

ELECTRICAL PLAN GENERAL REQUIREMENTS

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IIEE – Cebu Chapter President**



INTRODUCTION

The growth of the real estate market have initiated the rise in business centers, in the metropolis and key cities in the country.

Real estate developers started the construction of high rise buildings during the construction boom of early eighties and have continued until the present.

To cope with this trend, the Electrical Engineer have to equip themselves with the technical know-how in the design and know the requirements and contents of the said design

DESIGN CONSIDERATIONS

A. BUILDING TYPE OF USAGE OR OCCUPANCY

A.1 Residential, Commercial or Industrial

A.2 Residential/Office Condominium

A.3 Mixed-Used (Malls, Office, Residential)

The type of usage will be a key factor in determining the total electrical requirement of the building.

B. POWER SERVICE CONNECTIONS

B.1 Determine service voltage to be used

- 230V Single Phase System
- 230V Three Phase System
 - 400V/ 230Y System
 - 480V or 460V System

The choice will depend on the dominant voltage requirement.

C. LOCATION OF SERVICE ENTRANCE & TRANSFORMER VAULT

During the initial planning stage, the Electrical Design Engineer have to coordinate with the architect regarding the locations of the following:

C.1 Location of XFormer vault– the preferred location is at the ground floor, where it can be easily accessed from the outside.

C.2 Location of Meter Centers

C.3 Location of Generator Set.



D. LOAD CONSIDERATIONS

Based on the type of usage or occupancy, the total load can be determine and applicable demand factors applied based on provisions of PEC 1.

The following shall be taken into account:

- A. Residential Loads
- B. Commercial Loads (office, spaces, stores, etc.)
 - Lighting/Power Load
 - Air Conditioning Load
 - Heating Load
 - Elevators
 - Pumps (Jockey pump, transfer pump, fire pumps)
 - Sewage Treatment Plant (STP) etc.

E. POWER DISTRIBUTION SYSTEM

Power is distributed from main transformer to low voltage switchgear.

Distribution to floor levels is through main secondary feeders in cables inside conduit, or through bus way system.

The design engineer should coordinate with the local utility on policies and requirements.

Most modern design utilizes busways in power distribution, as they are easier to install and relatively safe against pilferage.

Article 1.2 – Permits and Inspection Certificates of PEC 2009, Part 1, Vol. 1

Electrical permit needed before work is started – before starting any installation work, alteration, repair or extension on any electrical system, the owners, lessors, operators, occupants, or licensed electrical practitioners shall obtain electrical permit for buildings, trailers, mobile homes or other premises from the office of local building official (OBO), or for watercrafts from the maritime industry authority (MARINA). In securing electrical permit, the services of A licensed electrical practitioner is required under the new electrical engineering law (RA 7920)

The electrical permits shall include the following minimum information, applicant; PEE who signed and sealed electrical plans and specifications; licensed electrical practitioner who is in – charge of electrical works; building owner; lot owner and building official.

Five (5) sets of complete electrical plans and specification signed and sealed by PEE

Drawing Sheet Sizes

A. Electrical plans and drawings shall be drawn on drawing sheets of the following standard sizes:

760 mm x 100 mm

600 mm x 900 mm

500 mm x 760 mm

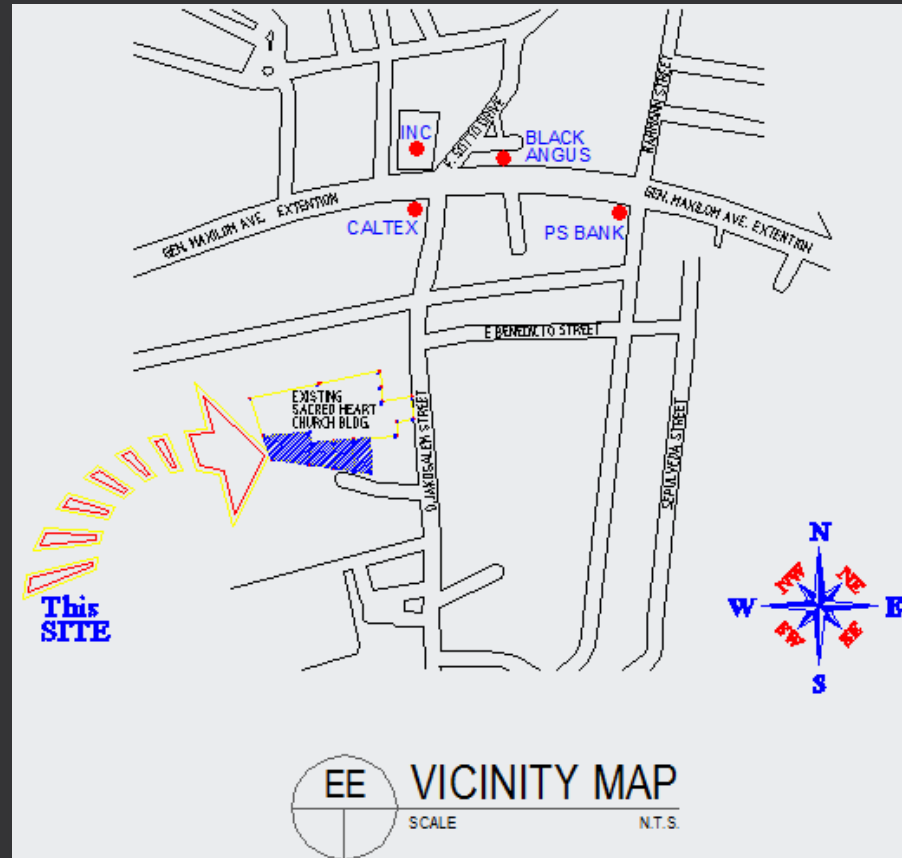
B. In cases such as projects of large magnitude, exemption in the use of standard drawing sheets may be granted by the office of the local building official.

C. For a dwelling unit having a floor area of not more than 50 square meters with the total load not exceeding 3680 VA, a drawing sheet of size 297 mm x 240 mm (A3 size) is permitted.

D. Metric drawing scale must be use. (usually 1:100)

Plans and Specifications

A. Location and Site Plans – with proposed structure and owner's land drawn in appropriate scale.

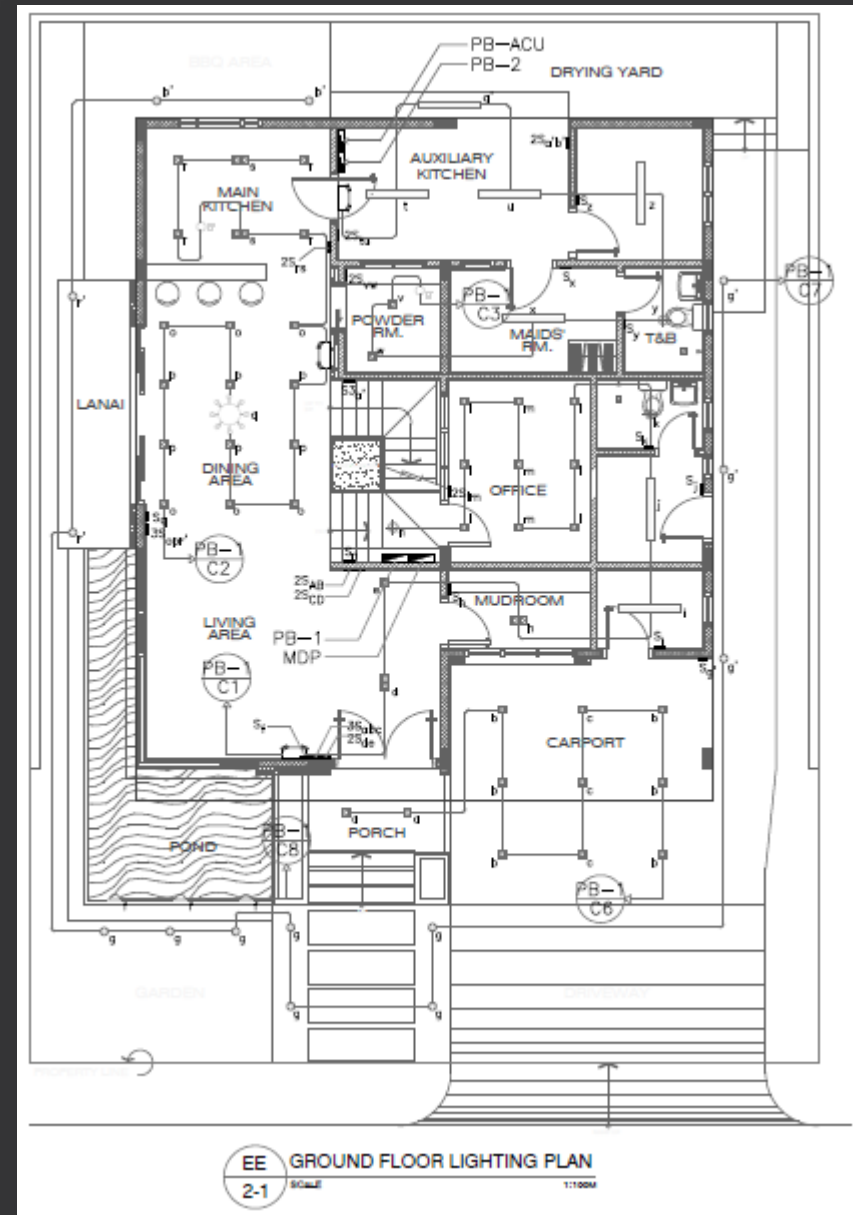


B. Legend and Symbols (Appendix A – Electrical Symbols)

Appendix A. Electrical Symbols		
No.	DESCRIPTION	SYMBOL
1.0 GENERAL ELECTRICAL SYMBOLS		
1.1	Lightning Arrester	
1.2	Surge Arrester	
1.3	Ground (Earth)	
1.4	Ground (Frame)	
1.5	Service Entrance (Power)	
1.6	Service Entrance (Telephone)	
1.7	Kilowatt-Hour Meter	
1.8	Safety Switch	
1.9	Disconnect Switch	
1.10	Transfer Switch	
1.11	Circuit Breaker	
1.12	Fuse	
1.13	Fuse Cutout	
1.14	Main Distribution Panelboard	
1.15	Power Panelboard	
1.16	Lighting Panelboard	
1.17	Motor Controller, 3 Pole Across-The-Line	

APPENDIX A – ELECTRICAL SYMBOLS		
No.	DESCRIPTION	SYMBOL
1.18	Combination Type Motor, Controller; ATL Starter Plus Fused Disconnect Switch	
1.19	Combination Type Motor, Controller; ATL Starter Plus Circuit Breaker	
1.20	Outlets	Ceiling Wall
	1. Incandescent Lamp	
	2. Vapor Discharge Lamp	
	3. Drop Cord Lamp	
	4. Exit Lamp	
	5. Fluorescent Lamp	
	6. Lamp Outlet with Pull Switch	
	7. Outlet with Blank Cover	
	8. Fan	
	9. Clock	
	10. Single Convenience	
	11. Duplex Convenience	
	12. Weatherproof Convenience	
	13. Cooking Range	
	14. Convenience with Switch	
	15. Special Purpose (ACU, WH, D, R, etc.)	
	16. Floor (P,T,I)	
	17. Antenna	
	18. Microphone	
	19. Telephone	
	20. Intercom	

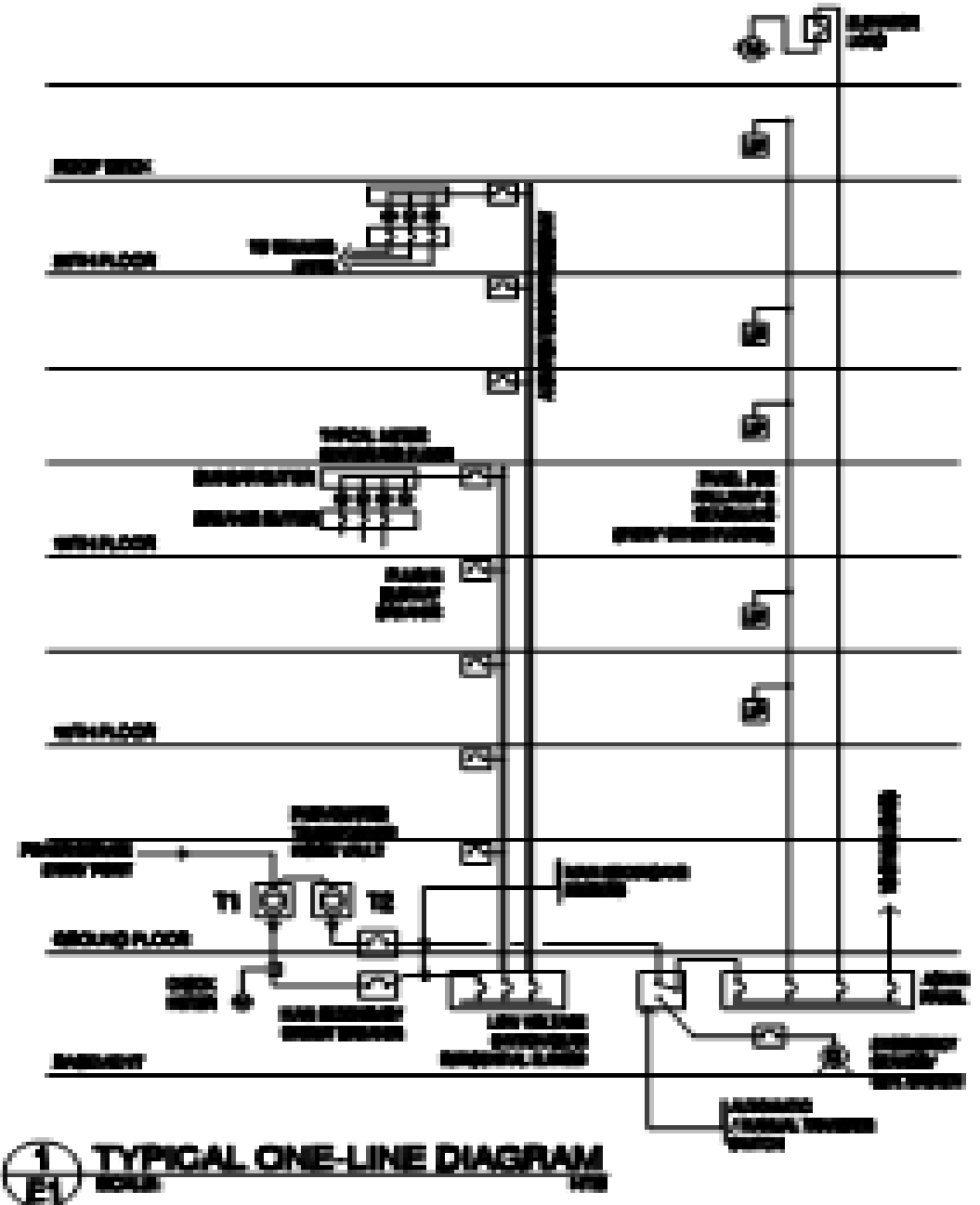
C. Electrical layout- floor plan showing the location of equipment and devices and their interconnection wiring.



E. Schedule of Loads – tabulated form of motor loads, lightings and receptacle loads and other loads.

PB-1 LOCATION: GROUND FLR. (OUTSIDE OFFICE AREA)		PHASE	VOLTAGE	POWER (VA)	CURRENT (AMPERES)				PROTECTION				CONDUCTOR		CONDUIT mm.Ø PVC	
CIRCUIT NO.	LOAD DESCRIPTION				ØAB	ØBC	ØCA	ABC	AT	POLE	AF	kAIC	LINE (mm² THHN)	GROUNDING (mm² TW)		
1	LIGHTING OUTLET (10-DL1,2-DL2,2-FL,2-PL,1-EL)	SINGLE	230	244	1.06					15	2	100	4	2-3.5	1-2.0	15
2	LIGHTING OUTLET (16-DL1,2-DL2,1-CHNDLR,1-EL)	SINGLE	230	282	1.23					15	2	100	4	2-3.5	1-2.0	15
3	LIGHTING OUTLET (2-DL1,1-BF,5-FL,1-PL,1-EL)	SINGLE	230	356			1.55			15	2	100	4	2-3.5	1-2.0	15
4	7 – CONVENIENCE OUTLET	SINGLE	230	1400			6.09			20	2	100	4	2-5.5	1-2.0	15
5	7 – CONVENIENCE OUTLET	SINGLE	230	1400		6.09				20	2	100	4	2-5.5	1-2.0	15
6	LIGHTING OUTLET (11-DL1) – CARPORT LIGHTS	SINGLE	230	99		0.43				15	2	100	4	2-3.5	1-2.0	15
7	LIGHTING OUTLET (14-FWL) – OUTSIDE LIGHTS	SINGLE	230	126	0.55					15	2	100	4	2-3.5	1-2.0	15
8	LIGHTING OUTLET (3-WL) – POND LIGHTS	SINGLE	230	30	0.13					15	2	100	4	2-3.5	1-2.0	15
9	7 – CONVENIENCE OUTLET	SINGLE	230	1400			6.09			20	2	100	4	2-5.5	1-2.0	15
10	SPACE															
TOTAL CURRENT IN EACH PHASE						2.97	6.52	13.73								
TOTAL DEMAND LOAD (VA)		COMPUTATIONS:						MAIN CONDUCTOR				MAIN PROTECTION				
5,339		$I_C = (125\% \text{ of Highest Load} + 1.732 \times \text{Highest Phase Load} + \text{3phase Loads}) \times 0.8$ $= (1.25 \times 6.09 + 1.732 \times 13.73) \times 0.8$ $I_C = 25.115 \text{ Amps.}$						LINE	3-8.0mm² THHN			RATING	40AT / 100AF			
ENCLOSURE: NEMA-1								GROUNDING	1-5.5mm² TW			POLE/kAIC	3P/6kAIC			
								CONDUIT	15mmØ PVC			VOLTAGE RATING	240V, BOLT-ON TYPE			
								BRAND	PHELPS DODGE			BRAND	SQUARE-D			

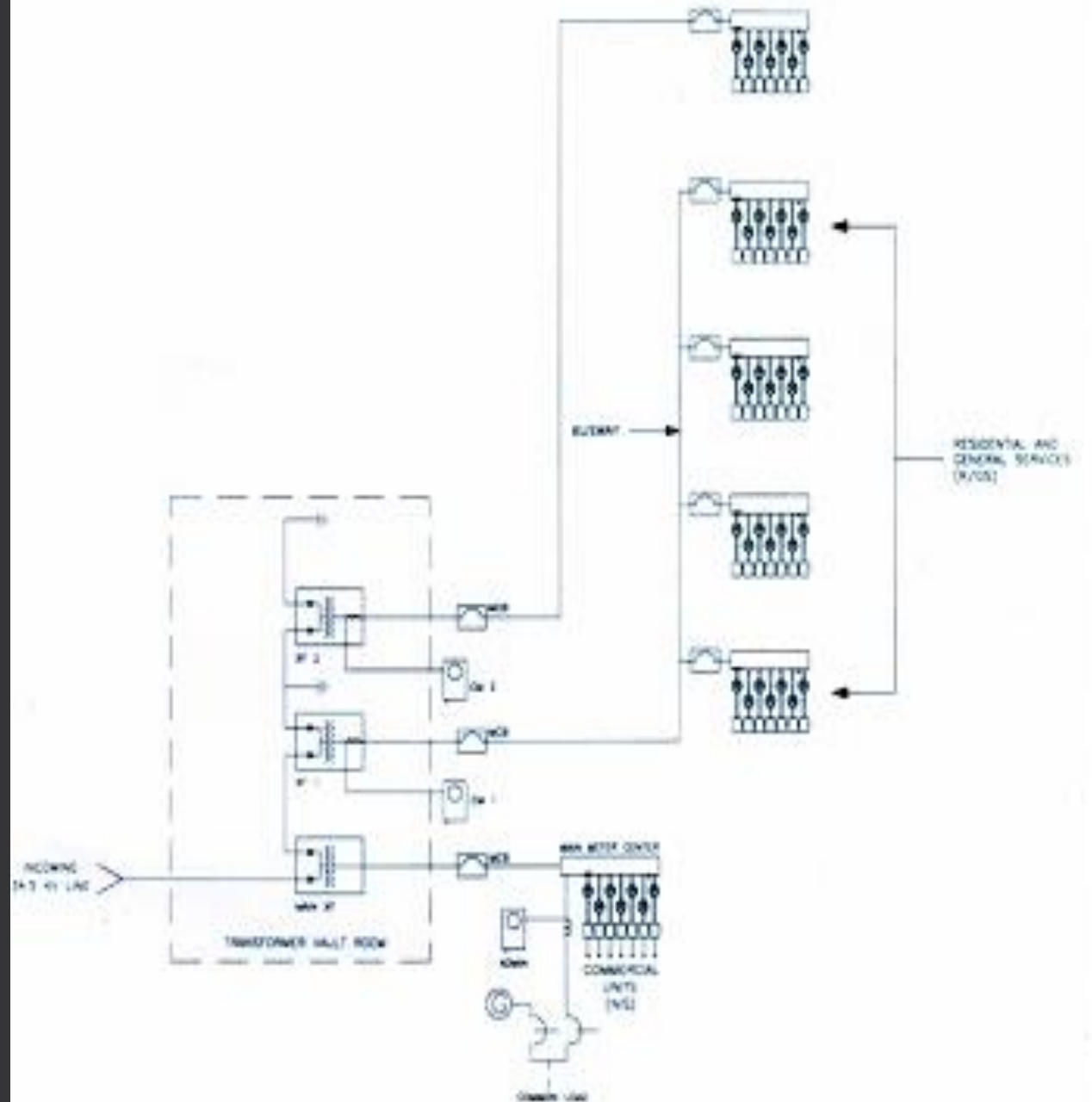
F. Single line riser diagram is a very important document in all electrical design. This diagram indicates by single lines and standard symbols, relative connection of major electrical equipment and component parts of an electric circuit or system of circuits.



G. Multi-metering per Floor Scheme

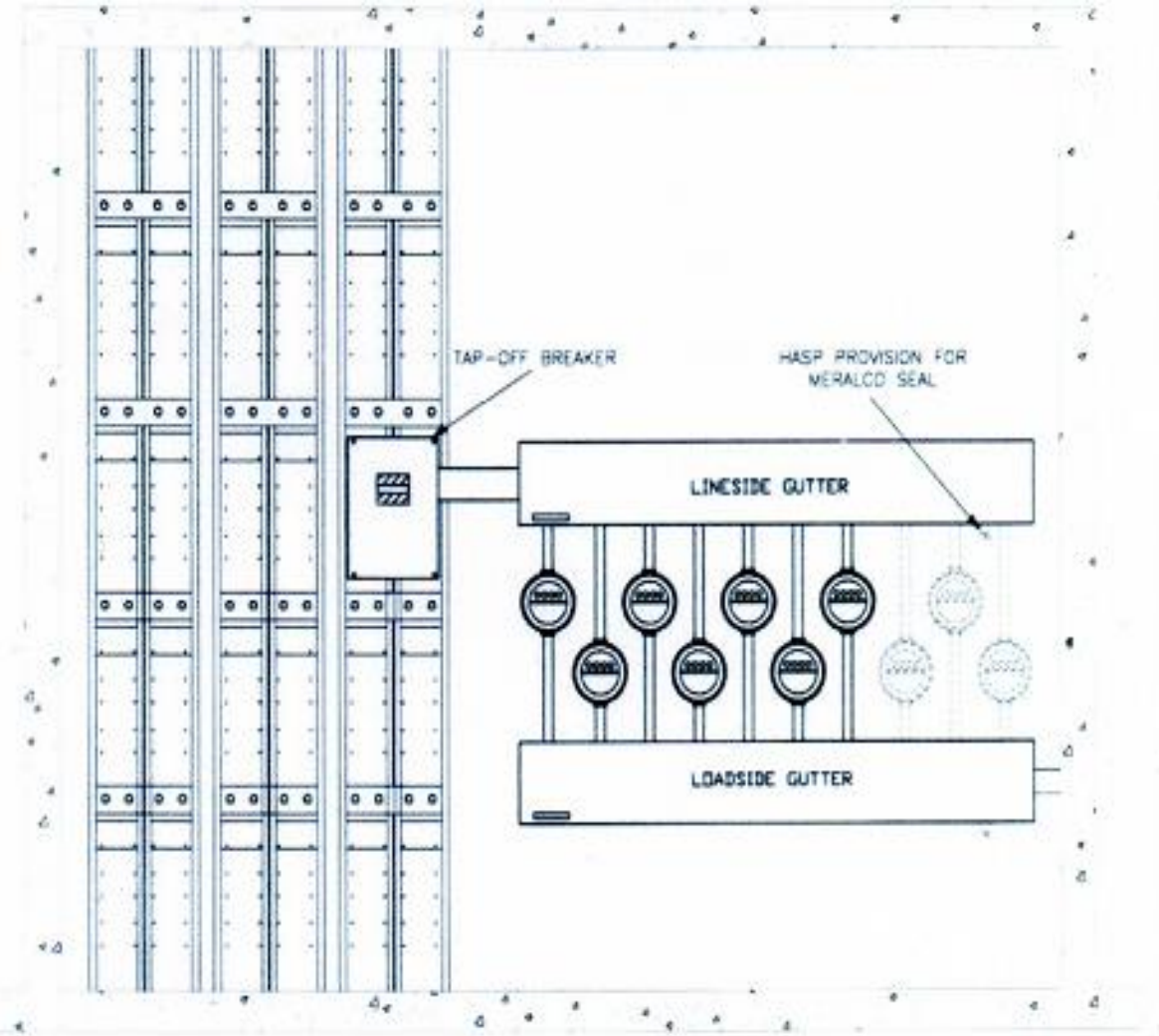
Power Single Line Diagram

(Separate XF for Residential and Commercial Units)



H. Multi-Metering Per Floor

METER CENTER ROOM)



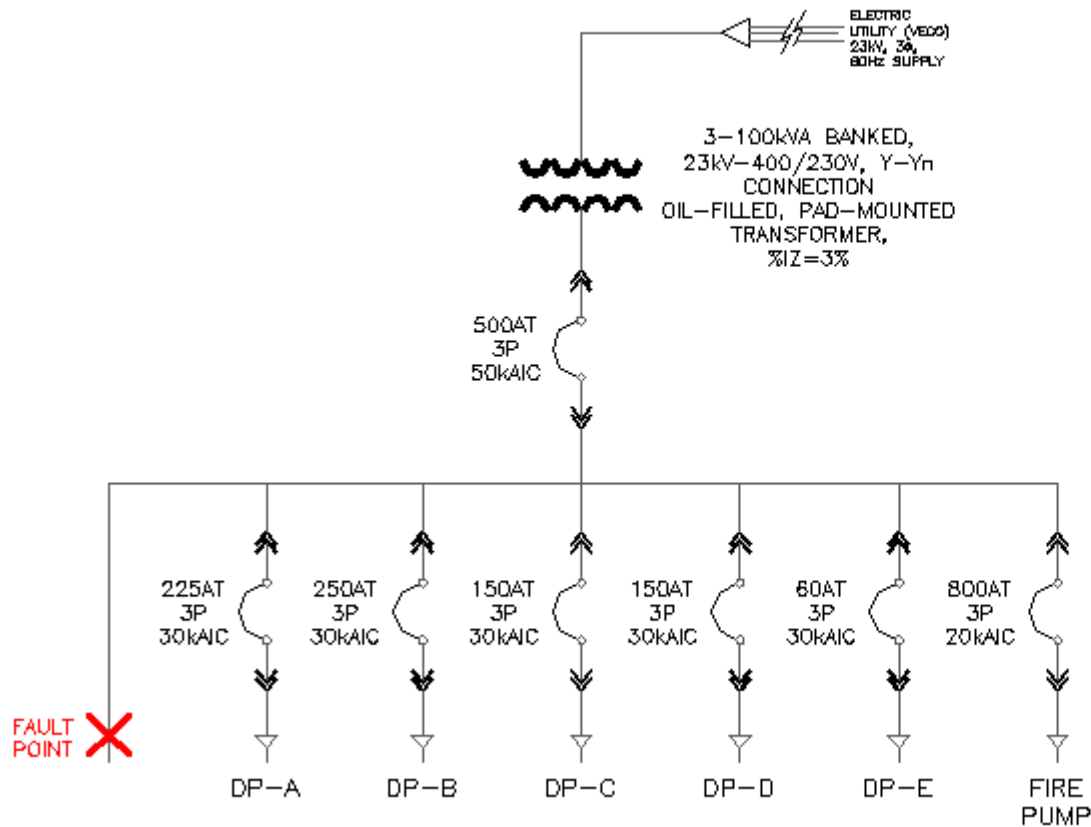
METER CENTER ROOM
SIDE VIEW
(SECTION THRU B-B)

I. Design analysis – design analysis shall be included on the drawing such as a.) branch circuit, feeders, setting and ratings of protective devices, b.) short circuit calculation, c.) voltage drop calculation and other necessary analysis.

MDP/MTS LOCATION: GROUND FLR. (OUTSIDE OFFICE AREA)		PHASE	VOLTAGE	POWER (VA)	CURRENT (AMPERES)				PROTECTION				CONDUCTOR		CONDUIT mm.Ø PVC	
CIRCUIT NO.	LOAD DESCRIPTION				ØAB	ØBC	ØCA	ABC	AT	POLE	AF	KAIC	LINE (mm ² THHN)	GROUNDING (mm ² TW)		
1	PB – 1	THREE	230	5,339	2.97	6.52	13.73		40	3	100	10	3–8.0	1–5.5	15	
2	PB – 2	THREE	230	5,750	17.95	7.25	6.7		60	3	100	10	3–14.0	1–5.5	20	
3	PB – 3	THREE	230	8,177	11.59	14.79	7.29		40	3	100	10	3–8.0	1–5.5	15	
4	PB – ACU	THREE	230	11,751.4	27.087	0.4	38.62		80	3	100	10	3–22.0	1–8.0	25	
5	SPACE															
TOTAL CURRENT IN EACH PHASE						59.6	28.96	66.34								
TOTAL CONNECTED LOAD = 31,017.4 VA		COMPUTATIONS:				MAIN CONDUCTOR				MAIN PROTECTION						
DEMAND FACTOR: 45% = 31,017.4(0.45)		$I_C = (125\% \text{ of Highest Load} + 1.732 \times \text{Highest Phase Load} + 3\text{phase Loads}) \times \text{D.F.}$ = (1.25x26.317 + 1.732x66.34)x0.8 $I_C = 118.240$ Amps.				LINE	3–50mm ² THW			RATING	125AT / 250AF					
TOTAL DEMAND LOAD: <u>13.958kVA</u>						GROUNDING	1–14mm ² TW			POLE/KAIC	3P/20KAIC					
						CONDUIT	32mmØ PVC			VOLTAGE RATING	240V, BOLT–ON TYPE					
						BRAND	PHELPS DODGE			BRAND	SQUARE–D					
GENERATOR UNIT SIZING:					MAIN CONDUCTOR				MAIN PROTECTION							
DEMAND LOAD: 13,957.83VA		$I_F = \frac{30,000}{1.732 \times 230} = 75.306$ Amps.				LINE	3–30mm ² THW			RATING	100AT / 125AF					
USE 30kVA/24kW, 3Ø, 230V, 60Hz, 1800rpm, DIESEL–DRIVEN GENERATOR SET		$I_C = 115\% \text{ of FLA}$ = 1.15(75.306) $I_C = 86.60$ Amps.				GROUNDING	1–8.0mm ² TW			POLE/KAIC	3P/20KAIC					
						CONDUIT	25mmØ PVC			VOLTAGE RATING	240V, BOLT–ON TYPE					
						BRAND	PHELPS DODGE			BRAND	SQUARE–D					

b. Short-Circuit Calculation

A.) SSMHJ ELECTRICAL SYSTEM SINGLE-LINE DIAGRAM:



B.) IMPEDANCE CALCULATION:

$$MVA_{BASE} = 100$$

$$kV_{BASE} = 0.38$$

B-1) 3-100kVA TRANSFORMER:

RATED LOAD: 300kVA or 0.3MVA
%IZ = 3%

$$X_{p.u. \text{ XMER}} = j0.03 \times \frac{100}{0.3}$$

$$X_{p.u. \text{ XMER}} = j10 \text{ p.u.}$$

C.) 3 ϕ SHORT-CIRCUIT CALCULATION:

$$I_{F3\phi} = I_{sc.p.u.} \times I_{sc.BASE}$$

$$I_{F3\phi} = \frac{1.0}{j10} \times \frac{100 \times 10^6}{1.732 \times 380}$$

$$I_{F3\phi} = 15,193.428 \text{ Amperes}$$

b. Voltage-Drop Calculations (continuation)

A-4.) POINT D VOLTAGE DROP

LINE: 3-14mm sq. THHN

FLC: 39.5A

DISTANCE: 4.65m

CONDUIT: PVC

FROM THE TABLE: (TABLE 9.1.1.9, PEC 2009 pg. 1506)

RESISTANCE(R) = 0.49 ohms/305m

INDUCTIVE REACTANCE(X_L) = 0.051 ohms/305m

SOLVING FOR THE CABLE IMPEDANCE:

$$R = \frac{0.49\Omega}{305m} \times 4.65m = 0.0075\Omega$$

$$X = \frac{0.051\Omega}{305m} \times 4.65m = 0.00078\Omega$$

$$VD_{\text{POINT D}} = 39.5 \sqrt{0.0075^2 + 0.00078^2}$$

$$VD_{\text{POINT D}} = 0.298 \text{ V}$$

A-5.) TOTAL VOLTAGE DROP FROM MDP/MTS TO 45kW ACCU :

$$VD_{\text{TOTAL}} = VD_{\text{POINT A}} + VD_{\text{POINT B}} + VD_{\text{POINT C}} + VD_{\text{POINT D}}$$

$$VD_{\text{TOTAL}} = 1.485 + 0.91 + 8.38 + 0.298$$

$$VD_{\text{TOTAL}} = 11.073\text{V}$$

A-6.) AMOUNT OF VOLTAGE SUPPLIED TO 45kW ACCU :

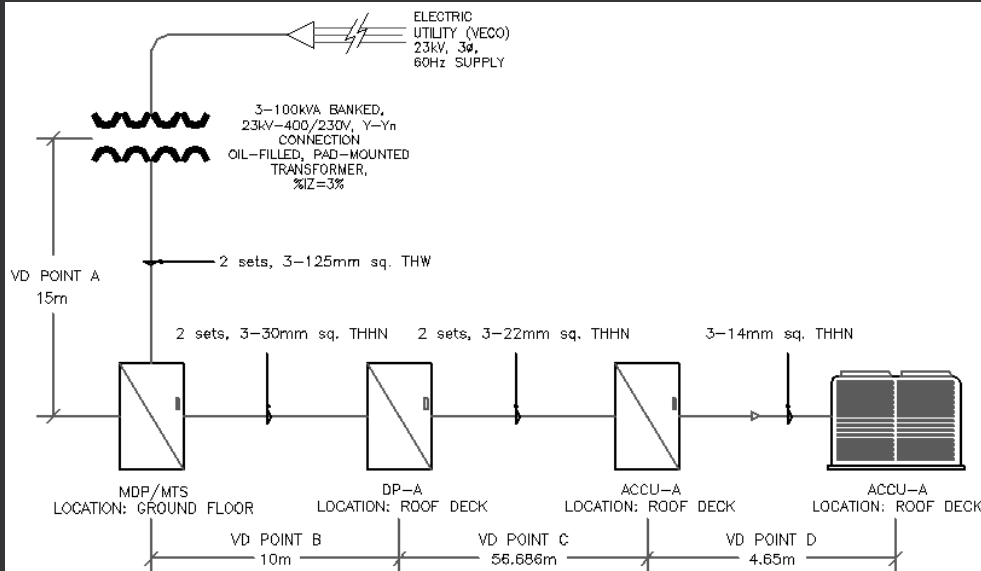
$$VD_{45\text{KW ACCU}} = 400\text{V} - 0.03(400\text{V}) - 11.073\text{V}$$

$$VD_{45\text{KW ACCU}} = 376.927\text{V}$$

*REMARKS:

- * THE VOLTAGE TOLERANCE LIMITS OF A STANDARD INDUCTION MOTOR AT $\pm 10\%$ OF NAMEPLATE RATINGS OF 230V AND 460V* (IEEE RED BOOK STD. 141-1993, RECOMMENDED PRACTICE FOR ELECTRIC POWER DISTRIBUTION PLANTS, pg.69)
- * SINCE THE VOLTAGE SUPPLIED TO THE 45kW ACCU IS 376.927V BASED ON THE CALCULATIONS, AND THE NAMEPLATE RATING OF THE ACCU MOTOR IS 400V, WE CAN CONSIDER A VOLTAGE TOLERANCE OF $\pm 10\%$, WHICH GIVE US AND ACCEPTABLE SUPPLY VOLTAGE OF 360V. THEREFORE, OUR VOLTAGE DROP IS OK SINCE WE HAVE A CALCULATED VOLTAGE OF 376.927V.

c. Voltage-Drop Calculations



A.) FARTHEST MOTOR LOAD FROM THE MDP: ACCU-A

A-1.) POINT A VOLTAGE DROP

LINE: 2sets, 3-125mm sq. THHN
 FLC: 455.802A
 DISTANCE: 15m
 CONDUIT: PVC

FROM THE TABLE: (TABLE 9.1.1.9, PEC 2009 pg. 1506)

RESISTANCE(R) = 0.052 ohms/305m
 INDUCTIVE REACTANCE(X_L) = 0.041 ohms/305m

SOLVING FOR THE CABLE IMPEDANCE:

$$R = \frac{0.052\Omega}{305m} \times 15m = 2.56 \times 10^{-3} \Omega$$

$$X = \frac{0.041\Omega}{305m} \times 15m = 2.016 \times 10^{-3} \Omega$$

$$VD = \sqrt{R^2 + X^2}$$

$$VD_{\text{POINT A}} = 455.802 \sqrt{(2.56 \times 10^{-3})^2 + (2.016 \times 10^{-3})^2}$$

$$VD_{\text{POINT A}} = 1.485 \text{ V}$$

A-2.) POINT B VOLTAGE DROP

LINE: 2sets, 3-30mm sq. THHN
 FLC: 141.94A
 DISTANCE: 10m
 CONDUIT: PVC

FROM THE TABLE: (TABLE 9.1.1.9, PEC 2009 pg. 1506)

RESISTANCE(R) = 0.19 ohms/305m

INDUCTIVE REACTANCE(X_L) = 0.045 ohms/305m

SOLVING FOR THE CABLE IMPEDANCE:

$$R = \frac{0.19\Omega}{305m} \times 10m = 6.23 \times 10^{-3} \Omega$$

$$X = \frac{0.045\Omega}{305m} \times 10m = 1.475 \times 10^{-3} \Omega$$

$$VD = \sqrt{R^2 + X^2}$$

$$VD_{\text{POINT B}} = 141.94 \sqrt{(6.23 \times 10^{-3})^2 + (1.475 \times 10^{-3})^2}$$

$$VD_{\text{POINT B}} = 0.91 \text{ V}$$

A-3.) POINT C VOLTAGE DROP

LINE: 2sets, 3-22mm sq. THHN
 FLC: 138.26A
 DISTANCE: 56.686m
 CONDUIT: PVC

FROM THE TABLE: (TABLE 9.1.1.9, PEC 2009 pg. 1506)

RESISTANCE(R) = 0.31 ohms/305m

INDUCTIVE REACTANCE(X_L) = 0.048 ohms/305m

SOLVING FOR THE CABLE IMPEDANCE:

$$R = \frac{0.31\Omega}{305m} \times 56.686m = 0.06 \Omega$$

$$X = \frac{0.045\Omega}{305m} \times 56.686m = 0.0084 \Omega$$

$$VD_{\text{POINT C}} = 138.26 \sqrt{0.06^2 + 0.0084^2}$$

$$VD_{\text{POINT C}} = 8.38 \text{ V}$$

Title Block

The title block or nameplate of plan and drawing shall be of standard strip of 40 mm high at the bottom of the sheet. It shall contain of the following:

- a. Name and location of installation or project;
- b. Name, signature and address of owner/manager/operator;
- c. Title sheet;
- d. Name, signature and seal of Professional Electrical Engineer together with the Professional Regulation Commission professional license number and validity, Professional Tax Receipt Number, and Tax Identification Number;
- e. Scale used, date drawn and;
- f. Sheet number

REPUBLIC OF THE PHILIPPINES
OFFICE OF THE BUILDING OFFICIAL
SORSOGON CITY

RECOMMENDING APPROVAL:

HEAD ELECTRICAL SECTION : DATE

APPROVED:

BUILDING OFFICIAL DATE

ROOM 302, KYROE BLDG. 4, DISTRICT 01, SORSOGON CITY, 6000
TEL/FAX NO. (052)204-4154 or (052)204-7741 for FAX, TEL. NO. 9022-028445
Email: erwin.salvador@multivector.com or erwin.salvador@ejs.com
PCAB LIC. NO. 37739



ERWIN J. SALVADOR
PROFESSIONAL ELECTRICAL ENGINEER

REG. NO. : 3442 DATE : 2011-10-03
PTR. NO. : 403388 DATE : 2014-01-07
T.I.N. : 209-322-176

SEAL :
SECTION 25-RA 545
The Professional Engineer shall be responsible for the design, construction, and maintenance of electrical systems in accordance with the National Electrical Code (NEC) and other applicable codes and standards. The Professional Engineer shall also be responsible for the safety of the electrical systems and the public.

PROJECT TITLE :
PROPOSED GAISANO SORSOGON
LOCATION :

PROJECT OWNER:
TAIPAN DEVT. INC.

SHEET CONTENTS
AS SHOWN

DESIGNED :	REVISIONS:		REMARKS	CAD.
	NO.	DATE		
CADD : ILG				
DATE :				
CHECKED :				
UPDATED :				

SHEET NO.
EE-9

THANK YOU AND GOD BLESS