Safe Cable Installation

Presented by
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MCMA
MALAYSIAN CABLE MANUFACTURERS ASSOCIATION

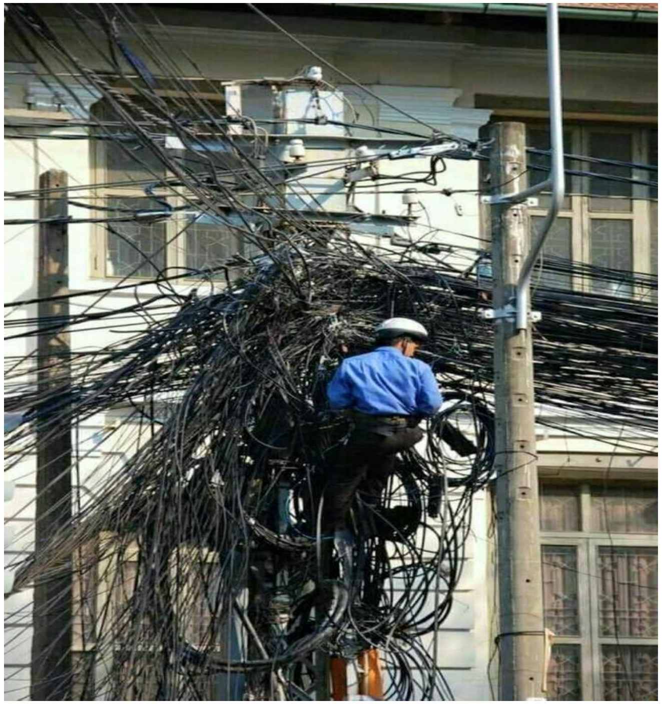
Prysmian Group
POWER CABLES MALAYSIA SDN BHD

- Installation
- Cable laying
- Cable jointing

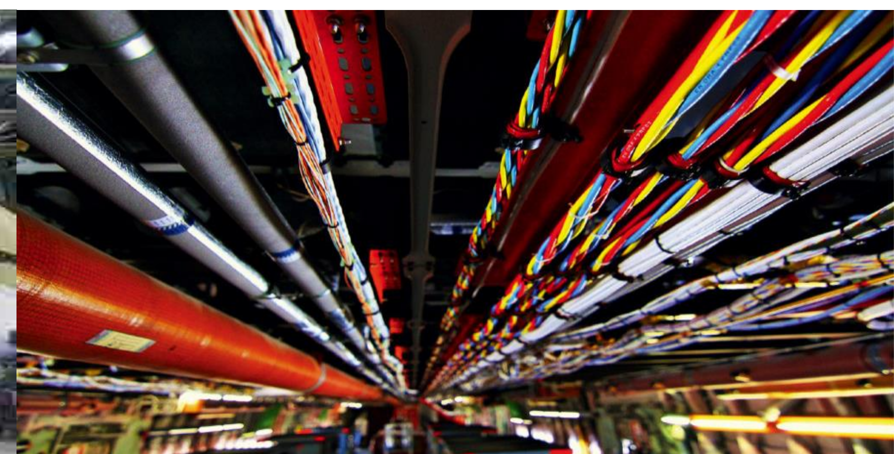
- Cable
- Design aspects
- Risk of fire
- Risk of “fake” cables
- Life cycle

To provide for a correct, orderly and consistent manner of cable installation, and to minimize the potential of any associated risk and safety hazards..

Cable and wire installations shall be conducted by "competent" personnel in the prescribed manner as per the regulatory requirements



…some 100 experienced workers sort, grade, bend into shape and connect up the 250-plus kilometers of cables forming part of each and every Boeing 747-8 and bundle them into cable harnesses ready for installation. **Each cable or wire has its special function in the aircraft and must be connected securely to the correct instrument, button or control panel.** It's a manual job performed by technicians working from detailed drawings and component lists. Every cable has a code of up to 10 digits indicating its position, connections and the cable harness to which it belongs…



DESIGN Conductors Insulation Protection

Aluminium Copper Solid Stranded Segmental

PILC PVC XLPE LSF HDPE LLDPE

Nylon Lead Tapes & Wires Water-Blocking

Extrusion Screening Bedding Armouring

CABLES

Curing Silane CCV Termites Voids Resistivity

Impedance Ampacity Short Circuit

AS/NZ BSI IEC AEIC EEMUA IEEE

HV Partial Discharge Ohms/km Capacitance

Installation Bond-Pulling Cross-Bonding

What Cable ?

- Aerial, underground, submarine,
- AC, DC, distribution, transmission
- Aluminium, Copper
- PILC, PVC, XLPE, Bare
- LV, MV, HV, EHV, 11kV etc.
- Screened, Belted, Armoured


Fire Safety Cables

Design Requirements

- Satisfies **power** needs
- Flexible
- Reliable
- Has LONG life
- Minimal maintenance
- **Economic**

Basic Design Elements

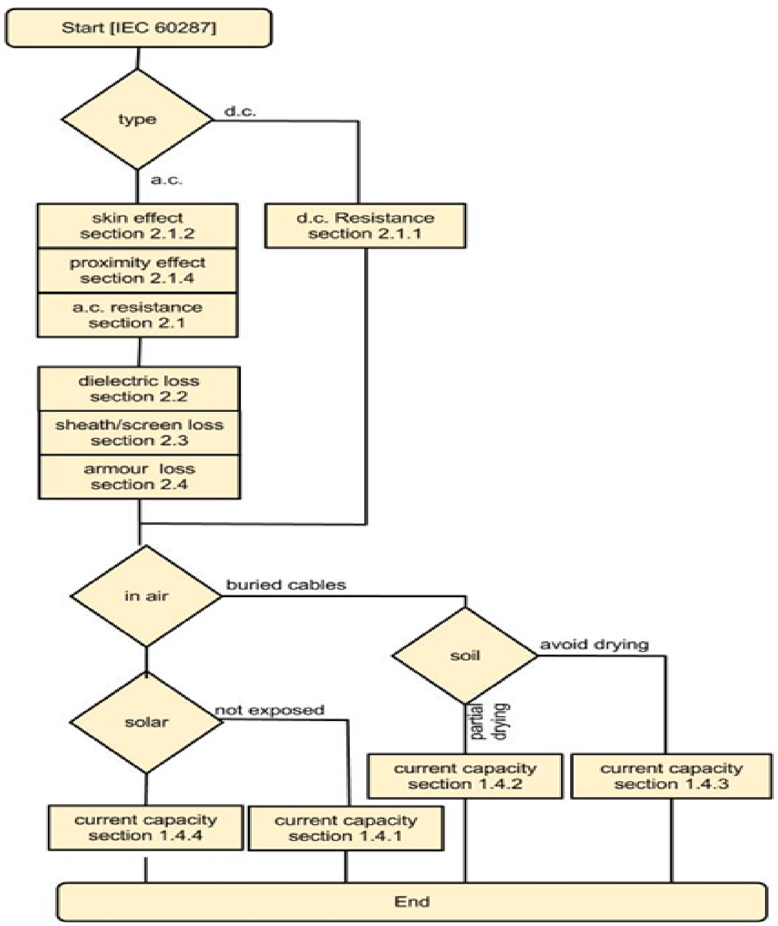
- CONDUCTOR
  - *determines base current ratings*
- INSULATION
  - *determines voltage / stress levels*
- PROTECTION
  - *determines installation conditions*

Cable Laying

- In principle, cables are laid as per conditions designed or as pre-determined to achieve its specified ratings
  - In Air – on racks, bridges, along walls, suspended on poles (aerial)
  - Laid in open/closed troughs, tunnels, in conduits (exposed)
  - Laid Direct in ground as-is or in pipes/ducts
  - Underwater, submarine or river crossing

- Key parameters for rating considerations
  - Ambient temperature
  - Soil thermal resistivity (laying in ground)
  - Lay configuration (single core – flat or trefoil)
  - Bonding system (single core – solid or special)

Current Rating Calculations



Current Rating Calculations

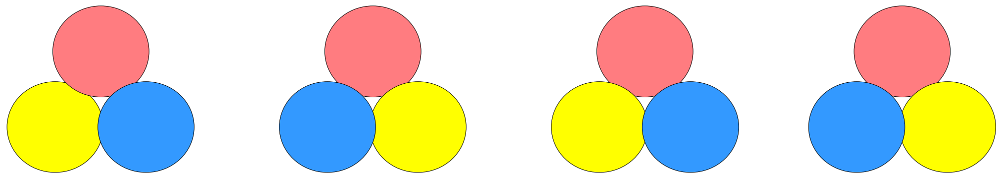
CUSTOMER	PRYSMIAN POWER CABLES &SYSTEMS AUSTRALIA PTY LTD
PROJECT/REF.	WOTONGA PROJECT
MANUFACTURER	POWER CABLES MALAYSIA SDN BHD
DOCUMENT NO.	PCM–CR–2011/259–1
DOC. TITLE	CURRENT RATING CALCULATIONS FOR XL1/0400C66.CPQV

Issued by : ZAIREEN	Date : 4–Jul–2011	Revision No. 0	Sheet No. 1 of 1

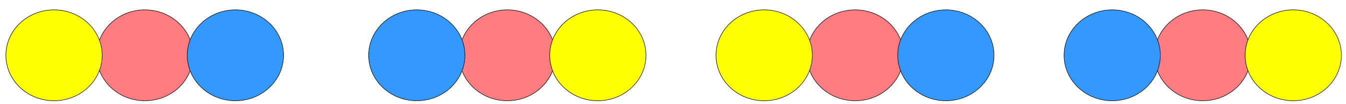
Cables laid direct in Ground, in PE Ducts, in Air (shaded) and in buried Trough.

Phase to earth voltage	38000	V	DC resistance at 20°C	47.0	µohm/m
Phase to phase voltage	66000	V	Ins. thm. resistivity	3.5	K.m/W
Power frequency	50	Hz	Non–metallic sheath TR	3.50	K.m/W
Ins. rel. permittivity	2.5	—	Soil thm. resistivity	1.2	K.m.W
Tangent delta	.001	—	Duct thm. resistivity	3.50	K.m/W
Duct "u" constant	1.87	—	Diameter over conductor	22.8	mm
Duct "v" constant	.31	—	Diameter over core	50.9	mm
Duct "y" constant	.00	—	Metal cov. mean diam.	54.0	mm
Air "z" trefoil,flat	.96,1.31	—	Overall diameter	64.9	mm
Air "e" trefoil,flat	1.25,2.00	—	Duct internal diameter	100	mm
Air "g" trefoil,flat	.20, .20	—	Duct external diameter	110	mm
Trough temp.rise trefoil	14.7	°C	Depth in ground, ducts	1200,1200	mm
Trough temp.rise flat	16.7	°C	Trough depth, width	1000, 500	mm
Capacitance	221.0	pF/m	Cross–bond sections	100/100/100	m/m/m

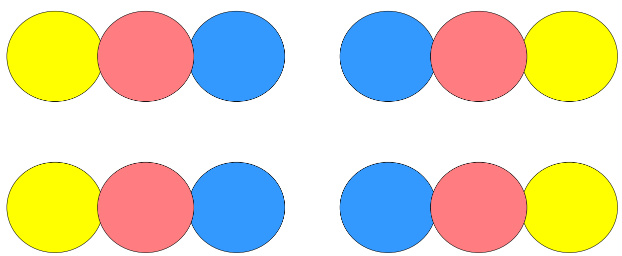
Lay configuration	—	Trefoil	Trefoil	Trefoil	Trefoil	Flat	Flat	Flat	Flat
Sheath bonding	—	Special	Special	Special	Special	Special	Special	Special	Special
Cable laying condition	—	Ground	Ducts	Air	Trough	Ground	Ducts	Air	Trough
Phase axial spacing	mm	65	110	65	65	130	220	130	130
Ambient lay temperature	°C	25.0	25.0	30.0	30.0	25.0	25.0	30.0	30.0
Max. conductor temperature	°C	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
Skin effect	—	.0225	.0225	.0225	.0225	.0225	.0225	.0225	.0225
Proximity effect	—	.0113	.0039	.0113	.0113	.0028	.0010	.0028	.0028
AC resistance at max. temp.	µohm/m	62.0	61.5	62.0	62.0	61.4	61.3	61.4	61.4
Metallic covering resistance	µohm/m	215.1	215.3	207.4	211.5	214.3	214.7	204.1	209.7
Metallic covering loss factor	—	.0406	.0154	.0421	.0413	.0207	.0098	.0097	.0095
Therm. resistance – Insulation	K.m/W	.4480	.4480	.4480	.4480	.4480	.4480	.4480	.4480
Therm. resistance – Oversheath	K.m/W	.1020	.1020	.0638	.0638	.0638	.0638	.0638	.0638
Therm. resist. cable to ducts	K.m/W	–	.3790	–	–	–	.3808	–	–
Therm. resist. of ducts	K.m/W	–	.0531	–	–	–	.0531	–	–
Therm. resist. outside ducts	K.m/W	–	1.8025	–	–	–	1.6354	–	–
Therm. resistance – External	K.m/W	2.1048	2.2345	.6930	.7387	1.9367	2.0692	.4933	.5303
External surface temperature	°C	76.9	77.3	65.0	71.8	76.9	77.3	59.6	68.8
Conductor loss per phase	W/m	23.7	23.0	48.5	35.3	26.3	25.0	59.4	41.3
Dielectric loss per phase	W/m	.10	.10	.10	.10	.10	.10	.10	.10
Metallic cov. loss per phase	W/m	.96	.35	2.04	1.46	.54	.24	.58	.39
Calculated ratings	Amps	618	612	885	755	654	639	983	820
Equivalent capacity	mva	70.68	69.97	101.16	86.28	74.75	73.02	112.38	93.76
Cct nos : centre spacing	no:mm	1:	1:	1:	1:—	1:	1:	1:	1:—
Tier nos : depth spacing	no:mm	1:—	1:—	1:—	1:—	1:—	1:—	1:—	1:—



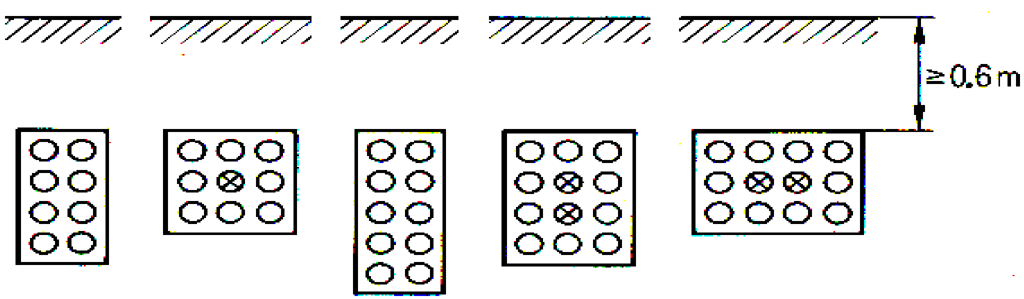
√ ***Single layer in Trefoil***



√ ***Single layer Flat formation***



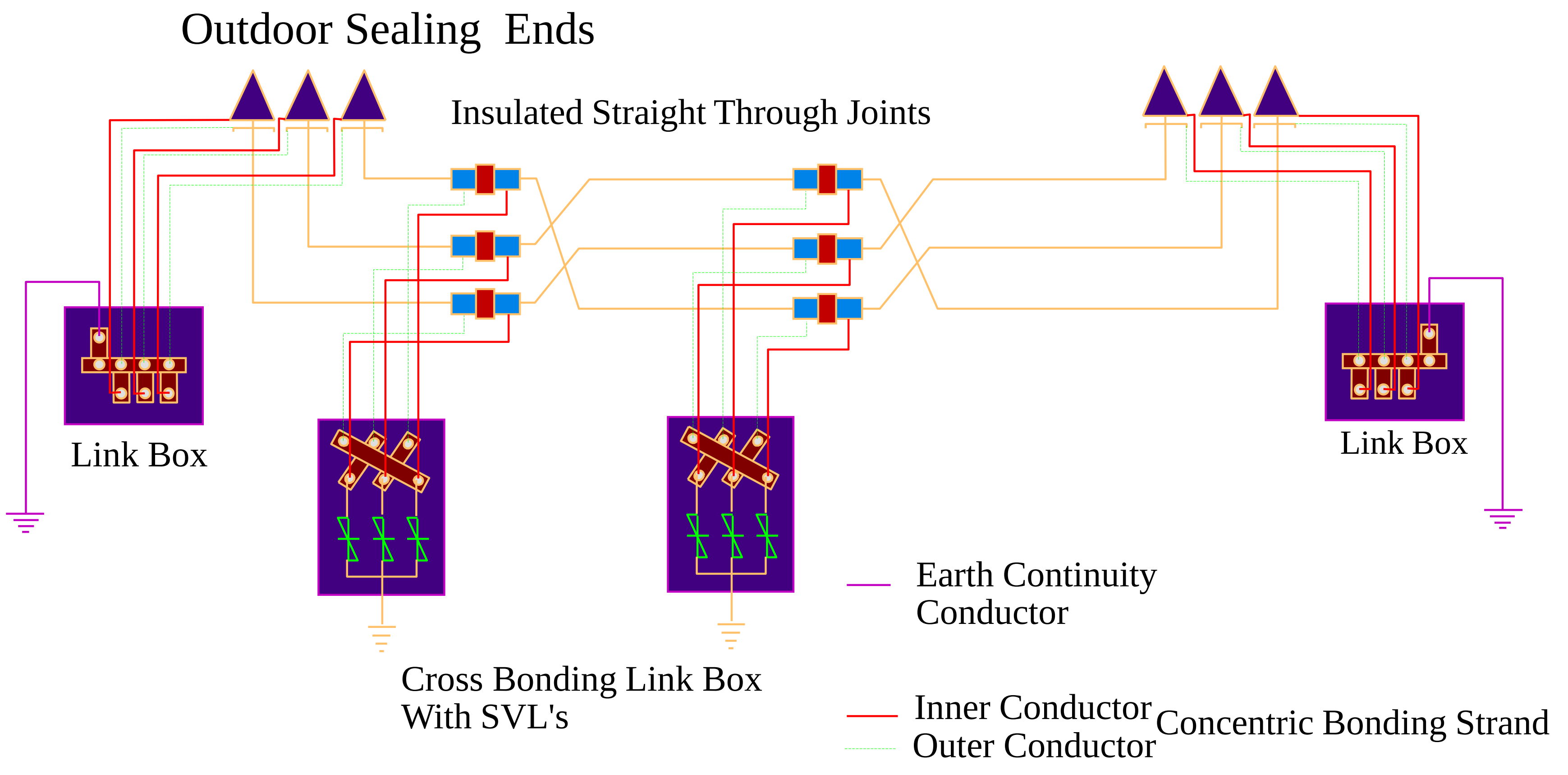
√ ***Two Tiers in Flat formation***

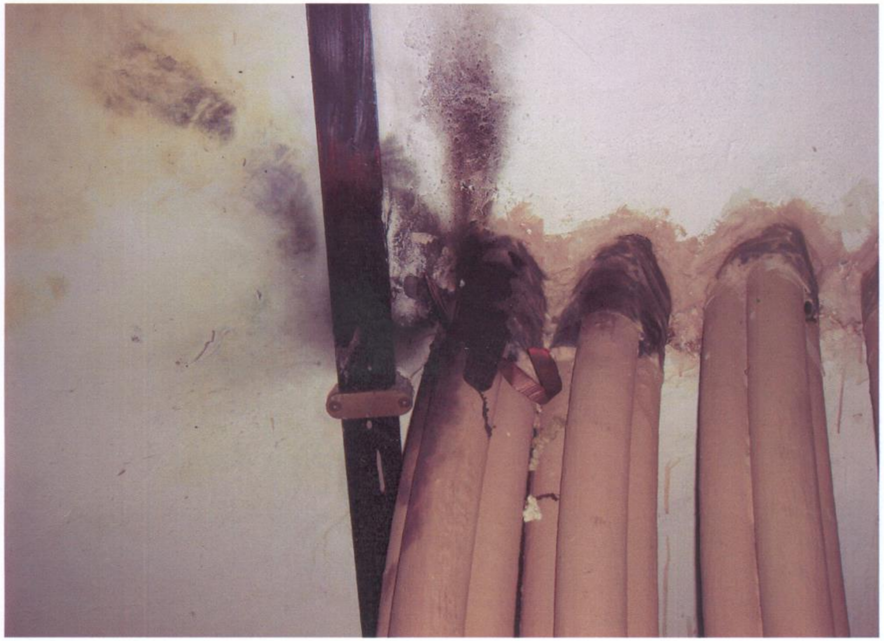


Electric Cables to be laid on the periphery of duct banks (not recommended for long spans)

⊗ unsuitable for power cables

Cross Bonding System





3.0 Discussions

The events leading to the fault is suggested as follows;

- Cuts were made on the cable by a sharp edge tool which were not deep enough to have caused an immediate failure
- With the copper wire screen of the cable partially exposed, an electrical connection would have developed over time between the screen and the nearest grounding earth
- The concrete wall and a metal bar in close proximity of the exposed screen provides the nearest point of ground return
- In solid bonding, a potential would be created for circulating currents to flow away from the grounded end to this near point.
- Over an undetermined period, the flow of current would have deteriorated further with a possible increase due to moisture ingression from the concrete wall, eventually leading to the occurrence of fault at the weakest point of damage.

4.0 Conclusion

From the investigation and aforementioned discussions, the conclusions are as follows;

- **The cable fault occurred over a period of time upon initiation of deep cuts exposing the wire screen to the elements of deterioration, leading to eventual failure**
- **Manufacturing defect can be ruled out due to its extensive nature and the unlikelihood that the observation of such damage can be missed during installation works**

End of Report

Cable Jointing

- In principle, the key elements of conductor, insulation and protection are to be reinstated to its original function
  - Conductor – closely connected using connectors of similar (or higher) electrical area and mechanical strength
  - Insulation – reinstated with compatible material of similar (or improved) breakdown strength
  - Protection - reinstated with compatible material of similar (or better) protective characteristics

- In general, joints are restricted for connecting cables of the exact size and construction

- Electric cables are safe until they are electrified
- Cables do not change color or produce any sound when electrified
- Heat dissipation of cables can only be detected when its outermost layer is hotter than the surroundings
- AC is several times more lethal than DC but both can kill
- Water (and moisture) is electrically conductive
- Always assume free cable ends are “live” - do not use any part of the body to confirm this
- Cables are not designed to last a lifetime - the service life of building cable & wires will not last the life of buildings
- Upon shutdown, charges may still persist especially on highly capacitive circuits and long span HV cables
- Do not exceed the minimum bending radius of cables
- Do not partially remove conductor wires to fit connectors
- When exposed over a period of time, an oxide coating will be formed on the surfaces of aluminum conductors

Basic Design Elements

- CONDUCTOR
  - *determines base current ratings*
- INSULATION
  - *determines voltage / stress levels*
- PROTECTION
  - *determines installation conditions*

Protection

- Cables need to be electrically protected against damage to adjacent cables, connecting equipment and for safety of users against electrical hazards
- PRIMARY – by the insulation & sheaths
- SECONDARY

  - by conductive layer(s) for the safe transfer of leakage currents, to be appropriately sized to meet system ratings and/or suitable grounding or bonding methods against leakages, transients and lightning

Property	PVC	Polyethylene	LSOH
Tensile (N/sqmm)	15	25	10
Elongation	150%	300%	100%
Density	1.3 - 1.5	0.91 - 0.96	1.4 - 1.6
Physical	Soft and flexible	Hard and rigid	Semi-hard and rigid
Abrasion Resistance	Poor	Excellent	Acceptable
Hot indentation	Acceptable	Excellent	Good
Impact Resistance (thick slab)	Good	Poor	Poor
Stress cracking	Resistant	Variable (dependent on molecular weight i.e. density)	Variable (dependent on base compound and mix)
Moisture	Absorbs moisture with prolonged contact	Negligible absorption	Absorbs and retains moisture within a short time
Vapour permeability	Reasonably permeable	Resistant	Permeable
High temp. performance	Increased ageing at higher temps.	Improved thermal & ageing performance	Generally stable
Low temp. performance	Brittle at sub zero	Stable at sub zero	Generally stable
Resistance to chemicals	Good	Excellent	Poor
Fire Performance	Flame retardant, emits toxic fumes & smoke	Low OI, burns without toxic fumes	Flame retardant, low smoke & no toxic fumes
Processability	Readily extrudable	Extrudable	Extrudable with special tools
Compound	Compounded with additives and fillers	Homogeneous	Highly filled base compound with additives and fillers
InstallationConditions :			
Direct in Ground - Dry	Excellent	Excellent	Good
Direct in Ground - Wet	Good (short term only)	Excellent	Not Recommended
Exposure to UV light	Resistant	Good (require UV resistant additives)	Variable (dependent on base compound and mix)

In its 124-year history there had never been mass loss of life in a fire on the London Underground. But on 18 November 1987 that would change, as a flashover - a sudden and rapid spread of fire caused by smoke or fumes igniting - claimed the lives of 31 people at King's Cross.

Section 12 Cables Explained - cable to sub-surface locations on the London Underground require Section 12 conforming cables. Following the King's Cross fire on the London Underground in 1987, the Fire Precautions (Sub-Surface Railway Stations) Regulations 1989 – also known as the Section 12 regulations – were introduced. Many people were affected by the smoke and toxic fumes during the fire and the Section 12 regulations stipulate that everything – from display boards to electrical cables – must adhere to stringent safety standards. Cable in Section 12 locations must meet the requirements of LUL Standard 1-085, which details the fire safety performance of materials used on the London Underground. In particular, Section 3.3.3 of the Standard lists the flammability, flame spread and smoke emission requirements for cable. All cables undergo rigorous testing to comply with the regulations.

FIRE PERFORMANCE CABLE TESTS	
Circuit Integrity	*IEC 60331-21; BS 6387 CWZ; DIN VDE 0472-814(FE180);*
	CEI 20-36/2-1; SS229-1; NBN C 30-004 (cat. F3);
	NF C32-070-2.3(CR1)
System circuit integrity	*DIN 4102-12, E30 depending on lay system*
Flame Retardance (Single Vertical Wire Test)	*EN 60332-1-2; IEC 60332-1-2; BS EN 60332-1-2;*
	VDE 0482-332-1 ; NBN C 30-004 (cat. F1); NF C32-070-2.1(C2);
	CEI 20-35/1-2; EN 50265-2-1; DIN VDE 0482-265-2-1**
Reduced Fire Propagation (Vertically-mounted bundled wires & cable test)	*EN 60332-3-24 (cat. C); IEC 60332-3-24; BS EN 60332-3-24; VDE 0482-332-3; NBN C 30-004 (cat. F2); NF C32-070-2.2(C1); CEI 20-22/3-4; EN 50266-2-4*; DIN VDE 0482-266-2-4*
Halogen Free	*IEC 60754-1; EN 50267-2-1; DIN VDE 0482-267-2-1;*
	*CEI 20-37/2-1 ; BS 6425-1**
No Corrosive Gas Emission	*IEC 60754-2; EN 50267-2-2; DIN VDE 0482-267-2-2;*
	*CEI 20-37/2-2 ; BS 6425-2**
Minimum Smoke Emission	*IEC 61034-1&2; EN 61034 -1&2; DIN VDE 0482-1034-1&2;*
	CEI 20-37/3-1&2; EN 50268-1&2; BS 7622-1&2**
No Toxic gases	*NES 02-713; NF C 20-454*
Plenum Applications	*NFPA 262 – Standard method of test for flame travel and smoke of wires and cables for use in air-handling spaces*
Riser Applications	*UL 1666 – Test for flame propagation height of electrical and optical-fiber cables installed vertically in shafts*
Vertical Tray Applications	*UL 1685 – Vertical-tray fire propagation and smoke-release, test for electrical and optical-fiber cables*
	CSA FT4 – Cables in cable trays
	IEEE 383 – Standard for qualifying Class 1E electric cables and field splices for nuclear power generating stations
	IEEE 1202 – Standard for flame testing of cables for use in cable trays in industrial and commercial occupancies
	JIS C 3521 – Flame test method for flame-retardant sheath of telecommunication cables

Danger in using inferior wires, says association

Items flooding the market of late do not conform to safety standards

KUALA LUMPUR, Wed: Thinking of rewiring your home, or office? Before you spend your money, take note that there has been an influx of substandard wires and cables flooding the market of late.

The Malaysian Electric Cable & Wires Association (Mecwa), the association representing Malaysia's wire and cable manufacturers, said today it will undertake a nationwide campaign to stamp out substandard cables and wires.

Mecwa president Datuk Kenneth H'ng said its members were aware of the increasing number of such home wires and cables in the market which do not conform to the quality and standards approved and recognised by the quality certification bodies.

"In addition, these cables are often packaged in short lengths duping the consumers into thinking that he or she is buying 100m but is, in fact, receiving less," he said in a statement.

H'ng said the low quality cables are a danger to the public, and the association is determined to approach the government and the standards authorities to get the products off the shelves.

"Substandard cables are a safety hazard. Consumers are being cheated when they purchase poor quality, falsely labelled product."

He said the association will recommend to the government that all wire and cable manufacturers attain the ISO 9001/9002 quality standard accreditation and that the authorities approve renewals based on successful quality accreditation.

He said the association will meet with relevant authorities, including Sirim, on the matter. – Bernama

Association: Low quality wires flooding market

KUALA LUMPUR: The Malaysian Electric Cable and Wires Association has warned the public to be wary of sub-standard wires and cables flooding the market.

Association president Datuk Kenneth H'ng, in making this revelation yesterday, said it would carry out a nationwide campaign to stamp out these sub-standard house wiring cables which had begun appearing in the market.

He said association members were aware of the rising quantity of such cables in the market which did not conform to the standards of certification bodies.

"In addition, these undersized and sub-standard cables are often packaged in short lengths so that consumers may think they're buying 100m but are, in fact, getting less," he said in a statement.

H'ng said the low-quality cables were dangerous to the public and the association was determined to approach the Government and the standards authorities for help.

"Sub-standard cables are safety hazards, and in addition, the consumers are being cheated when they buy poor quality, falsely-labelled products," he said.

H'ng said the association would recommend to the Government that all wire and cable manufacturers attain the ISO 9001/9002 quality standard accreditation.

He also called on the authorities to approve renewals based on successful quality accreditation. — Bernama

STATISTIK PUNCA KEBAKARAN, 2016

PUNCA KEBAKARAN	JOH	KED	KEL	MEL	NS	PHG	PRK	PLS	PP	SBH	SWK	SEL	TRG	W.P.KL	W.P. LAB	W.P. PTJY	JUMLAH
Elektrik	100	56	184	152	38	75	109	33	332	17	164	305	147	273	5	15	**2,005**
Puntung Rokok	167	4	25	10	35	44	24	8	172	1	28	42	145	47	-	1	**753**
Percikan Api	27	13	11	20	2	12	8	5	17	1	27	29	40	16	-	1	**229**
Mercun/ Bunga Api	7	1	1	4	-	1	2	-	7	-	2	6	6	5	-	-	**42**
Ubat Nyamuk/Lilin/Colok	10	1	4	5	1	7	8	1	18	-	15	11	3	13	-	1	**98**
Dapur Gas/Minyak	40	15	28	37	10	20	26	4	96	3	56	80	33	77	-	3	**528**
Reaksi Spontan	6	-	5	2	1	37	4	30	22	4	14	7	9	7	-	-	**148**
Sengaja Dibakar Niat Baik	415	425	294	618	81	143	312	138	673	6	333	377	815	77	-	3	**4,710**
Sengaja Dibakar Niat Jahat	63	5	11	12	1	15	41	1	39	3	136	73	13	80	-	-	**493**
Tidak Diketahui	82	15	13	18	3	62	220	1	38	17	34	44	79	22	-	1	**649**
Tindak Balas Kimia	4	1	-	1	-	-	-	-	-	-	1	1	1	1	-	-	**10**
Mancis Api	7	2	3	5	-	4	3	-	10	2	72	19	2	3	-	-	**132**
Lain-Lain Punca	4,220	3,833	1,630	1,582	1,947	2,518	5,819	866	2,071	4,566	1,130	7,167	1,098	1,077	483	71	**40,078**
JUMLAH	**5,148**	**4,371**	**2,209**	**2,466**	**2,119**	**2,938**	**6,576**	**1,087**	**3,495**	**4,620**	**2,012**	**8,161**	**2,391**	**1,698**	**488**	**96**	**49,875**

Sumber : Jabatan Bomba dan Penyelamat Malaysia

Malaysian Standards (MS) on Cables

1	MS 2108: 2007	Electric Cable : 6.35/11(12)kV single core XLPE insulated cables – non-armoured	MV-XLPE
2	MS 2109: 2007	Electric Cable : 6.35/11(12)kV single core XLPE insulated cables – armoured	
3	MS 2110 :2007	Electric Cable : 19/33(36)kV single core XLPE insulated cables – non-armoured	
4	MS 2111: 2007	Electric Cable : 19/33(36)kV single core XLPE insulated cables –armoured	
5	MS 2113*	Electric Cable : 12.7/22(24)kV single core XLPE insulated cables – non-armoured	
6	MS 2114*	Electric Cable : 12.7/22(24)kV single core XLPE insulated cables – armoured	
7	MS 2115*	Electric Cable : 6.35/11(12)kV three core XLPE insulated cables – non-armoured	
8	MS 2116*	Electric Cable : 6.35/11(12)kV three core XLPE insulated cables –armoured	
9	MS 2117*	Electric Cable : 12.7/22(24)kV three core XLPE insulated cables –armoured	
10	MS 2118*	Electric Cable : 2.7/22(24)kV three core XLPE insulated cables –armoured	
11	MS 2119*	Electric Cable : 19/33(36)kV three core XLPE insulated cables –armoured	
12	MS 2120*	Electric Cable : 19/33(36)kV three core XLPE insulated cables –armoured	
13	MS 2104:2007	Electric Cable and Wire: 600/1000(Um = 1200) V single core XLPE insulated cable – non-armoured	LV-XLPE
14	MS 2105:2007	Electric Cable and Wire: 600/1000(Um = 1200) V single core XLPE insulated cable –armoured	
15	MS 2106:2007	Electric Cable and Wire: 600/1000(Um = 1200) V multi core XLPE insulated cable –non-armoured	
16	MS 2107: 2007	Electric Cable and Wire: 600/1000(Um = 1200) V multi core XLPE insulated cable –armoured	
17	MS 2100:2006	Electric Cable and Wire: 600/1000(Um = 1200) V single core PVC insulated cable – non-armoured	LV-PVC
18	MS 2101:2006	Electric Cable and Wire: 600/1000(Um = 1200) V single core PVC insulated cable –armoured	
19	MS 2102:2007	Electric Cable and Wire: 600/1000(Um = 1200) V multi core PVC insulated cable –non-armoured	
20	MS 2103: 2007	Electric Cable and Wire: 600/1000(Um = 1200) V multi core PVC insulated cable –armoured	
21	MS 2112-1: 2009	Electric Cable and Wire: Polyvinyl Chloride(PVC) insulated cables of rated voltages up to and including 450/750 V – Part 1 : General requirements	450/750V-PVC
22	MS 2112-2: 2009	Electric Cable and Wire: Polyvinyl Chloride(PVC) insulated cables of rated voltages up to and including 450/750 V – Part 2 : Test Methods	
23	MS 2112-3: 2009 **	Electric Cable and Wire: Polyvinyl Chloride(PVC) insulated cables of rated voltages up to and including 450/750 V – Part 3 : Non-sheathed cables for fixed wiring	
24	MS 2112-4: 2009 **	Electric Cable and Wire: Polyvinyl Chloride(PVC) insulated cables of rated voltages up to and including 450/750 V – Part 4 : Sheathed cables for fixed wiring	
25	MS 2112-5: 2009 **	Electric Cable and Wire: Polyvinyl Chloride(PVC) insulated cables of rated voltages up to and including 450/750 V – Part 5 : Flexible cables	
26	MS 2112-6: 2009 **	Electric Cable and Wire: Polyvinyl Chloride(PVC) insulated cables of rated voltages up to and including 450/750 V – Part 6 : Cables for Lifts and flexible connections	
27	MS 2121*	Telecommunication Cable : Plastic Twin pair,triple and unit types, internal cable	Telecoms
28	MS 2122*	Telecommunication Cable : Jumper cable	
29	MS 2123*	Telecommunication Cable : Self supporting drop wire	
30	MS 2124*	Telecommunication Cable :Fully Filled Unit Twin moisture barrier polyethylene sheathed cable (FF PEUT)	
31	MS 2125*	Telecommunication Cable :Integral Barrier Unit Twin moisture barrier polyethylene sheathed cable (IB PEUT)	
32	MS 2126*	Telecommunication Cable :Polyethylene Insulated 25 Pair Unit Twin moisture barrier polyethylene sheathed cable (FS PEUT)	

Overview of Standards & Quality of Cables

Um (max voltage)	Class	Ref Stds & Specifications		Risk	Control on Quality & Inspection
		Existing/Prev	New		
Above 170kV	EHV	Utility	Utility	Nil	High scrutiny at all levels
37kV - 170kV	HV	IEC/Utility	IEC/Utility	VLow	High sampling rate of test & inspection
3.7kV - 36kV	MV	BS/IEC/Utility	IEC/MS	Low	Adequate control on test & inspection
1.2kV - 3.6kV	LV	BS/IEC/Owner	IEC/MS	Low	Adequate control on test & inspection
Below 1.2kV	**ELV**	**BS/MS**	**MS**	**High**	**Minimum or no control**

Empirically..

Cable type	Voltage	Primary	Service life	
			Low	Med
Bare Conductors	All	Reinforced	35	40
	All	Non-reinforced	25	35
Paper insulated, metal sheath	All	Fluid filled	35	50
	All	Solid	30	40
Thermosets (XLPE, EPR)	All	Metal sheathed	30	40
	All	Foil laminated	25	35
	All	Water tight	25	35
	All	Armoured/Ducted	25	35
	All	Non-armoured	15	25
Thermoplastics (PVC, PE, EVA)	>3.3kV	All types	10	20
	0.6/1kV	Armoured/Ducted	25	35
	0.6/1kV	Non-armoured	15	25
	<1kV	Armoured/Ducted	15	25
	<1kV	Non-armoured	10	20
	<1kV	*"Sub-standard"*	<5	--

NON-STANDARD CABLES

Cables which are designed and constructed to other standards which may not comply to the prevailing requirements & regulations on test approvals and/or installation conditions

The development of national standards for electric cables takes into account the principles and norms as established internationally, current prevailing conditions and local practices. It is important to understand that these aspects are majorly unbeknown to buyers and users, hence <u>failure to comply on critical aspects may present an undetermined risk on safety.</u>

SUB-STANDARD CABLES

Cables which are not designed, constructed, test approved, installed or used in accordance to their prescribed standards and/or specifications

The development of national standards for electric cables takes into account the principles and norms as established internationally, current prevailing conditions and local practices. It is important to understand that these aspects are majorly unbeknown to buyers and users, hence <u>failure to comply on critical aspects may present an undetermined risk on safety.</u>

Myths of Sub-Standard Cables

- **Conductors are smaller due to “technological improvements”**
- **Copper purity is higher**
- **Able to withstand higher temperatures hence more current**
- **The standards have “changed”**
- **“There is no problem, it still works..”**

Sub-Standard Element : Conductors

CRITERIA

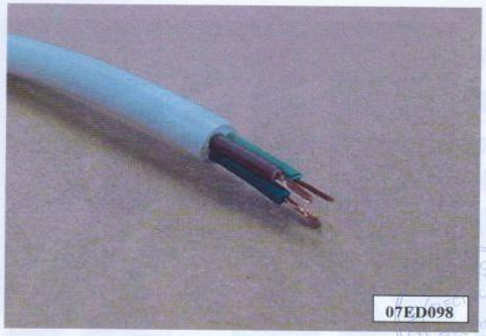
- Undersized – conductor does not meet the minimum cross-sectional area as determined by its specific resistance
- Construction not in accordance to prescribed standards on size & number of wires, buildup or dimensions
- ~~Metal content not meeting specifications (copper >99.9%, alum >99.7%)~~

IMPACT

- **Non-compliance to any of the above will result in conductor overload in excess of the maximum current loading of the cable**
- **This condition would lead to eventual breakdown of cable insulation, joints or connectors at installed positions or distribution boards**
- **Excessive overheating may result in short circuit conditions leading to an electrical fire**

Anatomy of Sub-Standard Cables

PHOTOGRAPH OF TEST SAMPLE



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NOTES:

1. This is a partial test report.
2. All the tests were conducted at SIRIM QAS International Sdn. Bhd. And had been checked in accordance with the following clauses;

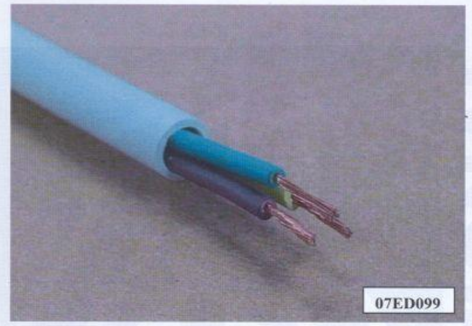
   a) Clause 5.1, 6.2, 7.2, 7.3, 7.4, 19.3 and 22.3 of MS 140: 1987
   b) Clause 7.1, 7.2, 7.3 and 7.4 of MS 69: 1995
   c) Tensile & elongation (before ageing) and resistance to crack of MS 138: 1995
3. The test sample as described in this test report deemed to comply with the requirements of those test conducted except clause 7.2 and 7.4 of MS 69: 1995 and tensile & elongation (before ageing) of MS 138: 1995.

ADDITIONAL INFORMATION:

1. Tested by : Effahaikal Mahmudi Signature : Date: 3/01/08
2. Checked by: Mr.Surian Rasol Signature : Date: 3/1/08
3. Date of test sample(s) received:
   a) 1st submission : 11 October 2007
   b) 2nd submission : -
   c) 3rd submission : -

[redacted] Prepared by: [redacted]

PHOTOGRAPH OF TEST SAMPLE



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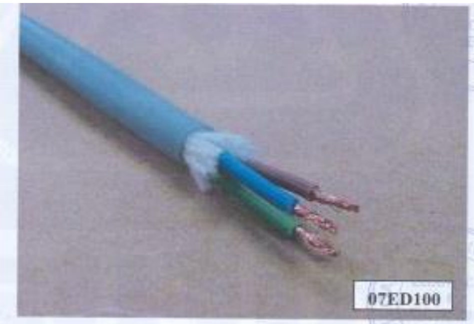

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[redacted] Prepared by: [redacted]

Sub-Standard Cables – A Lucrative Business?

Item	Flexible Cable 40/0.16mm (0.75sqmm) x 3C 300/500V PVC/PVC				
Reference		STD	07ED100	07ED099	07ED098
Conductor					
- number of wires		40	39	38	38
- resistance	ohm/km	26	29.8	69.3	112
- equiv area	sqmm	0.731	0.638	0.274	0.170
- cond diam	mm	1.061	0.991	0.650	0.511
- total weight	gm/m	19.490	17.004	7.312	4.524
Insulation					
- nominal thickness	mm	0.56	0.65	0.75	0.95
- weight per core	gm/m	4.278	5.027	4.948	6.542
- total weight	gm/m	12.834	15.080	14.843	19.625
- core diam	mm	2.181	2.291	2.150	2.411
- laidup diam	mm	4.711	4.949	4.644	5.208
Sheath					
- overall diam	mm	6.4	7.07	6.89	7.36
- nominal thickness	mm	0.84	1.06	1.12	1.08
- calc mass	litre	14.739	20.023	20.347	21.240
- total weight	gm/m	21.371	29.034	29.504	30.798
Cable overall weight	gm/m	**53.7**	**61.1**	**51.7**	**54.9**

Reference		STD	07ED100	07ED099	07ED098
Cu price	Myr/kg	30	30	30	30
PVC price	Myr/kg	4.5	4.5	4.5	4.5
Cu	Myr/m	0.585	0.510	0.219	0.136
PVC	Myr/m	0.154	0.199	0.200	0.227
Material cost	Myr/m	0.739	0.709	0.419	0.363
ROS (material only)	**Margin**	**0%**	**4%**	**76%**	**104%**

Sub-Standard Cables - Electrical Properties

Item	*Flexible Cable 40/0.16mm (0.75sqmm) x 3C*				
Reference		STD	07ED100	07ED099	07ED098
Conductor					
- resistance	ohm/km	*26*	*29.8*	*69.3*	*112*
- equiv area	sqmm	*0.731*	*0.638*	*0.274*	*0.170*
Current rating	**amp**	**7.5**	**6.5**	**2.8**	**1.7**
Short cct rating	**amp**	**84.0**	**73.3**	**31.5**	**19.5**
Voltage drop	**mv/A/m**	**63**	**72**	**168**	**271**
Max length (2.5% drop)	**metres**	**14**	**12**	**5**	**3**

Detecting Sub-Standard Cables (DIY)

- Check labels and markings for size, type, manufacturer name/logo and product standard
- Verify physical measurements against manufacturers' data
- Estimate the cross-sectional area of conductor by physical measurement i.e. area x number of wires
- Conduct a conductor d.c. resistance measurement to the Standards

Class II Copper Conductors 0.5 to 35 sqmm

STANDARD - MS/IEC/BS			ACTUAL - MIN		
cond size	wire no. min	max * ohm/km	area sqmm	cond gm/m	wire gm/m
0.5	7	37.11	0.479	4.258	0.608
0.75	7	25.26	0.704	6.256	0.894
1	7	18.66	0.953	8.468	1.210
1.5	7	12.47	1.425	12.67	1.810
2.5	7	7.639	2.327	20.68	2.955
4	7	4.753	3.740	33.25	4.750
6	7	3.175	5.598	49.76	7.109
10	7	1.887	9.421	83.76	11.97
16	7	1.186	14.99	133.3	19.04
25	7	0.749	23.72	210.8	30.12
35	7	0.540	32.90	292.5	41.79

Basis of calculations :

- ❖ Volume resistivity of 17.241 ohm.mm^2/km at 20^{o}C with a division factor of 0.97 for hard-drawn copper
- ➢ Specific gravity at 8.89 kg/m^3
- ➢ Resistance-temperature coefficient of 0.00393 /^{o}C at 20^{o}C

Factors at specific temperatures for correcting resistance measurements to 20^{o}C			
^{o}C	factor	^{o}C	factor
20	1.000	28	0.970
21	0.996	29	0.966
22	0.992	30	0.962
23	0.988	31	0.959
24	0.985	32	0.955
25	0.981	33	0.951
26	0.977	34	0.948
27	0.973	35	0.944

Objective :

To verify compliance of the cables to MS 2112-3

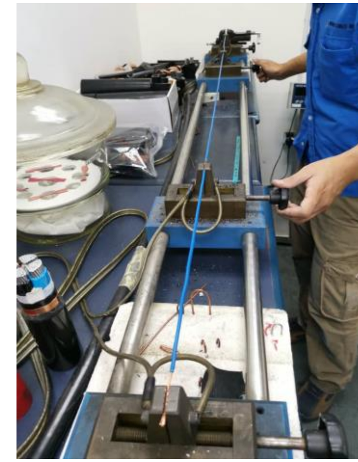
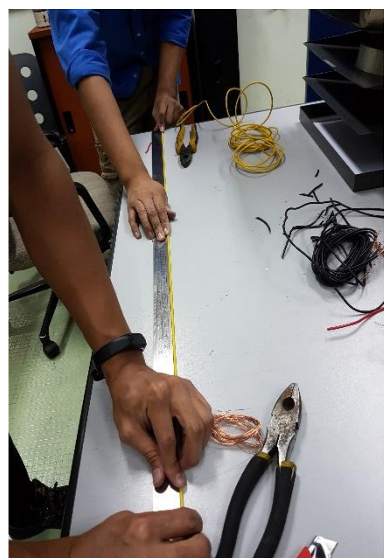
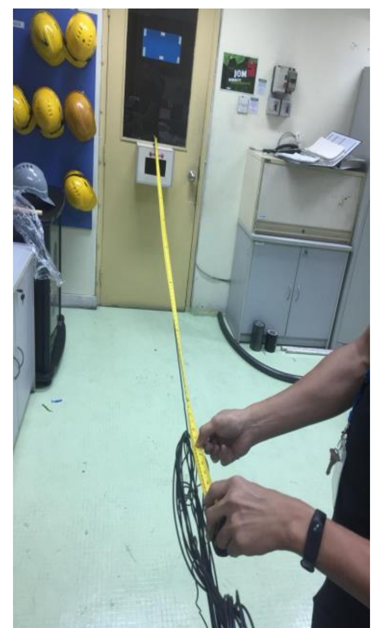
1st Level verification

1.1 Conductor size

1.2 Length

Methodology

- "In 1913, the standard conductivity of pure annealed copper was fixed by the International Electrotechnical Commission (IEC) as that of an annealed copper wire 1 m long, weighing 1 g and having a density of 8.89 g/cm3 . The wire exhibited a resistance of exactly 0.15328 Ω. This value was assigned a volume conductivity of 100 % of the International Annealed Copper Standard, written 100% IACS. It corresponds to a volume resistivity of 17.241nΩm.."
- $Cr_{@20°C} = Cr_{@\,T°C} \times \frac{1}{1+0.00393(T-20)}$; conductor ohm at 20°C
- $\frac{L_c}{Cr_c} = \frac{L_1}{Cr_1}$; resistance to length ratio
- $\frac{L_c}{M_c} = \frac{L_1}{M_1}$; mass to length ratio

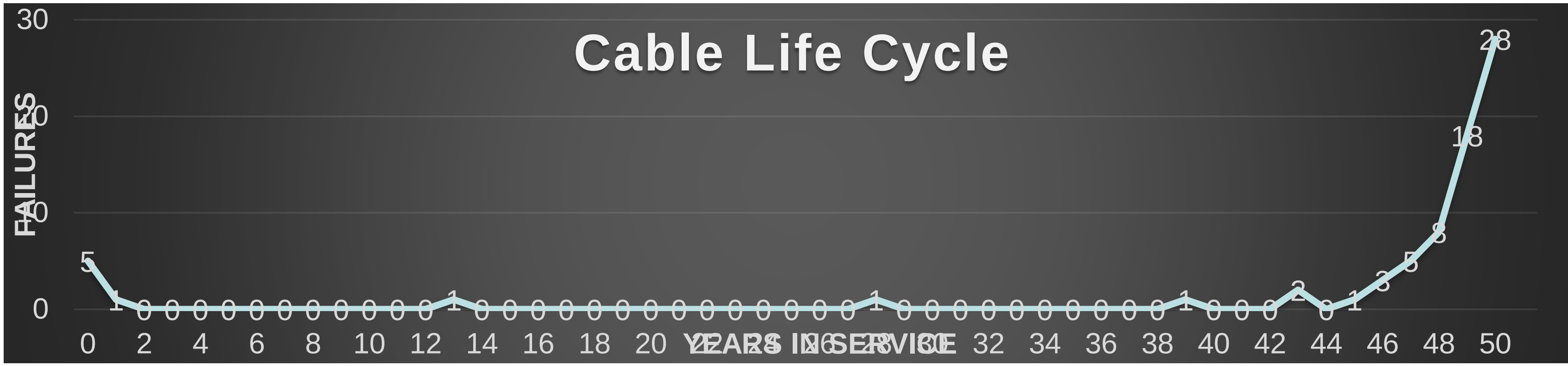

Summary of Results

Identification			Copper Conductor						Coil Length			Total Compliance to STD (%)
Brand	Nom Size	Color	CSA (mm^2)	Compliance to STD (%)	Ω/m @20°C	Compliance to STD (%)	Mass (gm/m)	Compliance to STD (%)	Physical Measure (m)	By Weight Ratio (m)	By Ohms Ratio (m)	
STD : MS/BS/IEC			1.425		0.01210		12.667		Label - 100 m			
M	1.5	Red	0.970	68.1	0.01822	66.4	8.660	68.4	92.1	89.7	92.5	61.2
T	1.5	Green	0.713	50.0	0.02218	54.6	6.947	54.8	74.7	73.8	73.7	40.8
E	1.5	Red	1.002	70.4	0.01560	77.6	9.830	77.6	88.7	88.6	90.1	68.8
S	1.5	Black	1.163	81.6	0.01482	81.6	10.580	83.5	97.8	94.9	98.8	79.9
Z	1.5	Black	1.113	78.1	0.01487	81.3	10.350	81.7	95.8	97.2	94.9	77.9
STD : MS/BS/IEC			2.327		0.00741		20.685		Label - 100 m			
Y	2.5	Green	1.374	59.1	0.01340	55.3	11.830	57.2	84.6	85.0	88.3	46.8
M	2.5	Black	1.544	66.4	0.01058	70.0	14.913	72.1	89.9	89.5	91.0	62.9
T	2.5	Yellow	1.214	52.2	0.01334	55.5	11.450	55.4	73.5	72.6	76.2	40.8
E	2.5	Blue	1.992	85.6	0.00912	81.2	17.020	82.3	89.2	89.5	85.9	72.5
S	2.5	Green	2.141	92.0	0.00845	87.7	18.370	88.8	95.1	96.0	100.6	83.4

CU Resistivity : 0.017241
CU Density : 8.89 gm/cm3

Cable Life – Contributing Factors

- Internal – the requirements of specifications & relevant standards, construction, manufacture, tests and transportation of cables to site
- External – the expected conditions to be endured by the cables during its service life
- Operational – the manner of handling, installing, jointing & terminating, loading and servicing as per system design



Years	<1	0-35	30-40	>40
Phase	Initiation stage	The Golden years	The Pensioner	The End
Failure freq	Diminishing	Erratic - low	Erratic - high	Increasing, exponentially
Key suspects	installation (workmanship)	physical damage (external)	imperfections (internal)	"unknown" (expired)
Action	repair & make good	cut & joint	replace cable length	replace cable lengths

The quadrants of cable life

Designed as required, installed & operated as intended	*Installed & operated as intended, NOT designed as required*
Designed as required, NOT installed or operated as intended	*NOT designed, NOT installed or operated as intended*

Empirically..

Cable type	Voltage	Primary	Service life	
			Low	Med
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	All	Non-reinforced	25	35
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	<1kV	Non-armoured	10	20
	<1kV	*"Sub-standard"*	<5	--

Thank you !