Internship Program Report

By

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18481A0234

In association with

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 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

Dr.G.Srinivasa Rao-Coordinator

Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Softwar/Technical Support

Program details

Smart Internz program schedule: 4 weeks starting from 3rd May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: Online through ZOOM

Presenter: Mr Ramesh V

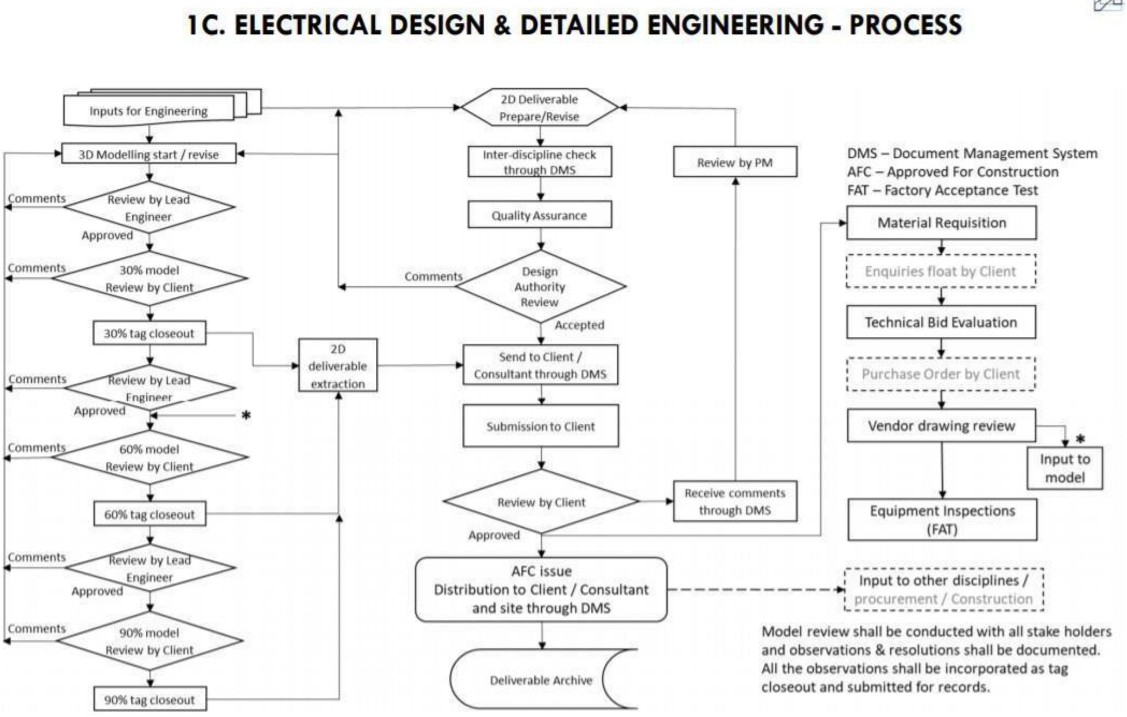
Internship program

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.

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:

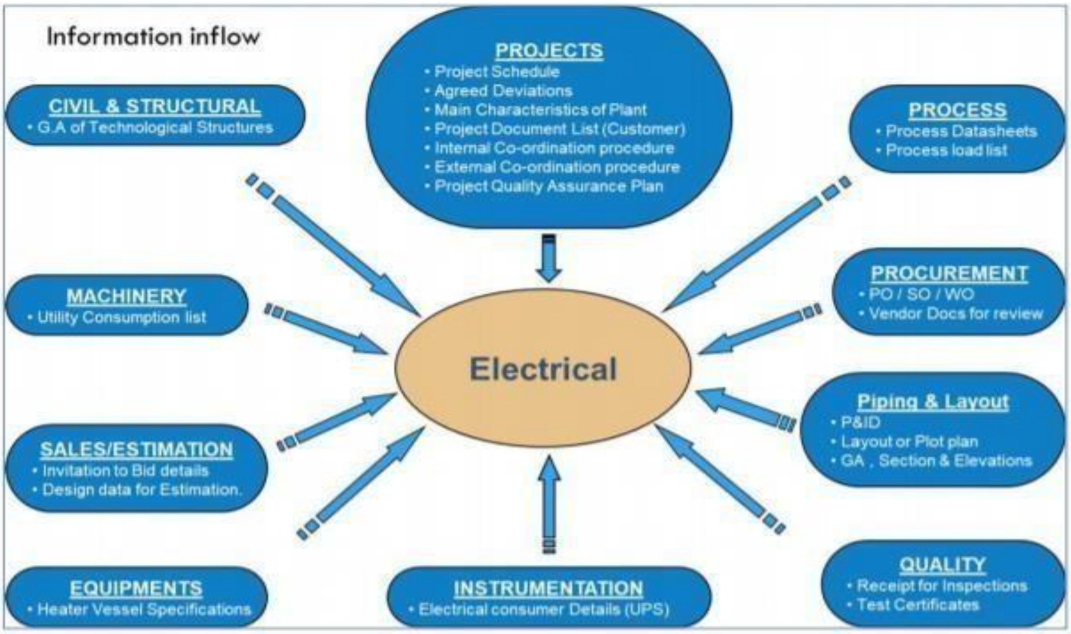


Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineer role at various phases of project.

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	Document submission and info exchange
		Deliverables types	Different types of deliverables

Topic details:



On this day I have learned the Deliverable list of details and work flow in electrical design.And after sequence of deliverables,Detailed engineering process,Document submission and exchange process,and at last I learned about different types of delivarables.

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.

3C. AUTOCAD BASIC COMMANDS

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		
		GRADIENT	GD	FILLET	F		
		REGION	REG	EXPLODE	X		
		BOUNDARY	BO				
		DONUT	DO				

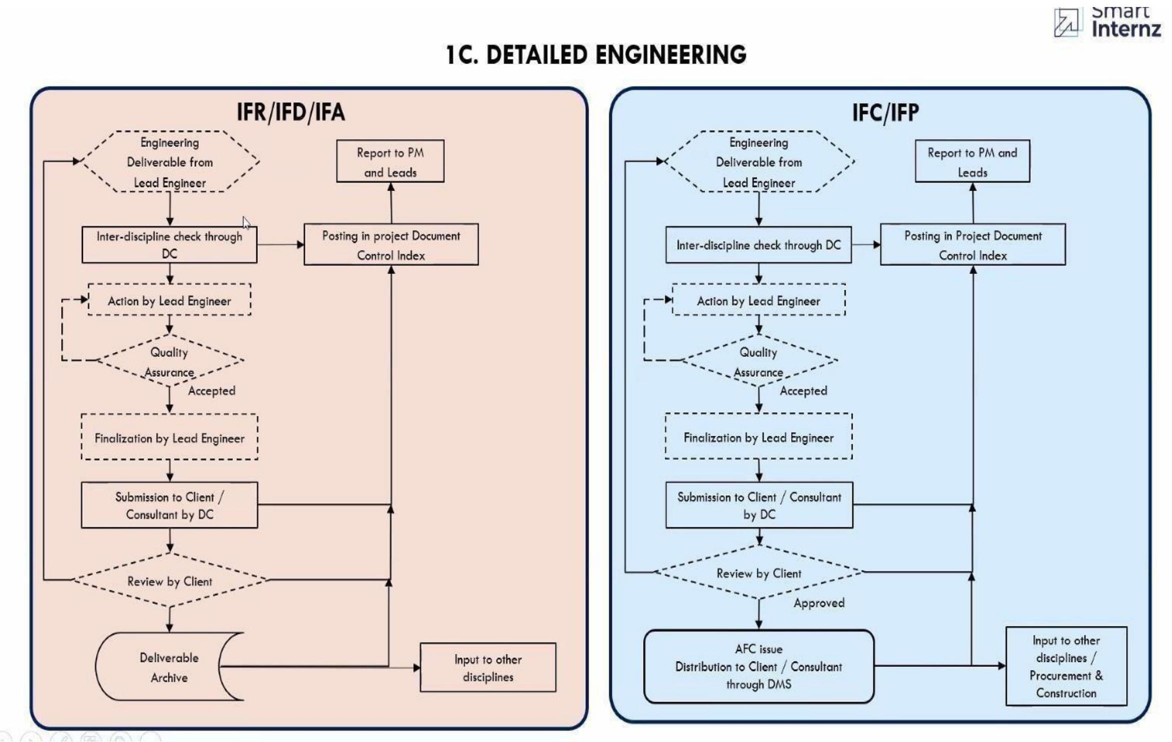
EXTRA				DRAFTING		PAPER SIZE
UNIT	UN	UCS	UCS	ORTHO	F8, Ctrl+L	A4=210*297
LIMITS	LIMITS	SINGLE TEXT	DT	OSNAP	F3, Ctrl+F	A3=297*420
(0,0; 1000,1000)		MULTILINE TEXT	MT	POLAR	F10, Ctrl+U	A2=420*594
ZOOM	Z	EDIT TEXT	ED	GRID	F7, Ctrl+G	A1=594*841
ALL	A	OBJECT SNAP	OB	OTRACK	F11	A0=841*1189
PAN	P	DIMENTION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

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

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.



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

10th May2021: Engineering documentation for Typical diagrams

5	Electrical system design for typical diagrams	Load lists shedule Single line diagram	Power flow diagram Typical schematic diagram

Topic details: Typical diagrams and Load calculations.

S.No	EQUIPMENT Equipment No.	Description	Supply by :-	Vital	Essential	Non essential	Restarting	Absorbed load A kW	Equipment rating B kW	Load factor =A/B or H/I C In decimals	Efficiency at load factor C D In decimals	Power factor at load factor C Cos φ	Consumed Load kW = A/D, kVAr = kW*tan j: Continuous No.	Continuous E kW	Continuous kVAr	Intermittent and spares No.	Intermittent and spares F kW	Intermittent and spares kVAr	Stand-by No.	Stand-by G kW	Stand-by kVAr	Remarks	Revision
	PROCESS LOADS																						
1	PD-3431	Portable MEG Injection Pump Package	LEWA			x		27.00	37.00	0.73	0.91	0.83				1	29.67	19.94				Portable Skid (Please refer Note-d)	B
2	34-PM8401A	Liquid Return Pump Motor	LEWA			x		25.45	31.00	0.82	0.93	0.81				1	27.37	19.81					01
3	34-PM8401B	Liquid Return Pump Motor	LEWA			x		25.45	31.00	0.82	0.93	0.81							1	27.37	19.81		01
4	34-PM8402A	Booster Pump Motor (LRP Package)	LEWA			x		1.40	2.20	0.64	0.78	0.84				1	1.79	1.16					01
5	34-PM8402B	Booster Pump Motor (LRP Package)	LEWA			x		1.40	2.20	0.64	0.78	0.84							1	1.79	1.16		01
6	34-PM7902A	Corrosion Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77	1	7.17	5.94								01
7	34-PM7902B	Corrosion Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77							1	7.17	5.94		01
8	34-PM7903A	Batch Corrosion Inhibitor Injection Pump Motor	RAM			x		133.50	160.00	0.83	0.96	0.80							1	139.06	104.30		01
9	34-PM7903B	Batch Corrosion Inhibitor Injection Pump Motor	RAM			x		133.50	160.00	0.83	0.96	0.80							1	139.06	104.30		01
10	34-PM7904A	KHI Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77	1	7.17	5.94							VSD for speed control	B
11	34-PM7904B	KHI Inhibitor Injection Pump Motor	LEWA			x		6.45	11.00	0.59	0.90	0.77							1	7.17	5.94	VSD for speed control	B
12	34-PM7905A	Scale Inhibitor Injection Pump Motor	FUTURE			x		3.00	4.00	0.75	0.85	0.81	1	3.53	2.56							Future	B
13	34-PM7905B	Scale Inhibitor Injection Pump Motor	FUTURE			x		3.00	4.00	0.75	0.85	0.81							1	3.53	2.56	Future	B
14	34-KM9602A	Nitrogen Compressor Motor	GENERON			x		30.00	37.50	0.80	0.90	0.80	1	33.33	25.00								01
15	34-KM9602B	Nitrogen Compressor Motor	GENERON			x		30.00	37.50	0.80	0.90	0.80	1	33.33	25.00								01
16	34-KM9602C	Nitrogen Compressor Motor	GENERON			x		30.00	37.50	0.80	0.90	0.80							1	33.33	25.00		01
17	34-EM9602A	Aftercooler for Nitrogen Compressor	GENERON			x		1.15	2.50	0.46	0.78	0.80				1	1.47	1.11					01
18	34-EM9602B	Aftercooler for Nitrogen Compressor	GENERON			x		1.15	2.50	0.46	0.78	0.80				1	1.47	1.11					01
19	34-EM9602C	Aftercooler for Nitrogen Compressor	GENERON			x		1.15	2.50	0.46	0.80	0.80							1	1.44	1.08		01
20	34-H9602	Nitrogen Heater						6.20	1.00	6.20	0.90	1.00											01
21	34-PM9701A	Hydraulic Fluid Pump - Wellhead HPU - Very High Pressure	FRAMES			x		0.19	0.55	0.35	0.80	0.70				1	0.24	0.24					B
22	34-PM9701B	Hydraulic Fluid Pump - Wellhead HPU - Very High Pressure	FRAMES			x		0.19	0.55	0.35	0.80	0.70				1	0.24	0.24					B
23	34-PM9702A	Hydraulic Fluid Pump - Wellhead HPU - Medium High Pressure	FRAMES			x		5.80	7.50	0.77	0.80	0.86				1	7.25	4.30					B
24	34-PM9702B	Hydraulic Fluid Pump - Wellhead HPU - Medium High Pressure	FRAMES			x		5.80	7.50	0.77	0.80	0.86				1	7.25	4.30					B
25	34-A9704A	Hydraulic Fluid Pump -IOPPS Valves HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
26	34-A9704B	Hydraulic Fluid Pump -IOPPS Valves HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
27	34-PM9705A	Hydraulic Fluid Pump - ESDV's HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
28	34-PM9705B	Hydraulic Fluid Pump - ESDV's HPU	LEDEEN			x		5.42	5.50	0.99	0.80	0.86				1	6.78	4.02					01
29	AC-3435	Crane motor	LIEBHERR			x		112.00	140.00	0.80	0.95	0.90				1	117.89	57.10					01
30	34-XZM8303	Lifeboat Recovery Starter Panel	SCHAT HARDING			x		8.74	9.39	0.93	0.91	0.82							1	9.60	6.70		01
31	CP34302	Flare Knock Out Drum Heater Control Panel	CHROMALOX			x		35.00	35.00	1.00	0.90	0.90				1	38.89	18.83					01
	HVAC LOADS																						
32	34-YH4201ACCU01	Air Cooled Condensing Unit - 01	CCTC		x			37.25	42.90	0.87	0.82	0.80	1	45.43	34.07								01
33	34-YH4201ACCU02	Air Cooled Condensing Unit - 02	CCTC		x			37.25	60.00	0.62	0.82	0.80							1	45.43	34.07		01
34	34-YH4201AHU01	Air Handling Unit - 01	CCTC		x			8.85	10.00	0.89	0.80	0.80	1	11.06	8.30								01
35	34-YH4201AHU02	Air Handling Unit - 02	CCTC		x			8.85	10.00	0.89	0.80	0.80							1	11.06	8.30		01
36	34-YH4201FF01	Fresh Air Fan - 01	CCTC		x			8.00	8.00	1.00	0.90	0.80	1	8.89	6.67								01
37	34-YH4201FF02	Fresh Air Fan - 02	CCTC		x			8.00	8.00	1.00	0.90	0.80							1	8.89	6.67		01
38	34-YH4201EF01	Exhaust Fan - Toilet	CCTC		x			1.00	1.00	1.00	0.90	0.80				1	1.11	0.83					01
39	34-YH4201EDH01	Duct heater - 01	CCTC		x			9.78	9.78	1.00	1.00	1.00				1	9.78	0.00					01
40	34-YH4201EDH02	Duct heater - 02	CCTC		x			4.69	4.69	1.00	1.00	1.00				1	4.69	0.00					01
41	34-YH4201EDH03	Duct heater - 03	CCTC		x			0.90	0.90	1.00	1.00	1.00				1	0.90	0.00					01
42	34-YH4201EDH04	Duct heater - 04	CCTC		x			4.98	4.98	1.00	1.00	1.00				1	4.98	0.00					01
	ELECTRICAL LOADS																						
43	AC-3431	Power Distribution Board	MASSEERA		x			41.00	51.50	0.80	0.98	0.80	1	41.84	31.38							Inclusive of MOV, Choke valve, Control valve and heat tracing loads	00
44	UPS-3441/3442/3443	UPS- Main/Bypass	GUTOR		x			24.00	24.00	1.00	0.82	0.80	1	29.27	21.95								B
45	BC-3442	Switchgear 24 V DC UPS	SAFT		x			1.20	1.20	1.00	0.80	0.80	1	1.50	1.13								00
46	LTR-3431	Lighting Transformer for LP-3431	SCHNEIDER		x			27.00	27.00	1.00	0.98	0.90	1	27.55	13.34							Inclusive of lighting load, convenience outlets and small power loads.	B
47	ELTR-3431	Lighting Transformer for ELP-3431	SCHNEIDER		x			27.00	27.00	1.00	0.98	0.90	1	27.55	13.34							Inclusive of lighting load, convenience outlets and small power loads.	B
48	WD-3431A	Welding Socket Outlet 1 - Upper Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
49	WD-3431B	Welding Socket Outlet 2 - Upper Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
50	WD-3432A	Welding Socket Outlet 1 - Lower Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
51	WD-3432B	Welding Socket Outlet 2 - Lower Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
52	WD-3433A	Welding Socket Outlet 1 - Mezz Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
53	WD-3433B	Welding Socket Outlet 2 - Mezz Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B
54	WD-3434	Welding Socket Outlet - Cellar Deck	STAHL			x		33.00	33.00	1.00	0.98	0.80							1	33.67	25.26		B

Max. of normal running plant load: (Est. x %E + y %F)	353 kW,	232 kVAr,	$\sqrt{(kW^2 + kVAr^2)}$	423 kVA	x = 100 y = 30	TOTAL	278	195	252	125	671	503
Peak load: (Est. x %E + y %F + z%G)	420 kW,	282 kVAr,	$\sqrt{(kW^2 + kVAr^2)}$	506 kVA	z = 10	$kVA = \sqrt{(kW^2+kVAr^2)}$	339		282		838	

Power factor without compensation [Cos φ] 0.836
Power factor with compensation [Cos φ1]
Reqd capacitor rat: [=kW(tan φ - tan φ1)] kVAr

Notes -

a) **Load classification/restarting:** For definitions of "Vital", "Essential" and Non - Essential", services and application of "Restarting", see DEP 33.64.10.10 - Gen. Electrical engineering guidelines.

b) **Absorbed loads:**
- for pumps, shaft load on duty point.
- for instrumentation, computers, communication, & air condit'g, the required load during full operation of plant.
- for lighting, during dark hours.
- for workshops, the average total load in normal full operation.

c) Consumed loads:
E - "Continuous"; all loads that may continuously be required for normal operation operation including lighting and workshops
F - "Intermittent and spares"; the loads required for intermediate pumping, storage, loading, etc, and all electrical spares of electrically driven units.
G - "Stand - by"; loads required in emergencies only, such as fire water pumps or those of not normally running electrically driven units & electrical stand - by for normally running steam - driven ones (e.g.charge pumps, boiler feed pumps)

d) The Panel shall feed Injection Pumps P7901A/B.

e) Batch Injection pump considered as standby load during normal running condition based on operating philosophy.

QATARGAS 3&4
OFFSHORE FACILITIES PROJECT
WELLHEAD PLATFORM 7

J. RAY McDERMOTT

REVISION	DATE	PREPARED BY	DESCRIPTION OF REVISION
01	24-Jun-07	AK	APPROVED FOR CONSTRUCTION
00	22-Aug-07	PJ	APPROVED FOR CONSTRUCTION WITH HOLD
B	18-Jul-07	PJ	ISSUED FOR COMPANY REVIEW
A	26-Oct-06	JG	ISSUED FOR IDC

We conclude here how to do load calculations and Typical diagrams and inernal structure and also about the power flow diagram.

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.

1 Ph. Pad mounted 3 Ph Pole mounted Commercial/ 3 Ph Oil filled (ONAN) Distribution Residential lighting Residential/ street lighting type for industrial & commercial.

415V Diesel generator sets for standby / 240V 1 ph diseal generator set for lighting and & small power only Emergency power supply.

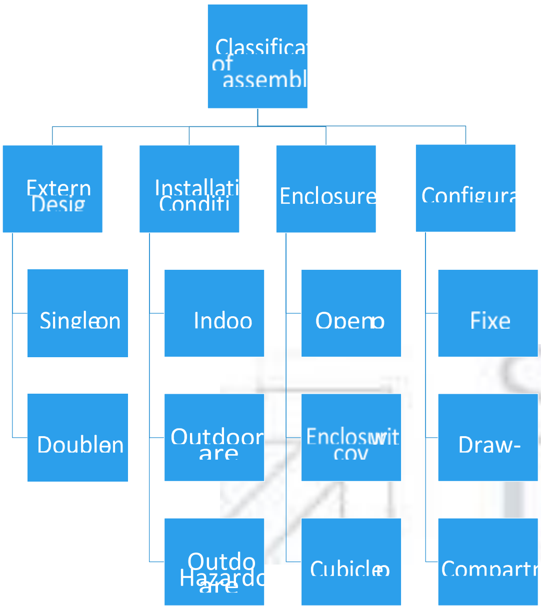
Transformer shall include a primary disconnect on the incoming power source. The disconnect means shall be either a breaker or a load break primary switch that is fused.Transformers are sized to carry the peak running load of all busses connected to them. In addition, feeders to and from power transformers shall be rated to carry full current at the maximum rating.

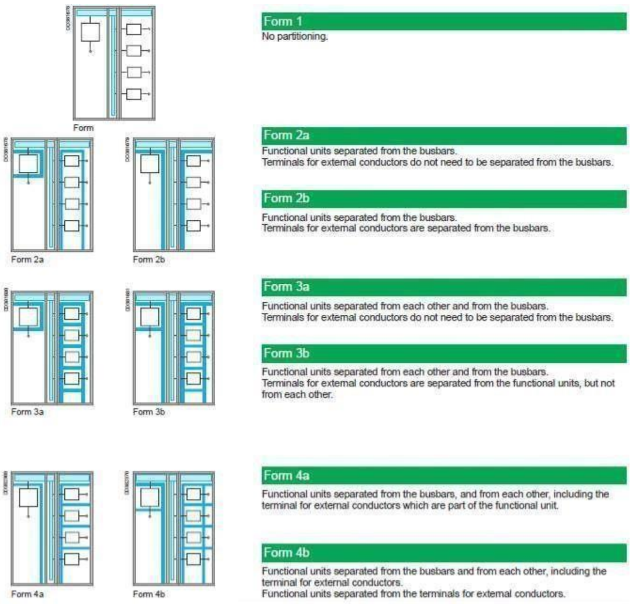
The packaged combination of a diesel engine, an alternator and various ancillary devices such as base, canopy, sound attenuation, control systems, circuit breakers, jacket water heaters, starting systems etc., is referred to as a Diesel Generating Set or a DG Set in short.

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

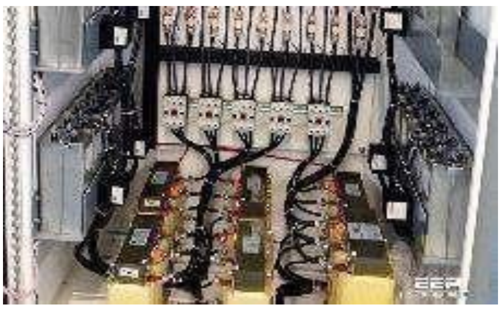
7	Classification of Switchgare construction and power factor improvement	Different types of Switchgare assembles	Power factor improvement

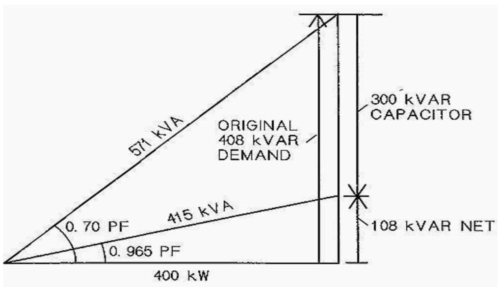
Topic details: Classifiaction of Switchgare contruction and Power Factor Improvement.





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.





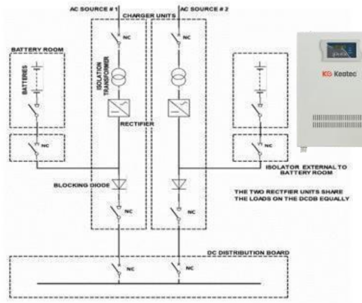
Power factor defined as the ratio of real power to volt-amperes and is the cosine of the phase angle between the voltage and current in an AC circuit.

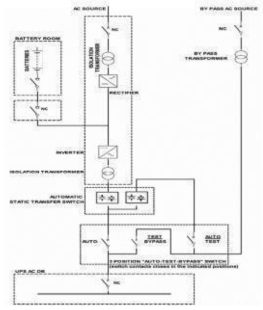
17th May2021: Detailing about UPS system and Busducts.

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

Topic details: Power distribution of UPS system and Busducts.

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.





110V or 220V DC UPS System

110V or 230V AC UPS System

Busducts are classified into various types depending on its application viz phase separated Busducts, segregated phase busducts, non-segregated phase busducts.

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

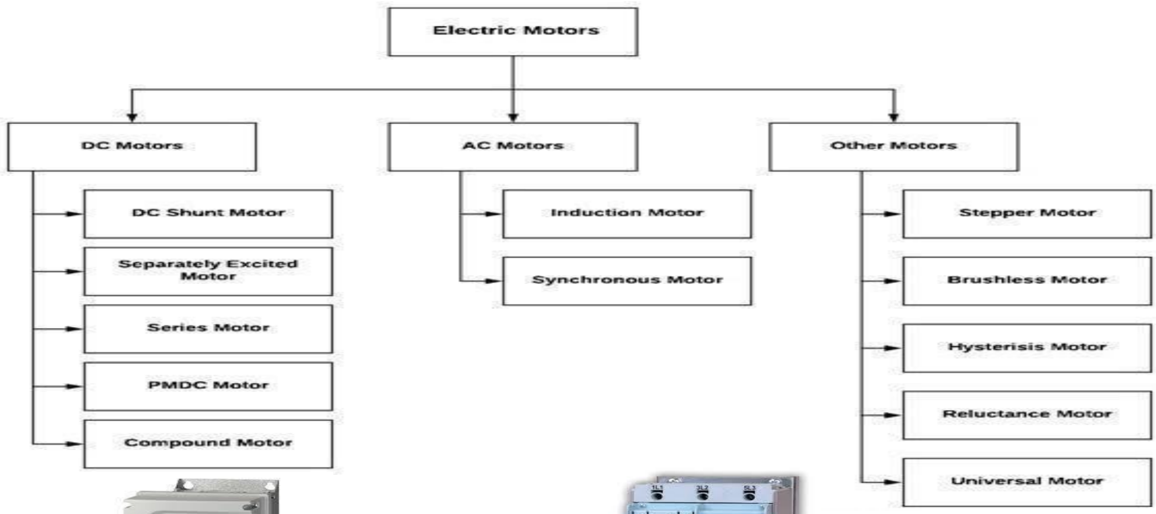
9	Detailing about Motor Starters and Sizing of motors	Motor starters and drives	Sizing and selection of motors

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.

Different types of motor starters are as follows:

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



- 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 staring/running voltage drop and short circuit current Vibration – monitoring based on KW rating.

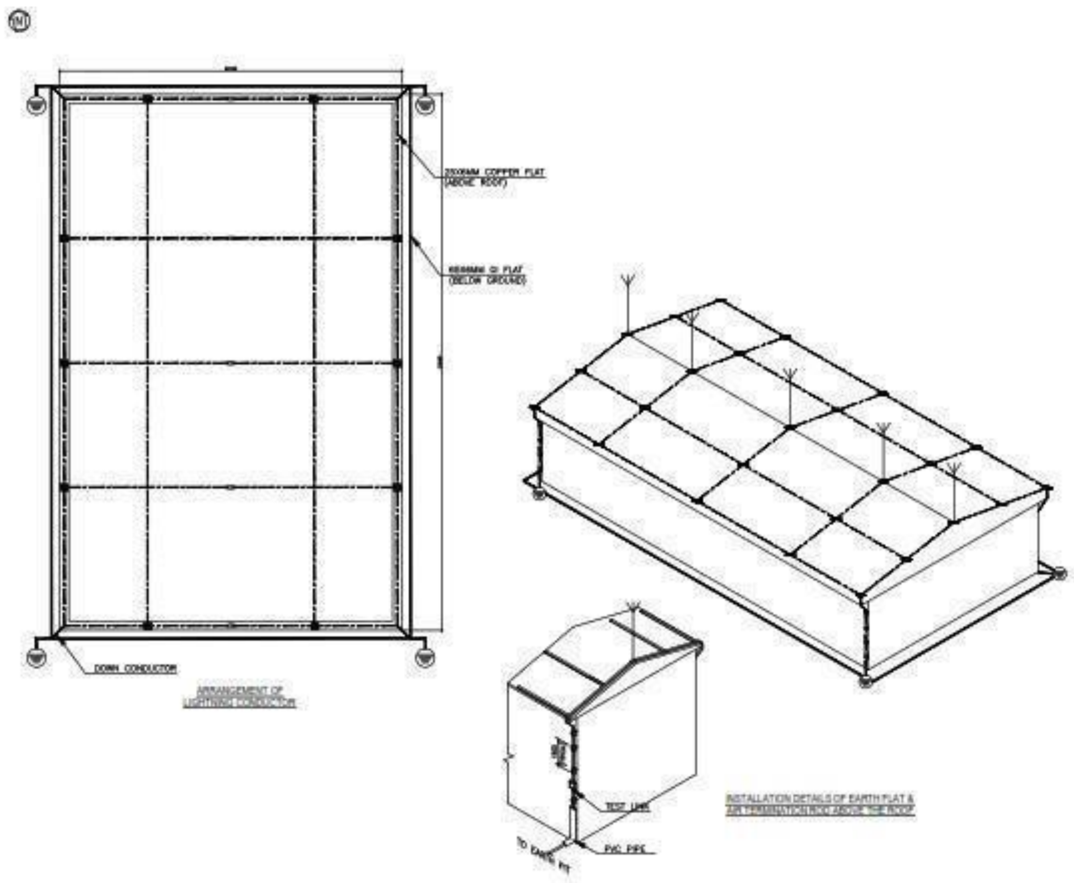
19th May2021: Discribing about Earthing system and Lighting Protection.

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

Topic details: Discribing about Earthing system and Lighting Protection.

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.

tall



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.

20th May2021: Lighting or illumination systems and calculations.

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

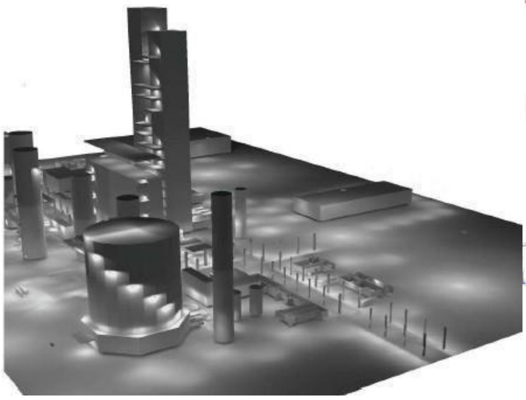
Topic details: Lighting or Illumination systems and Calculations.

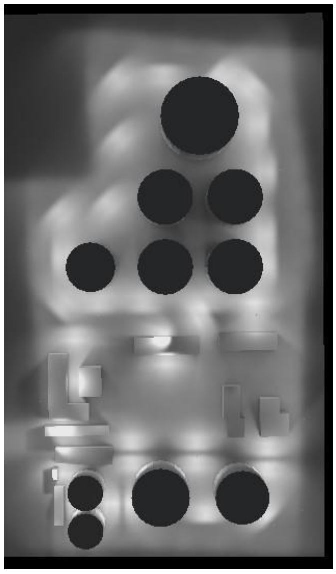
All outdoor lighting fittings shall be connected with armoured PVC cable of suitable no. of cores and size. Necessary type and no. of junction boxes shall be provided for branch connections. Indoor light fittings shall be connected with FRLS PVC wires laid in cable trunks or conduits.

Scale 1 : 2769

Calculation Surface List

No.	Designation	Type	Grid	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
1	Area 06: Cal Surface for Pump Maint	horizontal	128 x 128	97	21	168	0.220	0.127
2	Area 06: Cooling Tower	horizontal	128 x 128	71	3.38	241	0.047	0.014
3	Area-08: Cal Surface for Gang Comp Maint-607302	horizontal	128 x 128	172	72	244	0.420	0.297
4	Area-08: Nitrogen Compressor Area	horizontal	128 x 128	163	38	245	0.231	0.153
5	Area-08: Cal Surface for Gang Comp Maint607301	horizontal	128 x 128	155	89	207	0.575	0.431
6	Area-07: Cal Surface for T05 Turbine Maint	horizontal	128 x 128	163	33	216	0.203	0.153
7	Area-07: Cal Surface for T01 Turbine Maint	horizontal	32 x 32	144	14	311	0.097	0.045
8	Area-07:Warm turbine-I	horizontal	128 x 64	157	31	215	0.199	0.146
9	Area-07:Warm turbine-II	horizontal	128 x 64	142	5.99	296	0.042	0.020





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.

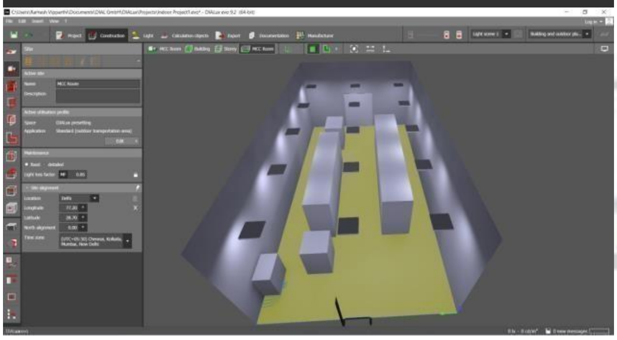
Types of light fittings: Industrial, flame prooftype (EX d), increased safety type (Ex e).

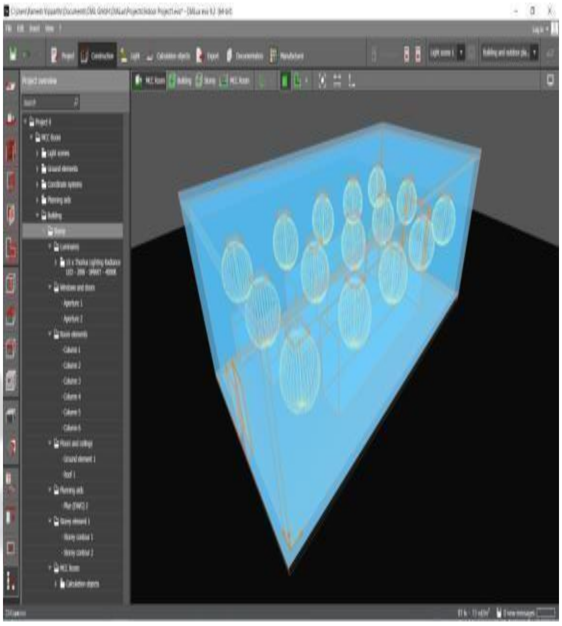
21th May2021: Lighting or illumination systems using DIALUX software.

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

Topic details: Lighting or Illumination Calculations using DIALUX software.

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

Indoor calculation

Piperack

Luminaire list

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

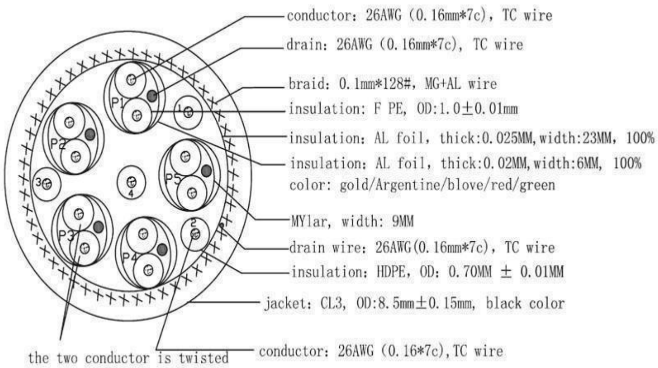
5	CEAG	122658811 03	eLLK 92018/18 CG-S	72.0 W	3170 lm	44.0 lm/W

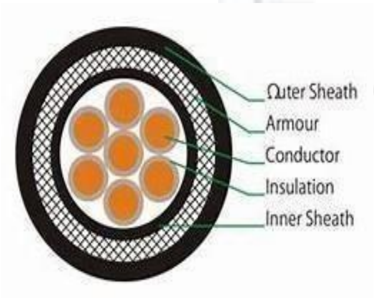
outdoor calculations

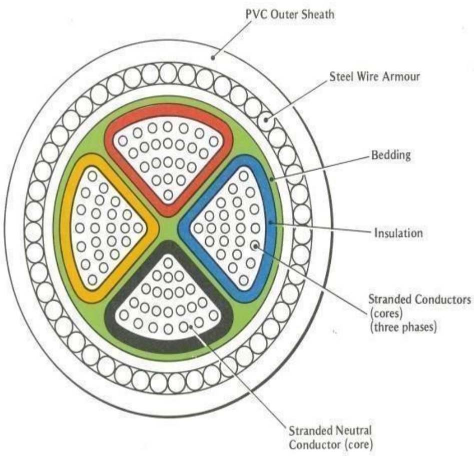
24th May2021: Cabling and their calculations and types.

13	Cabling and their types and claculations	Cabling calculations	Types of cabling materials

Topic details: Cabling and their types and claculations .







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 claculations and cable gland selection	Cabling calculations	Cable gland selection

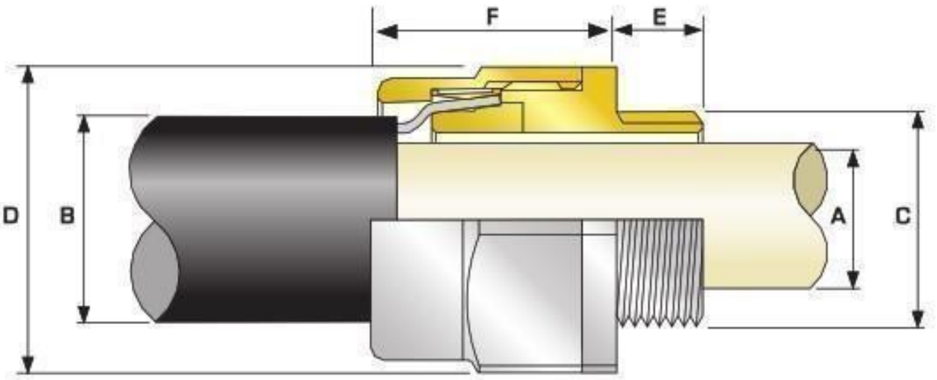
Topic details: Cable sizing calculation and cable gland selection.

Inputs required: Load List, Design basis, Electrical equipment layout, cable schedule, vendor catalogues for cable tray.

Cable tray sizing shall be performed for each branch of cable tray routing up to the 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.

Sl. No.	Equipment No.	Equipment Description	Breaker Rating (A)	Breaker Type	Breaker No. of Poles	ELCB Rating (mA)	Absorbed Load [A] kW	Motor / Load Rating [B] kW	Load Factor [A] / [B] [C] decimal	Efficiency at Load Factor [C] [D] decimal	Power Factor at Load Factor [C] cos φ	Continuous kW (kW = [A] / [D])	Continuous kVAR	Intermittent kW (Consumed Load)	Intermittent kVAR	Stand-by kW	Stand-by kVAR (kVAR = kW x tan φ)
1	PU2315	Silica filter feed pump					12.47	15.00	0.83	0.85	0.73	14.67	13.74				
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					3.62	4.70	0.77	0.85	0.73	4.3	4.0				
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					3.11	3.70	0.84	0.85	0.73					3.7	3.4
4	PU2305	Feed Pump (Seperator)					12.58	15.00	0.84	0.85	0.73	14.8	13.9				
5	MX2305	MIXER (W)					12.68	15.00	0.85	0.85	0.73	14.9	14.0				
6	MX 2308	MIXER (S)					12.68	15.00	0.85	0.85	0.73					14.9	14.0
7	BW2313	Blower					5.45	7.50	0.73	0.85	0.73	6.4	6.0				
8	Rotary valve	TK 2313B (I)					0.53	0.75	0.71	0.85	0.73			0.6	0.6		
9	SC2314	Screw conveyor (I)					1.23	1.50	0.82	0.85	0.73			1.45	1.35		
10	AG 2324A	Citric acid tan agitator (W)					0.91	1.10	0.83	0.85	0.73	1.07	1.00				
11	AG 2324B	Citric acid tank agitator (S)					0.91	1.10	0.83	0.85	0.73					1.1	1.0
12	AG 2305	Citric oil reotion vessol agitator					3.34	3.70	0.90	0.85	0.73	3.93	3.68				
13	AG 2309	Lye oil reaction vessel agitator					1.21	1.50	0.81	0.85	0.73	1.42	1.33				
14	AG 2310	Lye oil reaction vessel agitator					1.21	1.50	0.81	0.85	0.73	1.42	1.33				
15	AG 2314	Soap Adsorbant Tank Agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34				

Maximum of normal running plant load : (Est. x%E + y%F)	66.0 kW	61.8 kVAR	sqrt (kW² +kVAR²) = 90.4 kVA	TOTAL	65.40	61.23	2.07	1.94	19.65	18.39
Peak Load : (Est. x%E + y%F + z%G)	68.0 kW	63.7 kVAR	sqrt (kW² +kVAR²) = 93.1 kVA	kVA	89.59		2.84		26.91	

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

TR sizing 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	125.69	106.5	164.74	--- (i)
b. Intermittent load / Diversity Factor	4.15	3.9	5.69	--- (ii)
c. Stand-by load required as consumed load	37.57	31.4	48.98	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	130.7	110.8	171.34	
Future expansion load (20% capacity)	26.1	22.2	34.27	
Total Load =	156.8	133.0	205.61	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load = 171.3 kVA
Spare capacity = 34.3 kVA
Required capacity = 205.6 kVA
Transformer rated capacity = 120 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 = 220 KVA (%Z)= 4.17 & Ratio X/R = 3.4

Hence, %R = = 1.193 %

%X = = 4.00 %

P_M = 30 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos θs = 0.25

P_s = = 253.59 KVA

Cos $θ_s$ = 0.25 ,Corresponding to Angle θ = 75.522 Degrees for which Sin θ = 0.97

P_b = 126.28 KVA & PB in KW is = 107.33 & P_b in Kvar = 65.66 ∴ Cos $θ_b$ = 0.850

Cos $θ_b$ = 0.85 ,Corresponding to Angle θ = 31.795 Degrees, for which Sin θ = 0.53

P_{cp} = = 170.73 KW

P_{cq} = = 311.2 KVAR

P_c = = 354.96 KVA

Cos $θ_c$ = = 0.481 , where as Sin $θ_c$ = 0.877

Voltage Regulation ε = 6.6 %

Result During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx 6.60%

1.4 Selection of rated capacity

120 kVA transformer selected.

29th May2021: DG set calculations.

16	DG set calculations

Topic details:

Transformer and DG set calculations,types ,sizing or selections

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.74	Avg
	Efficiency	0.86	Avg
	Total operating load on DG set in kVA at 0.74 power factor	**166.4**	
	Largest motor to start in the sequence - load in KW	30	KW
	Running kVA of last motor (CosØ= 0.91)	47	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)	**283**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**119**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**119**	**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	402	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 (Transient	**205**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	402	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)	**268**	**KVA**

2nd june2021: Caluculations 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

		7			
	Location	Udaipur			
	Building	Concrete, Hospital			
	Type of Building	Flat Roofs (a)			
	Building Length (L)	17			
	Building breadth (W)	7			
	Building Height (H)	9			
	Risk Factor Calculation				
1	**Collection Area (A_c)**				
	A_c		=	(L*W) + (2*L*H) + (2*W*H) + (3.14*H*H)	
				805.34	
2	**Probability of Being Struck (P)**				
	P		=	A_c * N_g * 10^{-6}	
				0.001530146	
3	**Overall weighing factor**				
	a) Use of structure (A)		=	1.7	
	b) Type of construction (B)		=	0.4	
	c) Contents or consequential effects (C)		=	1.7	
	d) Degree of isolation (D)		=	1.0	
	e) Type of country (E)		=	0.3	
	Wo - Overall weighing factor		=	A * B * C * D * E	
			=	0.347	
4	**Overall Risk Factor**	Po	=	P * Wo	
		Po	=	0.000530655	
		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)	
			=	48	Mts.
6	**Down Conductors**				
	Perimeter of building		=	48	Mts.
	No. of down conductors based on perimeter		=	2	Nos.
	Hence 2 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)				

Earthing calculations:

Maximum line-to-ground fault in kA for 1 sec	13	
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	
Soil resistivity Ω-meter	8.5	
Ambient temperature in deg C	50	
Plot dimensions (earth grid) L x B in meters	70	130
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
$I_{l\text{-}g}$ - 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
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

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

18	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)	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
[illegible]	12.47	[illegible]	415	3	21.7	130.12	0.8	0.6	0.8	0.5	2	1	4.0	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
[illegible]	3.62	[illegible]	415	3	6.3	37.77	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	7.92	1.91	47.45	11.43	OK
[illegible]	3.11	[illegible]	415	3	5.4	32.45	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	60	9.4800	0.1007	4.30	1.04	25.75	6.20	OK
[illegible]	12.58	[illegible]	415	3	21.9	131.26	0.8	0.6	0.8	0.5	2	1	4.0	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
[illegible]	12.68	[illegible]	415	3	22.1	132.31	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	9.18	2.21	54.95	13.24	OK
[illegible]	12.68	[illegible]	415	3	22.1	132.31	0.8	0.6	0.8	0.5	2	1	4.0	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
Blower	5.45	[illegible]	415	3	9.5	56.87	0.8	0.6	0.8	0.5	2	1	4.0	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
[illegible]	0.53	[illegible]	415	3	0.9	5.53	0.8	0.6	0.8	0.5	2	1	4.0	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
[illegible]	1.23	[illegible]	415	3	2.1	12.83	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	0.89	0.21	5.33	1.28	OK
[illegible]	0.91	[illegible]	415	3	1.6	9.50	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	2.30	0.56	13.81	3.33	OK
[illegible]	0.91	[illegible]	415	3	1.6	9.50	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	0.66	0.16	3.94	0.95	OK
[illegible]	3.34	[illegible]	415	3	5.8	34.85	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	3.39	0.82	20.26	4.88	OK
[illegible]	1.21	[illegible]	415	3	2.1	12.63	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	85	9.4800	0.1007	2.37	0.57	14.19	3.42	OK
[illegible]	1.21	[illegible]	415	3	2.1	12.63	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	2.65	0.64	15.86	3.82	OK
[illegible]	2.12	[illegible]	415	3	3.7	22.12	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	3.17	0.76	19.01	4.58	OK

Cable Tray calculations:

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	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, 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 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]	Effi iency 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	decima	decimal	cos φ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					25.0	30.0	0.8	0.9	0.7	27.5	22.1					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					7.2	7.5	0.9	0.8	0.7	8.	8.					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					6.2	7.5	0.8	0.8	0.7					7.	6.	
4	PU2305	Feed Pump (Seperator)					25.3	30.0	0.8	0.9	0.7	27.	22.					
5	MX2305	MIXER (W)					25.5	30.0	0.8	0.9	0.7	28.	22.					
6	MX 2308	MIXER (S)					25.5	30.0	0.8	0.9	0.7					28.	22.	
7	BW2313	Blower					10.9	15.0	0.7	0.8	0.7	12.	12.					
8	Rotary valve	TK 2313B (I)					1.0	1.5	0.7	0.8	0.7			1.	1.			
9	SC2314	Screw conveyor (I)					2.4	3.0	0.8	0.8	0.7			2.8	2.7			
10	AG 2324A	Citric acid tan agitator (W)					1.8	2.2	0.8	0.8	0.7	2.1	2.0					
11	AG 2324B	Citric acid tank agitator (S)					1.8	2.2	0.8	0.8	0.7					2.	2.	
12	AG 2305	Citric oil rection vessol agitator					6.7	7.5	0.9	0.8	0.7	7.9	7.4					
13	AG 2309	Lye oil reaction vessel agitator					2.4	3.0	0.8	0.8	0.7	2.8	2.6					
14	AG 2310	Lye oil reaction vessel agitator					2.4	3.0	0.8	0.8	0.7	2.8	2.6					
15	AG 2314	Soap Adsorbant Tank Agitator					4.2	4.7	0.9	0.8	0.7	5.0	4.7					

						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)	126.9 kW	107.7 kVAR	sqrt (kW² +kVAR²) =	166. kVA	TOTAL	125.6	106.5	4.1	3.8	37.5	31.4
Peak Load : (Est. x%E + y%F + z%G)	130.7 kW	110.8 kVAR	sqrt (kW² +kVAR²) =	171. kVA	kVA	164.75		5.69		48.98	

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

Calculation for Transformer Capacity

Example of calculation for Transformer Capacity
Calculation for consumed load

Consumed loads used for this example are as follows :

		kW	kVar	kVA	
a.	Continuous load	125.69	106.5	164.74	--- (i)
b.	Intermittent load / Diversity Factor	4.15	3.9	5.69	--- (ii)
c.	Stand-by load required as consumed load	37.57	31.4	48.98	--- (iii)

	kW	kVar	kVA
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	130.7	110.8	171.34
Future expansion load (20% capacity)	26.1	22.2	34.27
Total Load =	156.8	133.0	205.61

Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	171.3 kVA
Spare capacity	=	34.3 kVA
Required capacity	=	205.6 kVA
Transformer rated capacity	=	120 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 = 220 KVA (%Z)= 4.17 & Ratio X/R =.........................3.4

Hence , **%R** = 1.193 %

%X = = 4.00 %

P_M = 30 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.h = 0.91 & Cos Qs = 0.25

P_S = = 253.593 KVA

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

P_B = 126.28 KVA & PB in KW is = 107.33 & P_B in Kvar = 65.66 \ Cos $θ_B$ = 0.850

Cos $θ_B$ = 0.85 ,Corresponding to Angle $θ_s$ = 31.7952 Degrees, for which Sin $θ_s$ = 0.53

P_{CP} = = 170.728 KW

P_{CQ} = = 311.2 KVAR

P_C = = 354.956 KVA

Cos $θ_C$ = = 0.48098 , where as Sin $θ_C$ = 0.877

Voltage Regulation e = 6.6 %

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx.... 6.60%

Selection of rated capacity

120 kVA transformer selected.

Assignment - 3

DG SIZING CALCULATIONS			
	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.74	Avg
	Efficiency	0.86	Avg
	Total operating load on DG set in kVA at 0.74 power factor	**166.4**	
	Largest motor to start in the sequence - load in KW	30	KW
	Running kVA of last motor (CosØ= 0.91)	47	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)	**283**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**119**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**119**	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA	402	KVA
	(Starting KVA of the last motor+Base load of DG set in 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)	**205**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	402	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)	**268**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	119	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	205	KVA
	Overload capacity P3	268	KVA
	Considering the last value amongst P1, P2 and P3	**268**	**KVA**
	Hence, Existing Generator 268 KVA is adequate to cater the loads as per re-scheduled loads		
	NOTE:VOLTAGE DIP CONSIDERED - 15%		

Assignment - 4
Lightning Caliculations

	7
Location	Udaipur
Building	Concrete, Hospital
Type of Building	Flat Roofs (a)
Building Length (L)	17
Building breadth (W)	7
Building Height (H)	9

Risk Factor Calculation

1 Collection Area (A_c)

A_c = (L*W) + (2*L*H) + (2*W*H) + (3.14*H*H)

805.34

2 Probability of Being Struck (P)

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

0.001530146

3 Overall weighing factor

a) Use of structure (A)	=	1.7
b) Type of construction (B)	=	0.4
c) Contents or consequential effects (C)	=	1.7
d) Degree of isolation (D)	=	1.0
e) Type of country (E)	=	0.3
Wo - Overall weighing factor	=	A * B * C * D * E
	=	0.347

4 Overall Risk Factor

Po = P * Wo

Po = 0.000530655

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)	
	=	48	Mts.

6 Down Conductors

Perimeter of building	=	48	Mts.
No. of down conductors based on perimeter	=	2	Nos.

Hence 2 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 – 5

CABLE SIZING

							Max. AC Resistance			Max. AC Resistance			Max. AC Resistance			Reactance			Reactance				
	t ground (30 deg C)		t in duct (30 deg C)		ct in air (40 deg C)		90 Deg C (XLPE)			70 Deg C (PVC)			85 Deg C (HR PVC)			XLPE			PVC / HR PVC			OD	Weight
Sq mm	Cu XLPE	Al XLPE	Cu XLPE	Al XLPE	Cu XLPE	Al XLPE	Plan Cu	Tin Cu	Al	Plan Cu	Tin Cu	Al	Plan Cu	Tin Cu	Al	Sinle core		Multi core	Sinle core		Multi core	(mm)	KG/Mtr
							Ohm/kM	Ohm/kM	Ohm/kM	Ohm/kM	Ohm/kM	Ohm/kM	Ohm/kM	Ohm/kM	Ohm/kM	Unarmoured	Armoured		Unarmoured	Armoured			
1.5	25	20	22	18	22	18	15.5	15.63	23.17	14.5	14.62	21.7	15.2	15.33	22.8	0.12	-	0.108	0.1239	-	0.1116	15	0.4
2.5	34	27	28	23	28	23	9.48	9.67	15.5	8.9	9.08	14.5	9.3	9.49	15.3	0.113	-	0.1007	0.1201	-	0.1077	16	0.5
4	44	34	37	28	38	31	5.9	6.01	9.48	5.52	5.63	8.9	5.79	5.9	9.35	0.107	-	0.0947	0.116	-	0.1035	17	0.6
6	55	43	46	37	51	45	3.94	3.98	5.9	3.69	3.73	5.54	3.87	3.91	5.82	0.103	-	0.0902	0.1106	-	0.098	18	0.7
10	72	57	60	48	66	60	2.34	2.35	3.94	2.19	2.2	3.7	2.3	2.31	3.89	0.098	-	0.0852	0.1045	-	0.0918	18	0.9
16	95	73	79	61	85	70	1.47	1.48	2.44	1.38	1.39	2.3	1.44	1.45	2.41	0.094	0.101	0.0815	0.0999	0.1058	0.0871	21	1
25	122	96	100	80	122	95	0.93	0.94	1.54	0.87	0.88	1.44	0.913	0.92	1.51	0.095	0.1	0.0816	0.0989	0.1037	0.0861	22	1.4
35	146	115	120	96	148	117	0.671	0.68	1.11	0.63	0.64	1.04	0.658	0.66	1.1	0.092	0.097	0.0794	0.0962	0.1004	0.0833	24	1.8
50	175	134	151	116	181	141	0.495	0.5	0.82	0.464	0.469	0.77	0.486	0.491	0.809	0.092	0.096	0.0792	0.0966	0.0997	0.0837	26	2.3
70	212	165	182	141	230	177	0.343	0.323	0.567	0.321	0.323	0.533	0.337	0.34	0.559	0.088	0.091	0.0752	0.091	0.0937	0.078	29	3.25
95	253	198	211	168	284	221	0.247	0.25	0.41	0.232	0.234	0.385	0.243	0.246	0.404	0.086	0.089	0.0734	0.0905	0.0928	0.0775	33	4
120	290	225	236	189	330	257	0.196	0.197	0.324	0.184	0.185	0.305	0.193	0.194	0.32	0.0857	0.0879	0.0726	0.0886	0.0906	0.0755	37	5
150	325	252	271	210	375	293	0.159	0.162	0.264	0.15	0.152	0.249	0.157	0.16	0.261	0.0863	0.0886	0.0732	0.0889	0.0911	0.0758	39	6
185	362	285	308	243	431	338	0.127	0.128	0.21	0.121	0.122	0.198	0.126	0.127	0.208	0.0858	0.0875	0.0727	0.0881	0.0898	0.075	43	7.6
240	418	330	357	282	512	401	0.0965	0.0975	0.16	0.093	0.094	0.152	0.0972	0.0982	0.159	0.0851	0.0866	0.0719	0.0876	0.0891	0.0745	48	9.5
300	467	371	406	316	582	459	0.0769	0.0777	0.128	0.075	0.0757	0.122	0.0787	0.0795	0.128	0.0843	0.0857	0.0711	0.087	0.0884	0.074	54	11.5
400	518	423	439	366	661	536	0.0602	0.0608	0.1	0.0604	0.061	0.0961	0.063	0.0636	0.101	0.0837	0.0855	0.0705	0.0865	0.088	0.073	59	15
500	583	474	512	412	765	620	0.0468	0.0472	0.0774	0.049	0.0494	0.0761	0.0509	0.0513	0.0796	0.0835	0.0851	0.0703	0.0863	0.0879	0.0732	66	18
630	645	532	570	463	860	715	0.0362	0.0366	0.06	0.0401	0.0405	0.0606	0.0416	0.042	0.0632	0.0829	0.0843	0.0697	0.0859	0.0876	0.0728	73	20
800							0.0283	0.0287	0.047	0.0339	0.0343	0.0495	0.0351	0.0355	0.0515	0.0826	0.0841	-	0.0848	0.0863	-		
1000							0.0225	0.0226	0.0372	0.0297	0.0298	0.0416	0.0306	0.0307	0.0431	0.0823	0.0836	-	0.0838	0.0851	-		

Conductor size								**Number of cores**							
area	N	1	2	3	3.5	4	5	7	10	12	19	27	37	78	
1.5	-	-	20s	20s	-	20s	20s	20s	20	20	25	25	32	32	
2.5	-	-	20s	20s	-	20s	20s	20	25	25	25	32	32	40	
4	-	-	20s	20s	-	20	20	25	25	25	32	40	40	50	
6	-	-	20s	20	-	20	-	-	-	-	-	-	-	-	
10	-	-	25	25	-	25	-	-	-	-	-	-	-	-	
16	-	-	25	25	-	25	-	-	-	-	-	-	-	-	
25	16	-	25	25	32	32	-	-	-	-	-	-	-	-	
35	16	-	25	32	32	32	-	-	-	-	-	-	-	-	
50	25	25	32	32	32	40	-	-	-	-	-	-	-	-	
70	35	25	32	40	40	40	-	-	-	-	-	-	-	-	
95	50	25	40	40	50	50	-	-	-	-	-	-	-	-	
120	70	25	40	50	50	50	-	-	-	-	-	-	-	-	
150	70	32	40	50	50	50	-	-	-	-	-	-	-	-	
185	95	32	50	50	63	63	-	-	-	-	-	-	-	-	
240	120	40	50	63	63	63	-	-	-	-	-	-	-	-	
300	150	40	63	63	75	75	-	-	-	-	-	-	-	-	
300	185	-	-	-	75	-	-	-	-	-	-	-	-	-	
400	185	50	63	75	75	75	-	-	-	-	-	-	-	-	
500	-	50	-	-	-	-	-	-	-	-	-	-	-	-	
630	-	50	-	-	-	-	-	-	-	-	-	-	-	-	
800	-	63	-	-	-	-	-	-	-	-	-	-	-	-	
1000	-	63	-	-	-	-	-	-	-	-	-	-	-	-	

Assignment – 6

CABLE TRAY

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	**0.9**	
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	16	1	21	**21**	2.9	**1**	
10	PU2305- VFD	4	16	1	21	**21**	1.2	**1**	
11	PU2305- VFD	5	1.5	1	15	**15**	1.2	**0.4**	
12	LV MCC	4	16	1	21	**21**	1.2	**1**	
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	16	1	21	**21**	2.4	**1**	
17	BW2313- VFD	4	16	1	21	**21**	0.85	**1**	
18	BW2313- VFD	5	1.5	1	15	**15**	0.85	**0.4**	
19	LV MCC	4	6	1	18	**18**	0.85	**0.9**	
20	LV MCC	5	1.5	1	15	**15**	1	**0.4**	
21	LV MCC	4	6	1	18	**18**	0.85	**0.9**	
	Total			**21**		**374**	**33.91**	**14.9**	

Calculation

Maximum Cable Diameter:	**21**	**mm**
Consider Spare Capacity of Cable Tray:	**30%**	
Distance between each Cable:	**0**	**mm**
Calculated Width of Cable Tray:	**486**	**mm**
Calculated Area of Cable Tray:		**Sq.mm**
No of Layer of Cables in Cable Tray:		
Selected No of Cable Tray:		**Nos.**
Selected Cable Tray Width:		**mm**
Selected Cable Tray Depth:		**mm**
Selected Cable Tray Weight Capacity:		**Kg/Meter**
Type of Cable Tray:	**Ladder**	
Total Area of Cable Tray:	**15000**	**Sq.mm**

Result

Selected Cable Tray width:		
Selected Cable Tray Depth:		
Selectrd Cable Tray Weight:		**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	**19%**	
Cable Tray Area Remaning:	**32%**	

Assignment - 7

Earthing calculations Input

	2	
Maximum line-to-ground fault in kA for 1 sec	13	
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	
Soil resistivity Ω-meter	8.5	
Ambient temperature in deg C	50	
Plot dimensions (earth grid) L x B in meters	70	130
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-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
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

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

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
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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

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Table 1—Material constants

Description	Material conductivity (%)	α_r factor at 20 °C (1/°C)	K_o at 0 °C (0 °C)	Fusing[a] temperature T_m (°C)	ρ_r 20 °C (μΩ·cm)	TCAP thermal capacity [J/(cm³·°C)]
Copper, annealed soft-drawn	100.0	0.003 93	234	1083	1.72	3.42
Copper, commercial hard-drawn	97.0	0.003 81	242	1084	1.78	3.42
Copper-clad steel wire	40.0	0.003 78	245	1084	4.40	3.85
Copper-clad steel wire	30.0	0.003 78	245	1084	5.86	3.85
Copper-clad steel rod[b]	20.0	0.003 78	245	1084	8.62	3.85
Aluminum, EC grade	61.0	0.004 03	228	657	2.86	2.56
Aluminum, 5005 alloy	53.5	0.003 53	263	652	3.22	2.60
Aluminum, 6201 alloy	52.5	0.003 47	268	654	3.28	2.60
Aluminum-clad steel wire	20.3	0.003 60	258	657	8.48	3.58
Steel, 1020	10.8	0.001 60	605	1510	15.90	3.28
Stainless-clad steel rod[c]	9.8	0.001 60	605	1400	17.50	4.44
Zinc-coated steel rod	8.6	0.003 20	293	419	20.10	3.93
Stainless steel, 304	2.4	0.001 30	749	1400	72.00	4.03

[a]From ASTM standards.
[b]Copper-clad steel rods based on 0.254 mm (0.010 in) copper thickness.
[c]Stainless-clad steel rod based on 0.508 mm (0.020 in) No. 304 stainless steel thickness over No. 1020 steel core.