

FIRE PROTECTION + RESIDENTIAL SMOKE ALARM SYSTEM

TO ALARM THE OCCUPANTS OF THE BUILDING IN THE EVENT OF FIRE BREAKS OUT.

SMOKE DETECTOR

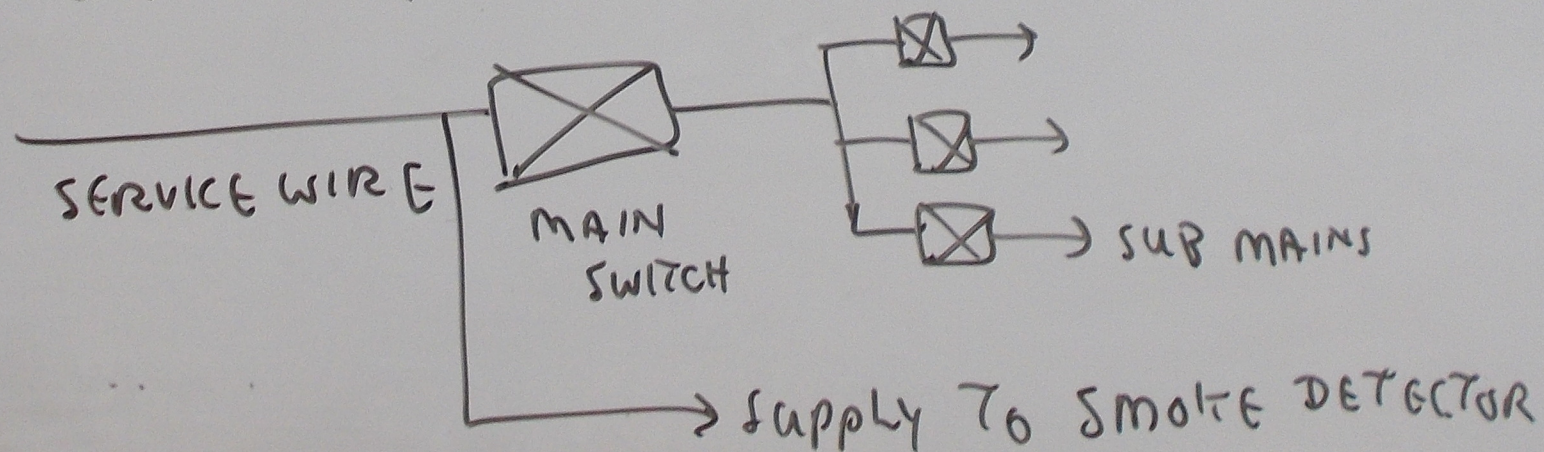
- DETECT THE SMOKE
- SOUND THE ALARM

SPRINKLER SYSTEM

- SMOKE / HEAT DETECTION + AUTOMATIC WATER SPRAYING

ELECTRICAL SUPPLY TO SMOKE DETECTOR

DIRECT THE ELECTRICAL SUPPLY TO SMOKE DETECTOR.
WHICH CAN NOT BE INTERRUPTED BY MAIN SWITCH.



SMOKE ALARM SYSTEM

BUILDING IN THE EVENT OF

WATER SPRAYING

KE DETECTOR

TO SMOKE DETECTOR.

PTED BY MAIN SWITCH.

→

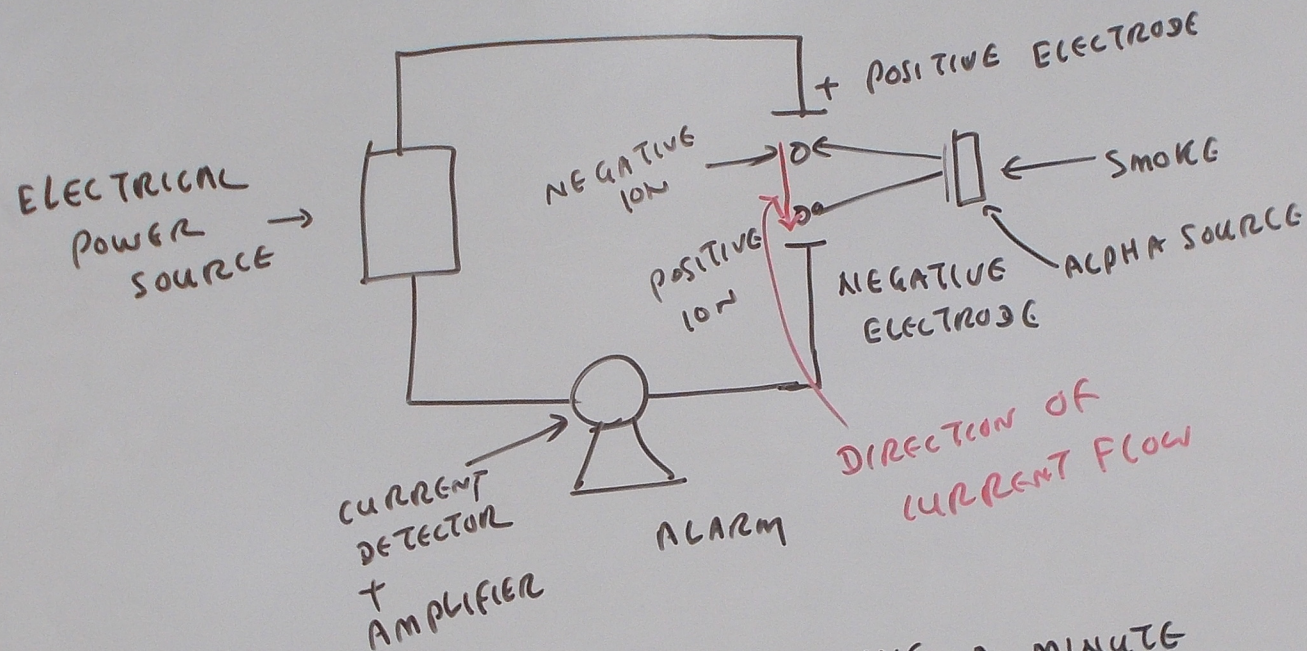
→

→ SUB MAINS

TO SMOKE DETECTOR

OPERATION OF SMOKE DETECTOR

QUESTION - WRITE THE OPERATION OF IONISATION SMOKE DETECTOR



AN IONISATION CHAMBER CONTAINING A MINUTE AMOUNT OF RADIO ACTIVE MATERIAL (AMERICIUM). UNDER NORMAL CONDITION, THE AIR CONTAINED IN THE IONISATION CHAMBER IS IONISED ALLOWING A SMALL CURRENT TO FLOW FROM BATTERY THROUGH THE CHAMBER.

WHEN SMOKE ENTERS THE CHAMBER, IT DISRUPTS THE CURRENT FLOW AND TRIGGERS AN ALARM.

IT IS MORE RESPONSIVE TO FLAME THAN TO FIRE.

QUESTION - ARE SMOKE ALARMS TO BE SAFETY DEVICES?

SMOKE ALARMS ARE NOT TO BE SAFETY SERVICE EQUIPMENT OF BS 5839 STANDARD.

TYPES OF SMOKE DETECTOR

- CARBON PARTICLE DETECTOR

- LIGHT DETECTOR

tion smoke

ELECTRODE

SMOKE

ALPHA SOURCE

OF
FLOW

MINUTE

AMERICIUM).

CONTAINED

USED ALLOWING

BATTERY THROUGH

WHEN SMOKE ENTERS THE CHAMBER, IT
DISRUPTS THE CURRENT FLOW AND ACTIVATES
AN ALARM.

IT IS MORE RESPONSIVE TO FLAMING
FIRE

QUESTION ARE SMOKE ALARMS CONSIDERED
TO BE SAFETY DEVICE?

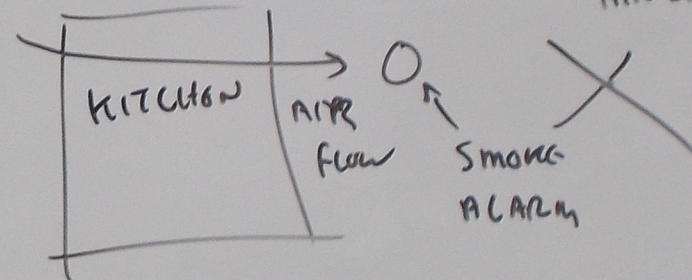
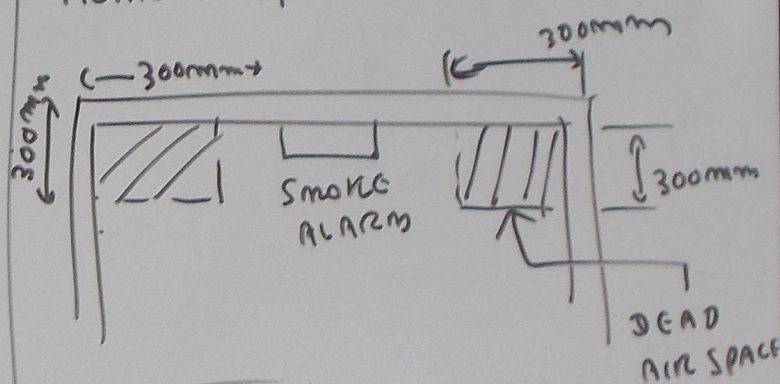
SMOKE ALARMS ARE NOT CONSIDERED
TO BE SAFETY SERVICE FOR THE PURPOSE
OF BS 3000 STANDARD.

TYPES OF SMOKE DETECTORS

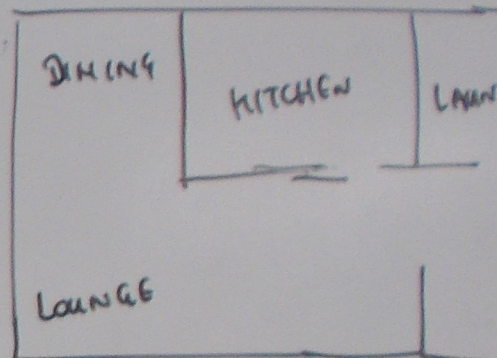
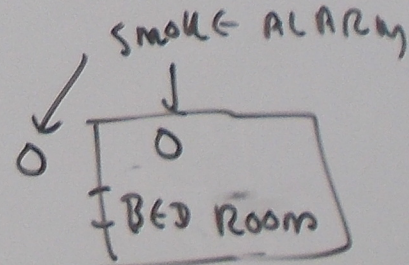
- CARBON PARTICLE DETECTOR
- LIGHT DETECTOR

INSTALLATION

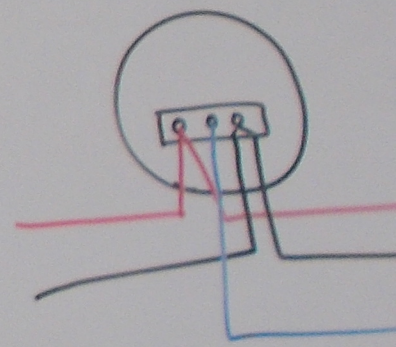
AVOID TO INSTALL THE SMOKE
ALARM AT DEAD AIR SPACE.



NOT IN BATH ROOM



SMOKE ALARM

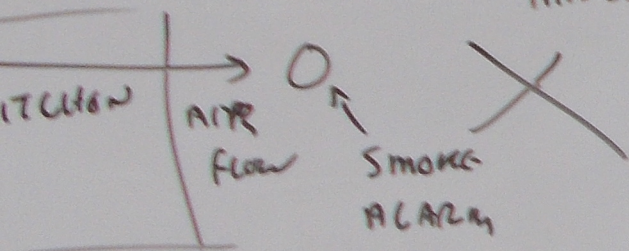
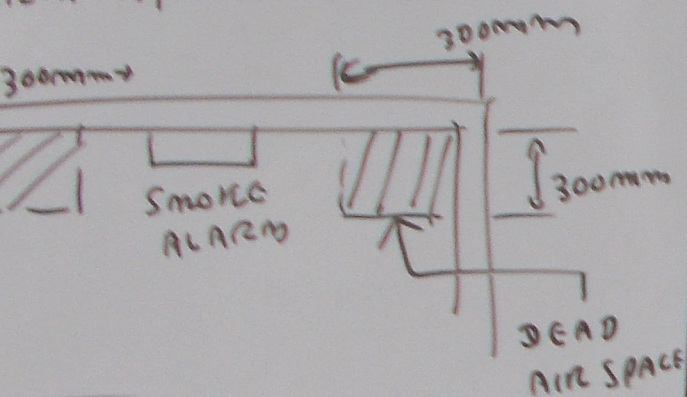


LOCATIONS OF

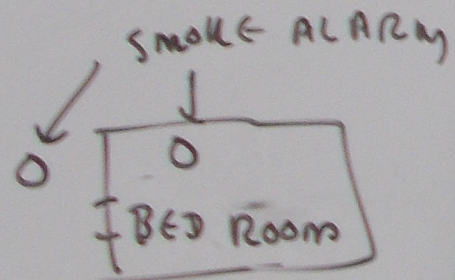
- close to B
- TOP of S
- OUTSIDE

INSTALLATION

DO NOT INSTALL THE SMOKE ALARM AT DEAD AIR SPACE.

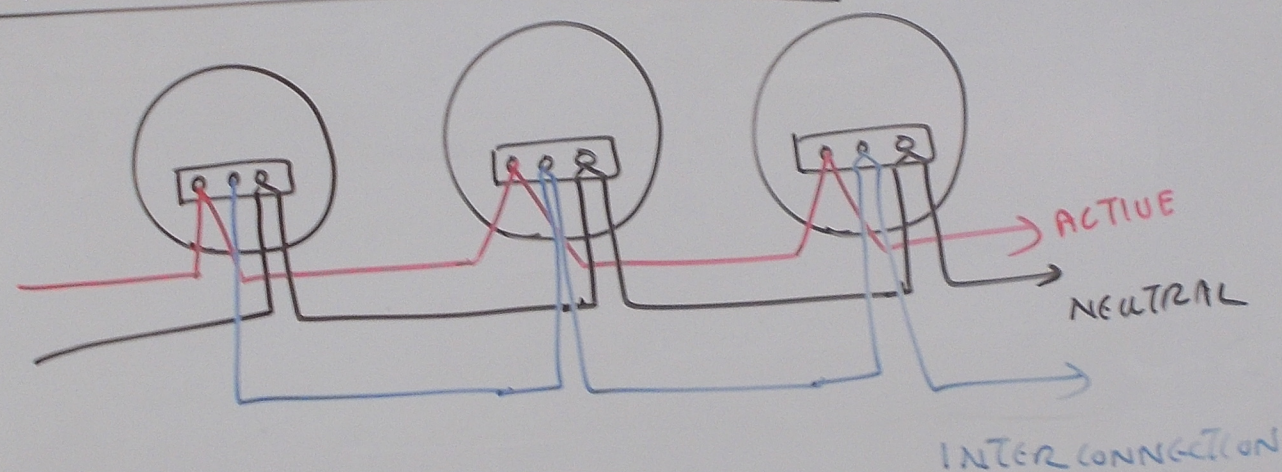


DO NOT INSTALL IN BATH ROOM



SMOKE ALARM

SMOKE ALARM ELECTRICAL WIRING



LOCATIONS OF SMOKE DETECTORS

- CLOSE TO BED ROOM
 - TOP OF STAIRS
 - OUTSIDE BED ROOM
- IONISATION SMOKE DETECTOR

IN KITCHEN → THERMAL SMOKE DETECTOR

LIMITATION

AVOID TO INSTALL SMOKE ALARM UNLESS THERMAL SMOKE DETECTOR

NOT IN

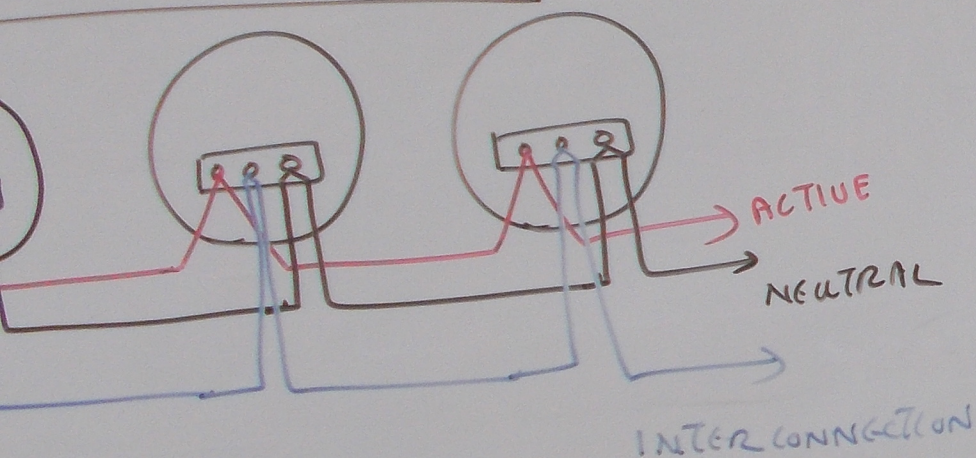
- BATHROOM
- GARAGE
- VERY HUMID AREA

3m FROM BATH ROOM
6.5m FROM GAS HEATER



● SMOKE ALARM

WIRING ELECTRICAL



of SMOKE DETECTORS

TO BED ROOM
OF STAIRS
SIDE BED ROOM

IONISATION
SMOKE
DETECTOR

IN KITCHEN → THERMAL
SMOKE
DETECTOR

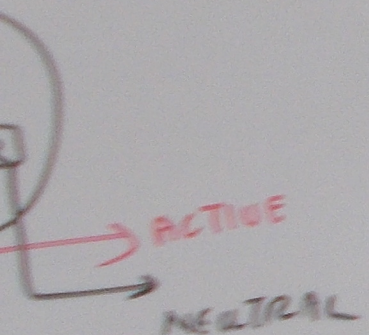
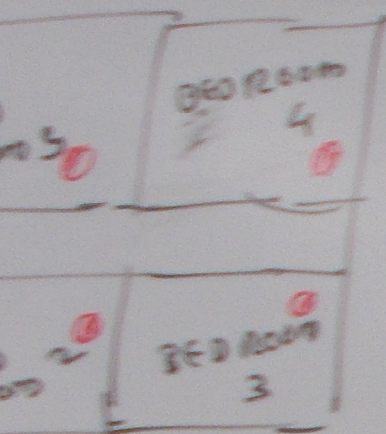
LIMITATION

AVOID TO INSTALL SMOKE ALARM IN KITCHEN
UNLESS THERMAL SMOKE DETECTOR IS USED

NOT IN

- BATHROOM
- GARAGE
- VERY HUMID AREA

3m FROM BATH ROOM
6.5m FROM GAS HEATER



INTER CONNECTION

IN KITCHEN → THERMAL SMOKE DETECTOR

LIMITATION

AVOID TO INSTALL SMOKE ALARM IN KITCHEN
UNLESS THERMAL SMOKE DETECTOR IS USED

NOT IN

- BATHROOM
- GARAGE
- VERY HUMID AREA

3m FROM BATH ROOM

6.5m FROM GAS HEATER

CABLE SELECTION

TABLES

AS 3000:2016 - TABLE S.1, S.2
8.1, 8.2

FROM MOODLE - ENPRA LOIA
WK 3+4, CH 3 CONTROL
AND PROTECTION STUDENT
WORK BOOK

PAGE 27 FIG 4-3-3.4

CABLE IMPEDANCE FOR
COPPER

PAGE 15 TABLE, CABLE SIZE, LENGTH
RESISTANCE

AS 3008

TABLE 34 → 39

TABLE 22, 25, 26

DERATED MAXIMUM
HRC FUSE PRO

ph A FACTORY INSTALLATION
400V SUPPLY WHICH HAS NO
NEUTRAL CONNECTION. THE MAX
CURRENT OF INSTALLATION IS CA
180 AMP / ph. THE GREATEST P
MAXIMUM DEMAND CURRENT
OVER THREE PHASES. THE
ARE 3 SINGLE CORE, NO
U90 INSULATED AND SHO
CABLE WITH COPPER COND
INSTALLATION OF CABLE PL
RIGID THERMO PLASTIC COND
GROUNDED AT THE DEPTH OF
AMBIENT SOIL TEMPERATURE

LIMITATION

AVOID TO INSTALL SMOKE ALARM IN KITCHEN
UNLESS THERMAL SMOKE DETECTOR IS USED

NOT IN

- BATHROOM
- GARAGE
- VERY HUMID AREA

3m FROM BATH ROOM
6.5m FROM GAS HEATER

CABLE SELECTION

TABLES

AS 3000:2016 - TABLE S.1, S.2
8.1, 8.2

FROM MODULE - ELECTRICAL
WKE 3+4, CH 3 WIRE
AND PROTECTION STUDENT
WORK BOOK

PAGE 27 FIG 4-3-3.4

CABLE IMPEDANCE FOR
COPPER

PAGE 15 TABLE, CABLE SIZE, LENGTH
RESISTANCE

AS 3008

TABLE 34 → 39

TABLE 22, 25, 26

DERATED MAXIMUM DEMAND FOR
HRC FUSE PROTECTION

ph A FACTORY INSTALLATION HAS A 3 ϕ
400V SUPPLY WHICH HAS MULTIPLE EARTHED
NEUTRAL CONNECTION. THE MAXIMUM DEMAND
CURRENT OF INSTALLATION IS CALCULATED AT
180 AMP/ph. THE GREATEST PORTION OF THE
MAXIMUM DEMAND CURRENT IS BALANCED
OVER THREE PHASES. THE ACTIVE CONDUCTORS
ARE 3 SINGLE CORE, NON ARMoured
V90 INSULATED AND SHEATHED CIRCULAR
CABLE WITH COPPER CONDUCTORS.
INSTALLATION OF CABLE PLACED THEM IN
RIGID THERMOPLASTIC CONDUIT BURED IN THE
GROUND AT THE DEPTH OF 500mm.
AMBIENT SOIL TEMPERATURE IS 25°C

THE CABLE
20°C/M
NEUTRAL
300 3

TWO MO
3 51
same

ASSUMING
IT DOES
ASSUM
IT DOES

ACTUAL
TO

20°C/M

AS 3008

TABLE 34 → 39

TABLE 22, 25, 26

DERATED MAXIMUM DEMAND FOR
HRC FUSE PROTECTION

pb A FACTORY INSTALLATION HAS A 3 ϕ
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INSTALLATION OF CABLE PLACED THEM IN
RIGID THERMOPLASTIC CONDUIT BURIED IN THE
GROUND AT THE DEPTH OF 500mm.
AMBIENT SOIL TEMPERATURE IS 25°C

THE CABLES ARE PROTECTED BY CIRCUIT BREAKER.
DETERMINE THE CONDUCTOR SIZE AND THE SIZE OF
NEUTRAL WIRE. CABLE LENGTH IS 100m.
3(1) 3(2) - AIR, 3(3), 3(4) GROUND

THAT NO PLASTIC CONDUIT (UG) → 3(4)

3 SINGLE CORES - ITEM(2)

SAME ENCLOSURE - 22 | SEPARATE ENCLOSURE 26(2)

ASSUME SEPARATE ENCLOSURE 26(2)

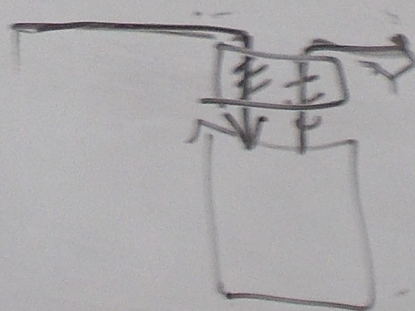
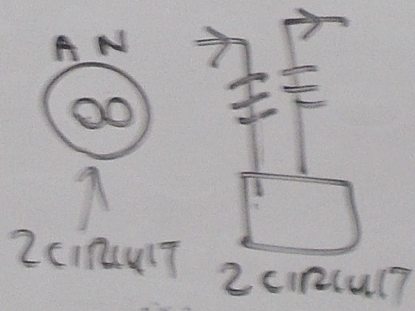
IT DOES NOT MENTION ABOUT NO. OF CIRCUITS.
ASSUME ACTIVE + NEUTRAL - 2 CIRCUITS.

IT DOES NOT SAY ABOUT SEPARATION → ASSUME TOUCHING

DERATING FACTOR = 0.9
ACTUAL CURRENT = $\frac{180}{0.9} = 200A$

TABLE 7/8 col 24-26
TABLE 9 16, 17

TOUCHING
V₉₀ - 90°C - TABLE (8)
col 24 - 26
SOLID STRAND COPPER
COL 24



SURG 22

30mm² → 203A

WIRING ENCLOSURE TABLE (41)

90°C (V₉₀)

70mm² → 0.623

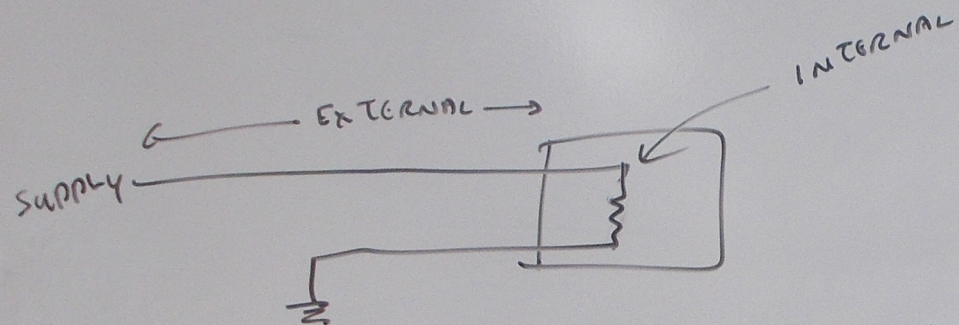
$$V_d = \frac{V_c L I}{1000} = \frac{0.623 \times 100 \times 200}{1000} = 12.46V$$

5% OF 415 = 20.75 | V_d (S) ACCEPTABLE

AS 3000
3.5.2 b 8W
ACTIVE
NEUTRAL
SAME
SIZE

ACTIVE
70mm²
NEUTRAL
70mm²

FAULT LOOP IMPEDANCE



ENPRA 101A WK 3+4, CH 3 STUDENT WORKBOOK
PAGE 15

CONDUCTOR SIZE LENGTH OF CABLE →

IMPEDANCE

PAGE 27

THE IMPEDANCE VALUE IS FOR
CALCULATING FAULT LOOP IMPEDANCE

$$Z_s = \frac{U_0}{I_a}$$

Z_s = TOTAL EARTH FAULT LOOP
IMPEDANCE (Ω)

U_0 = NOMINAL PHASE VOLTAGE
(V)

I_a = CURRENT CAUSING AUTOMATIC
OPERATION OF PROTECTIVE
DEVICE

TYPE (B) C.B. $I_a = 4 \times$ RATED CURRENT
OF C.B.

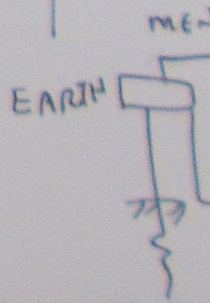
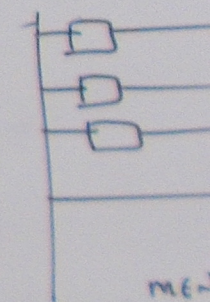
TYPE (C) C.B. $I_a = 7.5 \times$ RATED
CURRENT OF
C.B.

TYPE (D) C.B. $I_a = 12.5 \times$ RATED
CURRENT OF
C.B.

MAXIMUM DE
CABLE SE
ARRANGEMENT
of CIRCUIT
LIGHTS / CIRCUIT
SOCKET / CIRCUIT

WIRING
DE

SING



FAULT LOOP
(Ω)

SE VOLTAGE

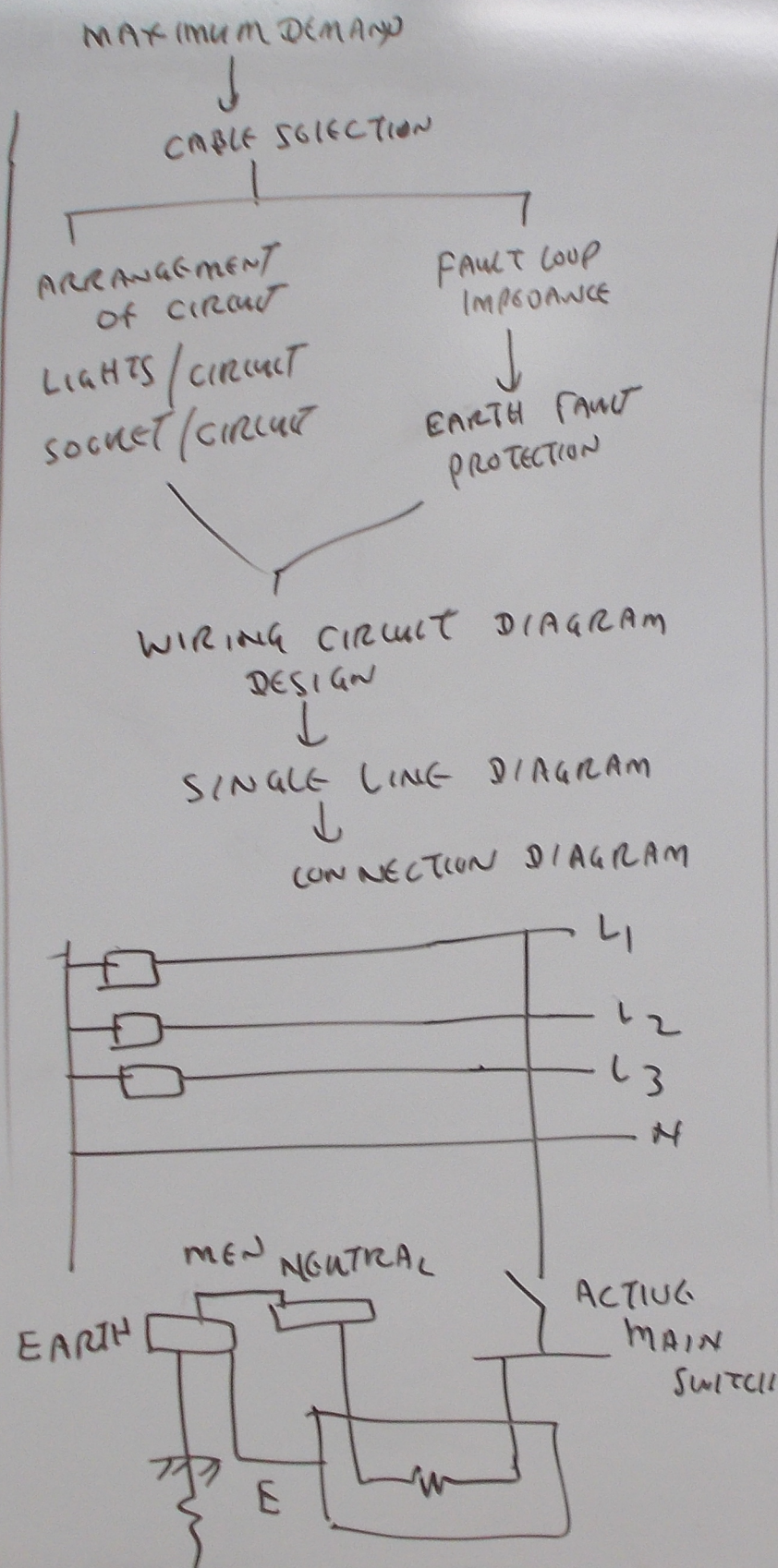
(V)

NG AUTOMATIC
F PROTECTIVE

$$I_a = 4 \times \text{RATED CURRENT OF C.B}$$

$$I_a = 7.5 \times \text{RATED CURRENT OF C.B}$$

$$I_a = 12.5 \times \text{RATED CURRENT OF C.B}$$



CABLE IMPEDANCE

AS 3008 TABLE 34 → 39

$$R = \frac{R_c \times L}{1000}$$

R = RESISTANCE OF CABLE Ω

R_c = TABLE VALUE IN Ω/km

L = LENGTH OF CABLE m

$$R = \frac{R_c L}{1000}$$

ENPR 101A WK 3+4 CH 3
STUDENT WORK BOOK
PAGES — USE DIRECTLY

CALCULATING AC RESISTANCE

EX X 6.5.1

CALCULATE AC RESISTANCE OF
IN 45m LENGTH OF 10mm²
(4C+E) V90 COPPER (Cu)

TABLE 34 — SINGLE CORE

— 35 — MULTI WIRE CIRCULAR

— 36 — MULTI CORE SHAPED

— 37 — FLEXIBLE

— 38 — MIMS

— 39 — SINGLE CORE REINFORCED

TABLE 35 — 4 CORE + 1
90C

10mm² — 2.33

$$R = \frac{R_c L}{1000} = \frac{2.33 \times 45}{1000}$$

CALCULATING AC RESISTANCE

Ex X 6.5.1

CALCULATE AC RESISTANCE OF A SINGLE CONDUCTOR IN 45m LENGTH OF 10mm² 4 CORE AND EARTH (4C+E) V90 COPPER (Cu) CABLE.

TABLE 34 - SINGLE CORE

- 35 - MULTI WIRE CIRCULAR ✓
- 36 - MULTI WIRE SHAPED
- 37 - FLEXIBLE
- 38 - MIMS
- 39 - SINGLE CORE AERIAL BARE

TABLE 35 - 4 CORE + E CIRCULAR

	90°C	
10mm ²	2.33	$R_c = 2.33$

$$R = \frac{R_c L}{1000} = \frac{2.33 \times 45}{1000} = 0.105 \Omega$$

INTERNAL EARTH FAULT LOOP IMPEDANCE

$$Z_{INT} = \frac{0.8 U_0}{I_a}$$

Ex X 6.5.5 EARTH FAULT LOOP IMPEDANCE

CALCULATE THE MAXIMUM PERMISSIBLE EARTH FAULT LOOP IMPEDANCE Z_{INT} OF THE CIRCUIT SUPPLYING A HOT WATER SERVICE TYPE (C) 20A MCB IN 230/400V INSTALLATION.

IF THIS CIRCUIT IS WIRED IN 2.5mm² 2C+E V90 ORANGE CIRCULAR CABLE AND LENGTH OF THE CABLE IS 60m.

(i) DETERMINE THE IMPEDANCE OF CABLE BETWEEN ACTIVE AND PROTECTIVE EARTHING CONDUCTORS

(ii) DOES THIS CIRCUIT COMPLIES WITH AS 3000 (OR) NOT

(iii) CALCULATE THE VOLTAGE DROP OF THIS SECTION OF CABLE.

$$Z_{INT} = \frac{0.8}{1} = 0.8$$

CABLE RESISTANCE
LESS THAN

CABLE R
2C+E
TABLE

$$R = \frac{R_c}{1000}$$

R

INTERNAL EARTH FAULT LOOP IMPEDANCE

$$Z_{INT} = \frac{0.8 U_0}{I_a}$$

EX X 6-S-S EARTH FAULT LOOP IMPEDANCE

CALCULATE THE MAXIMUM PERMISSIBLE EARTH FAULT LOOP IMPEDANCE Z_{INT} OF THE CIRCUIT SUPPLYING A HOT WATER SERVICE TYPE (C) 20A MCB IN 230/400V INSTALLATION.

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$$\begin{aligned} Z_{INT} &= \frac{0.8 U_0}{I_a} \\ &= \frac{0.8 \times 230}{7.5 \times 20} \leftarrow \text{TYPE (C)} \\ &= 1.227 \Omega \end{aligned}$$

CABLE RESISTANCE MUST BE

LESS THAN Z_{INT} $\rightarrow$ TO COMPLY WITH AS3000 AND EARTH LEAKAGE C.B WILL WORK

CABLE RESISTANCE = ?

2C+E — MULTICORE

TABLE 35

$$\begin{array}{c} 90^\circ\text{C} \\ | \\ 2.5\text{mm}^2 - 9.45 \leftarrow R_c \end{array}$$

$$R = \frac{R_c L}{1000} = \frac{9.45 \times 60}{1000} = 1.134$$

$$R < Z_{INT} - \text{COMPLY}$$

$$V_d = \frac{V_c L I}{1000}$$

$$I = 20\text{A}$$

$$L = 60\text{m}$$

$$V_c = ?$$

MULTICORE (2C)

$$2.5\text{mm}^2$$

$$V_d = \frac{16.1}{1000}$$

$$= 16.1$$

Not com

$$6\text{mm}^2$$

$$V_d =$$

$$U_0$$

$$\times 230$$

$$\times 20 \leftarrow \text{TYPE(C)}$$

2752

ce must be

$Z_{INT} \rightarrow$ TO COMPLY WITH
AS 3000
AND EARTH LEAKAGE
C.B WILL WORK

distance = ?

— MULTICORE

35

90°C

9.45 ← R_c

$$= \frac{9.45 \times 60}{1000} = 1.134$$

INT — comply

$$V_d = \frac{V_c L I}{1000}$$

$$I = 20A$$

$$L = 60m$$

$$V_c = ?$$

$$\text{MULTICORE}(2C+E) \rightarrow \text{TABLE 42}$$

90°C

$$2.5mm^2 \rightarrow 16.4 \text{ mV/A.m}$$

$$V_d = \frac{16.4 \times 60 \times 20}{1000}$$

$$= 19.68 \text{ V}$$

NOT comply

90°C

$$6mm^2 \rightarrow 6.2$$

$$V_d = \frac{6.2 \times 60 \times 20}{1000}$$

$$= 8.16 \text{ V ACCEPTABLE}$$

REGULATE CABLE RESISTANCE TO
COMPARE WITH Z_{INT}

TABLE 35

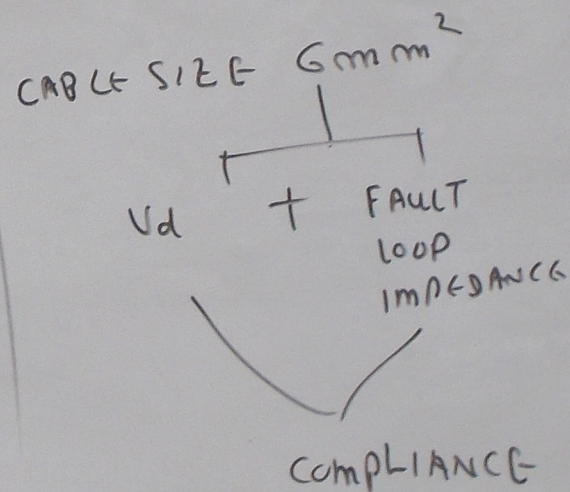
90°C

6mm² → 3.43

$$R = \frac{R_c L}{1000} = \frac{3.43 \times 60}{1000}$$

$$= 0.236 \Omega$$

$$R < Z_{INT} \text{ ACCEPTABLE}$$

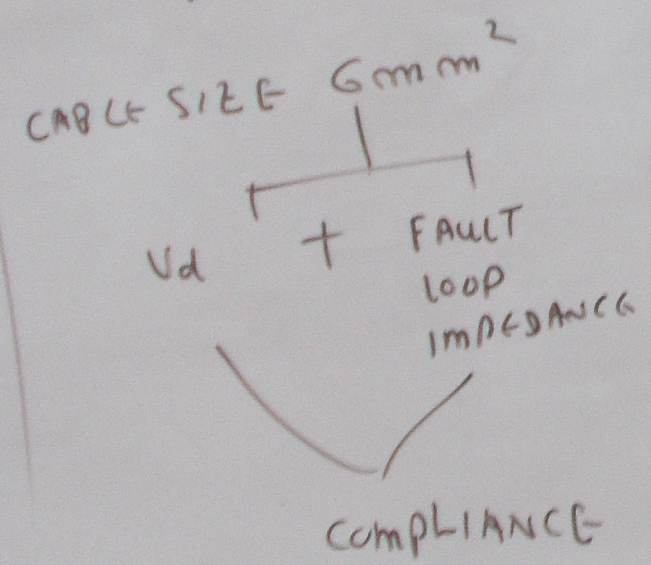


RECALCULATE CABLE RESISTANCE TO COMPARE WITH Z_{INT}

TABLE 35 $\downarrow$ 90°C
6mm² $\rightarrow$ 3.43

$$R = \frac{R_c L}{1000} = \frac{3.43 \times 60}{1000} = 0.206 \Omega$$

$R < Z_{INT}$ ACCEPTABLE



MAXIMUM LENGTH OF CONDUCTOR

$$L_{max} = \frac{0.8 U_0 S_{ph} S_{pe}}{I_a \rho (S_{ph} + S_{pe})}$$

L_{max} = MAXIMUM ROUTE LENGTH IN METRE

U_0 = NOMINAL PHASE VOLTAGE VOLT

ρ = RESISTIVITY (COPPER $22.5 \times 10^{-3} \Omega \cdot \text{mm}^2/\text{m}$)

I_a = CURRENT CAUSING INSTANTANEOUS OPERATION OF CIB

S_{ph} = CROSS SECTIONAL AREA OF ACTIVE CONDUCTOR

S_{pe} = CROSS SECTIONAL AREA OF PROTECTIVE EARTHING CONDUCTOR

EX G.S.G. CALCULATE MAXIMUM ROUTE LENGTH 4mm² (2C+E)

U_0 CIRCUIT SUPPLYING A WORK TOP PROTECTED BY C25A
CIPSAL MCB IN 230/400V INSTALLATION

$U_0 = 230V$, $S_{ph} = 4\text{mm}^2$, $I_a = 7.5 \times 25$, $S_{pe} = ?$

TABLE S.1
ACTIVE COL 2

4mm² $\rightarrow$ 2.5mm²

$$L_{max} = \frac{0.8 \times 230 \times 4 \times 2.5}{7.5 \times 25 \times 22.5 \times 10^{-3} (4 + 2.5)} = 67\text{m}$$

Ex 6.5.7

POINT OF
SUPPLY

CONSUMER
MAIN

3φ

MAIN
SWITCH
BOARD

400A

SUBMAIN

150mm² XLPE CU

TREFOIL ON CABLE LADDER

$I_z = 403A$

MD = 150A, L = 300m

AS 3000 2-5.3.1 $I_B < I_N < I_z$

MAXIMUM DEMAND 150A (I_B)

400A

I

$I_N = 400A$

PROTECTIVE
DEVICE RATING

$I_z =$ CIRCUIT WIRING RATING = 403A

$I_B(150) < I_N(400) < I_z(403)$

IT COMPLIES WITH AS 3000 (2-5.3.1)

DISTRIBUTION
BOARD

Load

THE FAULT CURRENT
RATING OF CB
IS B x CB
RATING

$V_d = ?$

$$V_d = \frac{V_c L I}{1000}$$

IT DOES NOT SAY NO. OF CORE
ASSUME SINGLE CORE → TABLE 40

XLPE USUALLY HAS 90°C RATING
90°C

$$150\text{mm}^2 \rightarrow 0.316 \text{ mV/A-m}$$

$$V_d = \frac{0.316 \times 300 \times 150}{1000}$$

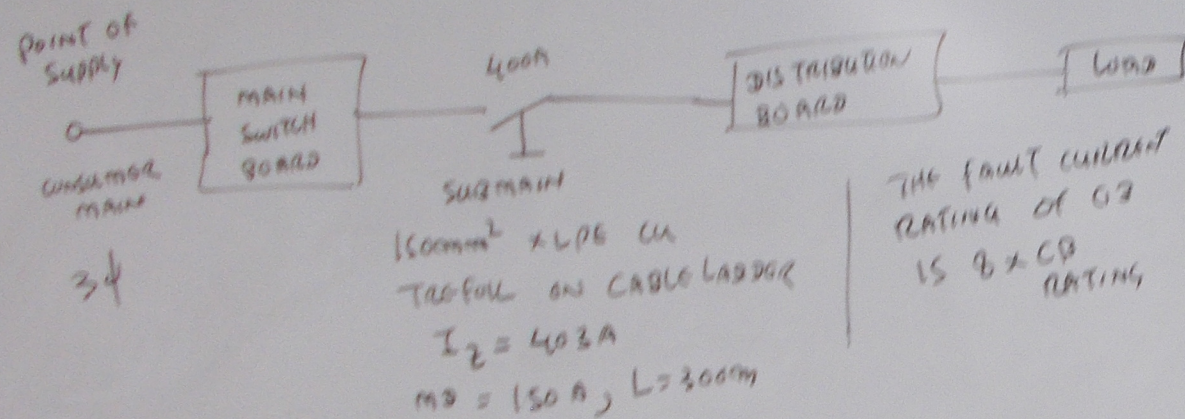
$$= 14.22V$$

SY. OF 400V = 20V

< SY.

ACCEPTABLE

Ex 6.5.7



THE FAULT CURRENT RATING OF CB IS 8 x CB RATING

AS 3000 2.5.3.1 $I_B < I_N < I_2$

MAXIMUM DEMAND 150A (I_B)

400A = I_N = 400A PROTECTIVE DEVICE RATING

I₂ = CIRCUIT WIRING RATING = 403A

I_B (150) / I_N (400) < I₂ (403)

IT COMPLIES WITH AS 3000 (2.5.3.1)

V_d = ?

$$V_d = \frac{V_c L I}{1000}$$

IT DOES NOT SAY NO. OF CORES
ASSUME SINGLE CORE → TABLE 40
XLPE USUALLY HAS 90°C RATING

$$150\text{mm}^2 \rightarrow 0.316 \text{ mV/A-m}$$

$$V_d = \frac{0.316 \times 300 \times 150}{1000}$$

$$= 14.22\text{V}$$

SY. OF 400V = 20V

< 5%

ACCEPTABLE

MAXIMUM LENGTH

$$Z_{int} = \frac{0.8 U_0}{I_a} = 0$$

IT NEEDS TO COM

ACTIVE

150mm²

SINGLE CORE - TABLE 34

90°C

ACTIVE 150mm²

0.16

EARTH 50mm² 0.44V

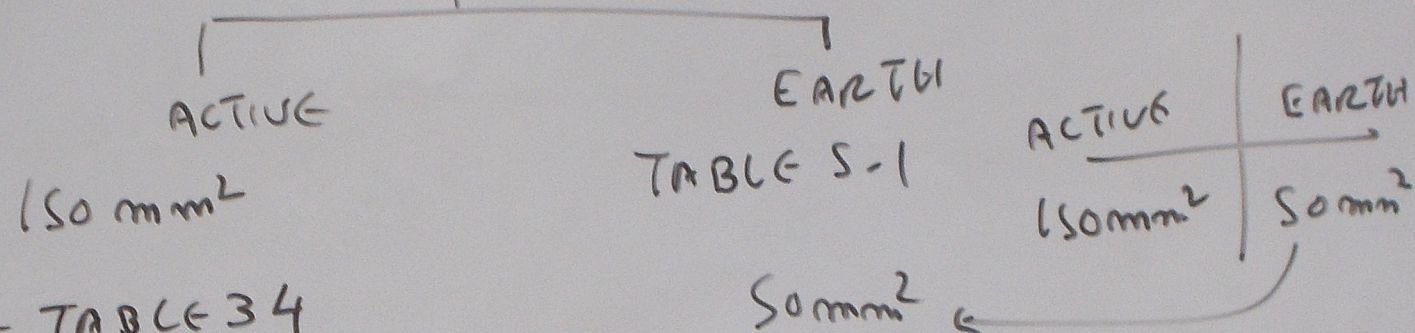
R m

NOW

MAXIMUM LENGTH

$$Z_{INT} = \frac{0.8 U_0}{I_a} = \frac{0.8 \times 230}{8 \times 400} = 0.0575 \Omega$$

IT NEEDS TO COMPARE WITH CABLE RESISTANCE



SINGLE CORE - TABLE 34

90°C

ACTIVE 150 mm² — 0.16 —→ $R_{PH} = \frac{R_c L}{1000} = \frac{0.16 \times 300}{1000} = 0.048 \Omega$

EARTH 50 mm² — 0.49V

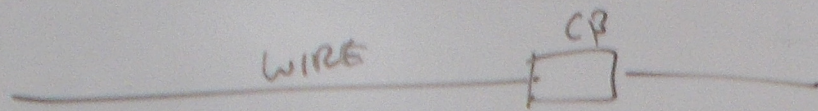
$$R_{PE} = \frac{0.494 \times 300}{1000} = 0.1482$$

$$R = R_{PH} + R_{PE} = 0.048 + 0.1482 = 0.1962$$

R must BE LESS THAN Z_{INT}

$$\text{NOW } Z_{INT} (0.0575) < R (0.1962)$$

NOT comply



CHANGE CB

$$Z_{INT} = \frac{0.8 \times 230}{B \times CB \text{ current}}$$

TO REDUCE

IT MUST BE LESS THAN 400A

CHANGE TO 150 A CB

$$Z_{INT} = \frac{0.8 \times 230}{B \times 150} = 0.153$$

IT DOES NOT COMPLY

INCREASE EARTHING CONDUCTOR TO 70mm²

TABLE 34

70mm² → 0.342

$$R_{pe} = \frac{0.342 \times 300}{1000}$$

$$= 0.1026 \Omega$$

$$R_T = R_{ph} + R_{pe} = 0.048 + 0.1026 = 0.1506 \Omega$$

$Z_{INT} > R_T$
ACCEPTABLE

CHANGING

① 150 A CB

② EARTHING CONDUCTOR → 70mm²