Seminar

"Electrical Design, Installation & Safety First for a Lasting Cable"

Organised by ST – MCMA

28th August 2018

Kuala Lumpur Convention Centre, Kuala Lumpur

Cable Design, Installation, Testing and Commissioning –

What are for Domestic & Non – Domestic Installations

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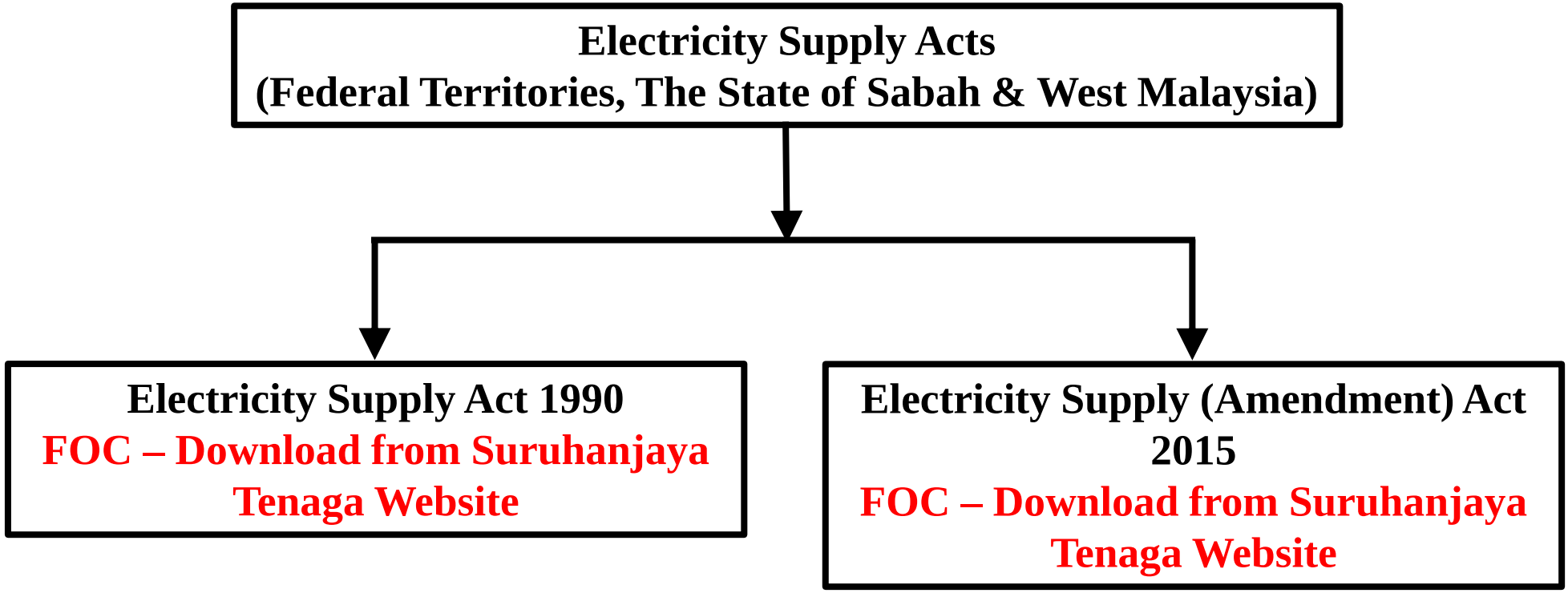
Malaysia Act (UK) 1963

Malaysia Act (UK) 1963
Electricity Acts & Ordinances,
&
Electricity Regulations & Rules

West Malaysia, Federal Territories &
The State of Sabah (Harmonised 1983)
Electricity Supply Acts
&
Electricity Regulations
IEE Wiring Regulations (Up to Year 1992) / IEC 60364 / BS 7671

The State of Sarawak
Electricity Ordinance Chapter 50
&
Electricity Rules 1999
IEE Wiring Regulations (Up to Year 1992) / BS 7671 (IEC 60364)

Electricity Supply Acts



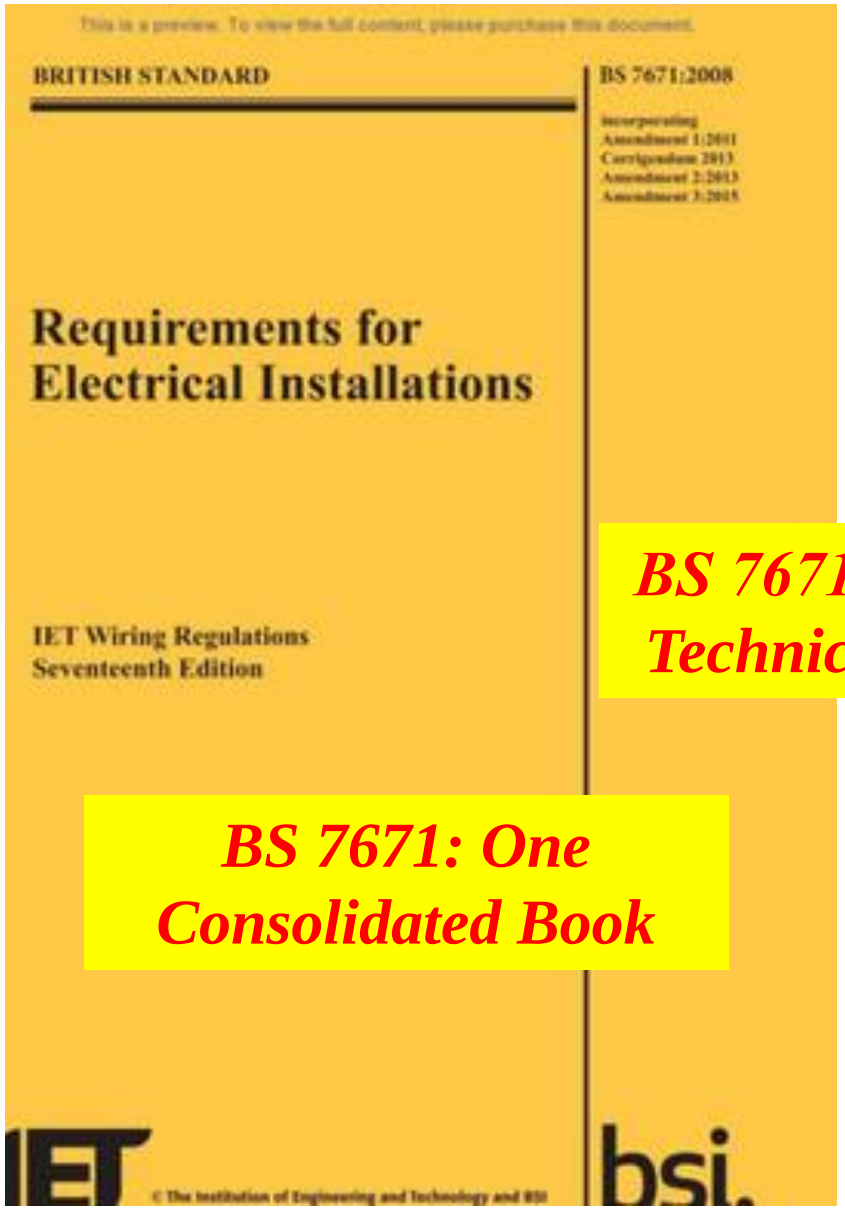
Electricity Regulations

Electricity Regulations
West Malaysia, Federal Territories and The State of Sabah

Electricity Supply Regulations 1990 (Revoked by Electricity Regulations 1994);
Electricity Regulations 1994
FOC – Download from Suruhanjaya Tenaga Website

Electricity (Amendment) Regulations 2013
Electricity (Amendment) Regulations 2014
Electricity (Amendment) (No. 2) Regulations 2014
FOC – Download from Suruhanjaya Tenaga Website

BS 7671: Harmonization with IEC 60364



BS 7671 ≈ IEC 60364
Technically Identical

BS 7671: One Consolidated Book

BS 7671: 2018

SPARKY NINJA™

BS 7671:2018

18th Edition

Part 8 - Energy Efficiency

The Mandatory Standards, Codes, Guides, etc.,

MS 1979: Domestic Installations

Rm 50-00
20 Aug 18

MS 1936: Non – Domestic Installations

Rm 110-00
20 Aug 18

The Mandatory Standards, Codes, Guides, etc.,

Suruhanjaya Tenaga
Energy Commission

Suruhanjaya Tenaga
Energy Commission

KOD/ST/No.4/2016

Date of Registration (Effective): 17th May 2017

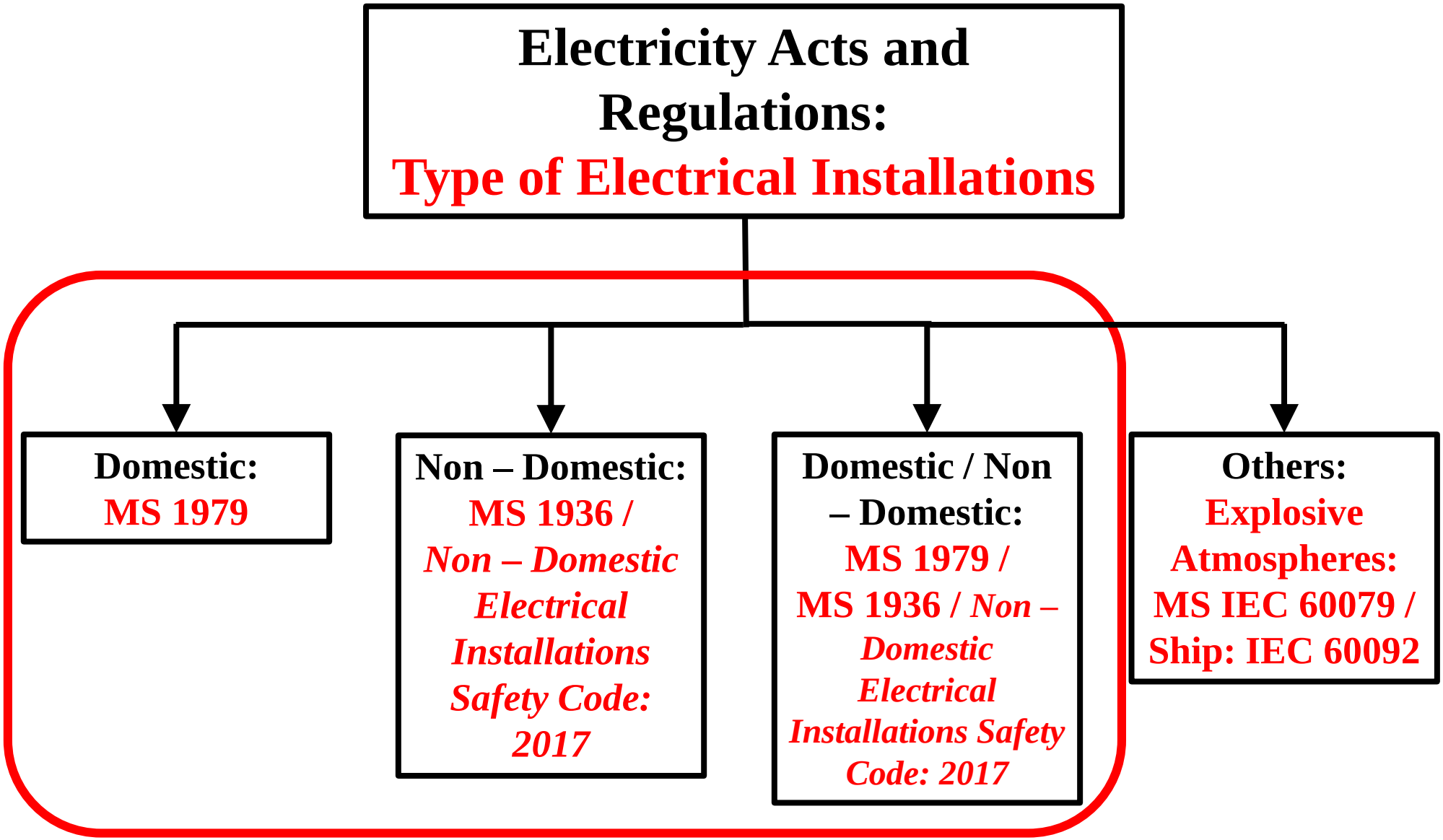
FOC: Suruhanjaya Tenaga Website

NON-DOMESTIC
ELECTRICAL
INSTALLATION
SAFETY CODE

GUIDELINE ON
ELECTRICAL
SAFETY
MANAGEMENT

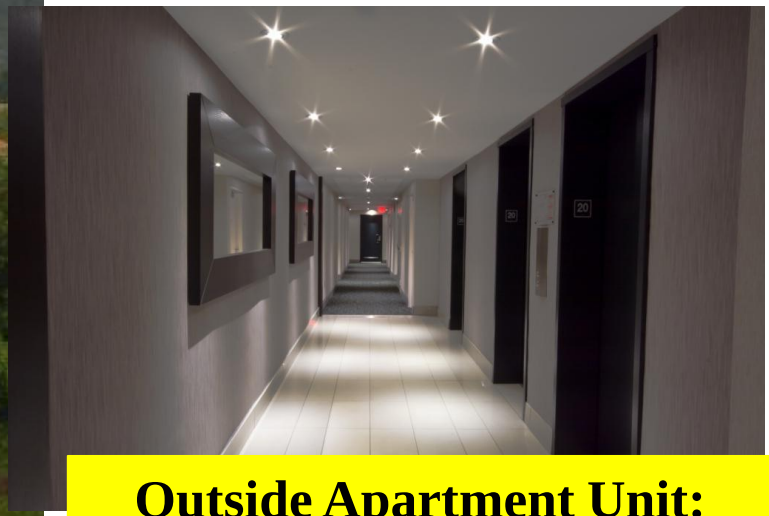
1.1.2 This code is developed in line with the requirement under section 33B of the Electricity Supply (Amendment) Act 2015 [Act A1501] which states that a non-domestic electrical installation owner or operator registered under this Act, licensee for retail and licensee for a private installation shall comply with the non-domestic electrical installation safety code and the safety management programme, or in the absence of such code or programme, with standards and prudent industry practices as may be determined by the Commission.

The Mandatory Standards, Codes, Guides, etc.,



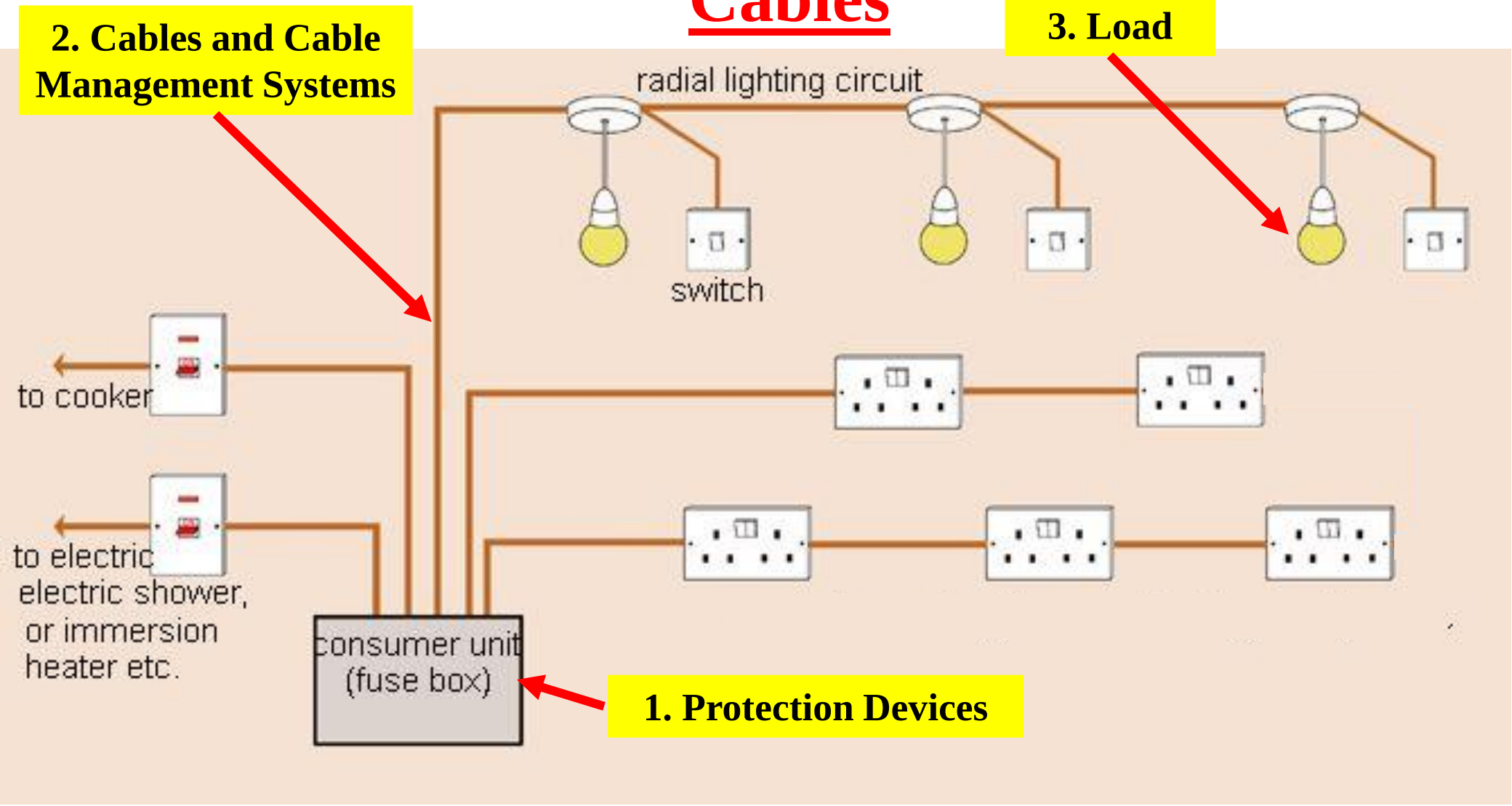
Domestic / Non – Domestic Electrical Installations

Inside Apartment Unit: Domestic



Outside Apartment Unit: Non – Domestic

The Electrical Installation Circuit: Safety of Cables



The Electrical Installation Circuit: Safety of Circuits

Objectives:

Selection, Sizing, Erection, Test and Commissioning, Operation and Maintenance of Safe and Reliable:

1. *Protection Devices;*
2. *Cables;*
3. *Cable Management Systems;*
4. *Accessories, Loads and Others*

Wiring Systems: BS 7671 /IEC 60364 – 5 – 521

Table 4A1 – Installation Methods in relation to conductors and cables

Conductors and cables		Installation Method							
		Without fixings	Clipped direct	Conduit systems	Cable trunking systems *	Cable ducting systems	Cable ladder, cable tray, cable brackets	On insulators	Support wire
Bare conductors		np	np	np	np	np	np	P	np
Non-sheathed cable		np	np	P[1]	P[1]	P[1]	np[1]	P	np
Sheathed cables (including armoured and mineral insulated)	Multi-core	P	P	P	P	P	P	n/a	P
	Single-core	n/a	P	P	P	P	P	n/a	P

P Permitted

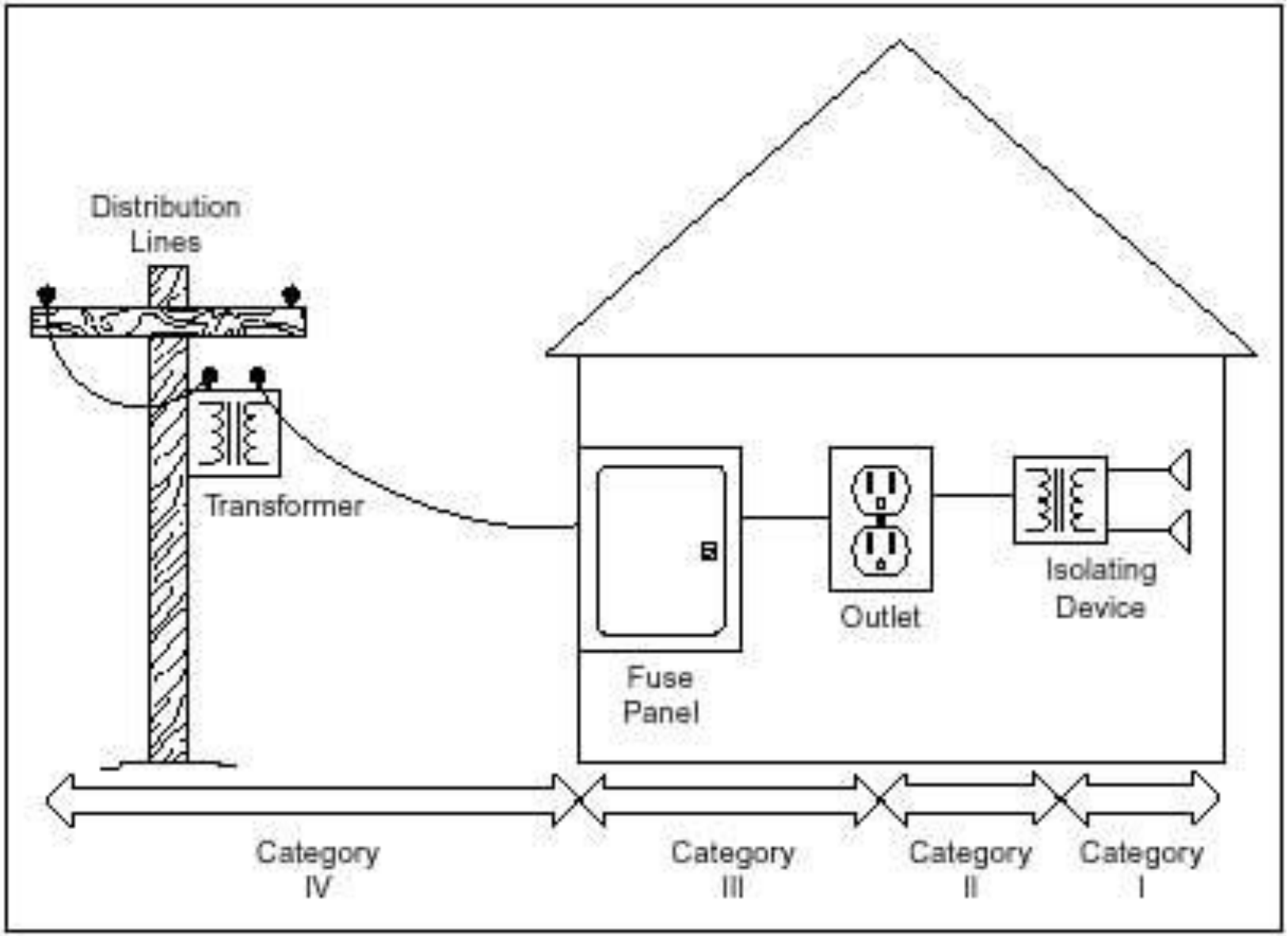
np Not permitted.

n/a Not applicable, or not normally used in practice.

* including skirting trunking and flush floor trunking

[1] Non-sheathed cables which are used as protective conductors or protective bonding conductors need not be laid in conduits or ducts

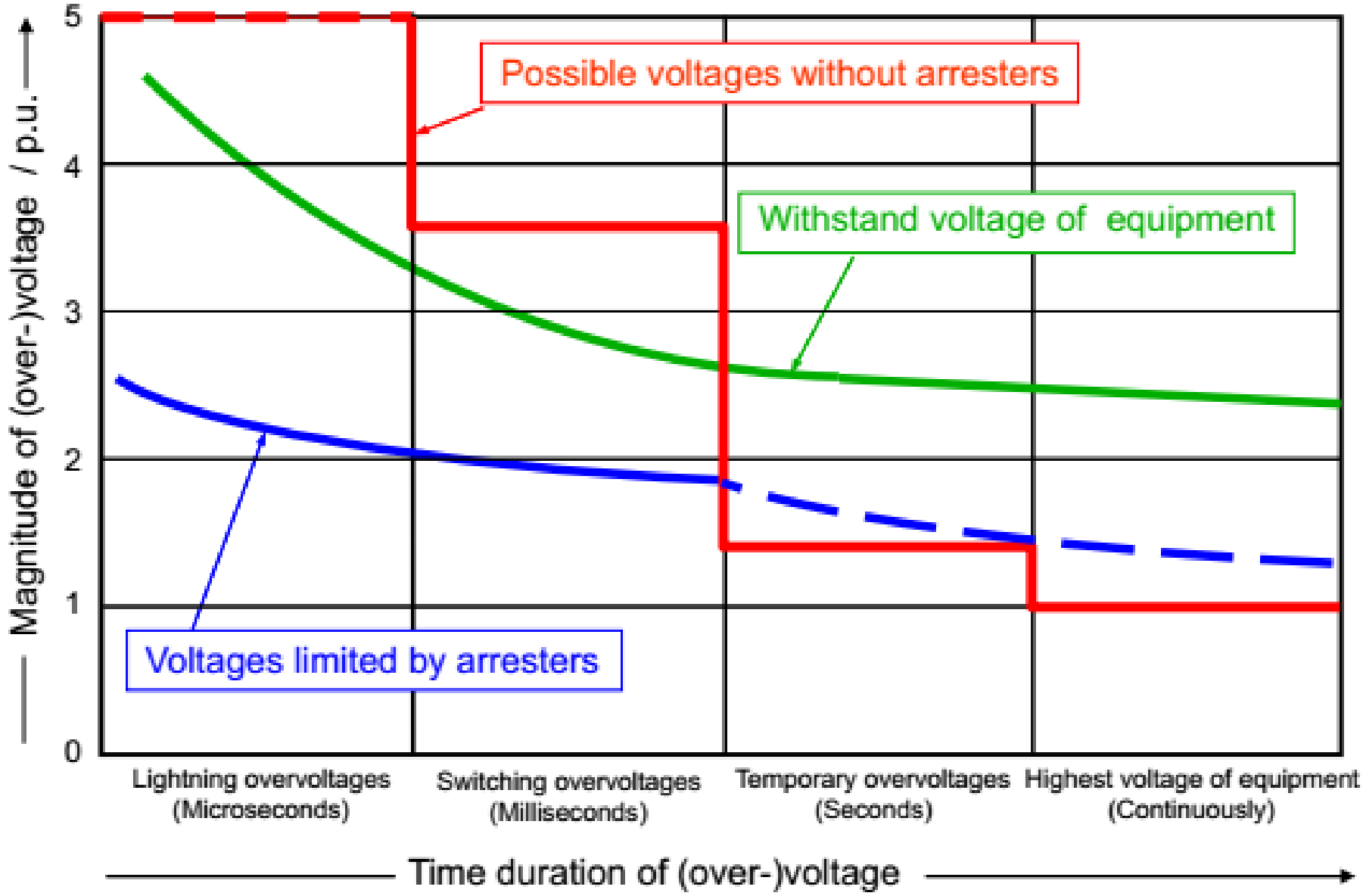
Impulse Withstand Voltage Categories



Minimum Impulse Withstand Voltages: BS 7671 / IEC 60364 – 4 – 44

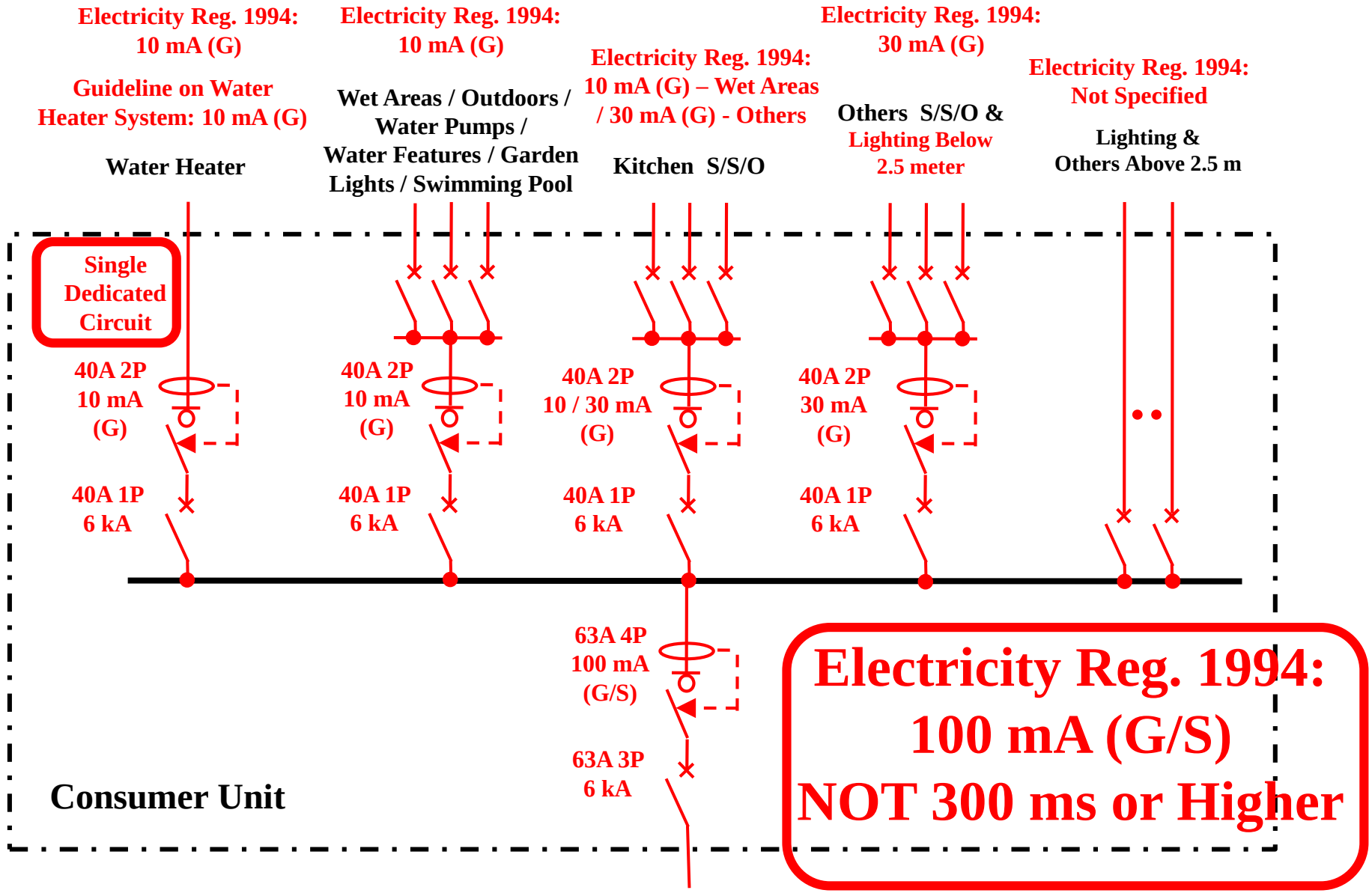
Nominal voltage of the installation V	Required minimum impulse withstand voltage kV			
	Category IV (equipment with very high impulse voltage)	Category III (equipment with high impulse voltage)	Category II (equipment with normal impulse voltage)	Category I (equipment with reduced impulse voltage)
230/240 or 277/480	6	4	2.5	1.5
400/690	8	6	4	2.5
1000	Values to be determined by the system engineer or, in the absence of information, the values for 400/690 V can be chosen.			

Insulation Coordination

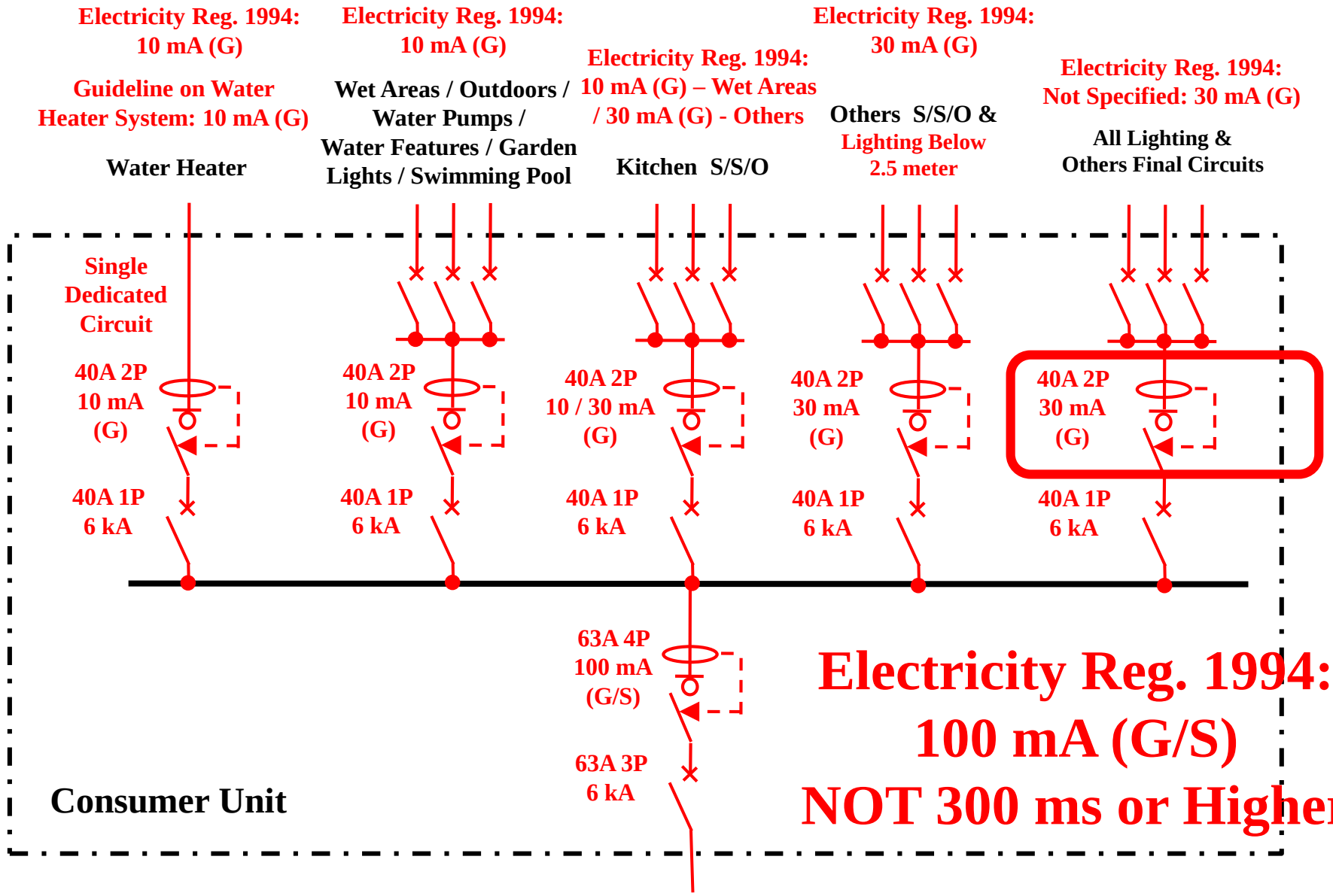


Pollution Degrees: Indoor and Outdoor Environments

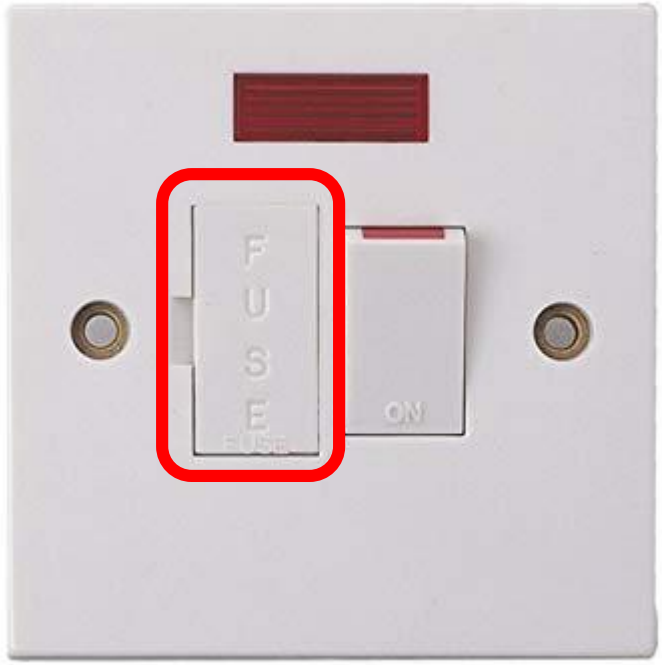
Domestic: Electric Shock Protection By RCD

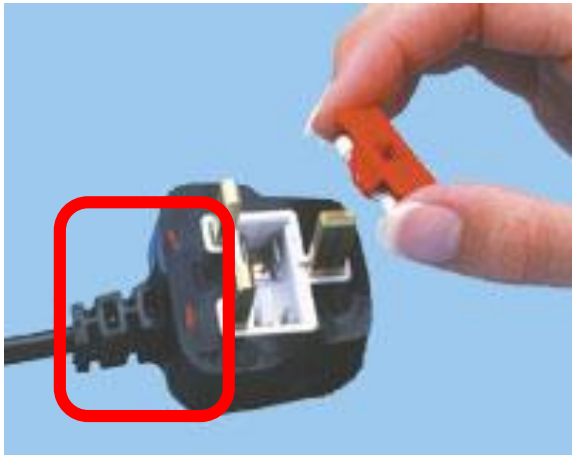


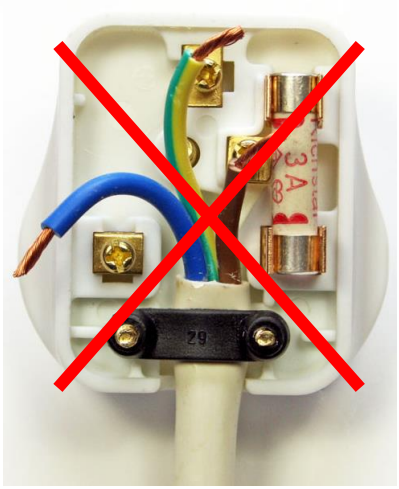
Domestic: BS 7671:2018 (Published July 2018)



Domestic: Fused Socket Outlets & Moulded Plugs





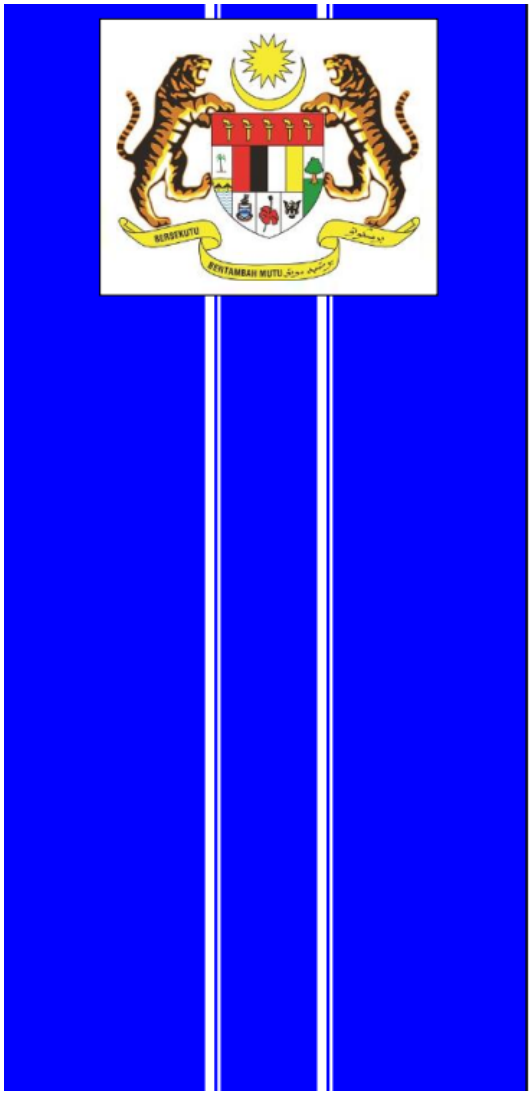


Solar Photovoltaics Electrical Installations to BS 7671 – 7 – 712 / IEC / MS IEC 60364 – 7 – 712,

Kuching,

4th July 2018

Primary Standard: BS 7671 Part 7 Section 712 / IEC / MS IEC 60364 – 7 – 712



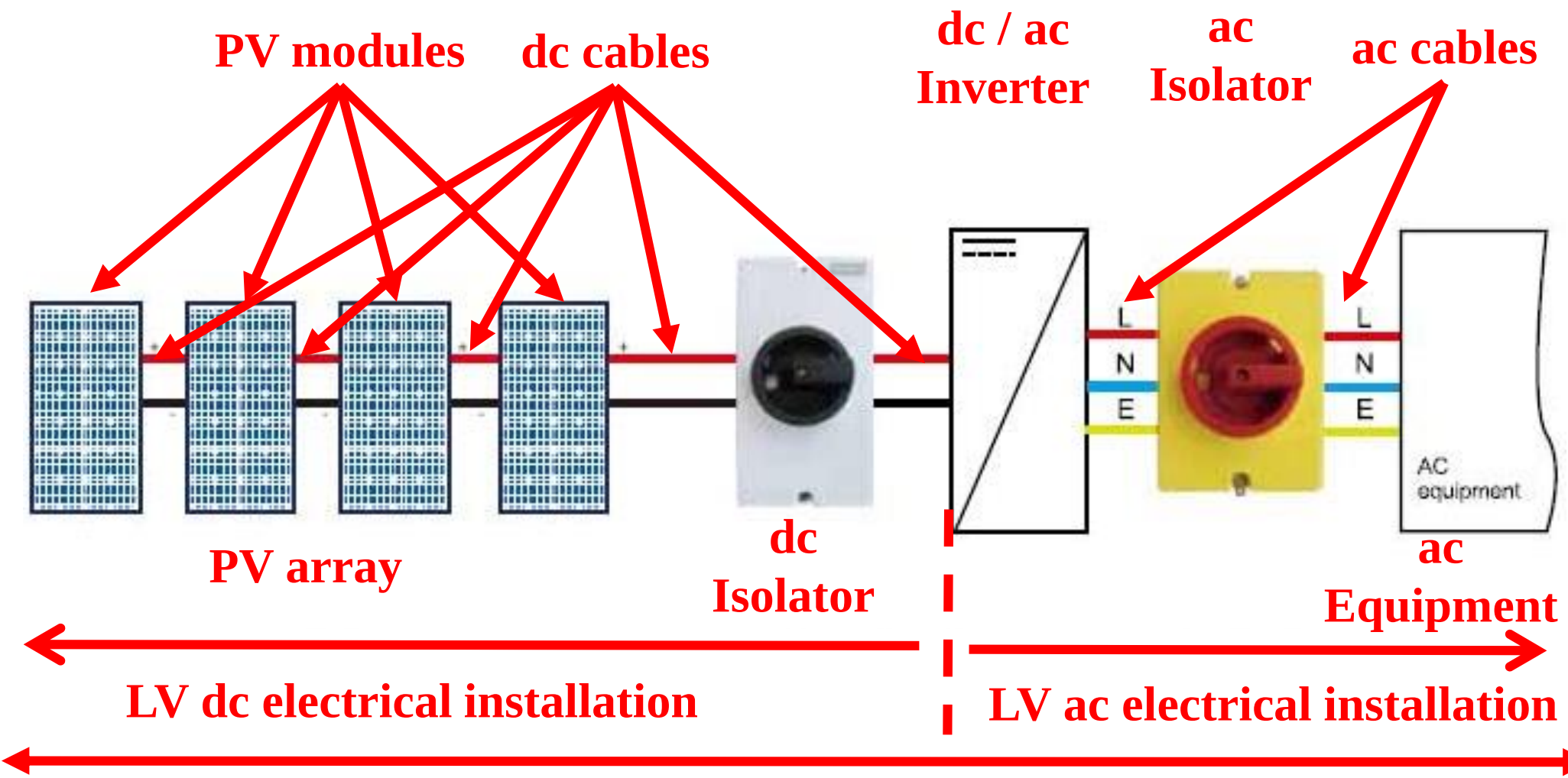
MALAYSIAN STANDARD

MS IEC 60364-7-712:2007
(CONFIRMED:2015)

Rm. 20 – 00

Electrical installations of buildings - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems (IEC 60364-7-712:2002, IDT)

Solar PV Systems and LV ac/dc Electrical Installations: BS 7671 / IEC 60364 – 7 – 712



BS 7671 / IEC 60364 – 7 – 712 (ac ≤ 1,000 Vrm and dc ≤ 1,500Vdc)

Sizing Solar Photovoltaic (PV) Cables

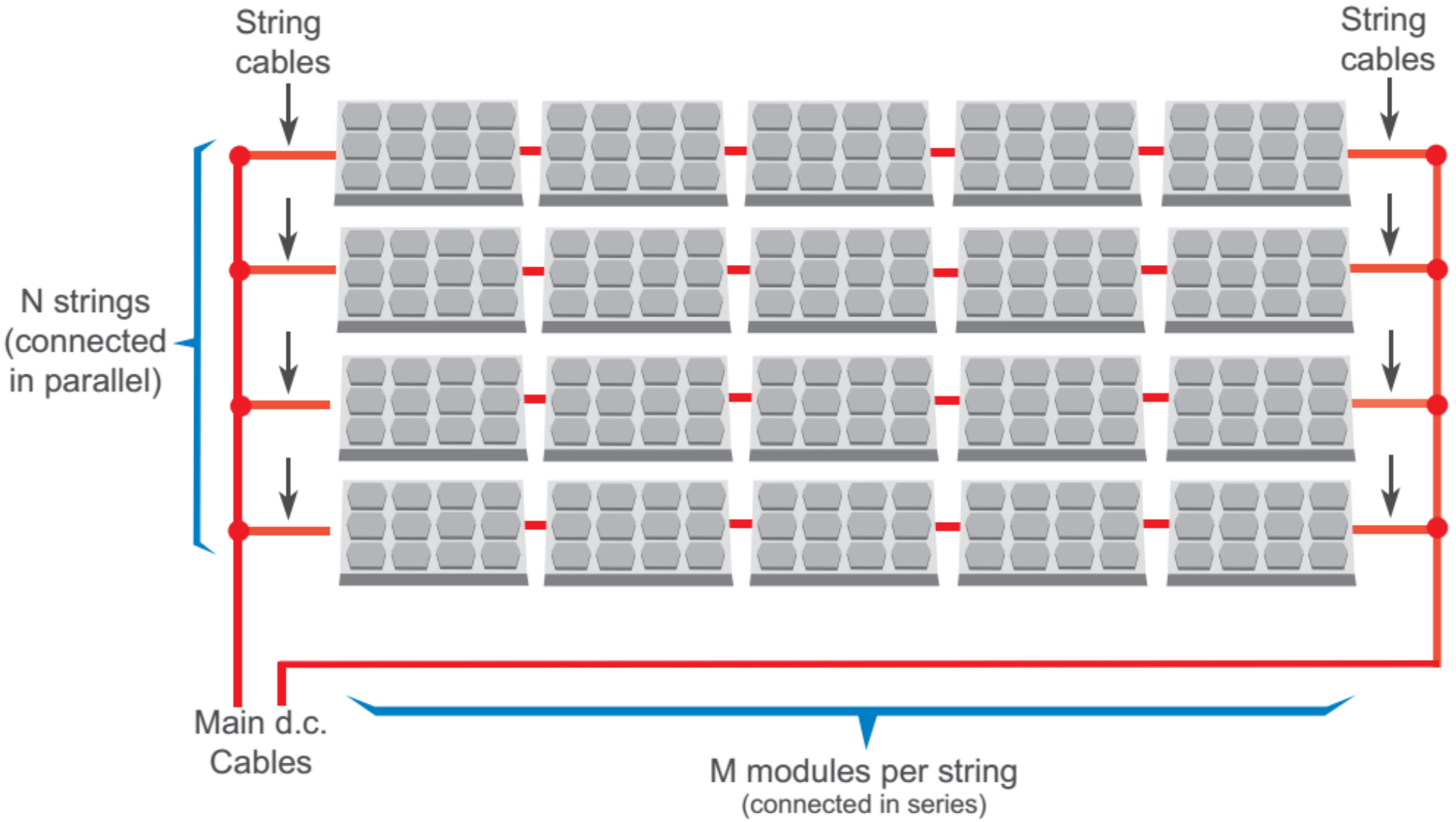
1. ***Current carrying capacity: Cable cross sectional area (CSA) sizing should be in accordance with BS 7671 which should take into account:***

   a. ***The multiplication factor of PV system : All dc equipment shall be rated, as a minimum:***

   - Voltage: V_{oc}(stc) x 1.15
   - Current: I_{sc}(stc) x 1.25

   b. ***The derating factors to be applied to typical current carrying capacity for cable as provided in BS 7671 Appendix 4 or in accordance with manufacturer's technical specification***

Sizing String and Main dc Cables



Sizing String Cables

1. *For an array with N string and M modules per string, string cable shall be rated as a minimum as follows:*

   a. *Voltage > Voc x M x 1.15*

   b. *Current > Isc x (N – 1) x 1.25*

2. *The cross sectional area (CSA) is calculated according to requirements of BS 7671:*

   a. *When string fuses are used, the cable size may be reduced*

Sizing Main dc Cables

1. *For an array with N string and M modules per string, string cable shall be rated as a minimum as follows:*
   a. *Voltage > Voc x M x 1.15*
   b. *Current > Isc x N x 1.25*
2. *The cross sectional area (CSA) is calculated according to requirements of BS 7671:*
   a. *When string fuses are used, the cable size may be reduced*

Cable Sizing: The Four (4) Steps

Step 1: Load

Step 1A:
Average load current I_B

Step 1B:
Max load current I_{Bi}

Step 2: Select MCB, In

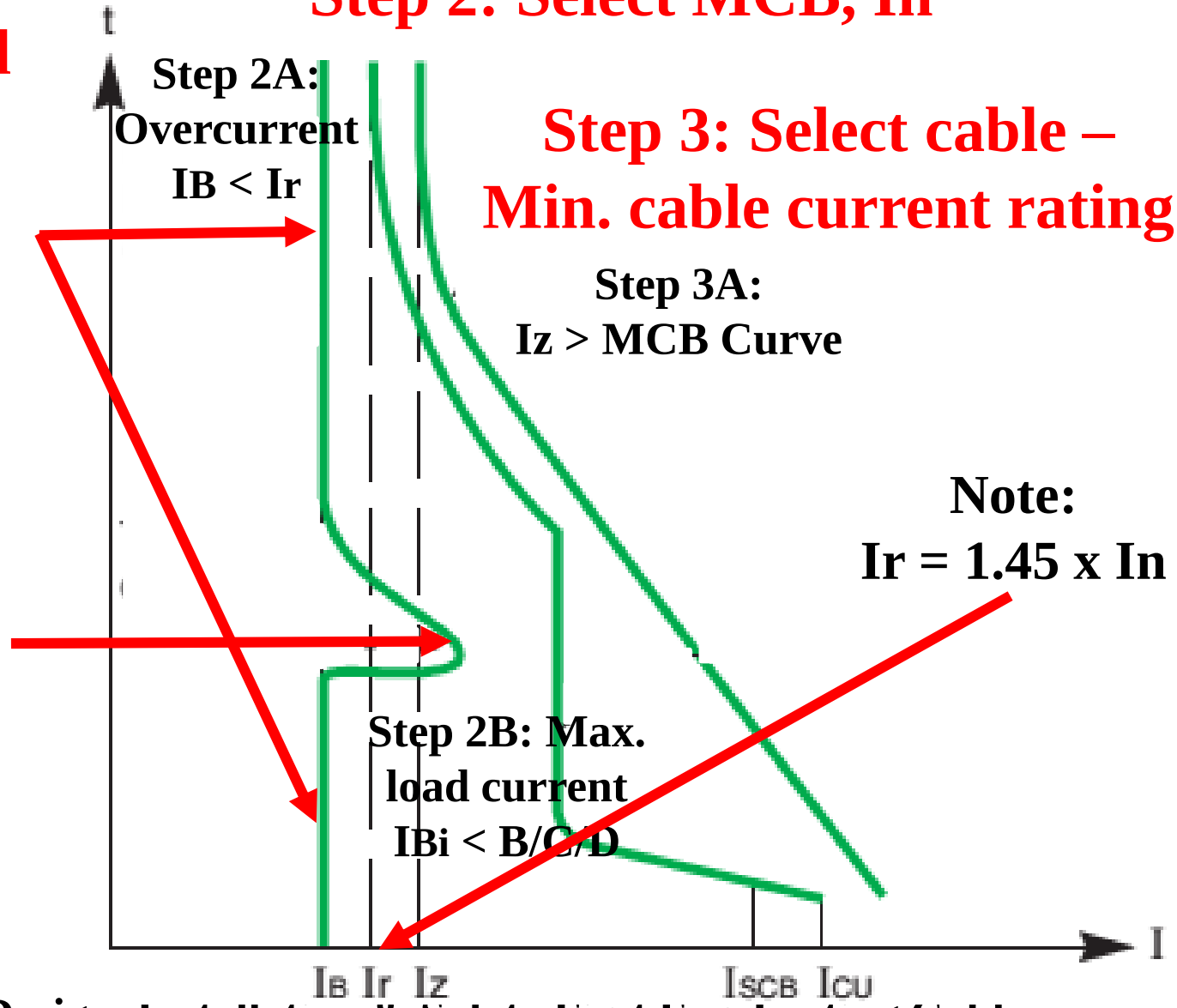
Step 2A:
Overcurrent
$I_B < I_r$

Step 2B: Max. load current
$I_{Bi} < B/C/D$

Step 3: Select cable – Min. cable current rating

Step 3A:
Iz > MCB Curve

Note:
Ir = 1.45 x In



Cable Sizing: Required Current Capacity

$$I_{CSA} \geq \frac{I_z \times \text{Safety Factor}}{C_g \times C_a \times C_s \times C_d \times C_i \times C_f \times C_c}$$

Derating Factors

1. C_g = *Grouping;*
2. C_a = *Ambient temperature);*
3. *Cs = Soil thermal resistivity;*
4. *Cd = Depth of burial;*
5. C_i = *Thermal insulation;*
6. C_f = *Protective device;*
7. C_c = *"In a duct in the ground" or buried direct*

Maximum Voltage Drop for PV dc Systems

2. ***Permitted voltage drop: The overall voltage drop, at array maximum operating power, between the array and the inverter if not specified is recommended < 3%;***

   a. ***BS 7671–7–712 (IEC, NEC, etc.,) does not require the calculation of voltage drop because it is not a safety issue;***

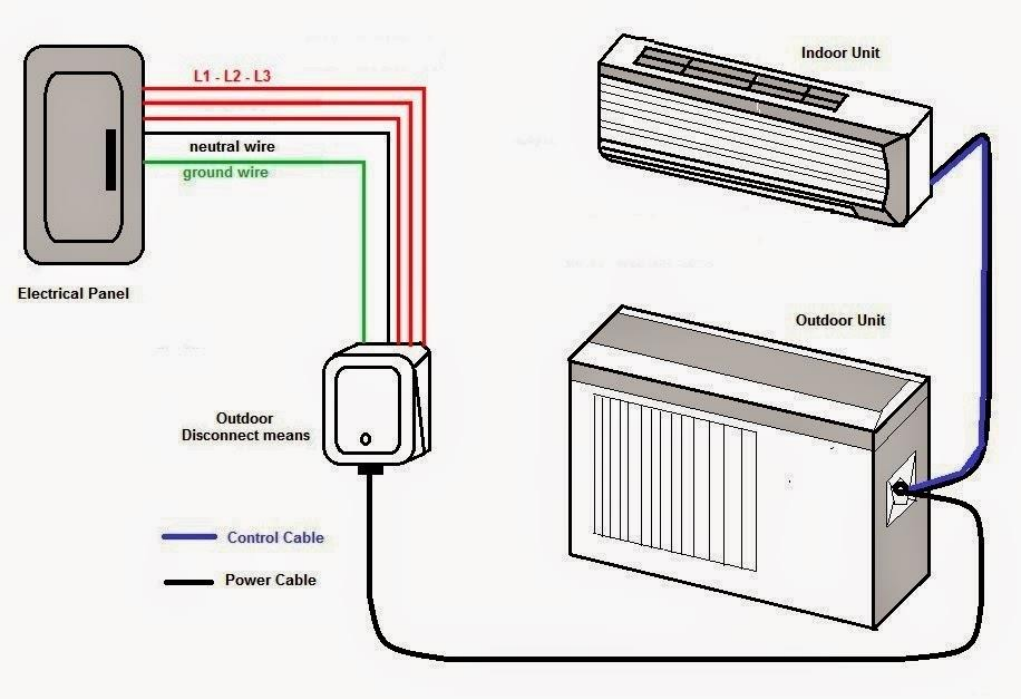
   b. ***Note: BS 7671 Annex G: table of voltage drop, applies to invert load side in electrical installation only***

   c. ***Voltage drop = Imax x 1.25 x mΩ/m x length***

Domestic Safety Gaps: “Unlimited” Socket Outlets on One Circuit

Domestic Safety Gaps: No Electric Shock Protection for Cable from Meter to Consumer

Domestic Safety Gaps: High Current Using / Inrush Appliances: 2.5 mm2 Cable CSA Sufficient ?



Non – Domestic: Safety Code – The "Book"

Suruhanjaya Tenaga
Energy Commission

KOD/ST/No.4/2016

Suruhanjaya Tenaga
Energy Commission

Date of Registration (Effective): 17th May 2017

NON-DOMESTIC
ELECTRICAL
INSTALLATION
SAFETY CODE

GUIDELINE ON
ELECTRICAL
SAFETY
MANAGEMENT
PLAN AND PROGRAMME

Earthing of Electrical Installations

2.4.3 Type of Earthing System

Type of earthing system to be used: –

i. where the earthing conductor of the installation is connected to earthed point of the source, a TN-S system shall be used with the load above 1 Mega Volt Ampere (MVA);

ii. where the earthing conductor of installation is connected to separate earthing of earth electrode, a TT system shall be used for the load below and up to 1 Mega Volt Ampere (MVA);

iii. where the earthing conductor is connected to the neutral of the source a TN-C shall not be used because it is not adequate for earth fault protection during the event of neutral breaking.

Minimum Cross – Sectional – Area (CSA) of a Buried Earthing Conductor

Table 5: Minimum cross-sectional area of a buried earthing conductor

	Mechanically protected	Mechanically unprotected
Protected against corrosion	25mm² Cu 50mm² Fe	16mm² Cu 16mm² Fe
Not protected against corrosion	25mm² Cu 50mm² Fe	

BS 7671 / IEC 60364 – 5: Minimum CSA of a Buried Earthing Conductor

TABLE 54.1 –
Minimum cross-sectional area of a buried earthing conductor

	Protected against mechanical damage	Not protected against mechanical damage
Protected against corrosion by a sheath	2.5 mm^2 copper 10 mm^2 steel	16 mm^2 copper 16 mm^2 coated steel
Not protected against corrosion	25 mm^2 copper 50 mm^2 steel	

BS 7671 / IEC 60364 – 5: Minimum CSA of a Protective Conductor

TABLE 54.7 –
Minimum cross-sectional area of protective conductor in relation to the cross-sectional area of associated line conductor

Cross-sectional area of line conductor S	Minimum cross-sectional area of the corresponding protective conductor	
	If the protective conductor is of the same material as the line conductor	If the protective conductor is not of the same material as the line conductor
(mm^2)	(mm^2)	(mm^2)
$S \leq 16$	S	$\frac{k_1}{k_2} \times S$
$16 < S \leq 35$	16	$\frac{k_1}{k_2} \times 16$
$S > 35$	$\frac{S}{2}$	$\frac{k_1}{k_2} \times \frac{S}{2}$

where:

k_1 is the value of k for the line conductor, selected from Table 43.1 in Chapter 43 according to the materials of both conductor and insulation.

k_2 is the value of k for the protective conductor, selected from Tables 54.2 to 6, as applicable.

Sizing of Neutral Conductor for Third Harmonic Currents

1. Three phase circuits only

Table 6: Size of neutral conductor due to third harmonic contents

Third harmonic content of the phase current %	Rating Factor	
	Size selection is based on phase current	Size selection is based on neutral current
Exceeding 0 but not exceeding 15	1.00	-
Exceeding 15 but not exceeding 33	0.86	-
Exceeding 33 but not exceeding 45	-	0.86
Exceeding 45	-	1.00

Minimum CSA of Protective Conductors

Minimum sizes of copper earthing conductor, copper bonding main protective bonding conductor and copper protective conductors not contained in a composite cable, flexible cable, or flexible cord.			
Nominal cross-sectional area of largest associated copper circuit conductor	Nominal cross-sectional area of earthing conductor	Nominal cross-sectional area of protective conductor	Nominal cross-sectional area of bonding main protective bonding conductor
mm^2	mm^2	mm^2	mm^2
1.0	6	1.0*	1.0*‡
1.5	6	1.0*	1.0*‡
2.5	6	1.0*	1.0*‡
4	6	2.5	1.0*‡
6	6	2.5	1.0*‡
10	6	6	2.5
16	6	6	2.5
25	16	16	6
35	16	16	6
50	16	16	6
70	50	50	16
95	50	50	16
120	50	50	16
150	50	50	16
185	70	70	50
240	70	70	50
300	70	70	50
400	70	70	50
500	70	70	50
630 and above	70	70	50

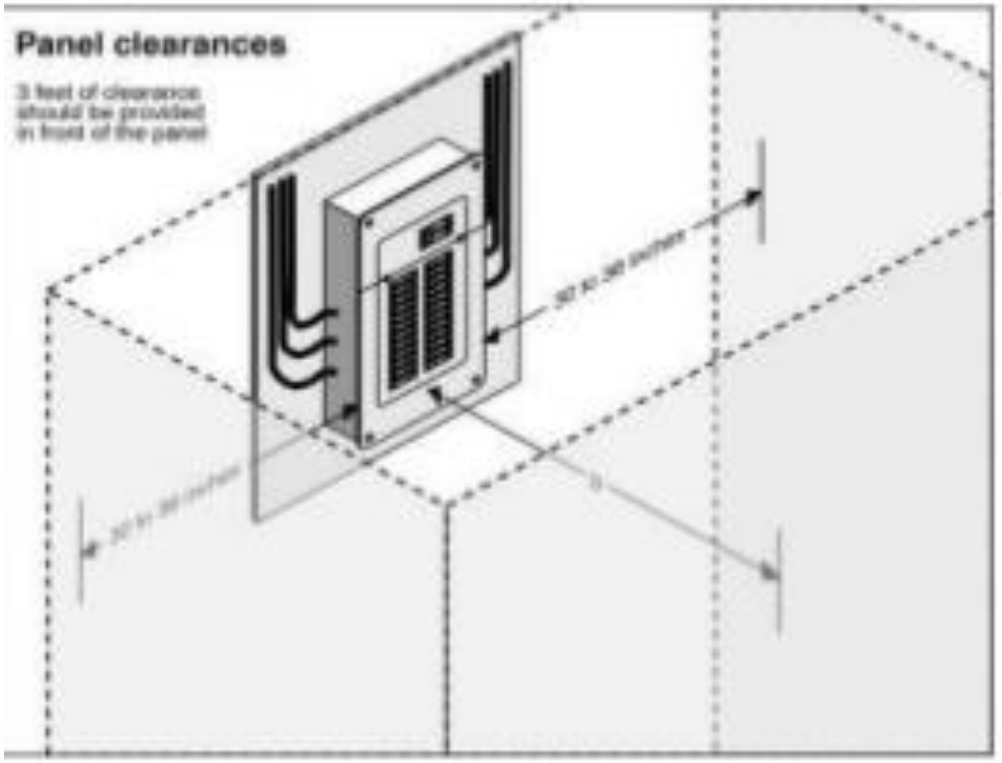
* 1.5 mm^2 where the earth protective conductor or bonding conductor is unenclosed
‡ 2.5 mm^2 for the bonding of metalwork or other services at points of entry to premises.

Minimum Safety and Working Clearance

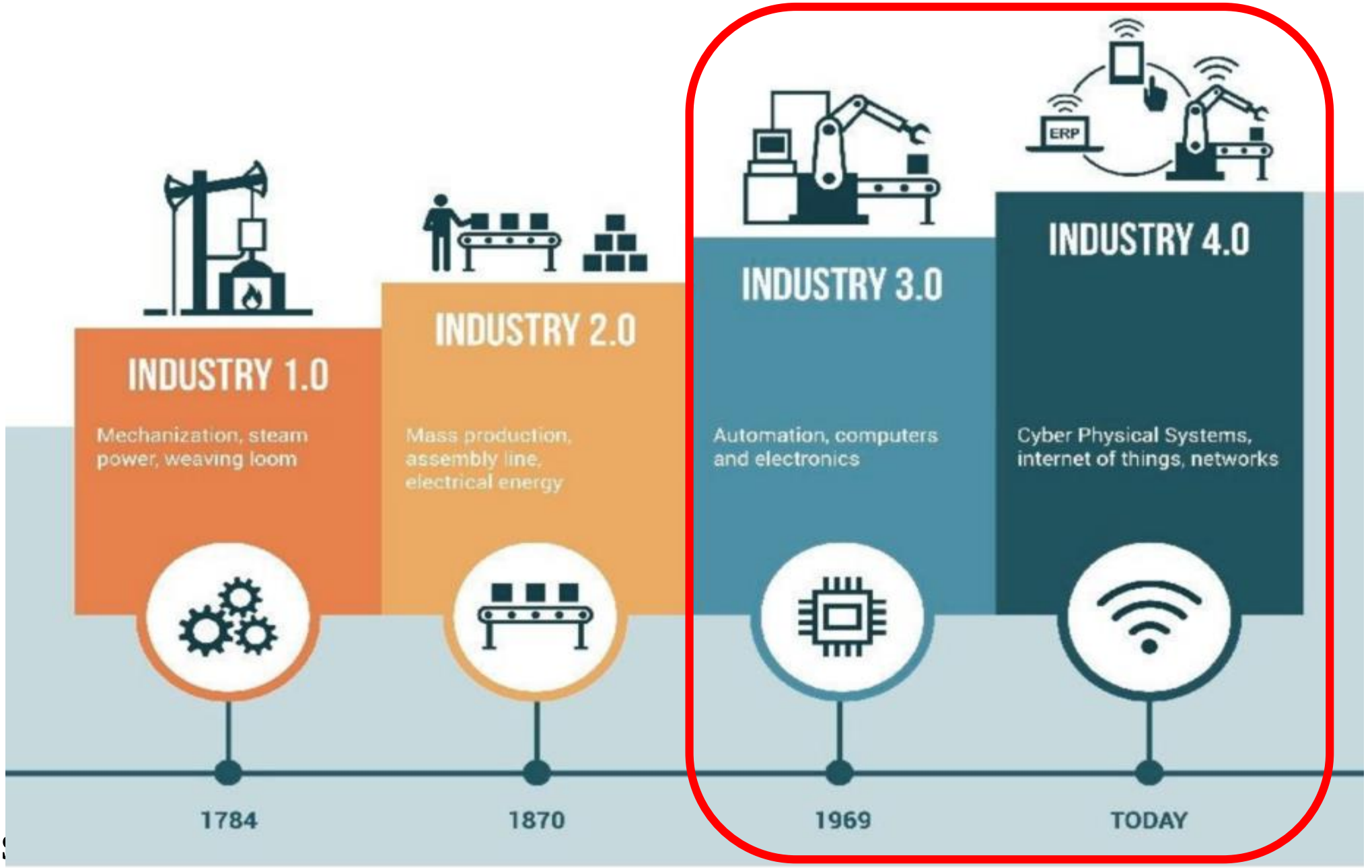
Table 9: Minimum safety and working clearance

U_n (kV)	U_m (kV)	earth air clearance (mm)	clearance (mm)
0.151-1	-	-	1,250
6	7.2	500	3,000
11	12	500	3,000
33	36	500	3,000
66	72.5	700	3,100
132	145	1,100	3,600
275	300	1,600	4,100
500	525	3,600	6,400

Working Spaces: National Electrical Code (NEC) USA



Industry Revolution 3: Power Quality



The Act: ESA 2015 Section 4 – Power Quality

d. ~~*(d) to promote the interests of consumers of electricity supplied by licensees in respect of*~~ *to exercise regulatory function in respect of the consumers' interests and the enforcement in respect of:*

i. *(i) the prices to be charged and the other conditions of electricity supply;*

ii. *(ii) the continuity of electricity supply; ESA 2015: ~~and~~*

iii. *(iii) the quality of the electricity supply services provided; ESA 2015: and*

iv. *ESA 2015: (iv) the quality of electricity supply which includes reliability and power quality;*

Costs Per Event of Power Quality: Malaysia

PQ Cost Per Sector for Malaysian's Industries

Industry	Cost (RM)
Glass/ Stone/ Clay/ Cement & Ceramic & Tiles	RM 400,000
Metal / aluminium / copper products	RM 700,000
Plastics/Rubber	RM 153,000
Services (Hospitals / Pharmaceuticals/ Banks/Hotels/ leisure/Commercial Premise/Wholesale Business)	RM 100,000
Semiconductors/ wafer	RM 3,000,000
Semiconductors/ EMS (Electronics Manufacturing Services)/Electrical & Electronics	RM 500,000
Oil / petroleum refining/ Gas product /Petrochemicals & Polymers	RM 200,000
Wood based / Furniture	RM 200,000
Food products Manufacturing	RM 200,000
Automotive/Machinery & Equipment	RM 229,537
Printing/Packaging (Paper)	RM 91,000
Garment Textile /Apparel	RM 300,000
Petrochemicals	RM 164,000

Industry Revolutions 3 and 4: Electromagnetic Interferences (EMI)

radio frequency radiation

electromagnetic device

ElectroMagnetic Interference (EMI)

bio-electromagnetic organ

BS EN / IEC 61000 Series: Electromagnetic Compatibility (EMC)

Part	Description
1: General	1. The safety function requirements 2. The safety integrity requirements
2. Environment	1. Description of the environment 2. Classification of the environment 3. Compatibility Levels
3. Limits	1. Emission Limits 2. Immunity Limits
4. Test and Measurement Techniques	1. Measurement Techniques 2. Testing Techniques

BS EN / IEC 61000 Series: Electromagnetic Compatibility (EMC)

Part	Description
5: Installation and Mitigation Guidelines	***1. Installation Guidelines*** ***2. Mitigation methods and Devices***
6. General Standards	
7 – 9: Open	
9. Miscellaneous	

BS EN / IEC 61000 – 5 – xx: Installation and Mitigation Guidelines

Part	Description
5 – 1	General Considerations – Basic EMC Publications
5 – 2	***Earthing and Cabling***
5 – 6	Mitigation of External EM Influences
5 – 7	Degree of Protection Provided by Enclosures against electromagnetic disturbances (EM Code)
5 – 3/4/5	HEMP protection

BS EN / IEC / MS IEC 61000 – 5 – 2

RAPPORT TECHNIQUE – TYPE 3

TECHNICAL REPORT – TYPE 3

CEI IEC 61000-5-2

Première édition
First edition
1997-11

Compatibilité électromagnétique (CEM) –

Partie 5: Guides d'installation et d'atténuation – Section 2: Mise à la terre et câblage

Electromagnetic compatibility (EMC) –

Part 5: Installation and mitigation guidelines –

BS EN 61000 – 5 – 2:
Member: 254 Pounds
Non – Member: 127 Pounds
IEC 61000 – 5 – 2:
CHF: 300–00
(Rm. 1,236–00: 20 Aug 2018)

MALAYSIAN STANDARD

MS 61000-5-2:2011

ELECTROMAGNETIC COMPATIBILTY (EMC) - PART 5: INSTALLATION AND MITIGATION GUIDELINES - SECTION 2: EARTHING AND CABLING

MS IEC 61000 – 5 – 2:
Rm. 80–00

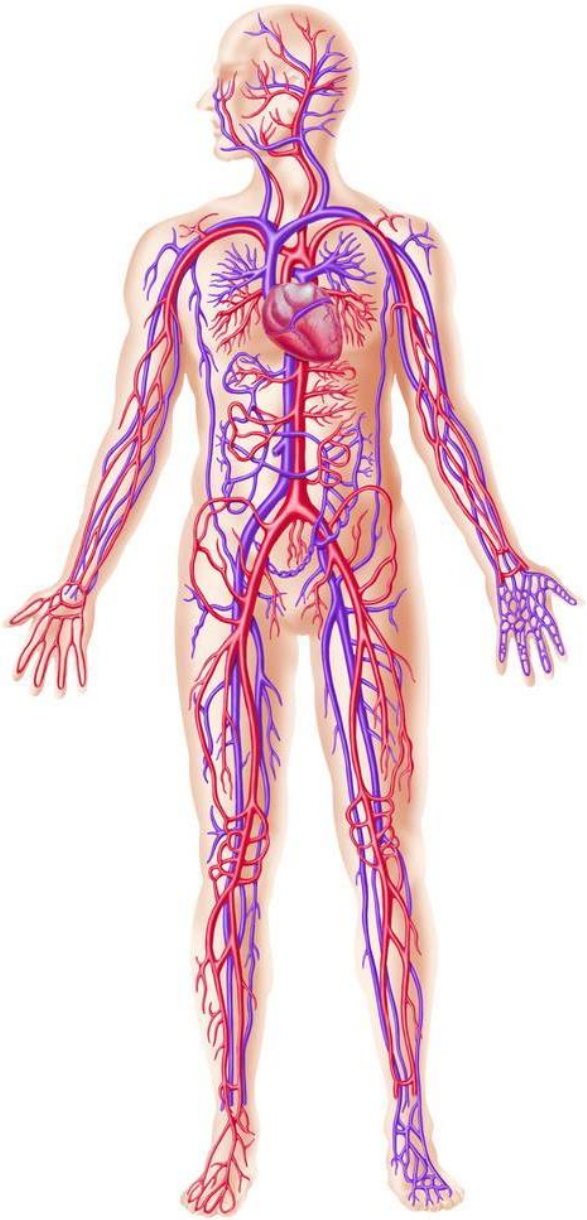
ICS: 33.100

Descriptors: installation, mitigation, earthing, cabling

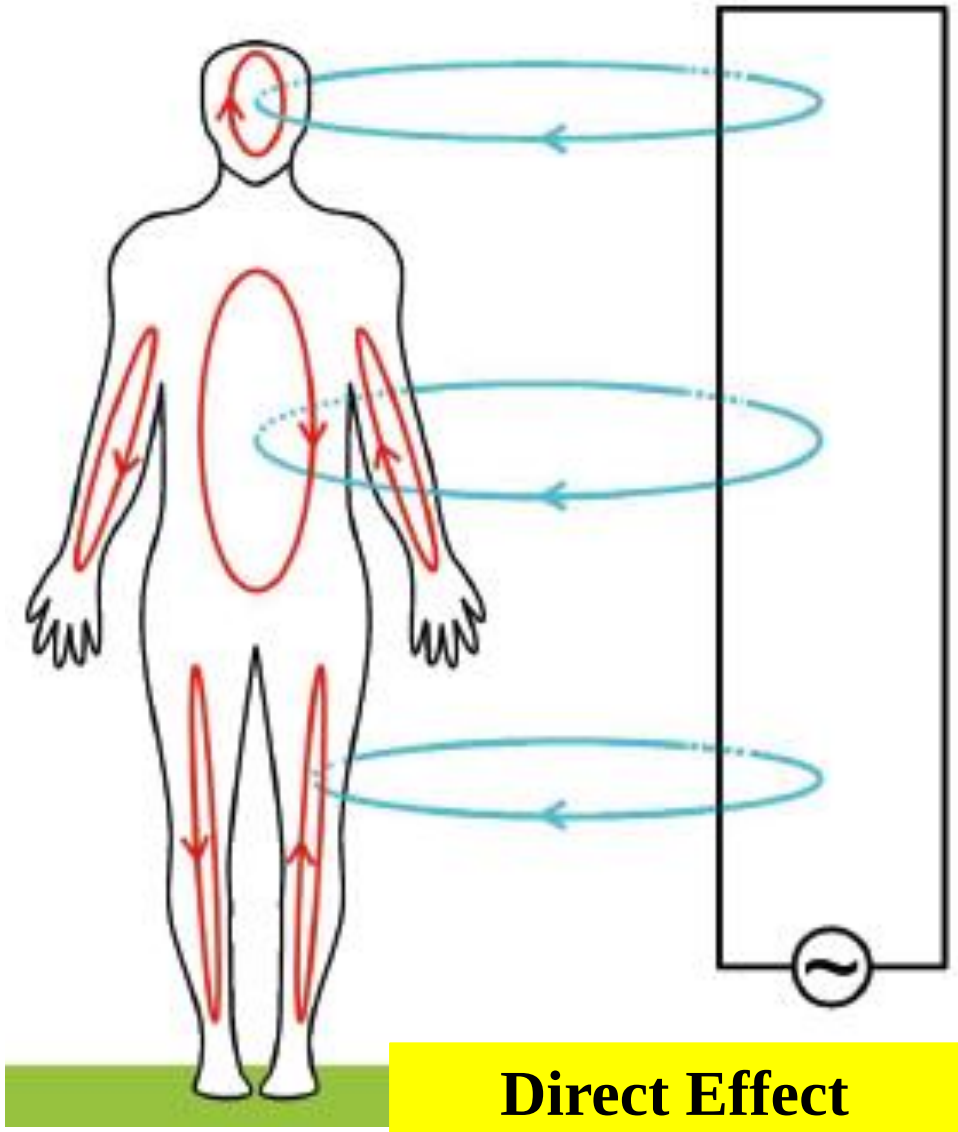
DEPARTMENT OF STANDARDS MALAYSIA

The Biological “Electrical Installations”

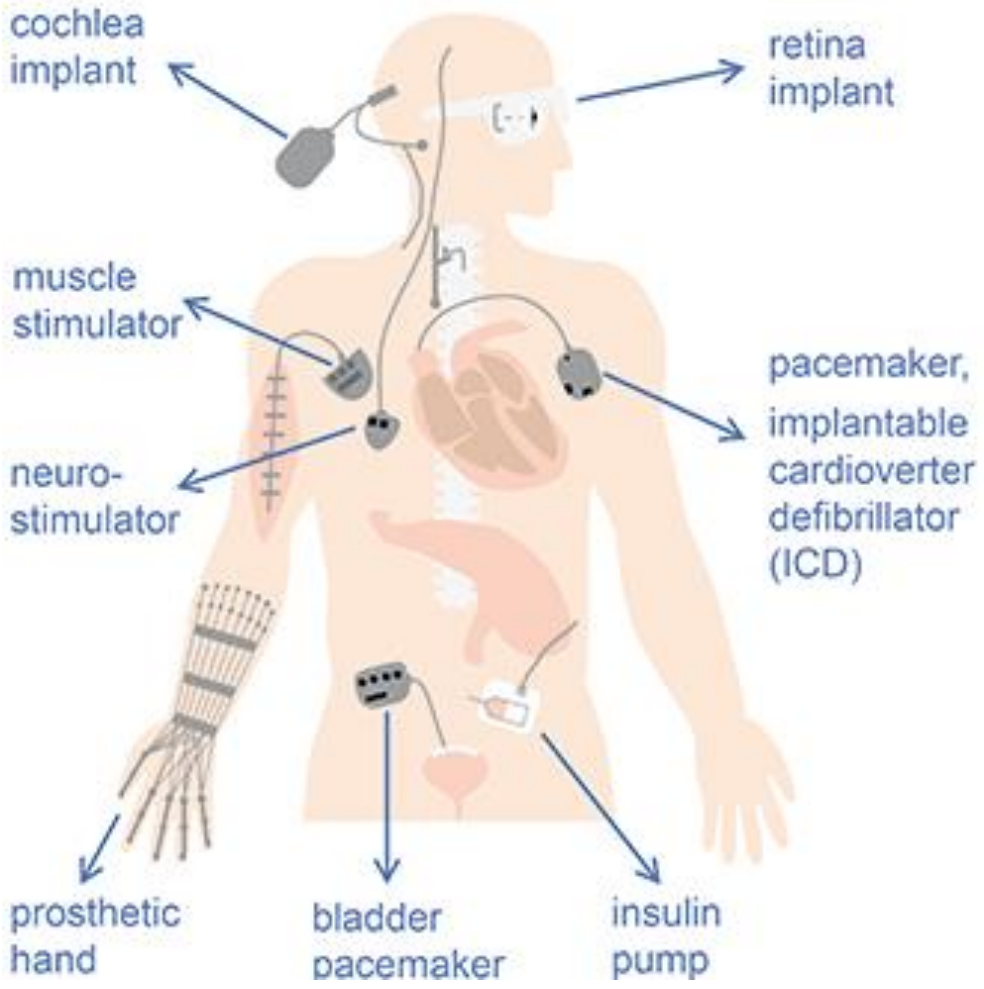
1. *Heart: Electrical source;*
2. *Blood vessels: Wiring or Cabling;*
3. *Blood: Current*



The European Directive 2013/35/EU

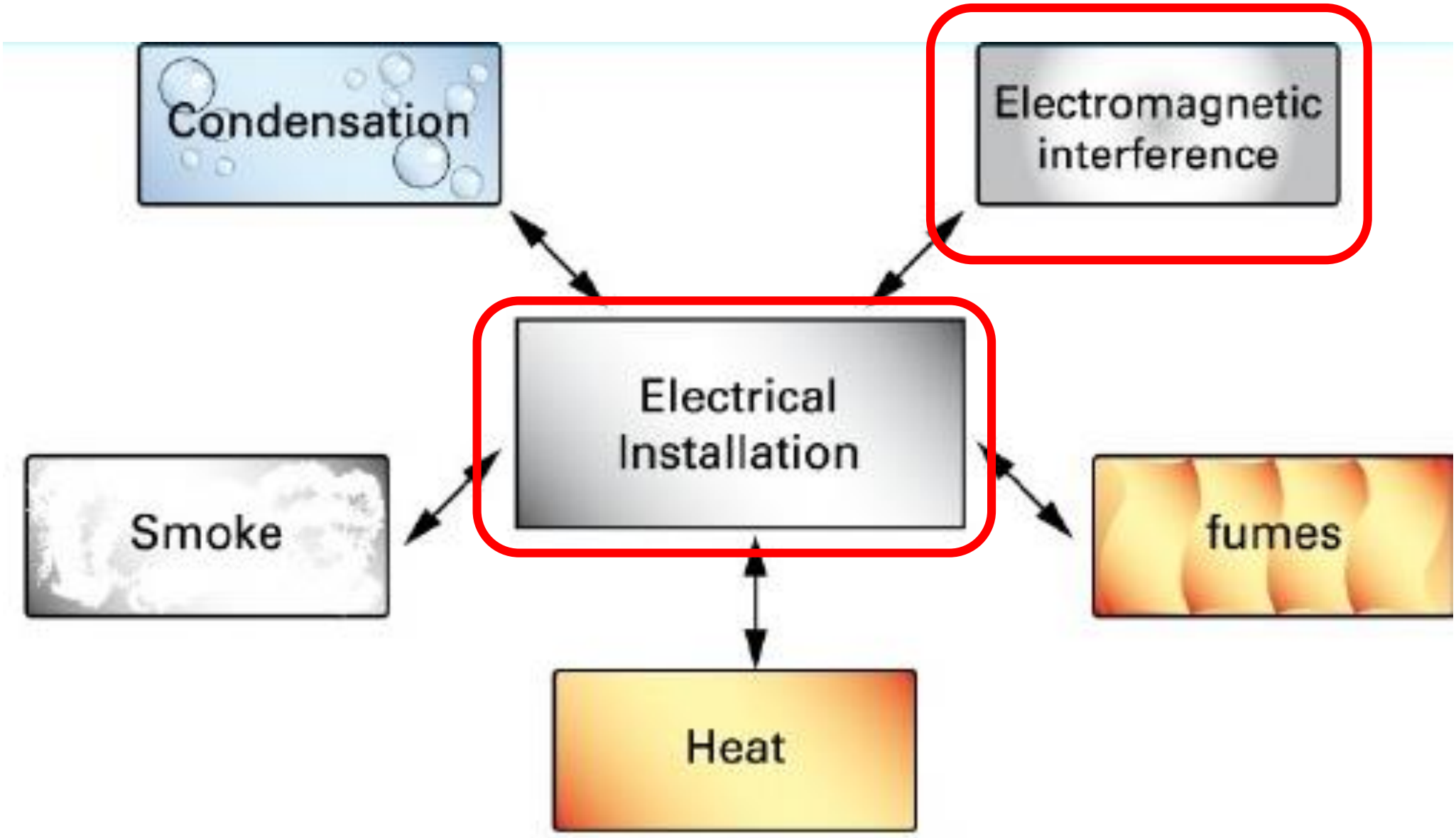


Direct Effect

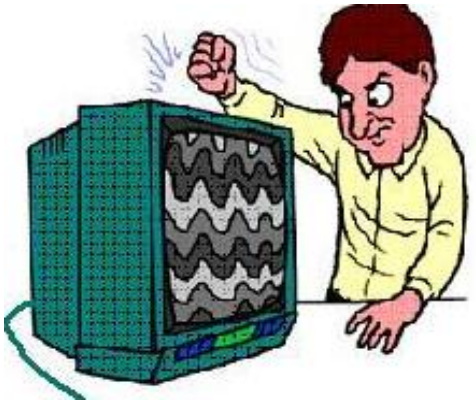


Indirect Effect

Electrical Installations External Influences: EMI



The EMI Triangle



Source

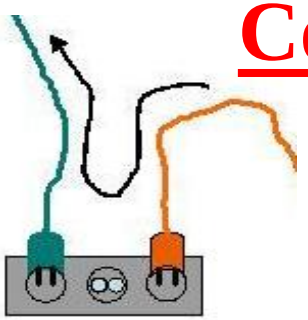
Victim

EMI Triangle

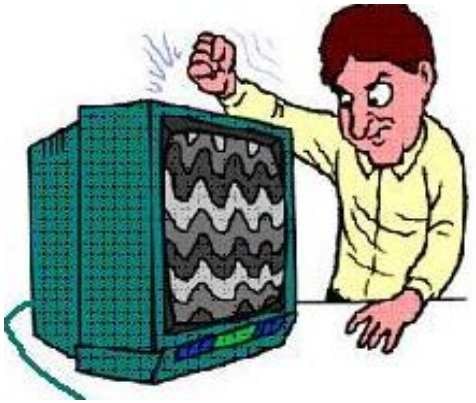
Radiated

Conducted

Coupling Path



The EMI Mitigation Triangle



Source

Electromagnetic Compatibility (Emission)

EMI Triangle

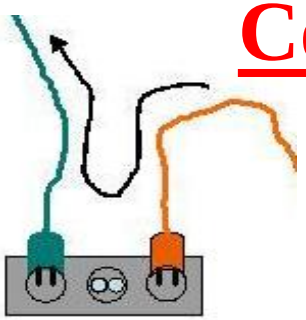
Victim

Electromagnetic Compatibility (Immunity)

Radiated

Shielding, Separation

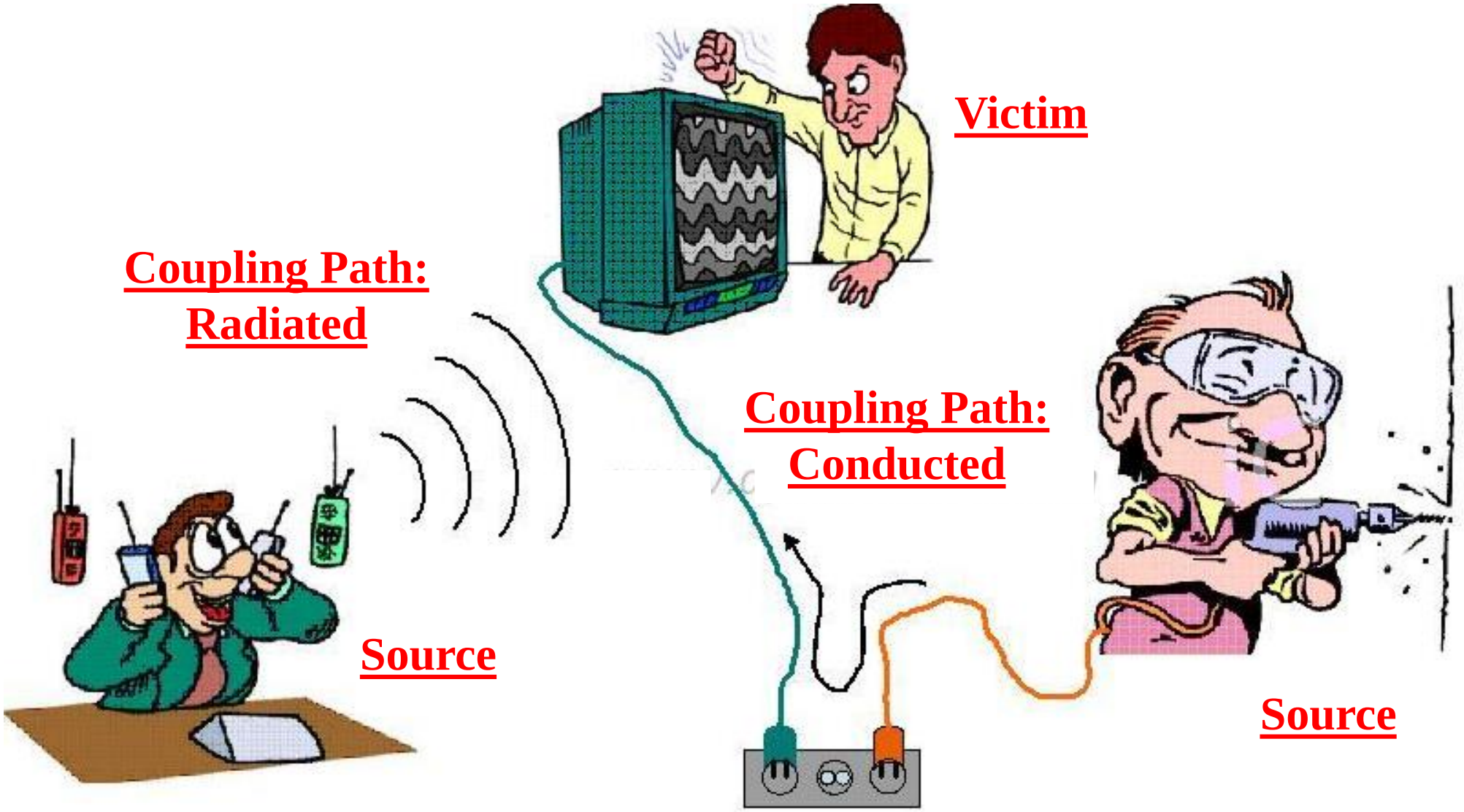
Coupling Path



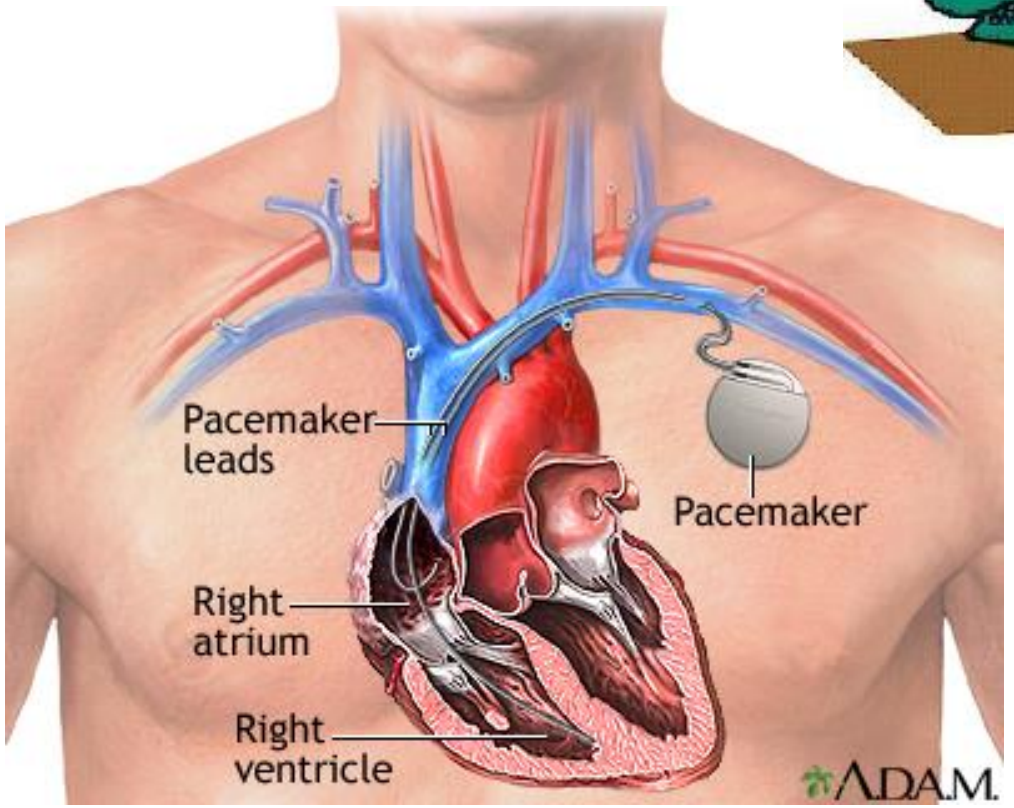
Conducted

Filter, Isolation, SPD

The EMI Triangle

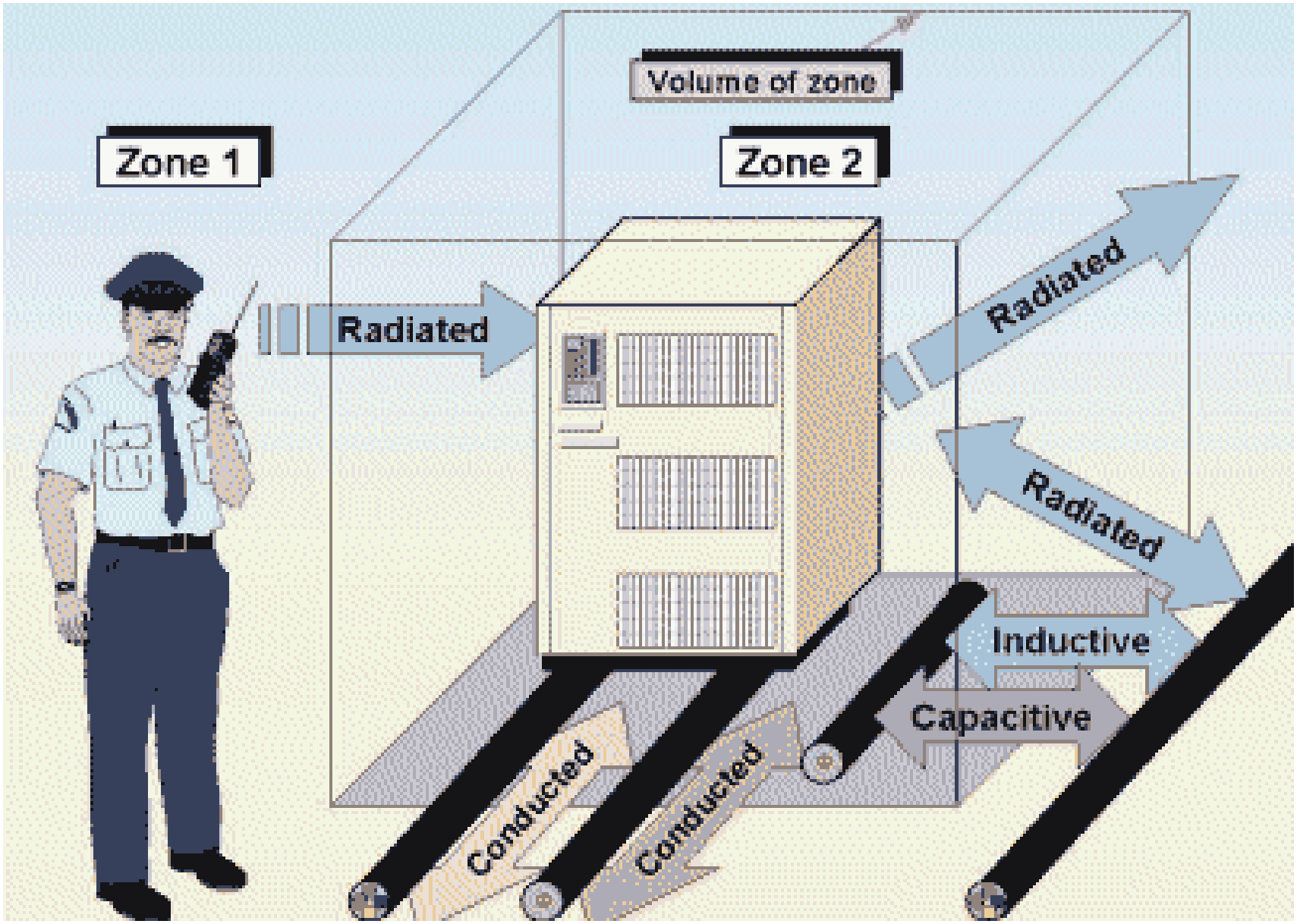


Medical Devices: Heart Pacer

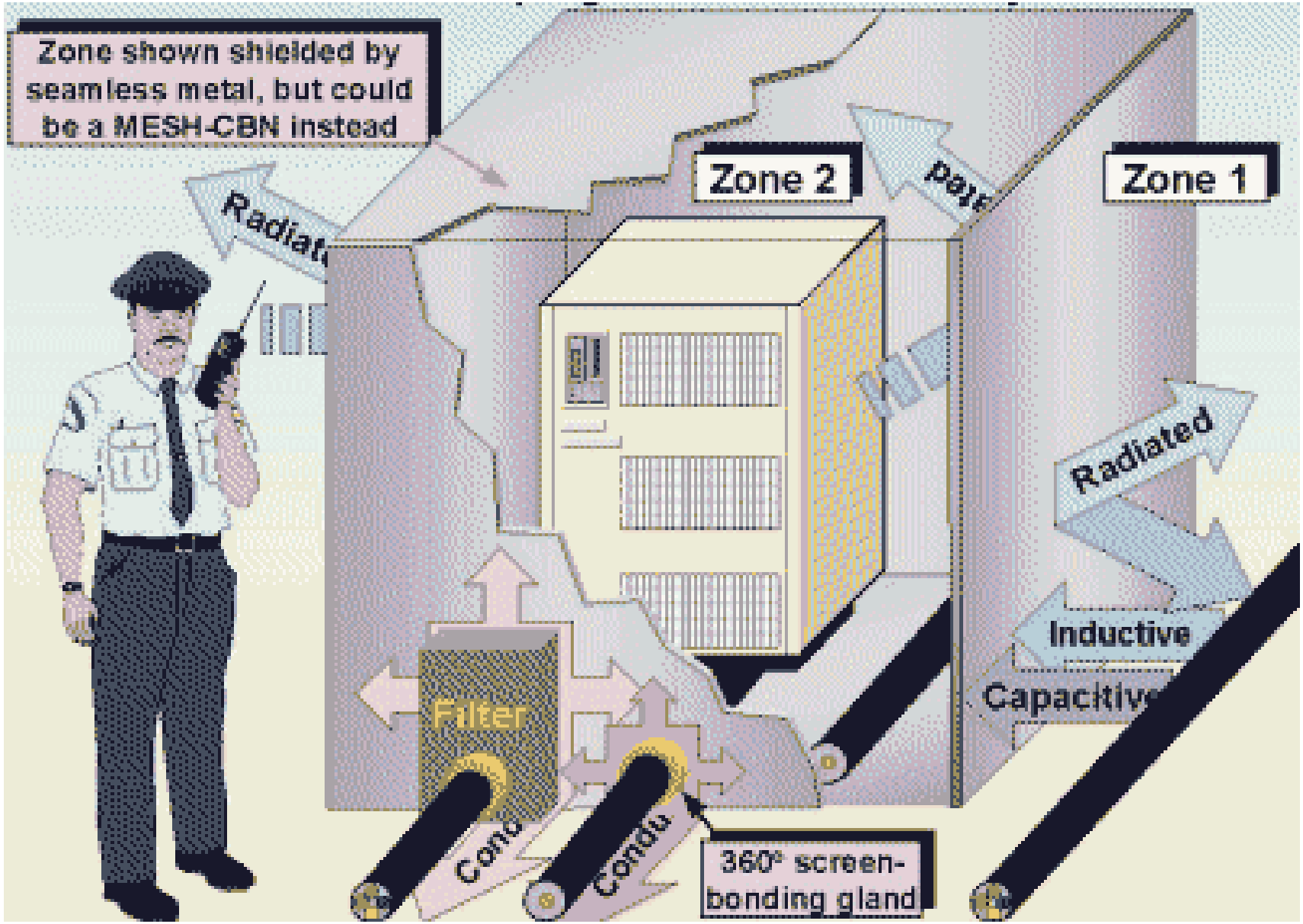


EMI

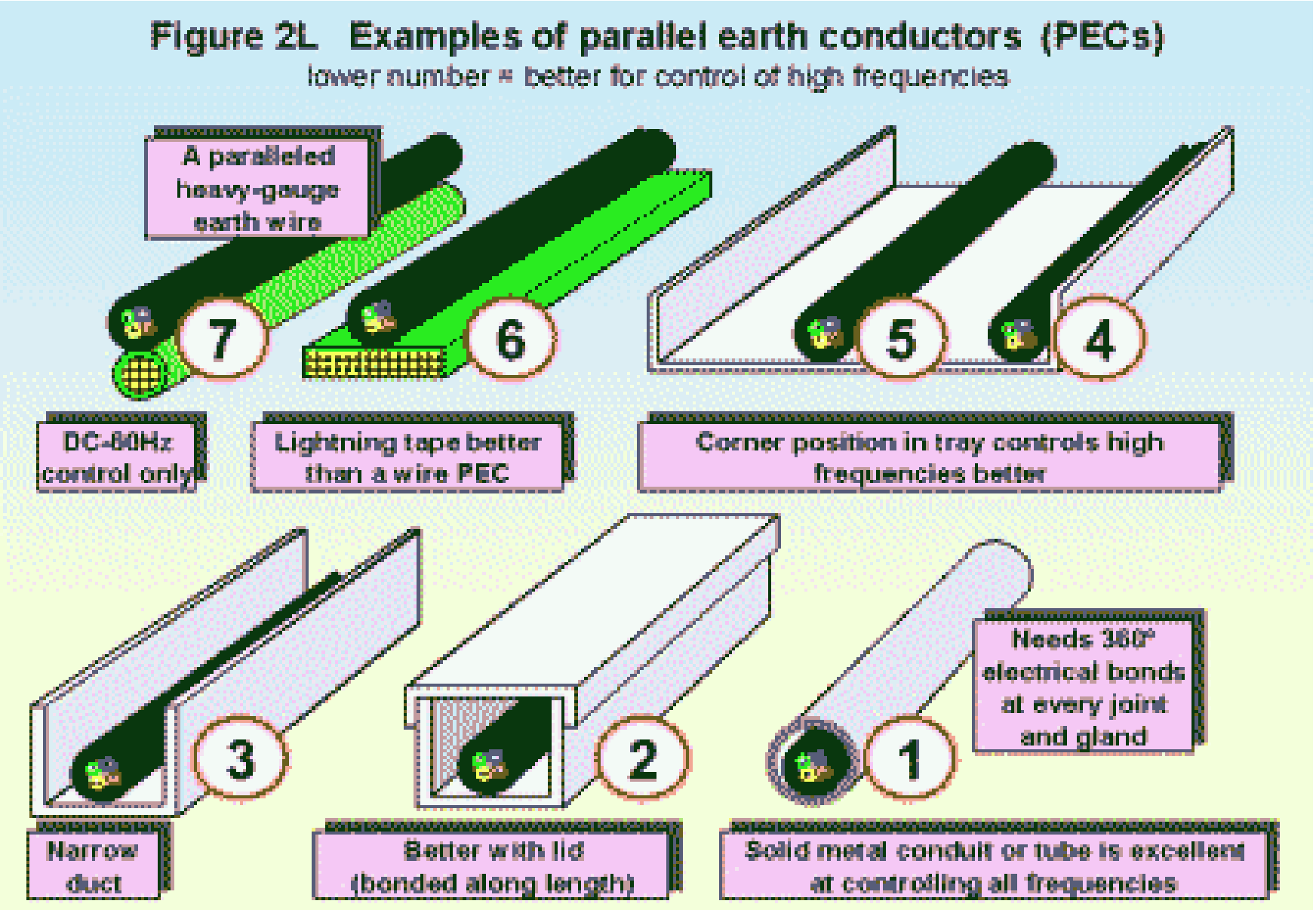
EMI Coupling Across a Zone's Boundary



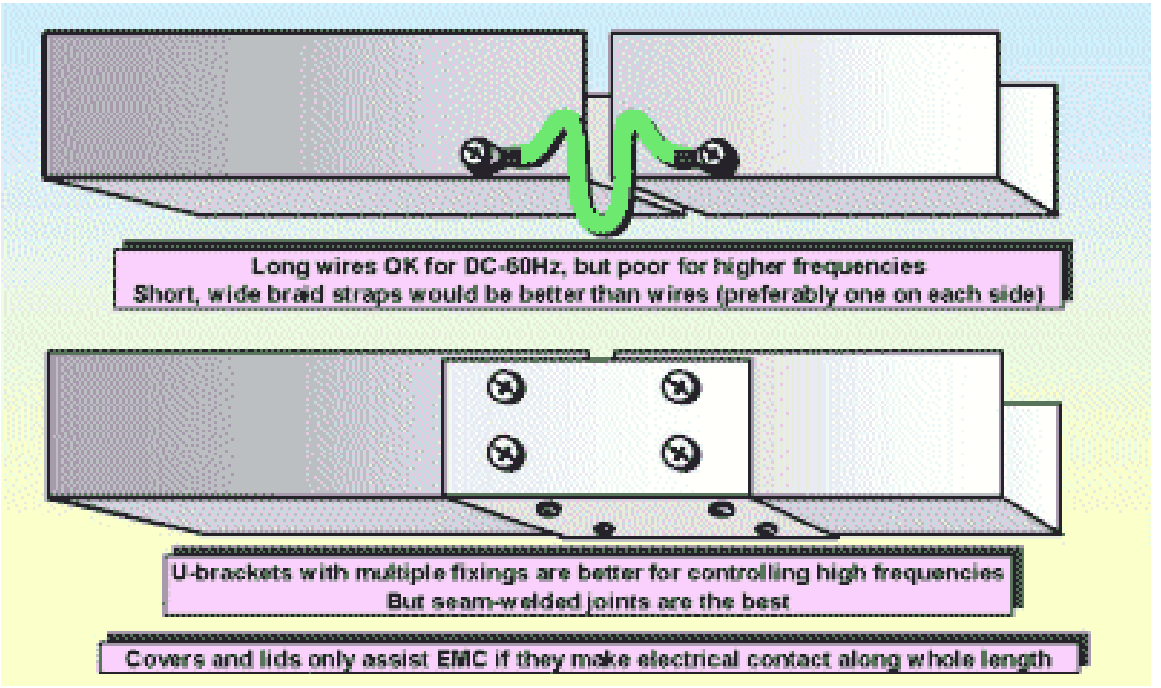
EMI Reduction Across a Zone's Boundary

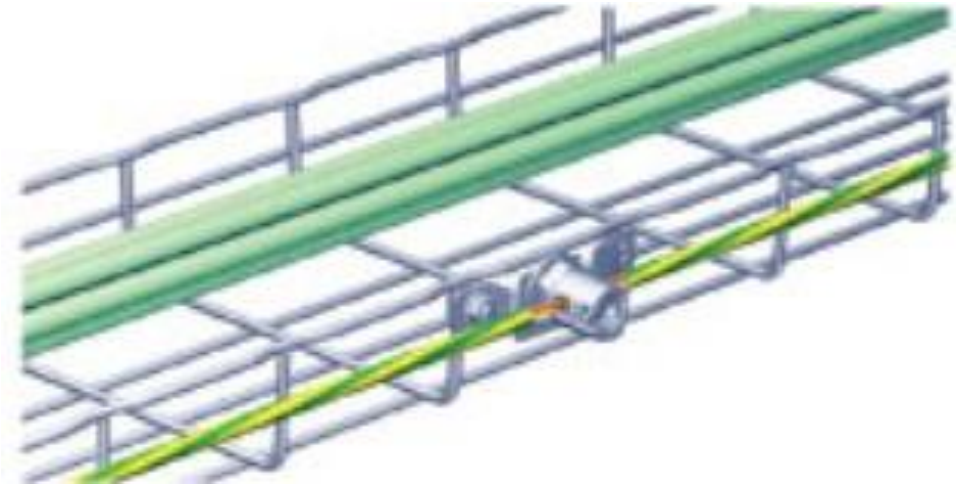


Multicore Cables & Cable Management System

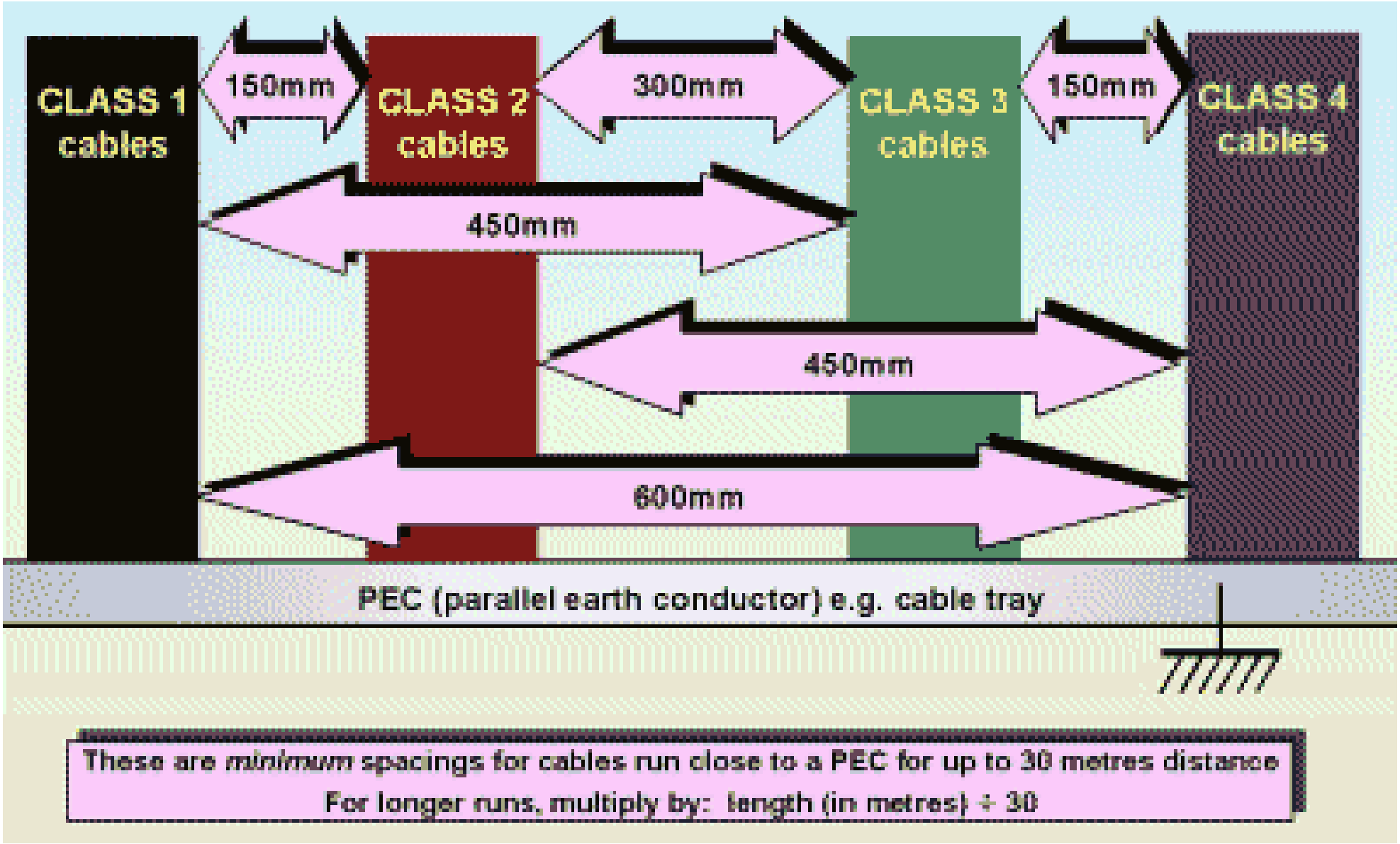


EMI Shield Equipotential Bonding

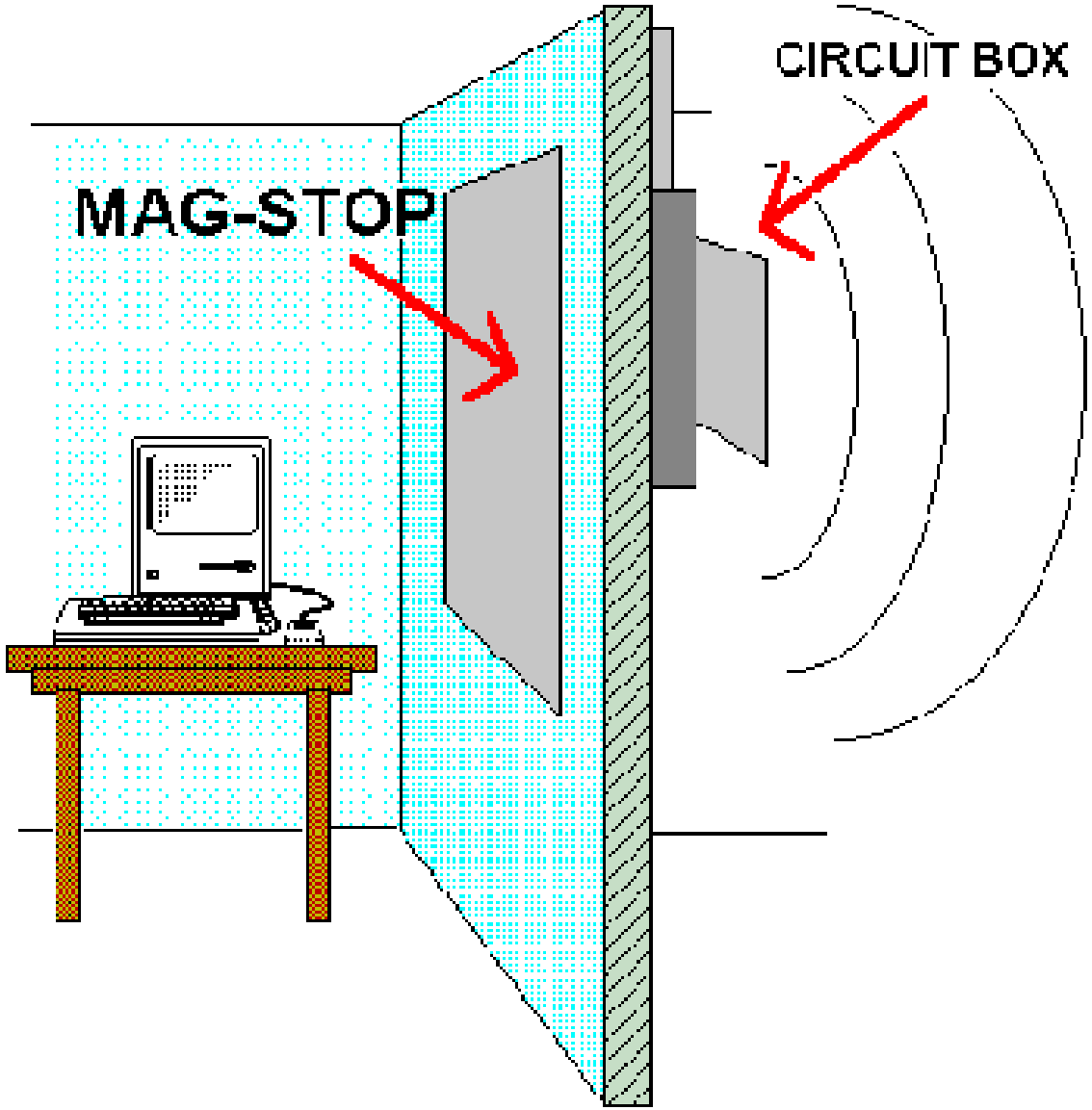




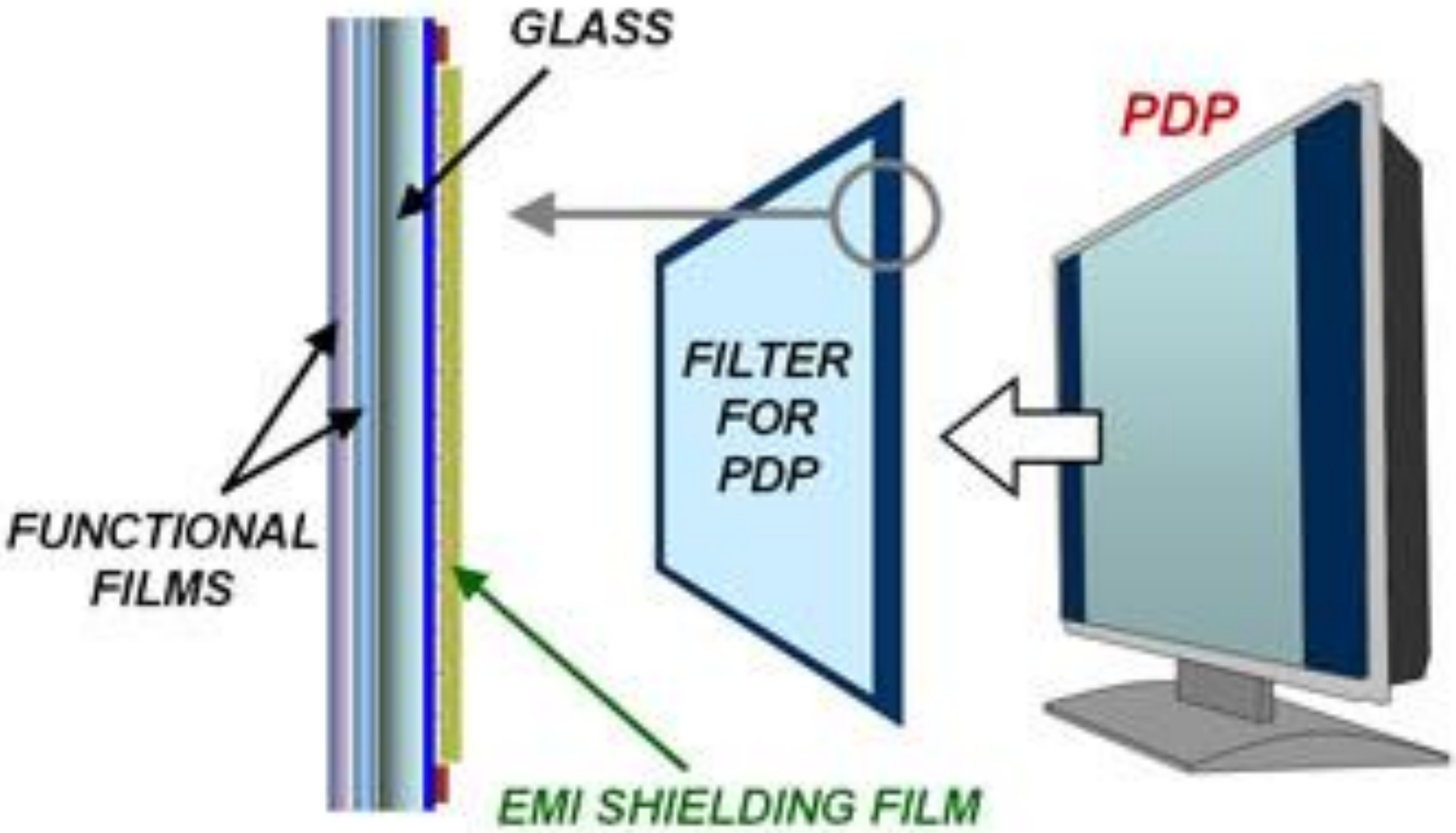
Segregation Distances



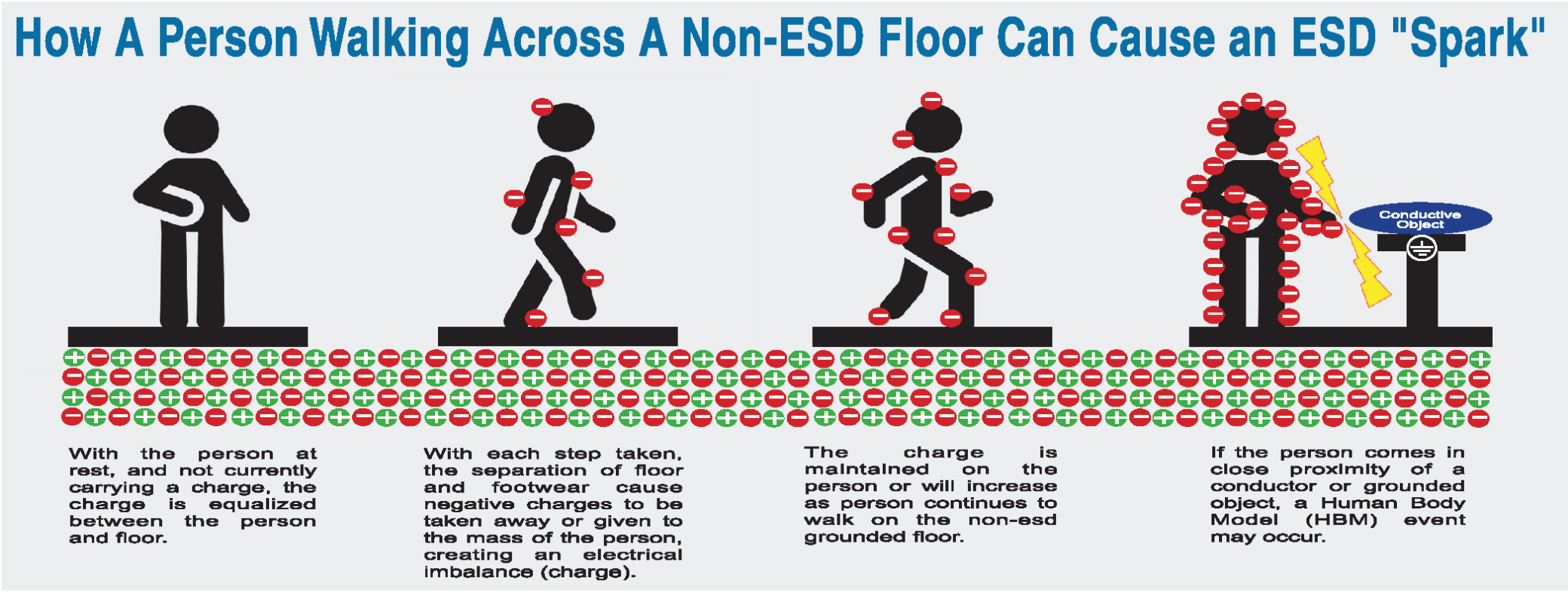
Faraday Cage Shielding: Directional



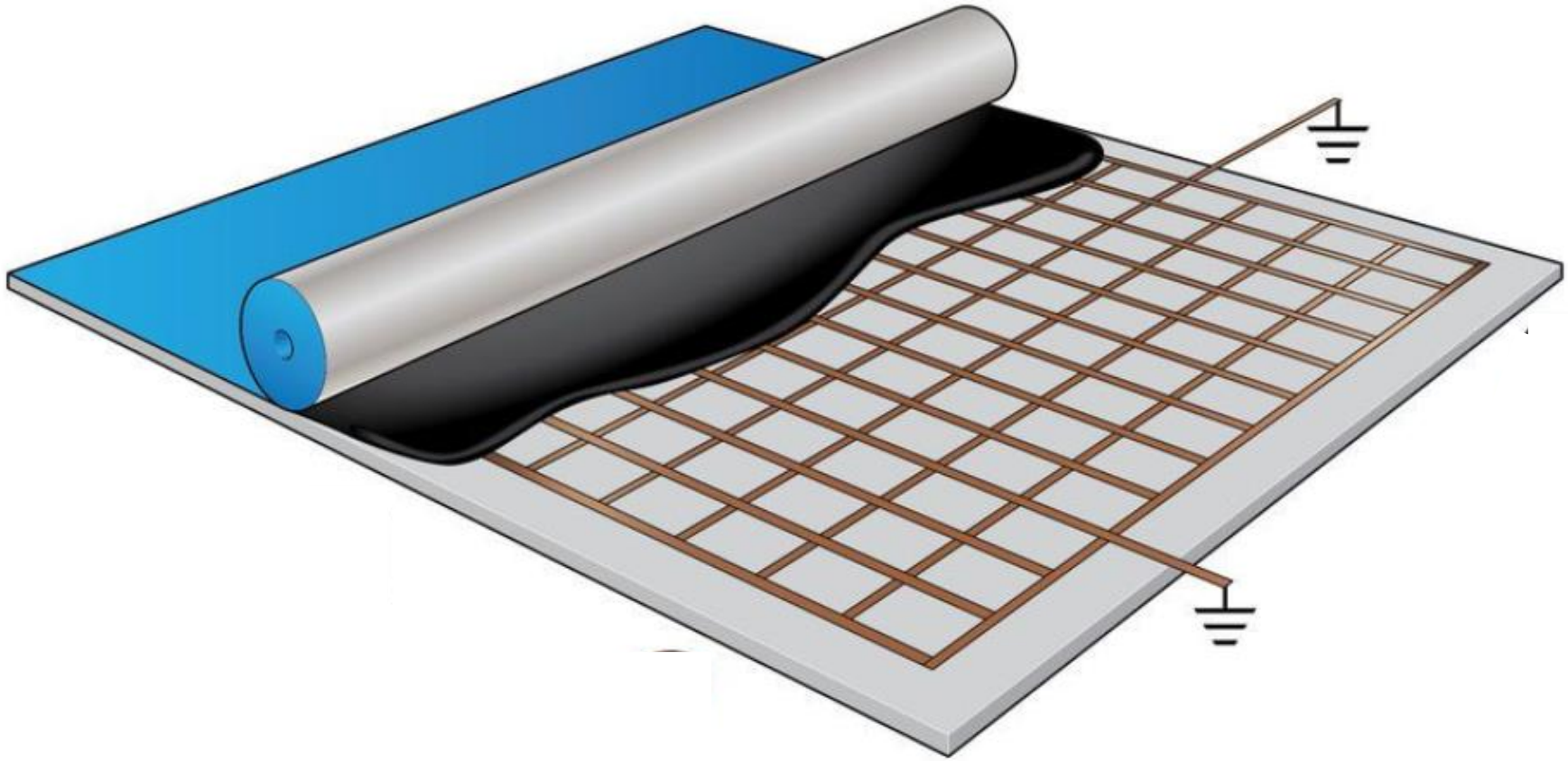
Faraday Cage Shielding: Directional



Electrostatic Discharge



How to Earth ESD Flooring: ESD “Cabling”



Copper Foil Grid

Your Choice: Malaysian Minister's Basic Salary

Suruhanjaya Tenaga
Energy Commission

KOD/ST/No.4/2016

NON-DOMESTIC
ELECTRICAL
INSTALLATION
SAFETY CODE

Maximum Fine: Rm. 200,000 – 00 and / or Maximum Imprisonment : 2 years

Thanks

Any Questions