

- **Job Briefing:** Ensure that the supervisor or designee conducts a job briefing with affected workers.
  - **Job Hazard Analysis:** Identify all hazards associated with the job and discuss them.
  - ✓ **Personal Protective Equipment (PPE):** Provide and use the appropriate PPE needed to accomplish the job safely.

### **Restricted Areas**

- ✓ Provide effective barriers or other means to ensure that people do not use areas with electrical circuits or equipment as passageways when energized lines or equipment are exposed.
- ✓ Isolate exposed high-voltage equipment to prevent unauthorized access.
- ✓ Post DANGER—HIGH VOLTAGE warning signs at entrances to these areas
- ✓ Temporary Fences, Barrier Tape, Synthetic Rope Barrier to isolate restricted areas from designated work areas and entryways.

## DESIGN STEPS :

### Current calculation:

- 3 Phase current equation:

$$\text{Full load current , } I_C = \frac{\text{Power}}{\sqrt{3} * \text{Voltage} * \cos\phi}$$

where ,  $\cos\phi$ -Power factor  
 $V = 400V$

Eg: Given: Total load of DB,P = 18kW  
System Power factor = 0.9  
Then, Current drawn by DB =  $P / (\sqrt{3} * V * \cos\phi)$   
=  $18 / (1.73 * 400 * 0.9)$   
= 28A

- Sizing of final Circuit

The relationship between the Circuit load current ( $I_C$ ), the Protective Device nominal current rating ( $I_n$ ), and the current carrying capacity of the Circuit conductors ( $I_d$ ),

$$I_C \leq I_n \leq I_d$$

$$\text{where, } I_d \geq 1.15 * I_n$$

$$\text{Current } I_C = \frac{\text{Power}}{\text{Voltage} * \cos\phi}$$

(1 Phase voltage-230V)



A 3 Phase, 5 kW Induction Motor has a P.F (Power factor) of 0.75 lagging.

What size of Capacitor in kVAR is required to improve the P.F (Power Factor) to 0.90?

Motor input =  $P = 5 \text{ kW}$

Original P.F =  $\cos \theta_1 = 0.75$

Final P.F =  $\cos \theta_2 = 0.90$

$\theta_1 = \cos^{-1} (0.75) = 41^\circ.41$ ;  $\tan \theta_1 = \tan (41^\circ.41) = 0.8819$

$\theta_2 = \cos^{-1} (0.90) = 25^\circ.84$ ;  $\tan \theta_2 = \tan (25^\circ.50) = 0.4843$

Required Capacitor kVAR to improve P.F from 0.75 to 0.90

Required Capacitor kVAR =  $P (\tan \theta_1 - \tan \theta_2)$

=  $5 \text{ kW} (0.8819 - 0.4843)$

= **1.99 kVAR**

And Rating of Capacitors connected in each Phase

$1.99/3 = \mathbf{0.663 \text{ kVAR}}$

## Glossary of terms and abbreviations

ACB -----

CB -----

CP -----

CEC -----

CPC -----

ECC -----

Air Circuit Breaker

Circuit-Breaker

Connection Point

Circuit Earth Conductor

Circuit Protective Conductor

Earth Continuity Conductor

EEB ----- Earthed Equipotential Bonding

EEBS ----- Earthed Equipotential Bonded System

E/F ----- Earth Fault (protective device)

ELCB ----- Earth Leakage Circuit-Breaker

ELP ----- Earth Leakage Protection

ELPS ----- Earth Leakage Protected System

ELV ----- Extra-Low Voltage

FCU ----- Fan Coil Unit

FDB ----- Final Distribution Board

HRC ----- High Rupture Capacity

MCB ----- Miniature Circuit-Breaker

MCCB ----- Moulded Case Circuit-Breaker

RCCB - Residual Current Circuit Breaker

RCD → Residual Current device

RCBO Residual ~~circuit~~ circuit Breaker  
overload protection

## Fault Current

- Maximum 3Phase fault current at LV shall be,
- 50kA(1 sec)-MDB
- 36kA(1 sec)-SMDB
- 25kA(1 sec)-DB

## Meters & ELR Ratings

- Final circuits with high leakage currents may be provided with ELP devices with higher residual current ratings, upto 500mA
- Usually used ELR rating –(300-500mA)
- Switchboards rated 400A must be provided with instruments for voltage, current, maximum demand & pf measurement as well as phase indication lamps.
- For current measurement CT meters are used.

## LV switch rooms


Minimum size of LV switchrooms	
Main circuit breaker rating (A)	Intake room dimensions (m)
1600 - 2500	3.5 x 3.5
1000 - 1200	3.0 x 3.0
600 - 800	2.5 x 2.5
400 - 500	2.5 x 2.0
200 - 300	2.0 x 2.0

## LV switch rooms

- Doors to Electricity Intake rooms must be arranged to open outwards, be kept free from obstructions, and be capable of being opened from the inside without the use of a key.
- The use of Electricity Intake rooms as storage rooms for any tools, equipment or other materials is prohibited.
- For Electricity Intake rooms greater than 6 m in length, more than one door shall be provided as a means of emergency access.

## Insulation resistance tests

- Insulation resistance should be checked between all live conductors, and between live conductors and Earth.
- For SELV and PELV systems, insulation resistance should be measured between the Extra-Low Voltage and higher Voltage conductors at a d.c. test Voltage of 500 V.



Circuit Nominal Voltage	Test Voltage (d.c.)	Minimum insulation resistance (M ohms)
SELV and PELV	250	0.25
up to 500 V	500	0.5

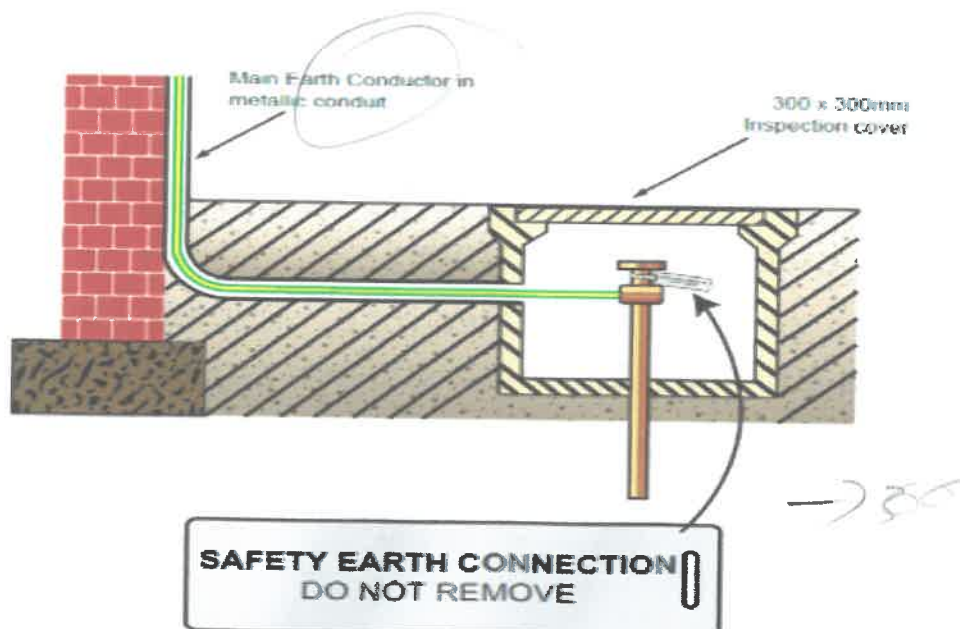
## Standby generator

- To maintain power in the case of a failure of the incoming supply
- Permitted only with the prior approval of the Distribution company
- Changeover circuit-breaker shall have 4 poles for a three-phase generator and 2 poles for a single-phase generator

## Minimum number of Earth Electrodes

Main incoming circuit-breaker rating (Amps)	Minimum number of Earth Electrodes	Minimum size of main Earth Conductor (mm <sup>2</sup> )
60/100	1	16
200	1	50
/ 300	1	50
/ 400	1	70
500	2	70
600	2	70
800	2	70
1000	2	70
/ 1600	2	70
/ 2000	2	150
2500	2	150

## Earth Electrode pit and standard labels





## Residual operating current settings

Equipment	Maximum Residual operating current settings (mA)
13 A switched-socket outlets	30
Water heaters	30
Kitchen fixed Appliances (e.g. washing machine)	30
Domestic water pumps	30
Swimming pool pumps, or jacuzzi	30
Underwater lighting	SELV only
General fixed lighting (except in bathrooms and swimming pools)	100
Floodlighting	100 - 300
Window or split type air-conditioning	100
Air handling, a/c fan coils etc	100
Central or package a/c units	100 - 300
Irrigation pump	100
Electric Cooker	30
Industrial machines etc	100 - 300
Elevators, escalators, lifts	300 - 500
Neon signs	300
School areas (e.g. laboratory for children)	10

## MCBs selection criteria

MCB nominal rating Amps	Cable size mm <sup>2</sup>	Cable rating at 30°C, PVC Amps, (kW)	Cable rating at 40°C, PVC Amps, (kW)	Typical Circuit application
6	1.5	17.5 (3.4)	15.2 (3.0)	Lighting (light load)
10	2.5	24.0 (4.7)	20.9 (4.1)	Lighting (heavy load)
16	2.5	24.0 (4.7)	20.9 (4.1)	Radial Circuit to socket-outlets
20	4.0	32.0 (6.3)	27.8 (5.4)	Radial Circuit to fixed appliance
32	2 x 4.0	48 (9.3)	41.7 (8.1)	Ring Circuit to socket-outlets
32	6.0	41.0 (8.0)	35.7 (7.0)	Radial Circuit to large Appliance (e.g. cooker)
40	10.0	67.0 (11.1)	49.6 (9.7)	Radial Circuit to machinery (e.g. chiller unit)

## Conduit Selection

Conductor (mm <sup>2</sup> )	Diameter of Conduit (mm)		
	20	25	32
	Maximum number of conductors		
1.5	7	12	-
2.5	5	9	12
4.0	3	6	9
6.0	-	5	8
10.0	-	3	6
16.0	-	-	4
25.0	-	-	3

## Cables

- For fixed wiring within Premises, PVC, rubber or XLPE insulated cables with stranded copper conductors must be used.
- For locations subject to a higher than normal risk of interference or damage, armoured cables are recommended.
- Armoured cables must be terminated using suitable cable glands which incorporate a suitably rated Earth tag.
- Solid-core copper or aluminium conductor cables are not permitted.

## Lighting

- Lighting Circuits will normally be fed from 6 A, 10 A or 16 A MCBs from a Final Distribution Board.
- The rating of lighting Circuits shall be selected in
  - accordance with the number of connection points to be
  - supplied, the type and rating of Luminaires to be used and
  - the Connected Load for the Circuit
- All Luminaires must be connected to Final Circuits using a ceiling rose or other purpose made connection point and not directly to such Circuits.
- Underwater lighting must be supplied by a Separated
- Extra-Low Voltage System (SELV) not exceeding 12 V a.c. or 30 V d.c.
- Emergency light fittings must comply with BS 5266 and shall be provided with a battery of minimum 3 hours rating.

## Approved and prohibited plugs and socket-outlets

Approved BS 1363 plug and socket (13 A fused)



Approved BS 548 plug and socket (15 A or 5 A unfused)



Prohibited CEE/CF similar plug and socket



## Minimum number of socket-outlets for domestic Electrical Installations

Room	Minimum number of outlets for domestic premises
<b>Kitchen:</b>	
13 A switched socket-outlets (worktops) ✓	Minimum 2 double, plus every 2 m of worktop
13 A switched socket-outlets (Appliances)	Minimum 1 single, plus as required for free standing Appliances (e.g. fridge)
Connection points (for washing machine, dryer etc)	Minimum 1, plus as required for number of items installed (flex outlets or socket-outlets)
Cooker control unit (if fitted with an integral socket-outlet)	1 (see note 5)
<b>Bedrooms</b>	3 double
<b>Lounge or dining</b>	4 double
<b>Hall or corridor</b>	1 double
<b>Bathrooms</b>	only BS EN 61558-2-5 shaver socket (if required)

Socket-outlets outside the arm's reach of water fountain	IPX6 + RCD of rating 30 mA
All Appliances, Luminaires and other Accessories Outside the arms reach in a water fountain	IPX5
Appliances, Luminaires or Accessories which are within Arm's Reach of a water fountain	IPX7 with SELV/PELV supply
Outdoor temporary Electrical Installations	IP55
Outdoor socket-outlets of temporary Electrical Installations	IP55 + RCD of rating 30 mA
External Lighting	IP55
Distribution boards and pedestals in marinas and similar locations	IP55 + corrosion resistant

#### A10. IP coding for ingress protection

Ingress protection: IP codes			
First digit: protection against ingress by solid objects		Second digit: protection against ingress of water	
X	Not tested or not applicable	X	Not tested or not applicable
0	No protection	0	No protection
1	Human hand or objects > 50mm	1	Vertically falling water
2	Human finger or objects > 12mm	2	Sprays of water < 15° from vertical
3	Objects > 2.5mm (e.g. tools or wires)	3	Sprays of water < 60° from vertical
4	Objects > 1.0mm (e.g. small wires)	4	Splashes of water (from any direction)
5	Limited protection against dust (to the extent that does not harm the equipment or impair safety)	5	Low pressure jets of water (from any direction)
6	Totally protected against dust	6	Strong jets of water (from any direction)
		7	Temporary immersion
		8	Total immersion



