Sub-standard Cables
Challenges & Way Forward

MCMA
MALAYSIAN CABLE MANUFACTURERS ASSOCIATION

Lokman A. Dahlan

Technical Advisor

Electric cable design requirements

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

Basic Elements

- **CONDUCTOR**
  determines base current ratings
- **INSULATION**
  determines voltage / stress levels
- **PROTECTIVE LAYER(S)**
  determines protection level
  & installation conditions









Um (max voltage)	Class	Ref Stds & Specifications		Control on Quality & Inspection	Risk
		Existing/Prev	New		
Above 170kV	EHV	Utility	Utility	High scrutiny at all levels	Nil
37kV - 170kV	HV	IEC/Utility	IEC/Utility	High sampling rate of test & inspection	VLow
3.7kV - 36kV	MV	BS/IEC/Utility	IEC/MS	Adequate control on test & inspection	Low
1.2kV - 3.6kV	LV	BS/IEC/Owner	IEC/MS	Adequate control on test & inspection	Low

Um (max voltage)	Class	Ref Stds & Specifications		Control on Quality & Inspection	Risk
		Existing/Prev	New		
Below 1.2kV	**ELV**	**BS/MS**	**MS**	**Minimum or no control**	**High**

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**

STATISTIK PUNCA-PUNCA KEBAKARAN BANGUNAN
BAHAGIAN PENYIASATAN KEBAKARAN
JABATAN BOMBA DAN PENYELAMAT MALAYSIA
TAHUN 2012
SELURUH MALAYSIA - Januari hingga Jun

KOD	KATEGORI BANGUNAN	PENGKELASAN PUNCA KEBAKARAN																				JUMLAH SIASATAN
		SEMULAJADI		KEMALANGAN									SENGAJA DIBAKAR								TIDAK DAPAT DIPASTIKAN	
		SUMBER NYALAAN																				
		SN1	SN2	SN3	SN4	SN5	SN6	SN7	SN8	SN9	SN10	SN11	SN3	SN4	SN5	SN6	SN7	SN8	SN9	SN10	SN11		
B1	Kilang / Bengkel	3	5	50	16	9	15	17	2	4	20	8	0	0	0	6	1	0	0	0	1	9	166
B2	Pejabat	2	0	49	14	1	5	5	0	0	0	1	0	0	0	6	0	0	1	0	0	3	87
B3	Kediaman	28	8	434	122	0	399	106	6	0	15	107	0	0	0	73	1	0	0	1	9	69	1,378
B4	Kedai	2	2	100	42	1	62	17	1	0	1	11	0	0	0	21	1	0	0	0	1	16	278
B5	Sekolah	7	0	31	13	0	4	3	0	0	1	4	0	0	0	3	1	0	0	0	1	2	70
B6	Pusat Membeli Belah	0	0	4	1	0	0	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	9
B7	Stor / Gudang	1	0	31	4	0	14	6	0	0	0	4	0	0	1	3	0	0	0	0	0	2	66
B8	Dewan Perhimpunan	0	1	9	3	0	4	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	21
B9	Hospital / Klinik	0	0	4	5	0	2	0	0	2	2	0	0	0	0	1	0	0	0	0	0	1	17
B10	Asrama / Hotel	2	1	17	5	0	6	3	0	0	1	1	0	0	0	3	0	0	0	0	0	1	40
B11	Stesen Minyak	0	0	3	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	6
B12	Struktur Khas	0	0	11	6	1	3	4	0	0	2	0	0	0	0	2	0	0	0	0	1	0	30
B13	Lain-lain Bangunan	1	4	66	8	0	21	10	0	1	5	18	0	0	0	6	0	0	0	0	2	7	149
JUMLAH		46	21	809	240	12	535	174	9	7	49	155	0	0	1	127	4	0	1	1	15	111	2,317

* Pengkelasan kategori bangunan yang terbakar adalah berdasarkan kepada tempat bermula kebakaran (Fire Origin) atau tempat yang paling teruk terbakar (Worst Damage)

Petunjuk : Sumber Nyalaan

SN1	Kilat / Cahaya Suria	**SN7**	Api berbara (Glowing fire)
SN2	Tindakbalas spontan	**SN8**	Letupan
SN3	Kegagalan sistem pendawaian elektrik	**SN9**	Tindakbalas kimia
SN4	Kegagalan fungsi peralatan elektrik	**SN10**	Permukan bahan berhaba tinggi (Hot surface material)
SN5	Kesan geseran / hentaman	**SN11**	Lain-lain
SN6	Api terbuka (Open flame)		

Controlled Items under Suruhanjaya Tenaga

Category 31 – Wires / Cables / Cords

CATEGORY	ITEM DETAILS	REF STDS (Prev)	NEW MS
Category 31 - WIRES / CABLES / CORDS 0.5 to 35 sqmm	Insulated flexible cords and cables	MS 140 : 1987	Electric Cable and Wire - Polyvinyl Chloride (PVC) Insulated Cables of rated voltages up to and including 450 / 750 V MS2112-1:2009 Part 1 : General Requirements MS2112-2:2009 Part 2 : Test Methods MS2112-3:2009 Part 3 : Non-Sheathed Cables for Fixed Wiring MS2112-4:2009 Part 4 : Sheathed Cables for Fixed Wiring MS2112-5:2009 Part 5 : Flexible Cables MS2112-6:2009 Part 6 : Cables for Lift and Flexible Connections
	PVC insulated cable (non-armoured) for electric power supply	MS 136 : 1987	
	Polyvinyl chloride (PC) insulated flexible cords	MS 140 : 1987 Equiv stds : BS/IEC/AS DIN/JIS/UL	
	Rubber insulated cord and flexible cables	MS 140 : 1987	Under review, to retain under MS 140 : 1987

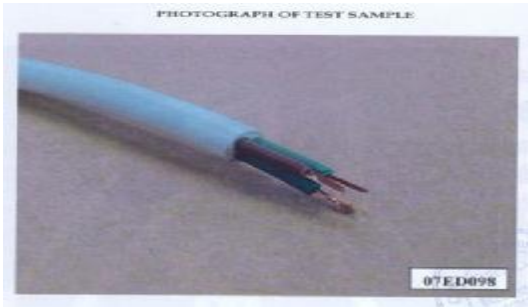
SUB-STANDARD CABLES

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 failure to comply on critical aspects may present an undetermined risk on safety.

Anatomy of Sub-Standard Cables

PHOTOGRAPH OF TEST SAMPLE



REPORT NO.: 2007ED121	PAGE : 2 OF 8

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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;

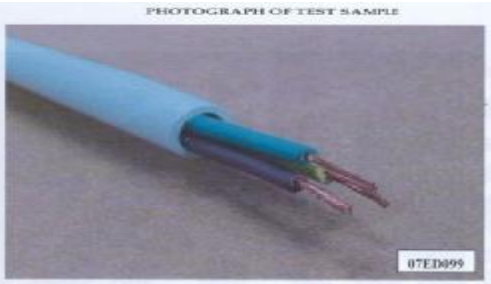
   a) Clause 5.1, 6.2, 7.2, 7.3, 7.4, 19.3 and 22.3 of MS 140: 1987
   b) Clause 7.1, 7.2, 7.3 and 7.4 of MS 69: 1995
   c) Tensile & elongation (before ageing) and resistance to crack of MS 138: 1995
3. The test sample as described in this test report deemed to comply with the requirements of those test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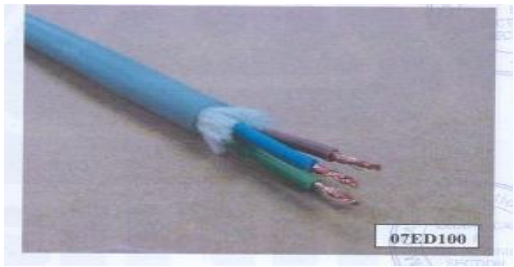

REPORT NO.: 2007ED123	PAGE : 2 OF 7

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[redacted] Prepared by: [redacted]

Sub-Standard Cables – Data

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

Sub-Standard Cables – Cost Analysis

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…

Its a lucrative business"

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

Killer sockets, deadly fuses

Fake Sirim stickers on electrical items sold to developers

ELECTRICAL components such as switches, plugs, sockets, fuses and cables are being sold in the market with fake Sirim certification stickers – and some are being sold to contractors and developers of huge housing projects, reported Harian Metro.

The paper said these products were manufactured illegally at [illegible] and did not adhere to Sirim safety specifications.

Calling these "killer sockets" and "deadly fuses", the newspaper disclosed that such products were the main cause of short circuits, "exploding" electrical gadgets and fires at homes and shops.

Sirim and the Domestic Trade and Consumer Affairs Ministry made this shocking discovery in Kepong on Thursday.

One of the wholesalers found having the electrical items was a [illegible] outlet selling electrical products and components.

Ministry and Sirim officials said they found it shocking that Sirim stickers were being faked and used to deceive buyers into believing that the components were approved and safe.

The newspaper reported that one of the shop owners also admitted to the authorities that he had assembled the components at the back of his shop to save costs.

What was even more shocking, the report said, was that investigations showed that these unsafe electrical components were being sold by contractors [illegible]

Under the law, the owner of the premises found to have falsified the Sirim logo can be fined up to RM250,000.

> Kewujudan pelbagai komponen dan perkakas elektrik di rumah yang menggunakan pelekat Sirim palsu kini mengancam nyawa ratusan ribu pengguna. Difahamkan, peralatan seperti suis, fius, soket dan wayar penyambung bermutu rendah buatan pengilang haram itu juga tidak mendapat kelulusan Suruhanjaya Tenaga. Laporan Muhd Jaradat Ambia Md Dardin

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

Treasury, Malaysia – Circular Letter SPP Bil. 7 Effective June 5th 2002

- *Government agencies must ensure that specifications for local materials/goods used in all procurement exercise be based on Malaysian Standard (MS), issued by the Department of Standards Malaysia. If MS is not available for any particular materials/goods, other appropriate international standards or standards set by the Specifications Preparatory Committee of the agency concerned could be utilised*

- *Appropriate action including disciplinary action in the form of a "surcharge", will be taken against Government agencies and their principal officers for failing to comply with the ruling*

- *Errant contractors and consultants failing to comply would be penalised including being blacklisted and not being considered for other Government projects*

MS-2112 : 2009

MS 2112 consists of the following parts, under the general title *Electric cable and wire - PVC insulated cables of rated voltages up to and including 450/750 V*:

- *Part 1: General requirements*
- *Part 2: Test methods*
- *Part 3: Non-sheathed cables for fixed wiring*
- *Part 4: Sheathed cables for fixed wiring*
- *Part 5: Flexible cables*
- *Part 6: Cables for lift and flexible connections*

Note : All cable types of conductor sizes up to and including 35 mmsq are controlled items under the Suruhanjaya Tenaga Malaysia

1Malaysia vs Sub-Standard Cables – The Way Forward

- ü To review & establish MS standards for cables & wires in full compliance with international standards and with due consideration given to meet pertinent local requirements, conditions & practices
- ü To publicize and promote the use of MS standards where available on cables and wires for domestic use, local installations and elsewhere by Malaysian contractors
- Ø To combat against the manufacture, importation and use of sub-standard cables in the interest of public safety and towards sustaining an equitable and economically viable business for the cable manufacturing sector
- Ø To support all measures by the relevant authorities including the imposition of clear labeling and the prohibition of retail selling of cables and wires without the MS standard mark of approval for items listed under the control of Suruhanjaya Tenaga (ST)
- v To advocate the registration of all local manufacturers under MCMA as a prerequisite to be a supplier of the ST controlled MS standard cables
- v To continually support and enhance the local economy and the Buy Malaysia campaign via the use of a wide range of cables in full compliance to applied standards, Made in Malaysia

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

MS-2112 : ELECTRIC CABLE AND WIRE - PVC INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V
- PART 3: NON-SHEATHED CABLES FOR FIXED WIRING

Table 1. General data for type MS IV 01

Nominal cross-sectional area of conductor mm²	Class of conductor MS IEC 60228	Thickness of insulation Specified value (mm)	Mean overall diameter Lower limit (mm)	Mean overall diameter Upper limit (mm)	Minimum Insulation Resistance at 70 °C (MΩ – km)
1.5	2	0.7	2.7	3.3	0.010
2.5	2	0.8	3.3	4.0	0.009
4	2	0.8	3.8	4.6	0.0077
6	2	0.8	4.3	5.2	0.0065
10	2	1.0	5.6	6.7	0.0065
16	2	1.0	6.4	7.8	0.0050
25	2	1.2	8.1	9.7	0.0050
35	2	1.2	9.0	10.9	0.0043
50	2	1.4	10.6	12.8	0.0043
70	2	1.4	12.1	14.6	0.0035
95	2	1.6	14.1	17.1	0.0035
120	2	1.6	15.6	18.8	0.0032
150	2	1.8	17.3	20.9	0.0032
185	2	2.0	19.3	23.3	0.0032
240	2	2.2	22.0	26.6	0.0032
300	2	2.4	24.5	29.6	0.0030
400	2	2.6	27.5	33.2	0.0028
500	2	2.8	30.5	37.0	0.0028
630	2	2.8	34.0	41.0	0.0025

Table 2. Tests for type MS IV 01

Ref No	Test	Category of test	Test method described in MS	Test method described in Subclause
1	Electric tests			
1.1	Resistance of conductors	T, S	2112-2	5.1
1.2	Voltage tests at 2 500 V	T, S	2112-2	5.2
1.3	Insulation resistance at 70 °C	T	2112-2	5.4
2	Provisions covering constructional and dimensional characteristics		2112-2 and 2112-2	
2.1 .	Checking of compliance with constructional provisions	T, S	2112-2	Inspection and manual test
2.2	Measurement of insulation thickness	T, S	2112-2	4.6
2.3	Measurement of overall diameter	T, S	2112-2	4.8
3	Mechanical properties of insulation			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1, 3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	Pressure test at high temperature	T	60811-3-1	8.1
5	Heat shock test	T	60811-3-1	9.1
6	Test of flame retardance	T	60332-1	

Non-Sheathed Fire Resistant Cables

LOW SMOKE, ZERO HALOGEN, FLAME RETARDANT

Single Core

Construction

Conductor : Plain Annealed Copper to BS 6360
Fire Barrier : Mica Tape
Insulation : LSZH Compound to BS 7655

Technical Data

Reference Standard : BS 7211
Voltage Uo/U : 450/750V
Conductor Stranding : Class 2
Operating Temperature : Maximum 90°C
Minimum Bending Radius : 6D

TABLE 1

Code No.	Nominal Conductor Area mm²	No. & Diameter of Wire No./mm	Radial Thickness of Insulation mm	Approx. Overall Diameter mm	Approx. Weight kg/km	Minimum Insulation Resistant at 90°C MΩ • Km
34010010	1.5	7/0.53	0.7	3.6	27	0.010
34010020	2.5	7/0.67	0.8	4.2	39	0.009
34010040	4	7/0.85	0.8	4.8	55	0.0077
34010060	6	7/1.04	0.8	5.3	76	0.0065
34010100	10	7/1.35	1.0	6.7	124	0.0065
34010160	16	7/1.70	1.0	7.7	183	0.0050
34010250	25	7/2.14	1.2	9.5	286	0.0050
34010350	35	7/2.52	1.2	10.7	382	0.0043
34010500	50	19/1.78	1.4	12.4	515	0.0043
34010700	70	19/2.14	1.4	14.2	721	0.0035
34010950	95	19/2.52	1.6	16.5	991	0.0035
34011200	120	37/2.03	1.6	18.1	1,232	0.0032
34011500	150	37/2.25	1.8	20.1	1,512	0.0032
34011850	185	37/2.52	2.0	22.4	1,890	0.0032
34012400	240	61/2.25	2.2	25.4	2,467	0.0032
34013000	300	61/2.52	2.4	28.2	3,081	0.0030
34014000	400	61/2.85	2.6	31.6	3,917	0.0028
34015000	500	61/3.20	2.8	35.1	4,910	0.0028
34016300	630	127/2.52	2.8	39.1	6,263	0.0025

Fire Resistant Cables

LOW SMOKE, ZERO HALOGEN, FLAME RETARDANT

300/500V

Construction

Conductor : Plain Annealed Copper to BS 6360
Fire Barrier : Mica Tape
Insulation : XLPE Compound to IEC 60502-1
Sheath : LSZH Compound to BS 7655

Technical Data

Reference Specification : IEC 60502-1
Voltage Uo/U : 300/500V
Conductor Stranding : Class 2
Operating Temperature : Maximum 90°C
Minimum Bending Radius : 6D

TABLE 2

Code No.	Nominal Conductor Area mm²	No. & Diameter of Wire No./mm	Radial Thickness of Insulation mm	Radial Thickness of Sheath mm	Approx. Overall Diameter mm	Approx. Weight kg/km
35010010	1 x 1.5	7/0.53	0.5	0.5	4.2	29
35010020	1 x 2.5	7/0.67	0.5	0.5	4.6	40
35010040	1 x 4	7/0.85	0.5	0.5	5.2	56
35020010	2 x 1.5	7/0.53	0.5	0.8	7.9	90
35020020	2 x 2.5	7/0.67	0.5	0.8	8.8	118
35020040	2 x 4	7/0.85	0.5	0.8	9.8	162
35030010	3 x 1.5	7/0.53	0.5	0.8	8.4	110
35030020	3 x 2.5	7/0.67	0.5	0.8	9.3	146
35030040	3 x 4	7/0.85	0.5	0.8	10.5	203
35040010	4 x 1.5	7/0.53	0.5	0.8	9.2	132
35040020	4 x 2.5	7/0.67	0.5	0.8	10.2	180
35040040	4 x 4	7/0.85	0.5	0.8	11.5	252
35050010	5 x 1.5	7/0.53	0.5	0.8	10.1	156
35050020	5 x 2.5	7/0.67	0.5	0.8	11.2	213
35050040	5 x 4	7/0.85	0.5	0.8	12.7	300

Myths of Sub-Standard Cables

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

Sub-Standard [main] Element : Conductors

CRITERIA

- Metal content not meeting specifications (copper >99.9%, alum >99.7%)
- 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

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**

Table 2 — Class 2 stranded conductors for single-core and multi-core cables

1	2	3	4	5	6	7	8	9	10
Nominal cross-sectional area	Minimum number of wires in the conductor						Maximum resistance of conductor at 20°C		
	Circular		Circular compacted		Shaped		Annealed copper conductor		Aluminium or aluminium alloy conductor[c]
	Cu	Al	Cu	Al	Cu	Al	Plain wires	Metal-coated wires	
mm²							Ω/km	Ω/km	Ω/km
0,5	7	-	-	-	-	-	36,0	36,7	-
0,75	7	-	-	-	-	-	24,5	24,8	-
1,0	7	-	-	-	-	-	18,1	18,2	-
1,5	7	-	6	-	-	-	12,1	12,2	-
2,5	7	-	6	-	-	-	7,41	7,56	-
4	7	-	6	-	-	-	4,61	4,70	-
6	7	-	6	-	-	-	3,08	3,11	-
10	7	7	6	6	-	-	1,83	1,84	3,08
16	7	7	6	6	-	-	1,15	1,16	1,91
25	7	7	6	6	6	6	0,727	0,734	1,20
35	7	7	6	6	6	6	0,524	0,529	0,868
50	19	19	6	6	6	6	0,387	0,391	0,641
70	19	19	12	12	12	12	0,268	0,270	0,443
95	19	19	15	15	15	15	0,193	0,195	0,320
120	37	37	18	15	18	15	0,153	0,154	0,253
150	37	37	18	15	18	15	0,124	0,126	0,206
185	37	37	30	30	30	30	0,0991	0,100	0,164
240	37	37	34	30	34	30	0,0754	0,0762	0,125
300	61	61	34	30	34	30	0,0601	0,0607	0,100
400	61	61	53	53	53	53	0,0470	0,0475	0,0778
500	61	61	53	53	53	53	0,0366	0,0369	0,0605
630	91	91	53	53	53	53	0,0283	0,0286	0,0469
800	91	91	53	53	-	-	0,0221	0,0224	0,0367
1 000	91	91	53	53	-	-	0,0176	0,0177	0,0291
1 200				[b]			0,0151	0,0151	0,0247
1 400 [a]				[b]			0,0129	0,0129	0,0212
1 600				[b]			0,0113	0,0113	0,0186
1 800 [a]				[b]			0,0101	0,0101	0,0165
2 000				[b]			0,0090	0,0090	0,0149
2 500				[b]			0,0072	0,0072	0,0127

[a] These sizes are non-preferred. Other non-preferred sizes are recognized for some specialized applications but are not within the scope of this standard.

[b] The minimum number of wires for these sizes is not specified. These sizes may be constructed from 4, 5 or 6 equal segments (Milliken).

[c] For stranded aluminium alloy conductors having the same nominal cross-sectional area as an aluminium conductor the resistance value should be agreed between the manufacturer and the purchaser.

E.2 Conceptual constructions, nominal diameters of circular conductors and weights

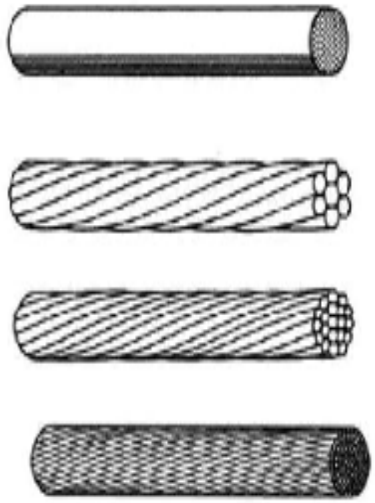
NOTE. The term 'conceptual construction' is used for the conductor construction from which the specified maximum resistance values were originally calculated. The conceptual constructions are theoretically feasible constructions for uncompacted circular conductors, not necessarily used in practice.

Additional data for annealed copper conductors and plain aluminium conductors of cables for fixed installations are given in tables 12 and 13 respectively. Additional data for flexible copper conductors are given in table 14.

Table 12. Additional data for annealed copper conductors of cables for fixed installations

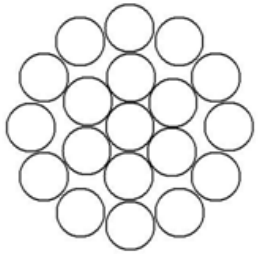
Nominal cross-sectional area	Conceptual construction no./diameter of wires	Nominal diameter of equivalent solid (class 1) conductor	Equivalent stranded (class 2) conductor no./diameter of wires	Nominal diameter of stranded (class 2) conductor	Nominal mass per km of conductor	
					Solid	Stranded
mm^2	—/mm	mm	—/mm	mm	kg	kg
0.5	1/0.80	—	7/0.31	0.93	4.5	4.8
0.75	1/0.97	—	7/0.37	1.11	6.6	6.9
1	1/1.13	—	7/0.44	1.32	9.0	9.7
1.5	1/1.38	—	7/0.53	1.59	13.3	14.0
2.5	7/0.67	1.77	—	2.01	21.9	22.4
4	7/0.85	2.24	—	2.55	35.0	36.1
6	7/1.04	2.74	—	3.12	52.4	54.0
10	7/1.35	3.56	—	4.05	88.5	90.8
16	7/1.70	4.48	—	5.10	140	145
25	7/2.14	5.64	—	6.42	222	229
35	7/2.52	6.64	—	7.56	308	317
50	19/1.78	7.72	—	8.90	416	429
70	19/2.14	9.28	—	10.70	601	620
95	19/2.52	10.93	—	12.60	834	860
120	37/2.03	12.29	—	14.21	1055	1086
150	37/2.25	13.62	—	15.75	1295	1334
185	37/2.52	—	—	17.64	—	1673
240	61/2.25	—	—	20.25	—	2199
300	61/2.52	—	—	22.68	—	2759
400	61/2.85	—	—	25.65	—	3528
500	61/3.20	—	—	28.80	—	4448
630	127/2.52	—	—	32.76	—	5744
800	127/2.85	—	—	37.05	—	7346
1000	127/3.20	—	—	41.60	—	9260

Conductor Constructions

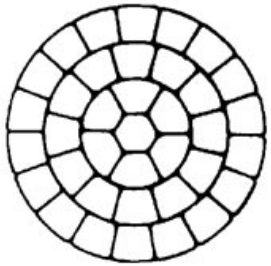


Solid

Stranded



Concentric,
Non-compacted



Compacted

Definition [edit]

Resistors or conductors with uniform cross-section [edit]

Many resistors and conductors have a uniform cross section with a uniform flow of electric current, and are made of one material. (See the diagram to the right.) In this case, the electrical resistivity ρ (Greek: rho) is defined as:

$$\rho = R\frac{A}{\ell},$$

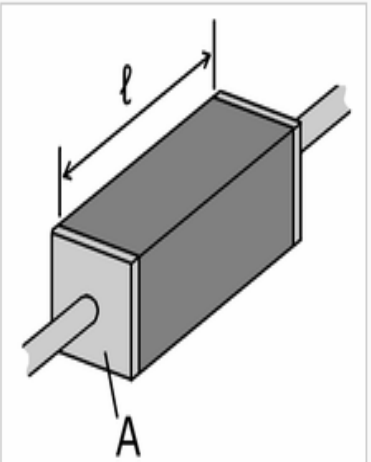
where

R is the electrical resistance of a uniform specimen of the material (measured in ohms, Ω)

ℓ is the length of the piece of material (measured in metres, m)

A is the cross-sectional area of the specimen (measured in square metres, m^2).

The reason resistivity is defined this way is that it makes resistivity an *intrinsic property*, unlike resistance. All copper wires, irrespective of their shape and size, have approximately the same *resistivity*, but a long, thin copper wire has a much larger *resistance* than a thick, short copper wire. Every material has its own characteristic resistivity – for example, resistivity of rubber is far larger than copper's.



A piece of resistive material with electrical contacts on both ends.

Conductor Metals – Cost per mho/km

Metals	VR @ 20°C (Ω.mm²/km)	Density (gm/cm³)	Mass (kg/km)	1990 (US$/km)	2015 (US$/km)
Silver	16.4	10.5	172.2	29,205	116,044
Copper	17.2	8.89	152.9	255	799
Gold	24.4	19.3	470.9	3,925,590	19,789,913
Aluminium	28.3	2.7	76.4	110	112
Tin	124	7.29	904	4,742	14,122
Lead	214	11.4	2440	754	4,243

Aluminium & Copper Conductors

- **Copper**
  - Highly Conductive
  - Good Mechanical Properties
  - Relatively Easy to Process
  - Usually Annealed
- **Aluminium**
  - 60% conductance of copper at same size
  - Half the weight of copper at the same conductance

Controlled Items under Suruhanjaya Tenaga

Category 31 – Wires / Cables / Cords

CATEGORY	ITEM DETAILS	REF STDS (Prev)	NEW MS
Category 31 - WIRES / CABLES / CORDS 0.5 to 35 sqmm	Insulated flexible cords and cables	MS 140 : 1987	Electric Cable and Wire - Polyvinyl Chloride (PVC) Insulated Cables of rated voltages up to and including 450 / 750 V MS2112-1:2009 Part 1 : General Requirements MS2112-2:2009 Part 2 : Test Methods MS2112-3:2009 Part 3 : Non-Sheathed Cables for Fixed Wiring MS2112-4:2009 Part 4 : Sheathed Cables for Fixed Wiring MS2112-5:2009 Part 5 : Flexible Cables MS2112-6:2009 Part 6 : Cables for Lift and Flexible Connections
	PVC insulated cable (non-armoured) for electric power supply	MS 136 : 1987	
	Polyvinyl chloride (PC) insulated flexible cords	MS 140 : 1987 Equiv stds : BS/IEC/AS DIN/JIS/UL	
	Rubber insulated cord and flexible cables	MS 140 : 1987	Under review, to retain under MS 140 : 1987

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







MCMA
MALAYSIAN CABLE MANUFACTURERS ASSOCIATION

The *Malaysian Cable Manufacturers Association* or *MCMA (formerly known as the Malaysian Electrical Cable & Wire Assoc. or MECWA)*, was established in 1980 comprising manufacturers of power and telecommunication cables with the following objectives:

To provide a platform of communication and enhance the cooperation of all members on matters of common interest to the industry

To promote the products & services and activities of members locally and abroad via a common website and by participation in seminars, exhibition and conferences

To represent and safeguard the interest of members through channels of discussion and liaison with customers, government agencies and other organisations

To actively participate and contribute to the development of MS Standards on Electric Cables and related products

To enhance the reputation of MCMA as an ethical and responsible association of members with a positive contribution to the community

www.mcma.org.my