or Illumination systems and Calculations.

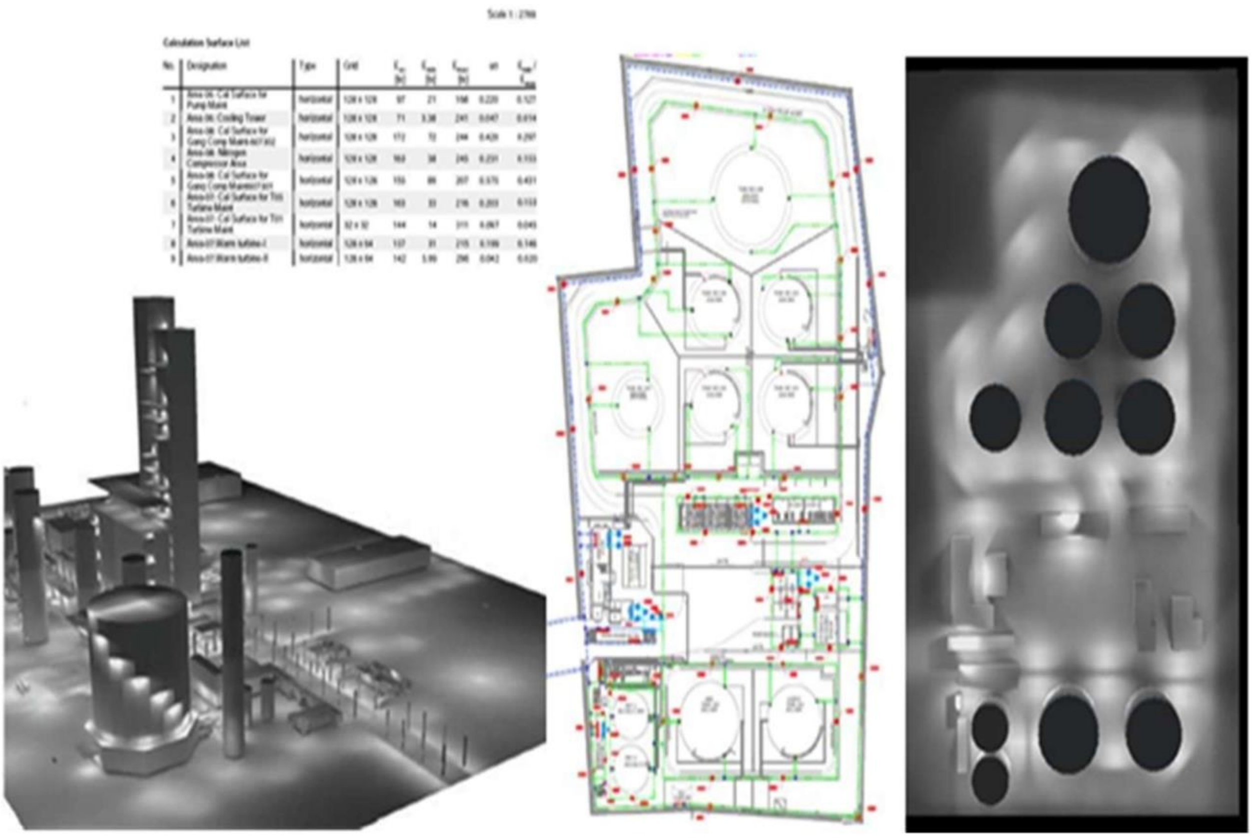
Industrial lighting load shall be grouped as normal, emergency and critical. Separate lighting DBs shall be provided for critical and emergency lighting load. Emergency lighting shall be 30% of total lighting fittings as per calculations. However, the circuiting shall be done such that the emergency lights shall also be switched on during normal condition. Critical light fittings shall be in off condition during normal plant operation. In case of failure of emergency supply which feeds emergency lighting load, critical supply shall be fed automatically, switching on the critical lighting fittings. Critical lighting load shall be 110V DC, for substations/ MCC rooms, control rooms, critical operating locations, entry exit location and near staircases. Critical lighting may be 15% of emergency lighting limited operating areas and escape routes.

Area	Lux (min)
Roads and tank farm	15-25
Pump house, sheds	100
Main operating platforms	100
Ordinary platforms & access stairs	60
Processareas, pipe racks, exchangers, heater,coolingtower, separators etc.	80
Switchgear room	200
Cable cellar	70
Battery room	150
Control room, laboratory	500
Ware house	100
Compressor area	150
Office	300

Utilization factor										Fixture efficiency
Ceiling(%)		70			50			30		
Walls(%)		50	30	10	50	30	10	50	30	10
Floor(%)		30 10	30 10	30 10	30 10	30 10	30 10	30 10	30 10	30 10
Room index	0.60	.27 .26	.22 .22	.19 .19	.26 .24	.22 .21	.19 .18	.26 .25	.21 .21	.19 .18
	0.80	.33 .31	.28 .27	.23 .23	.32 .30	.27 .26	.24 .23	.31 .30	.27 .26	.23 .23
	1.00	.38 .36	.32 .30	.28 .28	.36 .35	.32 .31	.29 .27	.35 .34	.31 .30	.28 .27
	1.25	.43 .40	.37 .35	.33 .32	.41 .39	.36 .35	.33 .32	.39 .37	.35 .34	.32 .31
	1.50	.47 .43	.41 .39	.37 .35	.44 .42	.40 .37	.36 .35	.42 .40	.39 .37	.36 .35
	2.00	.52 .47	.47 .44	.43 .41	.49 .46	.45 .43	.42 .40	.47 .45	.44 .42	.41 .40
	2.50	.56 .50	.51 .47	.48 .44	.53 .49	.49 .46	.46 .44	.50 .48	.47 .45	.45 .43
	3.00	.59 .52	.55 .49	.51 .47	.55 .52	.52 .48	.49 .46	.52 .50	.50 .48	.47 .46
	4.00	.62 .55	.59 .52	.56 .51	.58 .53	.56 .52	.53 .50	.55 .52	.53 .51	.51 .49
	5.00	.64 .56	.62 .55	.59 .53	.60 .55	.58 .53	.58 .52	.57 .54	.55 .52	.52 .51

TABLE FOR UTILISATION FACTORS

All outdoor lighting fittings shall be connected with armored PVC cable of suitable no. of cores and size. Necessary type and no. of junction boxes shall be provided for branch connections. Indoor light fittings shall be connected with FRLS PVC wires laid in cable trunks or conduits. Inputs required: Equipment and cable routing layouts, lighting calculations, Design basis for type of light fittings to be used, required lux levels Lighting calculations software: Dialux, Chalmlite, Calculux, Relux, Luxicon, CG Lux Applicable Standards: IS 6665: Code of practice for industrial lighting, IS 3646: Code of practice for interior illumination, IEC 60598: Luminaires, IEC 62493: Assessment of lighting equipment related to human exposure to electromagnetic field Deliverables: Indoor Lighting layouts, socket outlet layouts, Street lighting and area lighting layouts. BOQ. Types of light fittings: Industrial, flame proof type (EX d), increased safety type (Ex e).



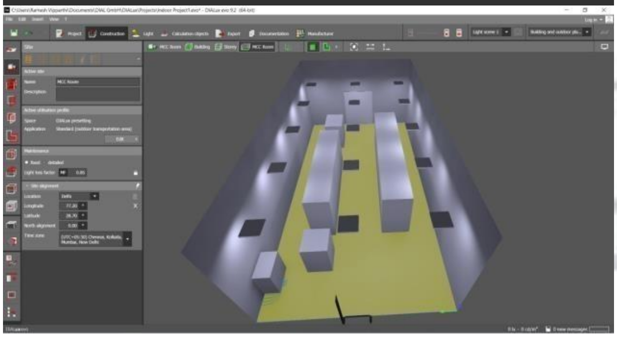
CALCULATIONS OF ILLUMINATION RESULTS

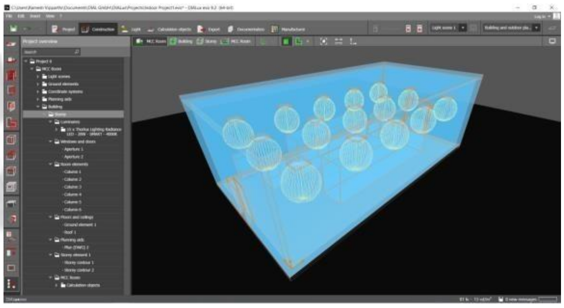
21th May2021: Lighting or illumination systems using DIALUX software.

12	Lighting or Illumination using DIALUXsoftware	Lighting or illumination systems	Operation of dialux software

Topic details: Lightingor Illumination Calculationsusing DIALUXsoftware.

Here we are using this Dialux evo 5.9.2 software windows to construct the power plant and we can perform the operation from this software.





We have the indoor calculations and outdoor calculations too.

Results

	Symbol	Calculated	Target	Check	Index
Workplane	$\bar{E}_{perpendicular}$	264 lx	≥ 500 lx	✗	S2
	g_1	0.077	-	-	S2
Consumption values	Consumption	1300 kWh/a	max. 3400 kWh/a	✓	
Lighting power density	Room	4.82 W/m²	-	-	
		1.83 W/m²/100 lx	-	-	

Utilisation profile: DIALux presetting, Standard (office)

Luminaire list

pcs.	Manufacturer	Article No.	Article name	P	Φ	Luminous efficacy
15	THORLUX	RAD16401	Radiance LED - 28W - SMART - 4000K	31.0 W	4130 lm	133.2 lm/W

Piperack

Luminaire list

Φ_{total}	P_{total}	Luminous efficacy
15850 lm	360.0 W	44.0 lm/W

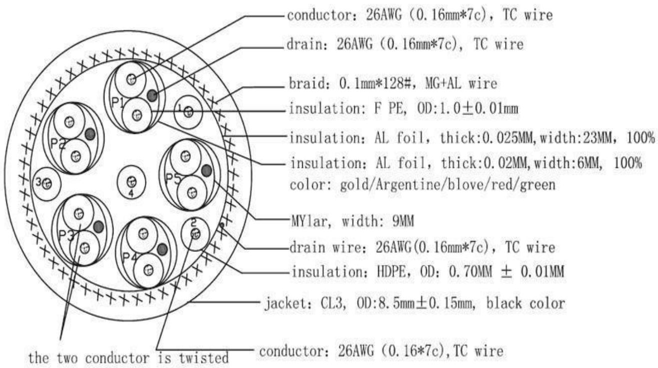
5	CEAG	122658811 03	eLLK 92018/18 CG-S	72.0 W	3170 lm	44.0 lm/W

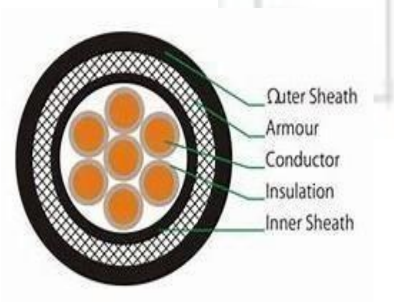
Indoor calculation outdoor calculations

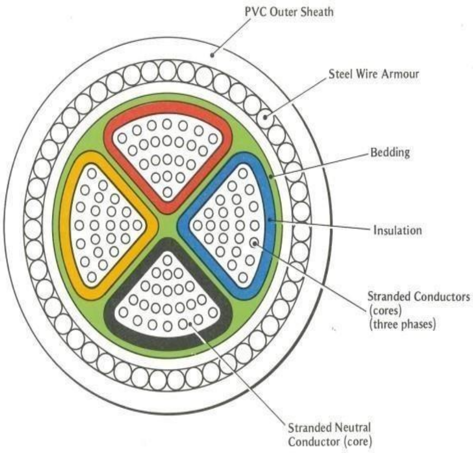
24th May2021: Cabling and their calculations and types.

13	Cabling and them types and calculations	Cabling calculations	Types of cabling materials

Topic details: Cabling and their types and calculations.







Electrical cables must be properly supported to relieve mechanical stresses on the conductors, and protected from harsh conditions such as abrasion which might degrade the insulation. Cables generally laid in the cable trays above ground, direct buried underground and in metallic or PVC conduits. Derating factors may be applicable for each type of cable laying conditions. Cable trays shall be generally loaded 60 to 70% leaving space for future use. Underground cabling shall be done in concrete cable trenches with cable trays in paved areas and directly buried with mandatory gap of 300mm between different systems of cables.

25th May2021: Cabling calculations and Cable gland selection.

14	Cabling calculations and cable gland selection	Cabling calculations	Cable gland selection

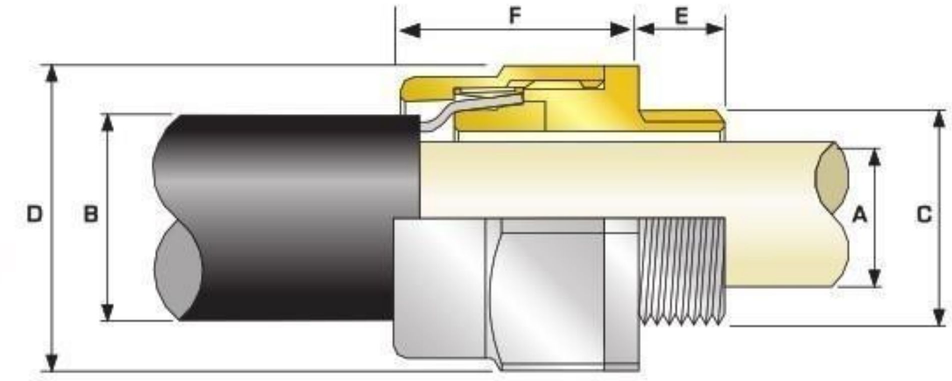
Topic details: Cable sizing calculation and cable gland selection.

Inputsrequired: Load List, Design basis, Electrical equipment layout, cableschedule, vendor catalogues for cabletray.

Cable traysizing shallbeperformedfor eachbranchofcabletray routing uptothe load point.

Results shall be checked with specified limits mentioned in design basis.

Cable gland:



Cable Gland Selection Table
Refer to illustration at the top of the page.

Cable Gland Size	Available Entry Threads "C" (Alternate Metric Thread Lengths Available)		Cable Bedding Diameter "A"	Overall Cable Diameter "B"	Armour Range		Across Flats "D"	Across Corners "D"	Protrusion Length "F"
	Metric	Thread Length (Metric) "E"	Max	Max	Min	Max	Max	Max	
20S16	M20	10.0	8.7	13.2	0.8	1.25	24.0	26.4	35.2
20S	M20	10.0	11.7	15.9	0.8	1.25	24.0	26.4	32.2
20	M20	10.0	14.0	20.9	0.8	1.25	30.5	33.6	30.6
25	M25	10.0	20.0	26.2	1.25	1.6	36.0	39.6	36.4
32	M32	10.0	26.3	33.9	1.6	2.0	46.0	50.6	32.6
40	M40	15.0	32.2	40.4	1.6	2.0	55.0	60.5	36.6
50S	M50	15.0	38.2	46.7	2.0	2.5	60.0	66.0	39.6
50	M50	15.0	44.1	53.1	2.0	2.5	70.1	77.1	39.1
63S	M63	15.0	50.0	59.4	2.0	2.5	75.0	82.5	52.0
63	M63	15.0	56.0	65.9	2.0	2.5	80.0	88.0	49.8
75S	M75	15.0	62.0	72.1	2.0	2.5	90.0	99.0	63.7
75	M75	15.0	68.0	78.5	2.5	3.0	100.0	110.0	57.3
90	M90	24.0	80.0	90.4	3.15	4.0	114.3	125.7	66.6

28 th May2021: Load calculations and Transformer sizing calculations

15	Load calculations and TR calculations	Load calculations	TR calculations

Topic details:

List of electrical 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 [A]	Motor / Load Rating [B]	Load Factor [A] / [B] [C]	Efficiency at Load Factor [C] [D]	Power Factor at Load Factor [C]	Consumed Load: Continuous (kW = [A] / [D])		Intermittent		Stand-by (kVAR = kW x tan φ)		Remarks
			A			mA	kW	kW	decimal	decimal	cos φ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					18.96	22.00	0.86	0.91	0.78	20.84	16.72					
2	PU 2314-A	Absorbent/Neutral oil pump (W)					5.50	7.50	0.73	0.85	0.73	6.5	6.1					
3	PU 2314 -B	Absorbent/Neutral oil pump (S)					4.74	5.50	0.86	0.85	0.73					5.6	5.2	
4	PU2305	Feed Pump (Seperator)					19.14	22.00	0.87	0.91	0.78	21.0	16.9					
5	MX2305	MIXER (W)					19.29	22.00	0.88	0.91	0.78	21.2	17.0					
6	MX 2308	MIXER (S)					19.29	22.00	0.88	0.91	0.78					21.2	17.0	
7	BW2313	Blower					8.29	9.20	0.90	0.85	0.73	9.8	9.1					
8	Rotary valve	TK 2313B (I)					0.81	1.10	0.74	0.85	0.73			1.0	0.9			
9	SC2314	Screw conveyor (I)					1.86	2.20	0.85	0.85	0.73			2.19	2.05			
10	AG 2324A	Citric acid tan agitator (W)					1.39	1.50	0.93	0.85	0.73	1.64	1.53					
11	AG 2324B	Citric acid tank agitator (S)					1.39	1.50	0.93	0.85	0.73					1.6	1.5	
12	AG 2305	Citric oil rection vessel agitator					5.08	5.50	0.92	0.85	0.73	5.98	5.60					
13	AG 2309	Lye oil reaction vessel agitator					1.84	2.20	0.84	0.85	0.73	2.16	2.03					
14	AG 2310	Lye oil reaction vessel agitator					1.84	2.20	0.84	0.85	0.73	2.16	2.03					
15	AG 2314	Soap Adsorbant Tank Agitator					3.23	3.70	0.87	0.85	0.73	3.80	3.56					

Maximum of normal running plant load (Est. x%E + y%F)	96.0 kW	81.5 kVAR	sqrt (kW² +kVAR²) =	125.9 kVA	TOTAL	95.06	80.57	3.19	2.95	28.41	23.76	
Peak Load : (Est. x%E + y%F + z%G)	98.9 kW	83.8 kVAR	sqrt (kW² +kVAR²) =	129.8 kVA	kVA	124.83		4.34		37.03		

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, intermittent and standby load.

LOAD CALCULATIONS

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	95.08	80.6	124.83	--- (i)
b. Intermittent load / Diversity Factor	3.19	3.0	4.38	--- (ii)
c. Stand-by load required as consumed load	28.41	23.8	37.06	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	98.9	83.9	129.64	
Future expansion load (20% capacity)	19.8	16.8	25.93	
Total Load =	118.7	100.6	155.57	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	129.6	kVA
Spare capacity	=	25.9	kVA
Required capacity	=	155.6	kVA
Transformer rated capacity	=	160	kVA

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 :

P_T = 160 KVA (%Z)= 4 & Ratio X/R = 1.5 (refer table)

Hence ; **%R =** = 2.219 %

%X = = 3.33 %

P_M = 22 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff. η = 0.91 & Cos Θs = 0.25

P_S = = 185.988 KVA

Cos θ_S = 0.25 ,Corresponding to Angle θ_s = 75.5225 Degrees for which Sin θ_s = 0.97

P_B = 96.42 KVA & PB in KW is = 81.957 & P_B in Kvar = 50.81 ∴ Cos θ_B = 0.850

Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 31.7883 Degrees, for which Sin θ_s = 0.53

P_{CP} = = 128.449 KW

P_{CQ} = = 230.873 KVAR

P_C = = 264.199 KVA

Cos θ_C = = 0.48618 , where as Sin θ_C = 0.874

Voltage Regulation ε = 6.6 % Selected Transformer rating is adequate.

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals shall be approx. 6.6% which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity

Hence 160kVA Transformer rating selected.

TRANSFORMER SIZING CACULATIONS

29th May2021: DG set calculations.

16 DG set calculations

Topic details:

DG set calculations, types, sizing or selections

DG SIZING CALCULATIONS			
	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.743	Avg
	Efficiency	0.866	Avg
	Total operating load on DG set in kVA at 0.743 power factor	125.9	
	Largest motor to start in the sequence - load in KW	22	KW
	Running kVA of last motor (CosØ= 0.91)	34	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)	205	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	92	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	92	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA	297	KVA
	Subtransient Reactance of Generator (Xd")	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd''' =(Xd"+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor P2 = Total momentary load in KVA x Xd''' x (1-Transient Voltage Dip) / (Transient Voltage Dip)	151	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	297	KVA
	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
	Capacity of DG set required considering overload capacity (P3) = Total momentary load in KVA / overcurrent capacity of DG (K)	198	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	92	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	151	KVA
	Overload capacity P3	198	KVA
	Considering the last value amongst P1, P2 and P3	**198**	**KVA**
	DG SET Rating	**200**	**KVA**
	Hence, Existing Generator 198 KVA is adequate to cater the loads as per re-scheduled loads		
	NOTE:VOLTAGE DIP CONSIDERED - 15%		

DG SET CALCULATIONS

2nd june2021: Calculations of Earthing and Lighting protection.

17	Calculation of Earthing and Lighting protection calculations	Earthing calculations	Lighting protection calculation

Topic details:

Calculation of Earthing and Lighting protection calculations

LIGHTING CALCULATIONS :

		5		
	Location	Karnool		
	Building	Concrete, Industrial		
	Type of Building	Flat Roofs (a)		
	Building Length (L)	15		
	Building breadth (W)	5		
	Building Height (H)	6		
	Risk Factor Calculation			
1	**Collection Area (A_c)**			
	A_c		=	(L*W) + (2*L*H]
				428.04
2	**Probability of Being Struck (P)**			
	P		=	$A_c * N_g * 10^{-6}$
				0.000813276
3	**Overall weighing factor**			
	a) Use of structure (A)		=	1.0
	b) Type of construction (B)		=	0.4
	c) Contents or consequential effects (C)		=	0.8
	d) Degree of isolation (D)		=	0.4
	e) Type of country (E)		=	0.3
	Wo - Overall weighing factor		=	A * B * C * D * E
			=	0.038
4	**Overall Risk Factor**	Po	=	P * Wo
		Po	=	3.12298E-05
		Pa		10^{-5}

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**		
	Perimeter of the building	=	2(L+W)
		=	40
6	**Down Conductors**		
	Perimeter of building	=	40
	No. of down conductors based on perimeter	=	2

Hence 2 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Ga
(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
Maximum line-to-ground fault in kA for 1 sec	17
Earthing material (Earth rod & earth strip)	GI
Depth of earth flat burrial in meter	0.5
Average depth / length of Earth rod in meters	4.5
Soil resistivity Ω-meter	9
Ambient temperature in deg C	55
Plot dimensions (earth grid) L x B in meters	80
Number of earth rods in nos.	6

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I_{LE} - 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
Earth rod dia in mm	12
Earth rod dia (including 25% corrosion allowance) in mm	15

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I_{LE} - 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
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

Rg - Grid resistance

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

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

ρ - Soil resistivity in Ω-meter=	9
L - Total buried length of ground conductor in meter	440
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	11200
Rg - Grid resistance	0.058

Rr - Earth Electrode resistance

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

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

EARTHING CALCULATIONS

5 th june 2021: Cable sizing and cable tray sizing calculations.

18 and	Cable sizing and cable tray sizing calculations	Cable sizing calculations	Cable tray calculation

Topic details: Cable sizing and cable tray sizing calculations for LV cables and MV/HV cables.

Description	Consumed Load KW	Load Rating KW	Voltage (V)	No of ph	Full Load Current (A)	Starting Current (A)	Load P.F. Running	SIN φ Running	Motor P.F Staring	SIN φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)
[illegible]	12.47	[illegible]	415	3	21.7	130.12	0.8	0.6	0.8	0.5	2	1	4.0	10
[illegible]	3.62	[illegible]	415	3	6.3	37.77	0.8	0.6	0.8	0.5	2	1	4.0	2.5
[illegible]	3.11	[illegible]	415	3	5.4	32.45	0.8	0.6	0.8	0.5	2	1	4.0	2.5
[illegible]	[illegible]	[illegible]	415	3	21.9	131.26	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	[illegible]	[illegible]	415	3	22.1	132.31	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	[illegible]	[illegible]	415	3	22.1	132.31	0.8	0.6	0.8	0.5	2	1	4.0	10
[illegible]	5.49	[illegible]	415	3	9.5	56.87	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	0.53	[illegible]	415	3	0.9	5.53	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	1.23	[illegible]	415	3	2.1	12.83	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	0.91	[illegible]	415	3	1.6	9.50	0.8	0.6	0.8	0.5	2	1	4.0	2.5
[illegible]	0.91	[illegible]	415	3	1.6	9.50	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	3.34	[illegible]	415	3	5.8	34.85	0.8	0.6	0.8	0.5	2	1	4.0	6
[illegible]	1.21	[illegible]	415	3	2.1	12.63	0.8	0.6	0.8	0.5	2	1	4.0	2.5
[illegible]	1.21	[illegible]	415	3	2.1	12.63	0.8	0.6	0.8	0.5	2	1	4.0	2.5
[illegible]	2.12	[illegible]	415	3	3.7	22.12	0.8	0.6	0.8	0.5	2	1	4.0	2.5

Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result
10	66	0.98	0.9	1	1	0.882	58.2	95	2.3400	0.0852	6.86	1.65	40.99	9.88	OK
2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	7.92	1.91	47.45	11.43	OK
2.5	28	0.98	0.9	1	1	0.882	24.7	60	9.4800	0.1007	4.30	1.04	25.75	6.20	OK
6	51	0.98	0.9	1	1	0.882	45.0	85	3.9400	0.0902	10.33	2.49	61.78	14.89	OK
6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	9.18	2.21	54.95	13.24	OK
10	66	0.98	0.9	1	1	0.882	58.2	105	2.3400	0.0852	7.71	1.86	46.07	11.10	OK
6	51	0.98	0.9	1	1	0.882	45.0	100	3.9400	0.0902	5.26	1.27	31.49	7.59	OK
6	51	0.98	0.9	1	1	0.882	45.0	100	3.9400	0.0902	0.51	0.12	3.06	0.74	OK
6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	0.89	0.21	5.33	1.28	OK
2.5	28	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	2.30	0.56	13.81	3.33	OK
6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	0.66	0.16	3.94	0.95	OK
6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	3.39	0.82	20.26	4.88	OK
2.5	28	0.98	0.9	1	1	0.882	24.7	85	9.4800	0.1007	2.37	0.57	14.19	3.42	OK
2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	2.65	0.64	15.86	3.82	OK
2.5	28	0.98	0.9	1	1	0.882	24.7	65	9.4800	0.1007	3.17	0.76	19.01	4.58	OK

Cable Tray calculations:

S. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm2)	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	10	1	18	18	3.95	0.9	
2	PU2315- VFD	4	10	1	18	18	0.37	0.9	
3	PU2315- VFD	5	1.5	1	15	15	3.95	0.4	
4	LV MCC	4	2.5	1	16	16	0.37	0.5	
5	LV MCC	5	1.5	1	15	15	3.95	0.4	
6	LV MCC	4	2.5	1	16	16	0.37	0.5	
7	PU 2314 -B- VFD	4	2.5	1	16	16	0.9	0.5	
8	PU 2314 -B- VFD	5	1.5	1	15	15	0.9	0.4	
9	LV MCC	4	6	1	18	18	2.9	0.7	
10	PU2305- VFD	4	6	1	18	18	1.2	0.7	
11	PU2305- VFD	5	1.5	1	15	15	1.2	0.4	
12	LV MCC	4	6	1	18	18	1.2	0.7	
13	LV MCC	5	1.5	1	15	15	1.45	0.4	
14	LV MCC	4	10	1	18	18	2	0.9	
15	LV MCC	5	1.5	1	15	15	2.4	0.4	
16	LV MCC	4	6	1	18	18	2.4	0.7	
17	BW2313- VFD	4	6	1	18	18	0.85	0.7	
18	BW2313- VFD	5	1.5	1	15	15	0.85	0.4	
19	LV MCC	4	6	1	18	18	0.85	0.7	
20	LV MCC	5	1.5	1	15	15	1	0.4	
21	LV MCC	4	6	1	18	18	0.85	0.7	
	Total			21		348	33.91	12.3	

Calculation			Result		
Maximum Cable Diameter:	18	mm	Selected Cable Tray width:	O.K	
Consider Spare Capacity of Cable Tray:	30%		Selected Cable Tray Depth:	O.K	
Distance between each Cable:	0	mm	Selectrd Cable Tray Weight:	O.K	Including Spare Capacity
Calculated Width of Cable Tray:	452	mm	Selected Cable Tray Size:	O.K	Including Spare Capacity
Calculated Area of Cable Tray:	8143	Sq.mm			
No of Layer of Cables in Cable Tray:	2		Required Cable Tray Size:	300 x 50	mm
Selected No of Cable Tray:	1	Nos.	Required Nos of Cable Tray:	1	No
Selected Cable Tray Width:	300	mm	Required Cable Tray Weight:	150.00	Kg/Meter/Tray
Selected Cable Tray Depth:	50	mm	Type of Cable Tray:	Ladder	
Selected Cable Tray Weight Capacity:	150	Kg/Meter			
Type of Cable Tray:	Ladder		Cable Tray Width Area Reman	25%	
~~Total Area of Cable Tray:~~	~~15000~~	~~Sq.mm~~	~~Cable Tray Area Remaning:~~	~~46%~~	

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, workshops ,debates, hackathons, 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 engineering for various industrial sectors.

ASSIGNMENT - 1

ELECTRICAL LOAD CALCULATIONS LV MCC

Sl. No.	Equipment No.	Equipment Description	Breaker Rating	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load [A]	Motor / Load Rating [B]	Load Factor [A]/[B] [C]	Efficiency at Load Factor [C] [D]	Power Factor at Load Factor [C]	Continuous (kW = [A] / [D])		Intermittent (Consumed Load)		Stand-by (kVAR = kW x tan ϕ)		Remarks
			A			mA	kW	kW	decimal	decimal	cos ϕ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					18.96	22.00	0.86	0.91	0.78	20.84	16.72					
2	PU 2314-A	Absorbent/Neutral oil pump (W)					5.50	7.50	0.73	0.85	0.73	6.5	6.1					
3	PU 2314 -B	Absorbent/Neutral oil pump (S)					4.74	5.50	0.86	0.85	0.73					5.6	5.2	
4	PU2305	Feed Pump (Separator)					19.14	22.00	0.87	0.91	0.78	21.0	16.9					
5	MX2305	MIXER (W)					19.29	22.00	0.88	0.91	0.78	21.2	17.0					
6	MX 2308	MIXER (S)					19.29	22.00	0.88	0.91	0.78					21.2	17.0	
7	BW2313	Blower					8.29	9.20	0.90	0.85	0.73	9.8	9.1					
8	Rotary valve	TK 2313B (I)					0.81	1.10	0.74	0.85	0.73			1.0	0.9			
9	SC2314	Screw conveyor (I)					1.86	2.20	0.85	0.85	0.73			2.19	2.05			
10	AG 2324A	Citric acid tan agitator (W)					1.39	1.50	0.93	0.85	0.73	1.64	1.53					
11	AG 2324B	Citric acid tank agitator (S)					1.39	1.50	0.93	0.85	0.73					1.6	1.5	
12	AG 2305	Citric oil rection vessol agitator					5.08	5.50	0.92	0.85	0.73	5.98	5.60					
13	AG 2309	Lye oil reaction vessel agitator					1.84	2.20	0.84	0.85	0.73	2.16	2.03					
14	AG 2310	Lye oil reaction vessel agitator					1.84	2.20	0.84	0.85	0.73	2.16	2.03					
15	AG 2314	Soap Adsorbant Tank Agitator					3.23	3.70	0.87	0.85	0.73	3.80	3.56					

						Continuous kW	Continuous kVAR	Intermittent kW	Intermittent kVAR	Stand-by kW	Stand-by kVAR
Maximum of normal running plant load : (Est. x%E + y%F)	96.0 kW	81.5 kVAR	sqrt (kW²+kVAR²) =	125.9 kVA	TOTAL	95.08	80.57	3.19	2.95	28.41	23.76
Peak Load : (Est. x%E + y%F + z%G)	98.9 kW	83.8 kVAR	sqrt (kW²+kVAR²) =	129.6 kVA	kVA	124.63		4.34		37.03	

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <=45	0.91	0.78
> 45 - <150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, intermittent and standby load.

ASSIGNMENT - 2

TRANSFORMER SIZING CALCULATIONS

1.0 Calculation for consumed load

Consumed loads used for this example are as follows :

	kW	kVar	kVA	
a. Continuous load	95.08	80.6	124.63	--- (i)
b. ~~Intermittent load / Diversity Factor~~	3.19	3.0	4.38	--- (ii)
c. Stand-by load required as consumed load	28.41	23.8	37.06	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	98.9	83.9	129.64	
Future expansion load (20% capacity)	19.8	16.8	25.93	
Total Load =	118.7	100.6	155.57	

1.1 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	129.6	kVA
Spare capacity	=	25.9	kVA
Required capacity	=	155.6	kVA
Transformer rated capacity	=	160	kVA

1.2 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 :

P_T = 160 KVA (%Z)= 4 & Ratio X/R = 1.5 (refer table)

Hence , **%R** = = 2.219 %

%X = = 3.33 %

P_M = 22 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.h = 0.91 & Cos Q_S = 0.25

P_S = = 185.968 KVA

Cos $θ_S$ = 0.25 ,Corresponding to Angle $θ_s$ = 75.5225 Degrees for which Sin q_s = 0.97

P_B = 96.42 KVA & PB in KW is = 81.957 & P_B in Kvar = 50.81 \ Cos $θ_B$ = 0.850

Cos $θ_B$ = 0.85 ,Corresponding to Angle $θ_s$ = 31.7883 Degrees, for which Sin $θ_s$ = 0.53

P_{CP} = = 128.449 KW

P_{CQ} = = 230.873 KVAR

P_C = = 264.199 KVA

Cos $θ_C$ = = 0.48618 , where as Sin $θ_C$ = 0.874

Voltage Regulation e = 6.6 % Selected Transformer rating is adequate.

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals shall be approx. 6.6% which meets the criteria to maintain less than 15% voltage regulation.

1.3 Selection of rated capacity

Hence 160kVA Transformer rating selected.

ASSIGNMENT – 3
DG SET CALCULATIONS

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.743	Avg
	Efficiency	0.866	Avg
	TotaloperatingloadonDGsetinkVAat0.743powerfactor	**125.9**	
	Largest motor to start in the sequence - load in KW	22	KW
	Running kVA of last motor (CosØ= 0.91)	34	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)	**205**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**92**	KVA
	Continous operation under load -P1		
A	Capacity of DG set based on continuous operation under load P1	**92**	**KVA**
	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	297	KVA
	Subtransient Reactance of Generator (Xd'')		
	Transient Reactance of Generator (Xd') Xd''' =(Xd"+Xd')/2	7.91%	(Assumed)
	Transient Voltage Dip	10.065%	(Assumed)
	Transient Voltage dip during Soft starter starting of Last motor	0.089875	
	P2 = Total momentary load in KVA x Xd''' x (1-Transient Voltage Dip) (Transient Voltage Dip)	15%	(Max)
	Overload capacity P3		
	Capacity of DG set required considering overload capacity	**151**	**KVA**
	Total momentary load in KVA		
C	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)		
	CapacityofDG setrequiredconsideringoverloadcapacity (P3) = Total momentary load inKVA / overcurrent capacity of DG (K)	297	KVA
		150%	
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	**198**	**KVA**
	TransientVoltagedipduringSoftstarterstartingofLastmotorP2		
	Overload capacityP3		
	Considering the last value amongst P1, P2 and P3		
	Hence,ExistingGenerator198KVAisadequatetocatertheloadsasperre-scheduled loads	DG SET Rating	
	NOTE:VOLTAGE DIP CONSIDERED - 15%	92	KVA
		151	KVA
		198	KVA
		198	**KVA**
		200	**KVA**

ASSIGNMENT – 4
EARTHING CALCULATIONS

	5
Maximum line-to-ground fault in kA for 1 sec	17
Earthing material (Earth rod & earth strip)	GI
Depth of earth flat burrial in meter	0.5
Average depth / length of Earth rod in meters	4.5
Soil resistivity Ω-meter	9
Ambient temperature in deg C	55
Plot dimensions (earth grid) L x B in meters	80
Number of earth rods in nos.	6

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

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - 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

Thedatatakenfrom IEEE 80-2000, Clause 11.3, Table-1 forcladsteelrod:

14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114
Earth rod dia in mm	12
Earth rod dia (including 25% corrosion allowance) in mm	15

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

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - 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

Thedatatakenfrom IEEE 80-2000, Clause 11.3, Table-1 forcladsteelrod:

14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114
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

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

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

ρ - Soil resistivity in Ω-meter=	9
L - Total buried length of ground conductor in meter	440
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	11200

Rg - Grid resistance 0.058

Rr - Earth Electrode resistance
Gridresistance canbe calculated using Eq. 55 of IEEE 80

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

ρ - Soil resistivity in Ω-meter, 16.96	9
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	4.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	11200

Rr-EarthElectroderesistance 3.30673

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_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance **0.057**

The calculated resistance grounding system is less than the allowable 1 Ω value.

<u>ASSIGNMENT</u> - 5

LIGHTING CALCULATIONS

Location	Kurnool
Building	Concrete, Industrial
Type of Building	Flat Roofs (a)
Building Length (L)	15
Building breadth (W)	5
Building Height (H)	6

Risk Factor Calculation

1 Collection Area (A_c)

A_c = (L*W) + (2*L*H

428.04

2 Probability of Being Struck (P)

P = A_c* N *$_g$ 10^{-6}

0.000813276

3 Overall weighing factor

a) Use of structure (A)	=	1.0
b) Type of construction (B)	=	0.4
c) Contents or consequential effects (C)	=	0.8
d) Degree of isolation (D)	=	0.4
e) Type of country (E)	=	0.3
Wo - Overall weighing factor	=	A*B*C*D*E
	=	0.038

4 Overall Risk Factor

Po = P * Wo

Po = 3.12298E-05

Pa 10^{-5}

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

Perimeter of the building = 2(L+W)

= 40

6 Down Conductors

Perimeter of building	=	40
No. of down conductors based on perimeter	=	2

Hence 2 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Ga

(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
CABLE SIZING CALCULATIONS

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
1	LV MCC	PU2315	Silica filter feed pump	18.96	22	415	3	33.0	197.84	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1	0.882	75.0	95	1.4700	0.0815	6.65	1.60	39.61	9.54	OK	21	20
2	LV MCC	PU 2314-A	Absorbesnt/Neutral oil pump (W)	5.50	7.5	415	3	9.6	57.39	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	95	5.9000	0.0947	7.52	1.81	45.02	10.85	OK	17	20s
3	LV MCC	PU 2314 -B	Absorbesnt/Neutral oil pump (S)	4.74	5.5	415	3	8.2	49.46	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	60	9.4800	0.1007	6.55	1.58	39.24	9.46	OK	16	20s
4	LV MCC	PU2305	Feed Pump (Seperator)	19.14	22	415	3	33.3	199.71	0.8	0.6	0.8	0.5	2	2	4.0	6	51	0.98	0.9	1	1	0.882	45.0	85	3.9400	0.0902	7.86	1.89	47.00	11.33	OK	18	20s
5	LV MCC	MX2305	MIXER (W)	19.29	22	415	3	33.5	201.28	0.8	0.6	0.8	0.5	2	2	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	6.99	1.68	41.80	10.07	OK	18	20s
6	LV MCC	MX 2308	MIXER (S)	19.29	22	415	3	33.5	201.28	0.8	0.6	0.8	0.5	2	2	4.0	6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	9.78	2.36	58.51	14.10	OK	18	20s
7	LV MCC	BW2313	Blower	8.29	9.2	415	3	14.4	86.50	0.8	0.6	0.8	0.5	2	2	4.0	4	38	0.98	0.9	1	1	0.882	33.5	100	5.9000	0.0947	5.96	1.44	35.71	8.61	OK	17	20s
8	LV MCC	Rotary valve	TK 2313B (I)	0.81	1.1	415	3	1.4	8.45	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	100	9.4800	0.1007	1.87	0.45	11.18	2.69	OK	16	20s
9	LV MCC	SC2314	Screw conveyor (I)	1.86	2.2	415	3	3.2	19.41	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	1.35	0.32	8.06	1.94	OK	18	20
10	LV MCC	AG 2324A	Citric acid tan agitator (W)	1.39	1.5	415	3	2.4	14.50	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	3.52	0.85	21.10	5.08	OK	16	20s
11	LV MCC	AG 2324B	Citric acid tank agitator (S)	1.39	1.5	415	3	2.4	14.50	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	1.01	0.24	6.02	1.45	OK	18	20
12	LV MCC	AG 2305	Citric oil rection vessol agitator	5.08	5.5	415	3	8.8	53.01	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	5.15	1.24	30.82	7.43	OK	18	20
13	LV MCC	AG 2309	Lye oil reaction vessel agitator	1.84	2.2	415	3	3.2	19.20	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	0.37	0.09	2.22	0.53	OK	22	32
14	LV MCC	AG 2310	Lye oil reaction vessel agitator	1.84	2.2	415	3	3.2	19.20	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	4.02	0.97	24.12	5.81	OK	16	20s
15	LV MCC	AG 2314	Soap Adsorbant Tank Agitator	3.23	3.7	415	3	5.6	33.70	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	65	9.4800	0.1007	4.83	1.16	28.97	6.98	OK	16	20s

Basis:

1. Overall derating factor k = k1 x k2 x k3 xk4

   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, Armoured, PVC outer sheathed

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

ASSIGNMENT – 7

CABLE TRAY SIZING CACLULATIONS

LT CABLES									
CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	Cable Route (From-To)	Type & Cable Size	Size of Cable (mm2)	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	16	1	21	21	3.95	1	
2	PU2315- VFD	4	16	1	21	21	0.37	1	
3	PU2315- VFD	5	1.5	1	15	15	3.95	0.4	
4	LV MCC	4	6	1	18	18	0.37	0.7	
5	LV MCC	5	1.5	1	15	15	3.95	0.4	
6	LV MCC	4	2.5	1	16	16	0.37	0.5	
7	PU 2314 -B- VFD	4	2.5	1	16	16	0.9	0.5	
8	PU 2314 -B- VFD	5	1.5	1	15	15	0.9	0.4	
9	LV MCC	4	10	1	18	18	2.9	0.9	
10	PU2305- VFD	4	10	1	18	18	1.2	0.9	
11	PU2305- VFD	5	1.5	1	15	15	1.2	0.4	
12	LV MCC	4	10	1	18	18	1.2	0.9	
13	LV MCC	5	1.5	1	15	15	1.45	0.4	
14	LV MCC	4	16	1	21	21	2	1	
15	LV MCC	5	1.5	1	15	15	2.4	0.4	
16	LV MCC	4	6	1	18	18	2.4	0.7	
17	BW 2313- VFD	4	6	1	18	18	0.85	0.7	
18	BW 2313- VFD	5	1.5	1	15	15	0.85	0.4	
19	LV MCC	4	2.5	1	16	16	0.85	0.5	
20	LV MCC	5	1.5	1	15	15	1	0.4	
21	LV MCC	4	6	1	18	18	0.85	0.7	

Calculation		
Maximum Cable Diameter:	18	mm
Consider Spare Capacity of Cable Tray:	30%	
Distance between each Cable:	0	mm
Calculated Width of Cable Tray:	464	mm
Calculated Area of Cable Tray:	8354	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:	50	mm
Selected Cable Tray Weight Capacity:	150	Kg/Meter
Type of Cable Tray:	Ladder	
Total Area of Cable Tray:	15000	Sq.mm

Result		
Selected Cable Tray width:	O.K	
Selected Cable Tray Depth:	O.K	
Selectrd Cable Tray Weight:	O.K	Including Spare Capacity
Selected Cable Tray Size:	O.K	Including Spare Capacity
Required Cable Tray Size:	300 x 50	mm
Required Nos of Cable Tray:	1	No
Required Cable Tray Weight:	150.00	Kg/Meter/Tray
Type of Cable Tray:	Ladder	
Cable Tray Width Area Remaning	23%	
Cable Tray Area Remaning:	44%	