TECHNICAL DATA ON

unistar®

CABLES AND CAPACITORS

UNIVERSAL CABLES LIMITED

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CONTENTS

COMPANY PROFILE

UNIVERSAL CABLES LIMITED **(UCL)** was established in the year 1962 as a modern mass production unit to manufacture paper insulated power cables in technical collaboration with world's largest cable producer BICC, UK. Late Shri M. P. Birla, who had adorned the chair of the Company for over 25 years since its inception, enabled the Company to flourish in a highly competitive world, while distinguishing itself by the latest technological tie-ups with the foremost leaders in the world of this industry and the most up-to-date technology.

Universal Cables Limited entered into a collaboration agreement with ABB High Voltage Cables, Sweden in 1977 to manufacture cross-linked Polythene Power Cable for the first time in the country. The Company is the foremost manufacturer of XLPE Cables with modern dry cured dry cooled process for voltage range extending from 1.1 KV to Extra High Voltage.

Under the collaboration agreement with ABB High Voltage Cables, Sweden, UCL brought in complete know how of compounding of Polymer and produced complete range of dielectrics presently used in all special cables.

In 1983, UCL embarked on a joint venture with MPAVN to manufacture Jelly Filled Telephone Cable in technical collaboration with one of the world's leading manufacturers of Telephone Cable, Ericsson Cable AB, Sweden. This plant was incorporated as Vindhya Telelinks Limited (VTL) and is situated at Rewa, only 50 Kms away from its Power Cable Plant at Satna.

Since 1985, ABB High Voltage Cables, Sweden, is further assisting UCL to manufacture Fluoroplastic Cables, specifically for very high temperature operation and high frequency signaling circuitry.

In 1993, UCL & VTL jointly entered into the field of optical communication by way of manufacturing Optical Fibre Cables in technical and financial collaboration with Ericsson Cables AB, Sweden. This marked the birth of Birla Ericsson Optical Limited (BEOL).

QUALITY CONSCIOUSNESS

Whether conventional or specially designed to any Indian or International specification, UCL's products are put to the grill of rigorous in-process quality checks by stage inspection and testing. Its quality is taken as standard in the world market.

MEANS ARE AS IMPORTANT AS THE END

UCL proudly claims to have the most sophisticated plant, equipment, laboratory and testing facilities available in the country. The entire plants housed in a dust-proof pressurized building to ensure consistency in the product quality.

CERTIFICATION

The above claim is certified by various test authorities of the country like NTH Calcutta and CPRI Bhopal & Bangalore and all consultants like EIL, DCPL, M.N. Dastur, Lloyds register of Shipping, MECON, Crown Agents and others. This confirms the dependability and reliability of UCL products.

ISI MARKING

All standard UNISTAR cables are ISI marked.

IS/ISO QUALITY CERTIFICATION

UCL is also accredited with IS/ISO 9002 Quality Systems Certification in recognition of the High Quality Standard of its cables.

PAGE 3

TECHNICAL ADVICE

The Company welcomes enquiries on cable engineering problems and provides solutions through its design and development team. It also assists customers in cable design to suit their specific requirement.

RESEARCH & DEVELOPMENT

UCL emphasizes on in-house Research and Development. The R & D programme is mainly directed to applied research for product development, process development and technological up gradation. The R & D Laboratory of UCL's a recognized unit of Department of Scientific and Industrial Research of Govt. of India. This laboratory has developed many new Cables special applications such as Flamuni range FRLS Cable, 1.1 KV XLPE Cable, etc.

CAPACITORS

UCL set up its Capacitor Division in the year 1967, in technical collaboration with world renowned TOSHIBA, to manufacture Paper & Power Capacitors. In 1977 this divisicn entered into a technical collaboration with General Electric Company of USA, to manufacture Mixed Dielectric Capacitors. Subsequently the collaboration was extended to include All Polypropylene (All-PP) Dielectric Capacitors impregnated with Non PCB oil. Today the Capacitor Division is rated to be the foremost manufacturer of All-PP Power Capacitors in LT & HT range in the country.

This division offers complete schemes for power factor improvement and can supply capacitors along with associated equipments on turnkey basis. It can also carry out harmonic analysis of Power System on request and design & supply Filter Banks.

EXPORTS

UCL also exports its products to various countries of the world and has earned due recognition for its export efforts.

Universal Cables Limited is a vibrant progressive company, a leader in its field of activities, serving the aspiration of the nation in the field of Power Development.

UNISTAR RANGE OF PRODUCTS

Sr. No.	Products	Specification	Application
A.	**RODS**		
	Aluminum redraw rods	IS-5484	Cables and over head Conductors
B.	**BARE AND COVERED OVER-HEAD CONDUCTORS**		
1.	Grooved Copper/Cadmium-Copper trolley contact wire	BS-23 IS-3476	Railway and Electric Traction Conductors.
2.	Round Copper/Cadmium-Copper Catenary wire.	BS-125	Railway and Electric Traction Conductors.
3.	Earth Conductors-Copper	BS-6360	General earth Conductors.
4.	Over-head Conductors with Aluminium Aluminium Alloy AAC, ACSR, AAAC & ACAR.	IS-398 BS-215	Over-head bulk power transmission lines.
5.	Insulated over-head Conductors of Copper and Aluminium with PVC.covering	BS-6485	Over-head distribution line conductor for corrosive atmosphere.
6.	Cadmium-Copper over-head Conductors with PVC Insulation	CIL/P/125B	Over-head distribution line conductor for corrosive atmosphere.
7.	Aerial Bunched Conductors (ABC).	REC-32/84 & IEC-502	Over-head power transmission and distribution.
C.	**PILC CABLES**		
1.	Power Cables.	IS-692 VDE 0255 GOST – 18410 BS-6480	General Power transmission and distribution network.
2.	Pilot and Communication Cables.	BS-6480 BEBS-C-5	Cables for auxilliary and communication circuits.
3.	Submarine Cables.	BS-6480	Under-water Power Transmission.
4.	HV DC Cables upto and including 100 KV.	Gen to IS-692	Electrostatic Precipitators.
D.	**XLPE CABLES**		
1.	1 KV Power Cables (1.1 KV).	IS-7098 Part-I IEC-502	1.1 KV Power distribution and control Circuits.
2.(a)	HV Power Cables from 3.3 KV to 33 KV.	IS-7098 Part-II IEC-502	Medium and High Voltage Power transmission & distribution.
(b)	EHV Power Cables above 33 KV & upto 145 KV.	IS-7098 Part-III IEC-502 IEC-840 SS4241417 AEIC CS7	Medium and High Voltage Power transmission & distribution.

UNISTAR RANGE OF PRODUCTS

Sr. No.	Products	Specification	Application
3.	Submarine Cables.	IS-7098 (Part I & II) IS-692	Under water Power Transmission.
4.	Radiation resistant power cables up to 11 KV.	IS-7098 Part I & II	Power and control cables used inside reactor building.
E.	**PVC CABLES**		
1.	Power and Control Cables up to 11 KV.	IS-1554 Part I & II	General power distribution & Control purposes.
2.	Mining Cables.	NCB-UK IS-1554 Part I & II	Power distribution Cables inside coal mines.
3.	Wiring and Service Cables including flexible cords weather proof service cables.	IS-694 BS-6004 BS-6500	General purpose flexible and fixed type wiring cables with PVC and Rubber insulation.
4.	Air field lighting cables.	Defence specifications.	Run-way illumination.
5.	Railway Signalling Cables.	IRS-S-35 IRS-S-63	Railway Signalling circuits for use in Electric traction area
6.	Flexible wiring cables for Coaches.	ICF/Elect/807 RDSO E-14/01 (III)	Power and Control Cables for coaches.
7.	Wiring Cables for vehicles.	IS-2465 BS-6862	Automobile wiring cables with PVC/Rubber insulation.
8.	Equipment wires screened / unscreened and microphone Wires.	DEF-61-12 DEF-10	Communication equipment wiring, especially for Defence
9.	Power and Control Cables with better flame resistance with low smoke and toxicity (FRLS and Survival type Cables).	IS-1554 Part I & II IS-7098 Part I & II IS-9968 Part I IEC-502	Cables for Power generating stations and other hazardous industrial installations.
10.	Instrumentation Cables.	IS-1554 Part I IS-9968 Part I IEC-502 BS-5308	Cables for sensitive solid state devices in electronic control system i.e. Computer, etc.
11.	Winding wires for submersible pump motors.	IS-8783, NSW	Submersible motor winding.
F.	**RUBBER CABLES**		
1.(a)	Natural rubber and synthetic rubber insulated sheathed flexible/ non-flexible cables for power distribution lighting and control etc. upto 11 KV (UE).	IS-9968 (Part I & II) IEC-502	General wiring, control and power distribution flexible / trailing use for mine etc. with special properties thermal endurance, oil resistance and Flame Retardant combined with higher mechanical strength.
(b)	Welding Cables with Aluminium & Copper Conductors.	IS-9857	For use in electric welding.

PAGE 6

UNISTAR RANGE OF PRODUCTS

Sr. No.	Products	Specification	Application
2.	Ship wiring cables upto 1000 V.	DGS-211, DGS-212, ABS, LRS,DNV,BV, [EC-92-3, IRS and BS-6883	Power and Control in ships.
3.	High temperature Silicone Rubber insulated Cables for the use upto 200 ^{O}C.	BS-6007 IS-9968 (Part I & II) and BS-6195	Used in location of high ambient temperature.
4.	Mining & Quarry Cables upto 6.6 KV Flat Shuttle Car Cables, Miners Cap-Lamps Cable.	IS-1026 IS-691 BS-6708 BS-6116 IS-2593 NCB-UK	Mining cables of all varieties.
5.	Power Cables and conductors for rolling stock.	RDSO-E-14/01 (I) & (II)	Cables for Electric locomotives,diesel locomotives & Electric multiple units.
6.	PVC and Elastomeric Lift Cables with and without steel hauser upto 1100 V.	IS-4289 OTIS Specification	Power and Control use in Elevators and Lifts.
7.(a)	Aircraft ignition and wiring Cables UNINYVIN, UNIPREN, UNITERSIL and UNI-PLUG SHEATH Cables.	BSG-177 BS-2E-21 BSG-189 EL-1 895	Aircraft wiring and ignition circuits.
(b)	Radar and Data-Transmission Cables.	Defence Specifications	Cables for radar and Anti-Aircraft Guns.
8.	High frequency Coaxial Cables.	BS-2316 MILC-1 7E	High frequency communication circuits Cable TV.
9.	Fluoro-plastic Cables and wires.	JSS and MIL Specifications	Aircraft wiring, High Temp. Equipment wires, Cables for Oil rigs, computers and electronic exchanges.
10.	Electro Logging cables.	ONGC	Cables for Oil exploration equipments.
G.	**CAPACITORS FOR AC SYSTEM**		
1	**Power Factor improvement capacitors**		
(a)	High voltage All-Polypropylene dielectric capacitors impregnated with Non-PCB Oil Unit rating - 50 to 400 KVAR Unit voltage - 3.3 to 13.5 KV Bank rating - By assembly of basic units as per required KVAR Bank voltage – 3.3 KV to 132 KV.	IS-2834	Power Factor improvement in industries (individual) compensation of motor, group compensation) EHV & HV sub-stations, large arc Furnaces (Capacitor for static VAR control, filter circuit and group compensation) net-work (Pole mounted capacitor).

PAGE 7

UNISTAR RANGE OF PRODUCTS

Sr. No.	Products	Specification	Application
(b)	Low and medium voltage self healing low loss metallized polypropylene capacitors. (MPP OIL COOLED) Unit rating - 1 to 50 KVAR Unit voltage - 380 to 440 V AC Bank rating - By assembly of basic units as per required KVAR Bank voltage - 380 to 440 V AC. ISI marked.	IS-2834	Power factor improvement in industrial low voltage load (with or without automatic control).
(c)	Low and medium voltage 3 phase 50 Hz capacitor made from All-Polypropylene impregnated with Non-PCB oil Unit rating - 1 to 50 KVAR Unit voltage - upto 600 V AC Bank rating - By assembly of basic units as per required KVAR.	IS-2834	Power factor improvement in industrial low voltage load (with or without automatic control).
(d)	Power and medium frequency capacitors Air/Water cooled for induction furnace application Capacitors made from All-Polypropylene impregnated with Non-PCB oil Unit rating - 25 to 150 KVAR Voltage rating - 380 to 1600 V AC@	IS-2834 IS-9251	Power factor improvement and load balancing in induction furnace.
2.	**DC Capacitors**		Special application like impulse generators filter circuits.
3.	**Surge Capacitors**		
	Surge capacitors made from All-Polypropylene impregnated with Non-PCB Oil for 3.3, 6.6 and 11 KV system.		Surge protection of Motors Transformers, etc.

CONVERSION FACTORS

Length:

1 Inch	= 25.4	Millimeters (mm)
1 Foot	= 304.8	Mm
1 Yard	= 0.9144	metre (m)
1 Mile	= 1.609	kilometre (km)
1 Mm	= 0.039	Inch
1 M	= 1.094	Yard
1 Km	= 0.621	Mile
1 Mil	= 0.0254	Mm
1 Micron	= 0.001	Mm

Area:

1 $inch^2$	= 645.16	square millimetre ($mm^{2)}$
1 $foot^2$	= 0.093	square metre (m^2)
1 $yard^2$	= 0.836	m^2
1 mm^2	= 0.002	$inch^2$
1 m^2	= 1.196	$yard^2$
1 $inch^2$	= 12.73240	circular mils (circ mils)
1 circ mil	= 0.00050671	mm^2
1 Acre	= 4046.86	m^2

Volume:

1 $inch^3$	= 16387.1	mm^3
1 $foot^3$	= 0.0283	m^3
1 cm^3	= 0.061	$inch^3$
1 m^3	= 35.315	$foot^3$
1 $inch^3$	= 0.01639	Litres
1 Gallon	= 4.546	Litres
1 Litre	= 0.22	Gallons

Density:

1 $lb/inch^3$	= 2.768 $x10^4$	kg/m^3
	= 27.68	Gm/cm^3 or gm/ml
1 lb/ft^3	= 16.019	kg/m^3
	= 0.016	Gm/cm^3 or gm/ml
1 kg/m^3	= 0.0624	lb/ft^3
1 $tonne/m^3$	= 62.43	lb/ft^3

Pressure:

1 $lbf/inch^2$	= 6.895	KN/m^2
1 KN/m^2	= 0.145	$lbf/inch^2$
1 MN/m^2	= 0.102	kg/mm^2
1 Pa (pieze)	= 1	N/m^2
1 pz (pieze)	= 1	K Pa
1 Torr	= 133.322	Pa
1 Dyn/cm^2	= 0.1	Pa
1 Bar	= 10^5	Pa
	= 1.01972	kgf/cm^2
1 Bar	= 14.5	psi
	0.986923	atm
	750.062	torr

Linear velocity (speed) :

1 ft/sec	= 0.3048	m/s
1 mile/hr	= 0.447	m/s
	= 1.609	km/h
1 m/s	= 3.281	ft/sec
	= 2.237	mile/hr
1 Km/hr	= 0.621	mile/hr

Angular velocity:

1 Rad/s	= 0.159155	rev/s
1 Rev/s	= 360	degree/s

Power:

1 HP	= 745.70	Watts
	= 33000	foot pounds per minute
	= 550	foot pounds per seconds
1 KW	= 1.34	Hp

Weight:

1 lb	= 0.454	Kg
1 ton	= 1016	Kg
1 kg	= 2.205	Lbs

Magnetic:

Lines per square centi-metre (gauss)	=	0.155	Lines per square inch
Oersted	=	0.4947	Ampere turn per inch
Watts per kg	=	2.2046	watts per pound
Lines per square centi-metre (gauss)	=	10^4	webers per square metre

Force:

1 lbf (pound force)	=	4.448	newtons (N)
1 pdl (pound force)	=	0.138255	N
1 N	=	0.225	lbf
	=	0.102	kg
1 kgf	=	9.80665	kg m/s^2
	=	9.80665	N

Energy:

1 ft. lbf	=	1.356	joules (J)
1 Kwhr	=	3.60	Mega joules (MJ)
1 joule	=	0.738	ft lbf
	=	9.478 $x10^{-4}$	Btu
1 MJ	=	0.278	Kwhr

PAGE 9

TABLE 1

BRITISH STANDARD WIRE GAUGE (SWG)

Gauge No.	Diameter		Sectional area			Nominal weight of copper wires	
	Mil	mm	Circular mil	Sq. inch	Sq. mm	lb/1000 ft	Kg / Km
7/0	500	12.70	250000	0.1964	126.709	756.73	1126.17
6/0	464	11.76	215300	0.1691	109.097	651.69	969.85
5/0	432	10.97	186600	0.1466	94.580	564.90	840.68
4/0	400	10.16	160000	0.1257	81.097	484.31	720.75
3/0	372	9.449	138400	0.1087	70.129	418.88	623.38
2/0	348	8.839	121100	0.09512	61.368	366.57	545.53
0	324	8.230	105000	0.08245	53.193	317.75	472.88
1	300	7.620	90000	0.07069	45.606	272.42	405.42
2	276	7.010	76180	0.05983	38.600	230.58	343.15
3	252	1.401	63500	0.04988	32.181	192.22	286.06
4	232	5.893	53820	0.04227	27.271	162.92	242.46
5	212	5.385	44940	0.03530	22.774	136.04	202.45
6	192	4.877	36860	0.02895	18.677	111.58	166.05
7	176	4.47	30980	0.02433	15.697	93.762	139.54
8	160	4.064	25600	0.02011	12.974	77.489	115.32
9	144	3.658	20740	0.01629	10.510	62.766	93.41
10	128	3.251	16380	0.01287	8.3032	49.598	73.81
11	116	2.946	13460	0.01057	6.8193	40.730	60.61
12	104	2.642	10820	0.008495	5.4806	32.739	48.72
13	92	2.337	8464	0.006648	4.2890	25.620	38.13
14	80	2.032	6400	0.005027	3.2432	19.372	28.83

TABLE 1 (CONTD.)

BRITISH STANDARD WIRE GAUGE (SWG)

Gauge No.	Diameter		Sectional area			Nominal weight of copper wires	
	Mil	mm	Circular mil	Sq. inch	Sq. mm	lb/1000 ft	Kg / Km
15	72	1.829	5184	0.004072	2.6271	15.692	23.35
16	64	1.626	4096	0.003217	2.0755	12.398	18.45
17	56	1.422	3136	0.002463	1.5890	9.492	14.13
18	48	1.219	2304	0.001810	1.1677	6.974	10.38
19	40	1.016	1600	0.001257	0.81097	4.843	7.207
20	36	0.9144	1296	0.001018	0.65677	3.923	5.838
21	32	0.8128	1024	0.0008042	0.51884	3.100	4.613
22	28	0.7112	784.0	0.0006158	0.39729	2.373	3.531
23	24	0.6096	576.0	0.0004524	0.29187	1.744	2.595
24	22	0.5588	484.0	0.0003801	0.24523	1.465	2.180
25	20	0.508	400.0	0.0003142	0.20271	1.211	1.801
26	18	0.4572	324.0	0.0002545	0.16419	0.9807	1.459
27	16.4	0.4166	269.0	0.0002112	0.13626	0.8141	1.212
28	14.8	0.3759	219.0	0.0001720	0.11097	0.6630	0.9867
29	13.6	0.3454	185.0	0.0001453	0.09374	0.5599	0.8332
30	12.4	0.3150	153.8	0.0001208	0.07794	0.4654	0.6926
31	11.6	0.2946	134.6	0.0001057	0.06819	0.4073	0.6061
32	10.8	0.2743	116.6	0.00009161	0.05910	0.3531	0.5255

TABLE 1 (CONTD.)

BRITISH STANDARD WIRE GAUGE (SWG)

Gauge No.	Diameter		Sectional area			Nominal weight of copper wires	
	Mil	mm	Circular mil	Sq. inch	Sq. mm	lb/1000 ft	Kg / Km
33	10.2	0.2540	100.0	0.00007854	0.05067	0.3027	0.4505
34	9.2	0.2337	84.64	0.00006648	0.04289	0.2562	0.3813
35	8.4	0.2134	70.56	0.00005542	0.03575	0.2136	0.3179
36	7.6	0.193	57.76	0.00004536	0.02926	0.1748	0.2601
37	6.8	0.1727	46.24	0.00003632	0.02343	0.1400	0.2083
38	6.0	0.1524	36.00	0.00002827	0.01824	0.1090	0.1622
39	5.2	0.1321	27.04	0.00002124	0.01370	0.08185	0.1218
40	4.8	0.1219	23.04	0.00001810	0.01168	0.06974	0.1038
41	4.4	0.1118	19.36	0.00001521	0.009813	0.05860	0.08721
42	4.0	0.1016	16.00	0.00001257	0.008110	0.04843	0.07207
43	3.6	0.09144	12.96	0.00001018	0.006568	0.03923	0.05838
44	3.2	0.08128	10.24	0.000008042	0.005188	0.03100	0.04613
45	2.8	0.07112	7.840	0.000006158	0.003973	0.02373	0.03531
46	2.4	0.06096	5.760	0.000004524	0.002919	0.01744	0.02595
47	2.0	0.05080	4.000	0.000003142	0.002027	0.01211	0.01802
48	1.6	0.04064	2.560	0.000002011	0.001297	0.007749	0.01153
49	1.2	0.03048	1.440	0.000001131	0.0007297	0.004358	0.006486
50	1.0	0.02540	1.000	0.0000007854	0.0005067	0.003027	0.004505

TABLE 2

BROWN & SHARP'S GAUGE (A.W.G.)

Gauge No.	Diameter		Sectional area			Nominal weight of copper wires	
	Mil	mm	Circular mil	Sq. inch	Sq. mm	lb/1000 ft	Kg / Km
6/0	580	14.73	336400	0.2642	170.454	1018.26	1515.36
5/0	516	13.11	266256	0.2091	134.912	805.94	1199.38
410	460	11.68	211600	0.1662	107.219	640.50	95.1.18
3/0	410	10.41	168100	0.1320	85.177	508.83	757.23
2/0	365	9.271	133225	0.1046	67.505	403.26	600.13
0	325	8.255	105625	0.08296	53.521	319.72	475.80
1	289	7.341	83521	0.06560	42.321	252.82	376.23
2	258	6.553	66564	0.05228	33.728	201.48	299.85
3	229	5.817	52441	0.04119	26.572	158.74	236.23
4	204	5.182	41616	0.03269	21.087	125.97	187.46
5	182	4.623	33124	0.02602	16.784	100.27	149.21
6	162	4.115	26244	0.02061	13.298	79.439	118.22
7	144	3.658	20736	0.01620	10.507	62.766	93.41
8	128	3.251	16384	0.01287	8.3018	49.593	73.81
9	114	2.896	12996	0.01021	6.5850	39.338	58.54
10	102	2.591	10404	0.008171	5.2717	31.492	46.87
11	91	2.311	8281	0.006504	4.1960	25.066	37.36
12	81	2.057	6561	0.005153	3.3245	19.860	29.55

TABLE 2 (CONTD.)

BROWN & SHARP'S GAUGE (A.W.G.)

Gauge No.	Diameter		Sectional area			Nominal weight of copper wires	
	Mil	mm	Circular mil	Sq. inch	Sq. mm	lb/1000 ft	Kg / Km
13	72	1.829	5184	0.034071	2.6267	15.692	23.35
14	64	1.626	4096	0.003217	2.0754	12.398	18.45
15	57	1.448	3249	0.002552	1.6463	9.835	14.64
16	51	1.295	2601	0.002043	1.3179	7.873	11.72
17	45	1.143	2025	0.001590	1.0260	6.129	9.122
18	40	1.016	1600	0.001257	0.81070	4.843	7.207
19	36	0.9144	1296	0.001018	0.65670	3.923	5.838
20	32	0.8128	1024	0.0008042	0.51886	3.100	4.613
21	28.5	0.7239	812.25	0.0006379	0.41157	2.459	3.659
22	25.3	0.6426	640.09	0.0005027	0.32434	1.937	2.883
23	22.6	0.5740	510.76	0.0004011	0.25880	1.546	2.301
24	20.1	0.5105	404.01	0.0003173	0.20471	1.223	1.820
25	17.9	0.4547	320.41	0.0002516	0.16235	0.9699	1.443
26	15.9	0.4039	252.81	0.0001986	0.12810	0.7652	1.139
27	14.2	0.3607	201.64	0.0001584	0.10217	0.6104	0.9083
28	12.6	0.3200	158.76	0.0001247	0.08044	0.4805	0.7151
29	11.3	0.2870	127.69	0.0001003	0.06470	0.3865	0.5752
30	10.0	0.2540	100.00	0.00007854	0.05067	0.3027	0.4505

TABLE 2 (CONTD.)

BROWN & SHARP'S GAUGE (A.W.G.)

Gauge No.	Diameter		Sectional area			Nominal weight of copper wires	
	Mil	mm	Circular mil	Sq. inch	Sq. mm	lb/1000 ft	Kg / Km
31	8.9	0.2261	79.21	0.00006221	0.04014	0.2398	0.3563
32	7.9	0.2007	62.41	0.00004902	0.03161	0.1889	0.2811
33	7.1	0.1803	50.41	0.00003959	0.02555	0.1526	0.2271
34	6.3	0.1600	39.69	0.00003117	0.02011	0.1201	0.1788
35	5.6	0.1422	31.36	0.00002463	0.01589	0.09492	0.1413
36	5.0	0.1270	25.00	0.00001963	0.01267	0.07567	0.1126
37	4.4	0.1118	19.36	0.00001520	0.009810	0.05860	0.08721
38	4.0	0.1016	16.00	0.00001257	0.008107	0.04843	0.07207
39	3.5	0.08890	12.25	0.000009621	0.006207	0.03708	0.05518
40	3.1	0.07874	9.61	0.000007548	0.004870	0.02909	0.04329

TABLE 3

PROPERTIES OF METALS USED IN CABLES

Properties	Unit	Annealed Copper	Aluminium	Steel	Lead
Specific gravity	--	8.89	2.703	7.86	11.37
Tensile Strength (Approx.)	Kg/mm^2	25	12 to 15	30 to 50	1.8
Melting point	^oC	1083	659	1400	327
Elongation	%	23 to 40	2 to 6	1.5	30
Young's Modules of Elasticity	Kg/mm^2	$9 \text{ to } 15.5 \times 10^3$	7000	19000	1600
Co-efficient of linear expansion	^oC	17×10^{-6}	23×10^{-6}	11.5×10^{-6}	29×10^{-6}
Specific heat	K cal/Kg ^oC	0.093	0.217	0.114	0.031
Thermal resistivity	^oC cm/watt	0.25	0.48	2.20	2.96
Specific electrical resistance at 20"C	Microhm/cm	1.7241	2.8264	14.5	21.4
Temp. co-efficient of resistance at 20"C	Per deg. C	0.00393	0.00403	0.0045	0.0040

TABLE 4

STANDARD ALUMINIUM STRANDED CONDUCTORS (AAC)

Code Name	Nominal Copper Area (sq. mm)	Stranding(Number and Nom. diameter of wires) (No/mm)	Approx. Ultimate Tensile Strength of Conductor (Kg)	Approx. Current Carrying Capacity at 40°C Ambient Temp. (Amps.)	Approx. Weight of Conductor (Kg/Km)
Rose	7.5	7/1.50	220	80	34
	1.3	7/1.90	385	112	58
Gnat	1.6	7/2.21	485	131	73
Iris	20	7/2.44	580	149	89
Lady Bird	25	7/2.79	737	178	117
Ant	30	7/3.10	892	205	144
Fly	40	7/3.40	1051	227	174
Blue Bottle	45	7/3.66	1203	250	201
Earwig	48	7/3.78	1272	260	215
Gross hopper	50	7/3.91	1356	272	230
Clegg	60	7/4.17	1523	297	261
Wasp	65	7/4.39	1673	320	290
--	80	19/3.00	2228	380	369
--	90	19/3.18	2484	396	414
--	110	19/3.53	2985	460	511
--	130	19/3.78	3381	510	586
--	140	19/3.99	3736	540	652
--	160	19/4.22	4144	585	730
--	185	19/4.65	4947	648	886
--	225	19/5.00	5695	710	1025
--	260	19/5.36	6516	780	1176
--	300	37/4.09	7289	850	1343
--	325	37/4.27	7878	895	1464

TABLE 5

STANDARD STEEL CORED ALUMINIUM CONDUCTORS (ACSR)

Code Name	Nominal Copper Area (sq. mm)	Stranding (Number and Nom. Diameter of wires) (No./mm)		Approx. Ultimate Tensile Strength of conductor (Kg)	Approx. Current Carrying Capacity at 40°C ambient Temp. (Amps.)	Approx Weight of Conductor (Kg/Km)
		Aluminium	Steel			
Mole	6.5	6/1.50	1/1.50	407	75	43
Squirrel	13	6/2.11	1/2.11	771	112	85
Gopher	16	6/2.36	1/2.36	952	131	106
Weasel	20	6/2.59	1/2.59	1136	149	128
Fox	23	612.79	1/2.79	1310	157	149
Ferret	25	6/3.00	1/3.00	1503	178	171
Rabbit	30	6/3.35	1/3.35	1860	205	214
Mink	40	6/3.66	1/3.66	2207	227	255
Horse	42	12/2.79	7/2.79	6108	247	542
Beaver	45	6/3.99	1/3.99	2613	250	303
Racoon	48	6/4.09	1/4.09	2746	260	318
Otter	50	6/4.22	1/4.22	2923	272	339
Cat	55	6/4.50	1/4.50	3324	300	385
Dog	65	6/4.72	7/1.57	3299	320	394
Leopard	80	6/5.28	7/1.76	4137	380	493
Coyote	80	26/2.54	7/1.90	4638	380	521
Tiger	80	30/2.36	712.36	5758	380	604
Wolf	95	30/2.59	7/2.59	6880	418	727
Lynx	110	30/2.79	7/2.79	7950	460	844
Panther	130	30/3.00	7/3.00	9127	510	976
Lion	140	30/3.18	7/3.18	10210	540	1097
Bear	160	30/3.35	7/3.35	11310	585	1219
Goat	185	30/3.71	7/3.71	13780	648	1492
Sheep	225	30/3.99	7/3.99	15910	710	1726
Kundah	250	42/3.50	7/1.94	9002	747	1282
Zebra	260	54/3.18	7/3.18	13316	780	1621
Deer	260	30/4.27	7/4.27	18230	780	1977
Elk	300	30/4.50	7/4.50	20240	850	2196
Camel	300	54/3.35	7/3.35	14750	850	1804
Moose	325	54/3.53	7/3.53	16250	895	2002

TABLE 6

FUSE WIRE RATINGS

Approximate sizes of fuse elements composed of tinned copper wire for use in semi-enclosed fuse

Current rating of fuse	Approximate fusing current	Tinned Copper Wire		
		SWG	Diameter	
Amps	Amps		Inch	Mm
1.5	3	40	0.0048	0.122
2.5	4	39	0.0052	0.132
3.0	5	38	0.0060	0.152
3.5	6	37	0.0068	0.173
4.5	7	36	0.0076	0.193
5.0	8	35	0.0084	0.213
5.5	9	34	0.0092	0.234
6.0	10	33	0.0100	0.254
7.0	11	32	0.0108	0.274
8.0	12	31	0.0116	0.295
8.5	13	30	0.0124	0.315
10.0	16	29	0.0136	0.345
12.0	18	28	0.0148	0.376
13.0	23	27	0.0164	0.417
14.0	28	26	0.0180	0.457
15.0	30	25	0.020	0.508
17.0	33	24	0.022	0.559
20.0	38	23	0.024	0.610
24.0	48	22	0.028	0.711
29.0	58	21	0.032	0.813
34.0	70	20	0.036	0.914
38.0	81	19	0.040	1.02
45.0	106	18	0.048	1.22
65.0	135	17	0.056	1.42
73.0	166	16	0.064	1.63
78.0	197	15	0.072	1.83
102.0	230	14	0.080	2.03
130.0	295	13	0.092	2.34

The figures given above are an approximate guide to the size of wire required.
The value at which the fuse will blow depends upon the type and construction of the fuse holder in which the wire is used.

TABLE 7

FULL LOAD CURRENT OF ELECTRIC MOTORS

(Approx. figure in Amperes for standard type of motors)

BHP	Single phase (A.C.)			Three Phase (A.C.)			D.C.		
	115V	230V	400V	230V	400V	440V	110V	220V	440V
1/8	3.0	1.5	0.86	0.70	0.40	0.36	1.8	0.9	0.45
1/4	5.2	2.6	1.5	1.13	0.65	0.59	2.9	1.5	0.73
1/2	8.0	4.0	2.3	2.1	1.20	1.10	5.0	2.5	1.30
3/4	11.2	5.6	3.2	2.8	1.60	1.44	7.5	3.7	1.90
1	14.0	7.0	4.0	3.5	2.0	1.8	9.6	4.8	2.40
11/2	18.0	9.0	5.2	4.9	2.8	2.6	14.0	7.0	3.5
2	22.0	11.0	6.3	6.1	3.5	3.2	17.5	8.8	4.4
3	32.0	16.0	9.2	8.7	5.0	4.6	25.0	12.5	6.3
5	52.0	26.0	15.0	14.0	8.0	7.3	42.0	21.0	10.5
71/.	76.0	38.0	22.0	20.0	11.50	10.5	63.0	32.0	15.3
10	100.0	50.0	29.0	26.0	15.4	13.8	84.0	42.0	21.0
15	144.0	72.0	41.0	38.0	22.0	20.0	121.0	61.0	30.0
20	180.0	90.0	52.0	50.0	29.0	27.0	160.0	80.0	40.0
25	220.0	110.0	63.0	63.0	36.0	32.0	195.0	97.0	49.0
30	260.0	130.0	75.0	73.0	42.0	38.0	234.0	117.0	58.0
40	--	--	--	98.0	56.0	51.0	310.0	155.0	78.0
50	--	--	--	122.0	70.0	64.0	376.0	188.0	94.0
60	--	--	--	146.0	84.0	76.0	450.0	225.0	113.0
75	--	--	--	180.0	104.0	95.0	550.0	275.0	138.0
100	--	--	--	240.0	138.0	124.0	--	370.0	185.0

TABLE 8

SELECTION TABLE FOR STARTER/RELAY/FUSE/CABLE FOR DOL MOTORS

HP 3 phase 415 V 50 HZ	KW 415 V 50HZ	Approximate Full load Current in Amps.	Relay Scale	Typical Backup, HRC Fuse (Amps.)	Typical Cable Sizes with normal PVC insulation	
					Al (sq.mm)	Cu Sq.mm
0.50	0.40	1.0	1-1.6	6	--	1.5
0.75	0.55	1.5	1 5-2.5	6	--	1.5
1.0	0.75	2.0	1.5-2.5	10	--	1.5
1.5	1.1	2.6	2.5-4	10	--	1.5
2.0	1.5	3.5	2.5-4	15	--	1.5
3.0	2.25	5.0	4-6.5	20	--	1.5
4.0	3.0	6.2	4-6.5	20	--	1.5
5.0	3.75	7.5	6-10	25	--	1.5
6.0	4.5	9	6-10	25	--	1.5
7.5	6.5	1.1	9-14	25	--	1.5
10	7.5	14	10-16	35	--	2.5
12.5	9.3	18	13-21	50	--	2.5
15	1.1	21	20-32	50	6	4
17.5	13	24	20-32	63	10	6
20	15	28	20-32	63	10	6
25	18.5	35	28-42	80	16	10
30	22	40	28-42	100	16	10
35	26	47	45-70	125	25	16
40	30	55	45-70	125	25	16
45	33.5	60	45-70	160	25	16
50	37.5	66	60-100	160	35	25
60	45	80	60-100	160	50	35
75	56	100	60-100	200	70	50
90	67.5	120	90-150	250	95	70
100	75	135	120-200	250	95	70
150	112	200	180-300	350	185	120
200	150	275	180-300	500	400	240
225	170	300	180-300	600	400	240

TABLE 9

SELECTION TABLE FOR STARTER/RELAY/FUSE/CABLE FOR STAR DELTA MOTORS

HP 3 Phase 415 V 50 HZ	KW 415 V 50 HZ	Approx. Full Load Current in Amps.	Phase Current in Amps.	Relay Scale	Typical Backup HRC Fuse (Amps)	Typical cable sizes with normal PVC insulation			
						Supply Side		Motor Side	
						Al (sq.mm)	Cu (sq.mm)	Al (sq.mm)	Cu (sq.mm)
3	2.25	5	2.88	2.4-4	10	--	1.5	--	1.5
5	3.75	7.5	4.32	4-6	20	--	1.5	--	1.5
7.5	5.5	1.1	6.34	6-10	25	--	1.5	--	1.5
10	7.5	14	8.10	6-10	25	--	2.5	--	1.5
12.5	9.3	1.8	10.02	9-14	35	--	2.5	--	1.5
1.5	1.1	21	12.10	10-16	50	6	4	--	1.5
20	1.5	28	16.0	10-16	63	10	6	4	2.5
25	18.5	35	20.2	20-32	63	16	10	6	4
30	22	40	23.0	20-32	100	16	10	6	4
35	26	47	27.0	20-32	100	25	16	10	6
40	30	55	30.3	28-42	100	25	16	10	6
45	33.5	60	34.6	28-42	125	35	25	16	10
50	37.0	66	35	28-42	125	35	25	16	1.0
60	45	80	45	30-45	125	50	35	25	16
65	48.5	87	50	45-70	160	70	35	35	16

TABLE 9 (contd.)
SELECTION TABLE FOR STARTER/RELAY/FUSE/CABLE FOR STAR DELTA MOTORS

HP 3 Phase 415 V 50 HZ	KW 415 V 50 HZ	Approx. Full Load Current in Amps.	Phase Current in Amps.	Relay Scale	Typical Backup HRC Fuse (Amps)	Typical cable sizes with normal PVC insulation			
						Supply Side		Motor Side	
						Al (sq.mm)	Cu (sq.mm)	Al (sq.mm)	Cu (sq.mm)
70	52	94	54	45-70	160	70	50	35	25
75	56	100	57.5	45-70	160	70	50	35	25
90	67.5	120	69	60-100	200	95	70	50	35
100	75	135	78	60-100	200	95	70	50	35
125	90	165	95	60-100	250	120	95	70	50
150	112	200	115	90-150	250	185	120	95	70
175	132	230	133	90-150	300	240	150	120	70
200	150	275	159	120-200	350	300	240	150	95
240	175	320	184.5	120-200	400	400	300	185	120
250	187.5	323	185	120-200	400	400	300	185	120
275	204	360	206	180-300	*400*	500	400	185	150
300	225	385	222	180-300	500	500	400	240	150

TEMPERATURE LIMITS OF ELECTRICAL INSULATING MATERIALS

Class	Description	Temperature
Y	Insulation consists of materials or combinations of materials such as cotton, silk and paper without impregnation.	90^{O}C
A	Insulation consists of materials such as cotton, silk and paper when suitably impregnated or coated or when immersed in a dielectric liquid such as oil.	105^{O}C
E	Insulation consists of materials or combinations of materials such as synthetic resin impregnated and enamelled wire not associated with fibrous materials such as cotton, silk and paper.	120^{O}C
B	Insulation consists of materials or combinations of materials such as mica, glass fibre, asbestos etc. with suitable bonding, impregnating or coating substances.	130^{O}C
F	Insulation consists of materials or combination of materials such as mica, glass fibre, asbestos etc. with suitable bonding, impregnating or coating substances as well as other materials or combinations of materials, not necessarily inorganic, which by experience or tests can be shown to be capable of operation at the class F temperature (materials processing a degree of thermal stability allowing them to be operated at 25,C higher than the class B materials).	155^{O}C
H	Insulation consists of materials such as silicone elastomer and combinations of materials such as mica, glass fibre, asbestos etc. with suitable bonding, impregnating or coating substances such as appropriate silicone resins.	180^{O}C
C	Insulation consists of materials or combinations of materials such as mica, porcelain, glass quartz and asbestos with or without an inorganic binder, PTFE and Polyimide (KAPTON).	Above 180^{O}C

TABLE 10

COMPARATIVE PERFORMANCE OF COMMONLY USED THERMOPLASTIC INSULATING AND SHEATHING MATERIALS

Material	General purpose PVC insulation type A to IS-5831/84	General purpose PVC insulation type B to IS-5831/84	Heat resisting PVC insulation type C to IS-5831/84	General purpose PVC sheath type ST1 to IS-5831/84	Heat resisting PVC sheath type ST2 to IS-5831/84	Low Temp. PVC	Special Heat resisting PVC	Poly - ethyelene	Polyte-trafluro-ethyline (PTFE)
Max. cond. temp for continuos operation (^{o}C)	70	70	85	70	90	70	105	70	260
Max cond. temp at the termination of short circuit (^{o}C)	160	160	160	160	160	160	160	130	500
Min. working temp. (^{o}C)	-20	-15	-15	-20	-15	-40	-30	-60	-75
Resistance to Ozone	E	E	E	E	E	E	E	E	G
Corona	E	E	E	E	E	E	E	P	P
Weather	G	G	G	G	G	G	G	P	E
Oil	G	G	G	G	G	G	G	F	E
Water	G	E	G	G	G	G	G	G	E
Chemical	G	G	G	G	G	G	G	G	E
Solvents	F	F	F	F	F	F	F	G	E
Abrasions	G	E	E	G	E	G	E	E	E
Flame resistance	E	E	E	E	E	E	E	P	E
Electricals:									
Insulation resistance	G	E	E	NA	NA	G	E	E	E
Voltage breakdown	G	G	G	NA	NA	G	G	E	E
A.C.Losses	F	F	F	NA	NA	F	F	E	E

E = EXCELLENT ; G = GOOD ; F = FAIR ; P = POOR ; NA = NOT APPLICABLE

TABLE 11

COMPARATIVE PERFORMANCE OF COMMONLY USED THERMOPLASTIC INSULATING AND SHEATHING MATERIALS

Material	Natural rubber (VIIR & TRS) including blends with SBR	Ethylene propylene rubber (EPR)	Polychloro-prene rubber (PCP)	Nitrile Butadiene rubber blend with PVC (NBR-PVC)	Chloro-sulphonated Polyethylene rubber (CSP)	Cross linked Polyethylene (XLPE)	Silicon rubber
Max. cond. temp for continuos operation (^{o}C)	60	90	90	90	90	90	150/180
Max cond. temp at the termination of short circuit (^{o}C)	200	250	200	200	200	250	350
Min. working temp. (^{o}C)	-55	-50	-40	-30	-35	-40	-55
Resistance to Ozone	P	E	G	G	E	G	E
Corona	P	E	NA	NA	G	P	G
Weather	P	G	E	G	E	G	E
Oil	P	P	G	E	G	G	P/F
Water	G	G	F	G	G	G	G
Chemical	F	G	F	F	G	G	F
Solvents	P	P	G	G	G	G	G
Abrasions	F	P	G	G	G	G	P/F
Flame resistance	P	P	E	G	E	P	E
Electricals:							
Insulation resistance	G	G	NA	NA	F	E	F
Voltage breakdown	G	G	NA	NA	G	E	G
A.C.Losses	G	G	NA	NA	F	E	G

E = EXCELLENT ; G = GOOD ; F = FAIR ; P = POOR ; NA = NOT APPLICABLE

CRITERIA FOR THE SELECTION OF POWER CABLES

The electrical current in a conductor causes a voltage drop and power losses. The temperature rise in the cable caused by the losses must be kept within certain limits in order not to shorten the service life of the cable. The temperature limit varies with the type of cable, or more precisely the type of insulation. The best way to keep the temperature within limits specified for the type of cable, is to choose the conductor cross-section so that the cable and its surroundings with the actual continuous load, achieve thermal balance at a temperature below or equal to the temperature limit recommended.

Cable type and size should be selected keeping in view the following:-

(1) Application.
(2) Working voltage; earthed or unearthed neutral system.
(3) Load current, load factor, starting duty and frequency.
(4) Installation method.
(5) The environment in which the cable has to operate.
(6) Short circuit current and system protection.
(7) Acceptable voltage drop.
(8) Economics.

How the above factors influence on the choice of cable ?

(1) The application of the cable determines the basic factors for the choice of cable type and the rules according to which it must be manufactured. Following are the major factors for choice of cable type.

(.a) Conductor materials: No doubt copper is better conductor material owing to its high electrical conductivity and other electrical/mechanical properties but due to its high cost and scarcity, researches are being carried out to find other cheaper and abundant metals which may be a close substitute to copper in electrical application. Aluminium conductors are being used in place of copper conductors for the past many years and have proved to be quite satisfactory.

The lower conductivity of a aluminium (61 % of the annealed copper) results increased dimensions of the cable and ultimately of conduits and fittings for the same current carrying capacity as that of a copper conductor cable. Aluminium conductor cables although bigger and somewhat stiffer when lower number of wires are used for the conductor than the equivalent copper conductor cables, are still flexible enough to be installed where a copper conductor cable was formerly used. The advantages of the lighter weight offsets the disadvantages of larger sizes for a given capacity.

(.b) The use of aluminium conductor cables should be preferred as far as possible. The use of flexible copper conductor is recommended where very high degree of flexibility is required as in the case of mines etc.

Insulating materials: The right type of insulation material for a particular usage depends upon the voltage grade, operating temperature required, degree of flexibility, current capacity requirement and restrictions on size etc. and other climatic conditions.

(.c) Metallic Sheathing: Either pure lead or different lead alloys are used for sheathing of PILC cables and each has its own advantages. The most common and popular alloy is lead Alloy 'E'.

(.d) Bedding and Serving materials: In case of PVC cables the normal bedding and serving materials are PVC compound. The normal bedding and serving in case of PILC cables consist of a combination of an impregnated paper, cotton and hessian tapes and bitumenous compound. These materials provide protection against corrosion of armour and lead and are suitable in great majority of installations. However, in special cases where severe chemical corrosion is to be encountered, the use of PVC bedding and PVC serving is recommended.

(e) Armouring: The purpose of armour is to provide mechanical protection to the cable and to facilitate earthing for safety requirements. This also carries phase to ground fault currents of the system safely.
Double steel tape provides good mechanical protection but when in addition longitudinal stresses are encountered during the installation or in service, steel wire/strip armouring should be preferred. Double wire armouring is recommended for vertical runs, river crossing, cables laid on bridges and mine shafts etc. where longitudinal stresses are expected.

2. The system voltage determines the voltage class of the cables.
3. The current rating is, in general, the decisive factor for fixing conductor cross section. But in certain applications where intermittent load is required, it is more relevant to use the squared average r.m.s. current with a reduced cross section.
4. The power cables must be capable of carrying, the required normal full load current continuously under the site conditions throughout the year. Therefore, the current ratings specified must be corrected to site conditions by applying suitable derating/uprating factors depending upon -
   (a) Ground or ambient air temperature (max.).
   (b) Thermal resistivity of soil during dry season.
   (c) Depth of laying.
   (d) Total number of cables/circuits in groups.
5. (a) Chemical substances in the environment might cause special stringent requirements on the outer covering.
   (b) If it is required or necessary to reduce the propagation of fire along cable route combined with low corrosivity, toxicity and smoke generation characteristics for cables, "FRLS" cables (Flame Retardant Low Smoke) with thermoplastic or thermosetting material or fire survival cables with elastomeric material should be used. These types of cables are designed with special composition of protective sheath materials, and by using heat barrier tapes etc. for use in such critical fire risk installations.
6. Short circuit current together with duration of short circuit determines the short circuit energy the cable insulation has to withstand thermally. In certain cases a larger size of cable then the cable required for normal full load current may be needed to match system short circuit current levels.
7. Voltage drop is also a major factor in deciding the conductor size of the cable. The cross section of the cable should be chosen such that voltage drop of the cable for the given route length does not exceed the statutory requirement.
8. Naturally, the most economical construction and the size of the cable consistent with required current carrying capacity and laying condition has to be selected. Thus the selection of particular type of cable i.e. PVC, XLPE, PILC or rubber and the particular material for screening, sheathing, bedding, armouring or serving etc. out of many choices available depends upon the usages, laying and climatic conditions. The design of the cable for a particular application must be optimized taking into account all the above mentioned factors. In case expert guidance in this respect is desired, please contact UCL Technical Service Division.

CURRENT RATINGS

The current ratings given in tables 12 to 45 are based on the following assumptions:

1	Maximum conductor temperature for continuous operation -		
(a)	PVC Cables	--	70^{O}C
(b)	HR PVC Cables	--	85^{O}C
(c)	XLPE Cables	--	90^{O}C
(d)	PILC Cables		
	i) 11 KV belted type, 22 KV & 33 KV cables	--	65^{O}C
	ii) 11 KV screened cables	--	70^{O}C
	iii) Upto 6.6 KV cables	--	80^{O}C
(e)	Natural rubber (VIR) insulated cables	--	60^{O}C
(f)	Synthetic rubber (EPR) insulated cables	--	90^{O}C
(g)	Silicone/CSP cables	--	105^{O}C
(h)	Silicone/G.F. Braided cables	--	150^{O}C/180^{O}C
2.	Ambient Air Temperature	--	40^{O}C
3.	Ground Temperature	--	30^{O}C
4.	Thermal Resistivity of Soil	--	150^{O}C cm/waft.
5.	Depth of Laying (to the highest point of cable laid direct in ground)		
(a)	1.1 KV cables	--	75 cm
(b)	3.3 KV to 11 KV cables	--	90 cm
(c)	22 and 33 KV cables	--	105 cm
6.	Multicore cables are laid singly.		
7.	Three single core cables are laid in trefoil formation and two single core cables in horizontal touching.		

TABLE 12

CURRENT RATINGS FOR PAPER-INSULATED ARMOURED SERVED THREE-, FOUR-AND FIVE-CORE BELTED LEAD-COVERED 1.1 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN SINGLE-WAY DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
6	47	37	42	34	44	35
10	64	51	57	45	60	48
16	82	65	74	58	78	62
25	105	85	95	74	105	81
35	130	100	115	88	125	98
50	155	125	140	110	160	125
70	190	150	170	135	200	155
95	220	175	200	160	235	190
120	255	195	230	180	275	220
150	290	225	260	200	320	255
185	335	260	295	230	370	290
240	385	300	345	270	440	345
300	425	340	385	305	490	390
400	485	390	435	350	580	460
500	530	420	470	380	640	520
630	570	475	510	430	730	610

TABLE 13

CURRENT RATINGS FOR PAPER-INSULATED ARMOURED SERVED THREE-CORE BELTED LEAD-COVERED 3.3 AND 6.6 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN SINGLE-WAY DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
16	83	65	74	58	81	64
25	110	85	95	74	110	84
35	130	105	115	89	130	105
50	160	125	140	110	165	130
70	190	150	175	135	205	155
95	230	180	205	160	240	190
120	255	200	225	180	275	220
150	290	225	260	200	320	255
185	330	260	295	230	370	295
240	380	300	340	270	440	350
300	420	330	380	300	500	395
400	475	380	430	345	590	465

TABLE 14

CURRENT RATINGS FOR PAPER-INSULATED ARMOURED SERVED THREE-CORE BELTED LEAD-COVERED 11 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN SINGLE-WAY DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
16	70	58	64	49	65	50
25	92	72	82	64	87	68
35	110	84	95	74	105	80
50	135	105	120	92	130	100
70	165	130	145	115	160	125
95	195	155	170	135	195	155
120	215	170	190	155	215	175
150	250	190	225	175	250	200
185	280	220	255	200	290	230
240	315	250	290	225	345	275
300	355	280	320	250	395	310
400	400	320	350	285	430	350

TABLE 15

CURRENT RATINGS FOR PAPER-INSULATED ARMOURED SERVED THREE-CORE SCREENED LEAD-COVERED 11 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN SINGLE-WAY DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
16	79	61	69	54	76	59
25	105	80	84	65	98	77
35	125	95	105	80	120	93
50	150	115	130	100	150	115
70	175	140	160	125	185	140
95	210	165	185	145	215	175
120	235	185	205	160	250	200
150	265	205	235	180	290	230
185	300	235	265	210	340	265
240	345	275	305	240	395	310
300	380	300	340	265	440	345
400	425	340	380	305	500	400

TABLE 16

CURRENT RATINGS FOR PAPER-INSULATED ARMOURED SERVED THREE-CORE SCREENED LEAD-COVERED OR THREE CORE SL 22 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN SINGLE-WAY DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
25	92	72	84	66	92	72
35	115	88	100	79	115	88
50	140	105	120	97	140	105
70	165	130	150	120	170	130
95	195	155	180	140	200	160
120	215	170	200	155	235	180
150	250	190	225	175	265	210
185	280	220	255	205	310	245
240	320	250	290	230	360	285
300	355	275	325	255	400	320
400	380	410	350	285	450	360

TABLE 17

CURRENT RATINGS FOR PAPER-INSULATED ARMOURED SERVED THREE-CORE SCREENED LEAD-COVERED OR THREE CORE SL 33 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN SINGLE-WAY DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
70	165	130	150	120	170	135
95	195	155	180	140	205	160
120	215	170	200	155	235	180
150	245	190	225	175	265	210
185	275	220	255	200	305	240
240	310	245	295	230	360	285
300	345	270	325	255	400	320
400	380	310	350	285	450	360

TABLE 18

CURRENT RATINGS FOR THREE PAPER-INSULATED UNARMOURED SERVED SINGLE-CORE LEAD-COVERED 11 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN TREFOIL DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
16	79	63	80	62	85	66
25	98	78	110	82	115	88
35	120	93	125	96	135	105
50	145	115	150	115	170	130
70	180	140	175	*140*	215	165
95	210	165	210	165	255	200
120	240	185	235	185	295	230
150	270	210	260	205	340	265
185	300	240	290	230	385	300
240	340	270	330	260	450	355
300	380	305	360	285	510	400
400	445	355	410	335	610	490
500	490	395	445	365	700	570
630	540	445	485	410	800	670

TABLE 19

CURRENT RATINGS FOR THREE PAPER-INSULATED UNARMOURED SERVED SINGLE-CORE LEAD-COVERED 22 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN TREFOIL DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
16	75	59	79	62	78	61
25	94	74	105	82	105	82
35	115	87	120	95	130	99
50	140	105	145	115	155	125
70	170	130	170	135	195	150
95	200	155	205	160	230	180
120	225	175	230	180	265	205
150	255	200	255	200	305	240
185	285	225	285	225	350	275
240	330	265	325	255	410	325
300	370	295	360	285	465	370
400	420	335	400	325	560	445
500	455	370	435	360	620	500
630	510	420	470	405	710	590

TABLE 20

CURRENT RATINGS FOR THREE PAPER-INSULATED UNARMOURED SERVED SINGLE-CORE LEAD-COVERED 33 KV CABLES ACCORDING TO IS:692

NOMINAL AREA OF	DIRECT IN THE GROUND		IN TREFOIL DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm^2	A	A	A	A	A	A
70	165	130	175	135	195	150
95	195	155	205	160	230	180
120	220	175	230	180	265	205
150	250	195	255	200	305	240
185	280	225	285	225	350	275
240	320	255	325	255	410	325
300	360	290	355	280	465	370
400	415	330	400	325	560	445
500	455	365	435	360	620	500
630	500	415	475	400	710	590

TABLE 21

CURRENT RATINGS FOR TWOSINGLE-CORE 650/1100 VOLTS UNARMOURED OR NON-MAGNETIC ARMOURED PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	25	21	23	19	24	18
2.5	35	28	31	25	32	25
4	46	36	42	33	43	32
6	57	44	54	42	54	41
1.0	75	59	72	56	72	56
16	94	75	92	71	92	72
25	125	97	120	93	125	99
35	150	120	140	110	155	120
50	180	145	165	130	190	150
70	220	170	200	155	235	185
95	265	205	230	180	275	215
120	300	230	255	200	310	240
150	340	265	280	220	345	270
185	380	300	305	240	390	305
240	420	335	340	270	445	350
300	465	370	370	295	500	395
400	500	410	405	335	570	455
500	540	435	430	355	610	490
630	590	485	465	395	680	560
800	645	530	505	430	780	640
1000	705	580	555	470	900	740

TABLE 22

CURRENT RATINGS FOR THREE SINGLE-CORE 650/1100 VOLTS UNARMOURED OR NON-MAGNETIC ARMOURED PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	22	17	21	17	20	15
2.5	30	24	29	24	27	21
4	39	31	38	30	35	27
6	49	39	48	37	44	35
10	65	51	64	51	60	47
16	85	66	83	65	82	64
25	110	86	110	84	110	84
35	130	100	125	100	130	105
50	155	120	150	115	165	130
70	190	140	175	135	205	155
95	220	175	200	155	245	190
120	250	195	220	170	280	220
150	280	220	245	190	320	250
185	305	240	260	210	370	290
240	345	270	285	225	425	335
300	375	295	310	245	475	380
400	400	325	335	275	550	435
500	425	345	355	295	590	480
630	470	390	375	320	660	550
800	530	440	410	350	770	640
1000	590	490	450	385	865	720

TABLE 23

CURRENT RATINGS FOR TWIN 650/1100 VOLTS ARMOURED OR UNARMOURED PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	23	18	20	16	20	16
2.5	32	25	27	21	27	21
4	41	32	35	27	35	27
6	50	40	44	34	45	35
10	70	55	58	45	60	47
16	90	70	75	58	78	59
25	115	90	97	76	105	78
35	140	110	120	92	125	99
50	165	135	145	115	155	125
70	205	160	180	140	195	150
95	240	190	215	170	230	185
120	275	210	235	190	265	210
150	310	240	270	210	305	240
185	350	275	300	240	350	275
240	405	320	345	275	410	325
300	450	355	385	305	465	365
400	490	385	425	345	530	420
500	520	415	460	365	575	455
630	565	460	510	405	655	520

TABLE 24

CURRENT RATINGS FOR THREE AND HALF AND FOUR CORE 650/1100 VOLTS ARMOURED OR UNARMOURED PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	21	16	17	14	17	13
2.5	27	21	24	18	24	18
4	36	28	30	23	30	23
6	45	35	38	30	39	30
10	60	46	50	39	52	40
16	77	60	64	50	66	51
25	99	76	81	63	90	70
35	120	92	99	77	110	86
50	145	110	125	95	135	105
70	175	135	150	115	165	130
95	210	165	175	140	200	155
120	240	185	195	155	230	180
150	270	210	225	175	265	205
185	300	235	255	200	305	240
240	345	275	295	235	355	280
300	385	305	335	260	400	315
400	425	335	360	290	455	375
500	470	370	405	320	540	425
630	515	405	445	350	610	480

TABLE 25

CURRENT RATINGS FOR TWO SINGLE-CORE 650/1100 VOLTS UNARMOURED OR NON-MAGNETIC ARMOURED HR PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	29	24	26	22	29	22
2.5	40	32	35	29	38	30
4	52	41	48	38	52	38
6	65	50	62	48	65	49
10	86	67	82	64	86	67
16	107	86	105	81	110	86
25	143	111	137	106	150	119
35	171	137	160	125	186	144
50	205	165	188	148	228	180
70	251	194	228	177	282	222
95	302	234	262	205	330	258
120	342	262	291	228	372	288
150	388	302	319	251	414	324
185	433	342	348	274	468	366
240	479	382	388	308	534	420
300	530	422	422	336	600	474
400	570	467	462	382	684	546
500	616	496	490	405	732	588
630	673	553	530	450	816	672
800	735	604	576	490	936	768
1000	804	661	633	536	1080	888

TABLE 26

CURRENT RATINGS FOR THREE SINGLE-CORE 650/1100 VOLTS UNARMOURED OR NON-MAGNETIC ARMOURED HR PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	25	19	24	19	24	18
2.5	34	27	33	27	32	25
4	44	35	43	34	42	32
6	56	44	55	42	53	42
10	74	58	73	58	72	56
16	97	75	95	74	98	77
25	125	98	125	96	132	101
35	148	114	143	114	156	126
50	177	137	171	131	198	156
70	217	160	200	154	246	186
95	251	200	228	177	294	228
120	285	222	251	194	336	264
150	319	251	279	217	384	300
185	348	274	296	239	444	348
240	393	308	325	257	510	402
300	428	336	353	279	570	456
400	456	371	382	314	660	522
500	485	393	405	336	708	576
630	536	445	428	365	792	660
800	604	502	467	399	924	768
1000	673	559	513	439	1038	864

TABLE 27

CURRENT RATINGS FOR TWIN 650/1100 VOLTS ARMOURED OR UNARMOURED HR PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	26	21	23	18	24	19
2.5	36	29	31	24	32	25
4	47	36	40	31	42	32
6	57	46	50	39	54	42
10	80	63	66	51	72	56
16	103	80	86	66	94	71
25	131	103	111	87	126	94
35	160	125	137	105	150	119
50	188	154	165	131	186	150
70	234	182	205	160	234	180
95	274	217	245	194	276	222
120	314	239	268	217	318	252
150	353	274	308	239	366	288
185	399	314	342	274	420	330
240	462	365	393	314	492	390
300	513	405	439	348	558	438
400	559	439	485	393	636	504
500	593	473	524	416	690	546
630	644	524	581	462	786	624

TABLE 28

CURRENT RATINGS FOR THREE AND HALF AND FOUR CORE 650/1100 VOLTS ARMOURED OR UNARMOURED HR PVC CABLES ACCORDING TO IS:1554 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	24	18	19	16	20	16
2.5	31	24	27	21	29	22
4	41	32	34	26	36	28
6	51	40	43	34	47	36
10	68	52	57	44	62	48
16	88	68	73	57	79	61
25	113	87	92	72	108	84
35	137	105	113	88	132	103
50	165	125	143	108	162	126
70	200	154	171	131	198	156
95	239	188	200	160	240	186
120	274	211	222	177	276	216
150	308	239	257	200	318	246
185	342	268	291	228	366	288
240	393	314	336	268	426	336
300	439	348	382	296	480	378
400	485	382	410	331	546	450
500	536	422	462	365	648	510
630	587	462	507	399	732	576

TABLE 29

CURRENT RATINGS FOR TWO SINGLE- CORE 650/1100 VOLTS UNARMOURED OR NON-MAGNETIC ARMOURED 1.1 KV XLPE CABLES ACCORDING TO IS:7098 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	31	24	28	22	25	19
2.5	41	32	37	29	33	26
4	54	42	49	38	44	34
6	68	52	61	47	55	43
10	89	69	80	62	80	60
16	116	90	104	81	104	82
25	148	116	133	104	139	108
35	181	139	163	125	172	136
50	213	162	192	146	213	163
70	259	199	233	179	271	208
95	310	241	279	217	335	258
120	352	273	317	246	389	303
150	393	305	354	275	447	348
185	444	347	400	312	524	407
240	518	407	466	366	623	488
300	583	458	525	412	722	569
400	657	518	591	466	850	669
500	731	592	658	533	976	786
630	823	666	741	599	1130	922
800	907	750	816	675	1284	1067
1000	981	833	883	750	1437	1220

TABLE 30

CURRENT RATINGS FOR THREE SINGLE- CORE 650/1100 VOLTS UNARMOURED OR NON-MAGNETIC ARMOURED 1.1 KV XLPE CABLES ACCORDING TO IS:7098 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	27	21	24	19	22	17
2.5	36	28	32	25	29	23
4	46	36	41	32	40	31
6	57	44	51	40	51	39
10	76	59	68	53	71	53
16	97	76	87	68	95	73
25	124	96	112	86	126	98
35	148	114	133	103	152	121
50	174	135	157	122	189	150
70	213	166	192	149	240	187
95	256	198	230	178	297	230
120	289	225	260	203	346	268
150	326	253	293	228	390	309
185	366	286	329	257	460	360
240	425	332	383	299	552	433
300	479	376	431	338	640	501
400	544	431	490	388	753	596
500	611	490	550	441	865	693
630	684	557	616	501	1001	814
800	762	632	686	569	1176	968
1000	828	701	745	631	1299	1102

TABLE 31

CURRENT RATINGS FOR TWIN 650/1100 VOLTS ARMOURED OR UNARMOURED 1.1 KV XLPE CABLES ACCORDING TO IS:7098 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	33	26	30	23	29	23
2.5	43	34	39	31	39	30
4	56	43	50	39	51	39
6	71	55	64	50	64	50
10	92	71	83	64	88	67
16	116	91	104	82	113	88
25	152	120	137	108	153	117
35	180	143	162	129	186	145
50	218	167	196	150	226	176
70	264	204	238	184	284	221
95	314	245	283	221	348	271
120	357	278	321	250	402	316
150	403	315	363	284	461	362
185	453	356	408	320	533	420
240	518	407	466	366	633	497
300	583	463	525	417	732	578
400	658	528	592	475	841	678
500	730	592	657	533	967	786
630	814	676	733	608	1103	913

TABLE 32

CURRENT RATINGS FOR THREE AND HALF AND FOUR CORE 650/1100 VOLTS ARMOURED OR UNARMOURED 1.1 KV XLPE CABLES ACCORDING TO IS:7098 (PART 1)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
1.5	25	20	23	18	22	18
2.5	34	27	31	24	30	23
4	44	34	40	31	40	31
6	55	43	50	39	51	40
10	73	57	66	51	70	53
16	97	73	87	66	90	70
25	122	94	110	85	123	96
35	146	113	131	102	151	117
50	172	133	155	120	183	142
70	211	164	190	148	231	179
95	253	196	228	176	285	221
120	287	223	258	201	330	257
150	321	249	289	224	375	292
185	361	282	325	254	430	337
240	416	326	374	293	508	399
300	464	367	418	330	575	455
400	521	418	469	376	661	530
500	582	470	524	423	753	612
630	644	529	580	476	851	707

TABLE 33

CURRENT RATINGS FOR THREE SINGLE CORE 1.9/3.3 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	125	97	113	87	134	104
35	149	115	134	104	164	127
50	176	136	158	122	197	153
70	214	166	193	149	248	192
95	256	198	230	178	306	237
120	289	225	260	203	353	275
150	326	253	293	228	409	317
185	365	285	329	257	465	362
240	422	330	380	297	554	433
300	476	373	428	336	644	504
400	539	427	485	384	754	598
500	605	485	545	437	866	694
630	678	551	610	496	1002	815
800	753	625	678	563	1168	969
1000	818	692	736	623	1303	1103

TABLE 34

CURRENT RATINGS FOR THREE SINGLE CORE 3.8/6.6 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	124	97	112	87	136	106
35	148	118	133	106	166	130
50	174	136	157	122	198	156
70	212	166	191	149	248	196
95	253	197	228	177	305	239
120	287	224	258	202	352	277
150	323	252	291	227	406	318
185	363	284	327	256	461	368
240	419	329	377	296	548	440
300	473	372	426	335	636	509
400	538	427	484	384	746	602
500	609	485	548	437	863	699
630	678	551	610	496	987	817
800	753	624	678	562	1142	965
1000	818	692	736	623	1272	1096

TABLE 35

CURRENT RATINGS FOR THREE SINGLE CORE 6.35/11 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	125	97	113	87	138	107
35	148	115	133	104	172	134
50	174	135	157	122	207	160
70	213	165	192	149	253	200
95	254	197	229	177	317	245
120	288	224	259	202	368	286
150	324	251	292	226	410	324
185	364	283	328	255	480	373
240	420	328	378	295	573	445
300	474	371	427	334	655	513
400	538	425	484	383	748	603
500	605	484	545	436	857	705
630	678	550	610	495	987	821
800	754	623	679	561	1146	964
1000	819	690	737	621	1271	1094

TABLE 36

CURRENT RATINGS FOR THREE SINGLE CORE 11/11 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	125	97	113	87	144	112
35	149	115	134	104	175	137
50	176	136	158	122	208	165
70	214	166	193	149	260	206
95	256	198	230	178	318	250
120	289	225	260	203	375	291
150	326	252	293	227	419	330
185	365	285	329	257	488	379
240	423	330	381	297	578	450
300	477	373	429	336	651	518
400	542	427	488	384	757	608
500	610	486	549	437	868	709
630	685	553	617	498	1000	822
800	764	628	688	565	1158	964
1000	831	697	748	627	1289	1090

TABLE 37

CURRENT RATINGS FOR THREE SINGLE CORE 12.7/22 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
35	148	114	133	103	176	143
50	173	134	156	121	215	167
70	211	164	190	148	268	207
95	252	195	227	176	319	253
120	286	221	257	199	375	291
150	323	250	291	225	427	333
185	361	280	325	252	489	380
240	417	326	375	293	565	450
300	471	367	424	330	652	521
400	534	420	481	378	777	616
500	602	478	542	430	871	709
630	675	545	608	491	1003	828
800	752	618	677	556	1159	975
1000	825	685	743	617	1317	1107

TABLE 38

CURRENT RATINGS FOR THREE SINGLE CORE 19/33 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
50	174	135	157	122	216	170
70	213	165	192	149	268	212
95	254	196	229	176	326	258
120	287	223	258	201	374	297
150	323	250	291	225	429	339
185	363	282	327	254	486	386
240	419	326	377	293	573	464
300	473	369	426	332	661	526
400	538	423	484	381	784	617
500	606	481	545	433	878	713
630	684	549	616	494	1014	832
800	763	620	687	558	1172	978
1000	832	686	749	617	1330	1110

TABLE 39

CURRENT RATINGS FOR THREE CORE 1.9/3.3 & 3.3/3.3 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	120	93	108	84	126	97
35	143	111	129	100	154	119
50	171	132	154	119	185	148
70	206	160	185	144	231	179
95	246	192	221	173	282	219
120	279	218	251	196	325	253
150	313	245	282	221	373	290
185	352	275	317	248	423	330
240	407	318	366	286	501	391
300	455	360	410	324	574	453
400	511	410	460	369	661	530
500	569	458	512	412	748	609
630	629	517	566	465	845	702

TABLE 40

CURRENT RATINGS FOR THREE CORE 3.8/6.6 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	120	94	108	85	129	100
35	143	111	129	100	157	121
50	168	130	151	117	187	145
70	206	160	185	144	233	181
95	246	191	221	172	284	221
120	278	217	250	195	326	254
150	312	243	281	219	373	290
185	351	274	316	247	423	330
240	404	317	364	285	498	390
300	454	358	409	322	571	450
400	511	408	460	367	657	525
500	569	462	512	416	744	603
630	631	522	568	470	845	698

TABLE 41

CURRENT RATINGS FOR THREE CORE 6.35/11 KV XLPE CABLES
ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	120	93	108	84	137	106
35	143	111	129	100	158	123
50	168	130	151	117	188	153
70	206	160	185	144	235	182
95	246	191	221	172	285	221
120	278	217	250	195	327	254
150	312	243	281	219	374	291
185	351	273	316	246	423	330
240	404	317	364	285	498	390
300	454	357	409	321	570	450
400	511	408	460	367	658	525
500	569	462	512	416	745	597
630	632	522	569	470	847	692

TABLE 42

CURRENT RATINGS FOR THREE CORE 11/11 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
25	121	94	109	85	142	110
35	144	112	130	101	161	133
50	168	131	151	118	191	158
70	206	160	185	144	238	197
95	246	191	221	172	288	237
120	278	217	250	195	329	257
150	312	243	281	219	376	292
185	350	273	315	246	424	331
240	404	316	364	284	498	390
300	453	357	408	321	569	448
400	512	408	461	367	657	523
500	571	462	514	416	745	602
630	634	518	571	466	846	696

TABLE 43

CURRENT RATINGS FOR THREE CORE 12.7/22 KV XLPE CABLES
ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
35	142	110	128	99	162	132
50	166	129	149	116	192	157
70	203	158	183	142	238	194
95	242	188	218	169	288	224
120	274	213	247	192	329	257
150	307	239	276	215	375	292
185	345	269	311	242	425	332
240	397	312	357	281	499	390
300	446	352	401	317	570	448
400	503	402	453	362	657	523
500	564	455	508	410	747	602
630	626	513	563	462	829	695

TABLE 44

CURRENT RATINGS FOR THREE CORE 19/33 KV XLPE CABLES ACCORDING TO IS:7098 (PART 2)

NOMINAL AREA OF	LAID DIRECT IN THE GROUND		IN DUCTS		IN AIR	
CONDUCTOR	Copper	Aluminium	Copper	Aluminium	Copper	Aluminium
mm^2	A	A	A	A	A	A
50	167	130	150	117	196	158
70	204	158	184	142	241	198
95	243	188	219	169	290	236
120	274	214	247	193	332	270
150	308	239	277	215	377	293
185	345	270	311	243	426	348
240	398	312	358	281	500	408
300	447	352	402	317	571	449
400	504	402	454	362	657	522
500	566	454	509	409	750	600
630	630	515	567	464	852	694

TABLE 45

CURRENT RATINGS OF FLEXIBLE CABLE AT AN AMBIENT AIR TEMPERATURE 40°C WITH THREE CONDUCTORS UNDER LOAD

Cable voltage rating -- VIR / Silicone insulated cables – up to 1.1 KV -- EPR insulated cables – up to 11 KV

Nominal Area of Conductor (sq.mm)	VIR Insulation (Amps)	EPR Insulation / SILICONE Insulation (Amps)	Nominal Area of Conductor (sq.mm)	VIR Insulation (Amps)	EPR Insulation / SILICONE Insulation (Amps)
1.5	15	21	70	167	234
2.5	21	28	95	201	282
4	28	38	120	235	329
6	36	50	150	270	378
10	49	69	185	308	432
16	66	93	240	365	512
25	88	123	300	422	592
35	109	152	400	498	699
50	135	190	500	561	788
			630	634	890

TABLE 46

CURRENT RATINGS OF ELASTOMERIC COIL LEADS TYPES 3,4 & 5 To BS-6195

Area of Conductor (sq.mm)	Current Ratings for BS-6195 type* (AMPS)	Area of Conductor (sq.mm)	Current Ratings for BS-6195 type* (AMPS)
1.0	16	50	210
1.5	20	70	265
2.5	29	95	320
4	40	120	370
6	52	150	430
10	74	185	490
16	100	240	590
25	130	300	680
35	165	400	820

** The ratings are based on a ambient temp. of 45°C for types 3 and 4 and 100°C for type 5. Max. continuous conductor operating temperatures are 90°C for type 3 and 4 and 150°C for type 5, they apply to Single Circuit in free air,

Rating factors for ambient temperature

Ambient temp (°C)	50	55	60	65	70	75	80
Rating factors for types 3 & 4	0.94	0.88	0.81	0.74	0.66	0.57	0.47
Ambient temp (°C)	105	110	115	120	125	130	135
Rating factors for type 5	0.94	0.89	0.83	0.77	0.70	0.63	0.56

Group Rating factors

Number of Cables in group	2	3	4	5	6	7	8
Rating factors	0.80	0.70	0.65	0.60	0.56	0.53	0.50

PAGE 63

TABLE 47
CURRENT RATINGS IN AMPS FOR COPPER CONDUCTOR WELDING CABLES TO IS:9857

Nominal Area of Conductor (sq. mm)	General Service Normal Duty Elastomeric Compound Covered Cables					HOFR Normal Duty Elastomeric Compound Covered Cables				
	Current rating at an ambient air temperature 30°C with maximum duty cycle* of									
	100%	85%	60%	30%	20%	100%	85%	60%	30%	20%
16	94	102	121	172	210	135	146	174	246	302
25	125	136	161	228	279	177	192	228	343	396
35	156	169	201	285	349	221	240	285	403	494
50	197	214	254	360	440	279	303	360	509	624
70	248	269	320	453	555	352	382	454	643	787
95	299	342	386	546	669	424	460	547	774	948

*The percentage duty cycles are based on a cycle time of 5 minutes

Rating Factors for variation in Ambient Temperature

Ambient air Temperature (°C)	25	30	35	40	45	50	Ambient air Temperature (°C)	25	30	35	40	45	50
Rating Factors	1.08	1.0	0.91	0.82	0.71	0.58	Rating Factors	1.04	1.0	0.96	0.91	0.87	0.82

TABLE 48
CURRENT RATINGS IN AMPS FOR ALUMINIUM CONDUCTOR WELDING CABLES TO IS:9857

Nominal Area of Conductor (sq. mm)	General Service Normal Duty Elastomeric Compound Covered Cables					HOFR Normal Duty Elastomeric Compound Covered Cables				
	Current rating at an ambient air temperature 30°C with maximum duty cycle* of									
	100%	85%	60%	30%	20%	100%	85%	60%	30%	20%
25	100	108	129	183	224	144	156	186	263	322
35	123	133	159	225	275	176	191	227	321	394
50	155	168	200	283	347	222	241	287	405	496
70	196	213	253	358	438	280	304	361	511	626
95	237	257	306	433	530	339	368	438	619	758
120	283	307	365	517	633	404	438	522	738	903

*The percentage duty cycles are based on a cycle time of 5 minutes

Rating Factors for variation in Ambient Temperature

Ambient air Temperature (°C)	25	30	35	40	45	50	Ambient air Temperature (°C)	25	30	35	40	45	50
Rating Factors	1.08	1.0	0.91	0.82	0.71	0.58	Rating Factors	1.04	1.0	0.96	0.91	0.87	0.82

TABLE 49

RATING FACTORS FOR VARIATION IN GROUND TEMPERATURE FOR CABLES LAID DIRECT IN THE GROUND

Max. Conductor temperature (^{O}C)	Ground temperature in ^{O}C						
	15	20	25	30	35	40	45
65	1.2	1.13	1.07	1.0	0.93	0.85	0.76
70	1.17	1.12	1.06	1.0	0.94	0.87	0.79
80	1.14	1.10	1.05	1.0	0.95	0.89	0.84
85	1.13	1.09	1.04	1.0	0.95	0.90	0.85
90	1.12	1.08	1.03	1.0	0.96	0.91	0.87

TABLE 50

RATING FACTORS FOR VARIATION IN GROUND TEMPERATURE FOR CABLES LAID IN DUCTS

The rating factors for all cables, excepting unarmoured paper insulated cables, shall remain same as specified above for cable laid direct in the ground.
The rating factors for paper insulated unarmoured cables are as under :-

Max. Conductor temperature (^{O}C)	Ground temperature in ^{O}C						
	15	20	25	30	35	40	45
65	1.0	1.0	1.0	1.0	0.93	0.85	0.76
70	1.0	1.0	1.0	1.0	1.0	0.93	0.85
80	1.0	1.0	1.0	1.0	1.0	0.94	0.88

TABLE 51

RATING FACTORS FOR VARIATION IN AMBIENT AIR TEMPERATURE

Maximum Conductor temparature. . .(°C)	Ambient Air temparature (°C)																		
	25	30	35	40	45	50	55	60	65	70	75	80	85	901	95	100	110	120	130	140
60	1.32	1.22	1.10	1.0	0.86	0.69	--	--	--	--	--	--	--	--	--	--	--	--	--	--
65	1.30	1.21	1.10	1.0	0.88	0.77	0.63	--	--	--	--	--	--	--	--	--	--	--	--	--
70	1.25	1.16	1.09	1.0	0.9	0.81	0.70	0.57	--	--	--	--	--	--	--	--	--	--	--	--
80	1.19	1.12	1.06	1.0	0.92	0.86	0.79	0.70	0.61	0.50	--	--	--	--	--	--	--	--	--	--
85	1.15	1.10	1.05	1.0	0.94	0.88	0.81	0.74	0.66	0.57	0.47	--	--	--	--	--	--	--	--	--
90	1.14	1.10	1.04	1.0	0.95	0.90	--	--	--	--	--	--	--	--	--	--	--	--	--	--
105	--	--	1.0	1.0	1.0	1.0	0.95	0.90	0.85	0.80	0.74	0.67	0.60	0.52	0.43	--	--	--	--	--
150	--	--	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.94	0.82	0.71	0.56	0.39

TABLE 52

RATING FACTORS
FOR VARIATION IN THERMAL RESISTIVITY OF SOIL FOR THREE SINGLE CORE CABLES LAID DIRECT IN GROUND IN TREFOIL TOUCHING

Nom. Area of conductor (sq.mm)	Thermal resistivity of Soil in ^{o}C cm/watt					
	100	120	150	200	250	300
1.5	1.18	1.09	1.0	0.9	0.82	0.76
2.5	1.18	1.09	1.0	0.9	0.82	0.76
4	1.18	1.09	1.0	0.9	0.82	0.76
6	1.18	1.09	1.0	0.9	0.82	0.76
10	1.18	1.09	1.0	0.89	0.81	0.75
16	1.19	1.09	1.0	0.89	0.81	0.74
25	1.19	1.09	1.0	0.88	0.80	0.74
35	1.20	1.09	1.0	0.88	0.80	0.74
50	1.20	1.09	1.0	0.88	0.80	0.74
70	1.21	1.10	1.0	0.88	0.80	0.74
95	1.22	1.10	1.0	0.88	0.80	0.74
120	1.22	1.10	1.0	0.88	0.79	0.74
150	1.22	1.10	1.0	0.88	0.79	0.73
185	1.22	1.10	1.0	0.88	0.79	0.73
240	1.22	1.10	1.0	0.88	0.79	0.73
300	1.22	1.10	1.0	0.88	0.79	0.72
400	1.24	1.11	1'0	0.88	0.79	0.72
500	1.24	1.11	1.0	0.88	0.79	0.72
630	1.24	1.11	1.0	0.88	0.79	0.72
800	1.24	1.11	1.0	0.88	0.79	0.72
1000	1.24	1.11	1.0	0.88	0.79	0.72

TABLE 53

RATING FACTORS
FOR VARIATION IN THERMAL RESISTIVITY OF SOIL FOR THREESINGLE CORE CABLES LAID DIRECT IN GROUND IN TREFOIL DUCT

Nom. Area of conductor (sq.mm)	Thermal resistivity of Soil in °C cm/watt					
	100	120	150	200	250	300
1.5	1.10	1.05	1.0	0.94	0.87	0.83
2.5	1.10	1.05	1.0	0.94	0.87	0.83
4	1.10	1.05	1.0	0.94	0.87	0.83
6	1.10	1.05	1.0	0.94	0.87	0.83
10	1.10	1.05	1.0	0.93	0.86	0.82
16	1.10	1.05	1.0	0.92	0.86	0.81
25	1.10	1.05	1.0	0.92	0.85	0.80
35	1.11	1.06	1.0	0.92	0.85	0.80
50	1.12	1.06	1.0	0.92	0.85	0.80
70	1.12	1.06	1.0	0.91	0.85	0.79
95	1.13	1.06	1.0	0.91	0.84	0.79
120	1.13	1.06	1.0	0.91	0.84	0.78
150	1.14	1.07	1.0	0.91	0.84	0.77
185	1.15	1.08	1.0	0.91	0.84	0.77
240	1.15	1.08	1.0	0.91	0.83	0.77
300	1.15	1.08	1.0	0.90	0.83	0.76
400	1.16	1.08	1.0	0.90	0.83	0.76
500	1.16	1.08	1.0	0.90	0.82	0.76
630	1.17	1.09	1.0	0.90	0.82	0.76
800	1.17	1.09	1.0	0.90	0.82	0.76
1000	1.17	1.09	1.0	0.90	0.82	0.76

TABLE 54

RATING FACTORS
FOR VARIATION IN THERMAL RESISTIVITY OF SOIL FOR TWIN AND MULTICORE CABLES LAID DIRECT IN GROUND

Nom. Area of conductor (sq.mm)	Thermal resistivity of Soil in °C cm/watt					
	100	120	150	200	250	300
1.5	1.10	1.05	1.0	0.92	0.86	0.81
2.5	1.10	1.05	1.0	0.92	0.86	0.81
4	1.10	1.05	1.0	0.92	0.86	0.81
6	1.10	1.05	1.0	0.92	0.86	0.81
10	1.10	1.06	1.0	0.92	0.85	0.80
16	1.12	1.06	1.0	0.91	0.84	0.79
25	1.14	1.08	1.0	0.91	0.84	0.78
35	1.15	1.08	1.0	0.91	0.84	0.77
50	1.15	1.08	1.0	0.91	0.84	0.77
70	1.15	1.08	1.0	0.90	0.83	0.76
95	1.15	1.08	1.0	0.90	0.83	0.76
120	1.17	1.09	1.0	0.90	0.82	0.76
150	1.17	1.09	1.0	0.90	0.82	0.76
185	1.18	1.09	1.0	0.89	0.81	0.75
240	1.18	1.09	1.0	0.89	0.81	0.75
300	1.18	1.09	1.0	0.89	0.81	0.75
400	1.19	1.10	1.0	0.89	0.81	0.75
500	1.21	1.10	1.0	0.89	0.81	0.75
630	1.22	1.10	1.0	0.89	0.81	0.74

TABLE 55

RATING FACTORS
FOR VARIATION IN THERMAL RESISTIVITY OF SOIL FOR TWIN AND MULTICORE CABLES LAID IN SINGLE WAY DUCTS

Nom. Area of conductor (sq.mm)	Thermal resistivity of Soil in °C cm/watt					
	100	120	150	200	250	300
1.5	1.05	1.03	1.0	0.96	0.91	0.88
2.5	1.05	1.03	1.0	0.96	0.91	0.88
4	1.05	1.03	1.0	0.96	0.91	0.88
6	1.05	1.03	1.0	0.96	0.91	0.88
10	105	1.03	1'0	0.95	0.90	0.87
16	1.06	1.03	1.0	0.95	0.90	0.86
25	1.07	1.04	1.0	0.95	0.90	0.85
35	1.08	1 .04	1.0	0.94	0.89	0.84
50	1.08	1.04	1.0	0.94	0.89	0.84
70	1.08	1.04	1.0	0.94	0.88	0.83
95	1.08	1.04	1.0	0.94	0.87	0.83
120	1.09	1.05	1.0	0.94	0.87	0.82
150	1.09	1 .05	1.0	0.93	0.86	0.82
185	1.10	1.05	1.0	0.93	0.86	0.81
240	1.10	1.05	1.0	0.92	0.86	0.81
300	1.10	1.05	1.0	0.92	0.86	0.81
400	1.11	1.06	1.0	0.92	0.86	0.81
500	1.12	1.06	1.0	0.92	0.86	0.81
630	1.12	1.06	1.0	0.92	0.85	0.80

TABLE 56

RATING FACTORS
FOR VARIATION IN DEPTH OF LAYING FOR CABLE LAID DIRECT IN GROUND

Depth of laying (cm)	1.1 KV Cables			3.3, 6.6 & 11 KV Cables	22 & 33 KV Cables
	Upto 25 sq. mm	Above 25 sq. mm upto 300 sq. mm	Above 300 sq. mm	(All sizes)	(All Sizes)
75	1.0	1.0	1.0	--	--
90	0.99	0.98	0.97	1.0	--
105	0.98	0.97	0.96	0.99	1.0
120	0.97	0.96	0.95	0.98	0.99
150	0.96	0.94	0.92	0.96	0.97
180 or more	0.95	0.93	0.91	0.95	0.96

TABLE 57

RATING FACTORS
FOR VARIATION IN DEPTH OF LAYING FOR TWIN AND MULTICORE CABLES LAID IN SINGLE WAY DUCTS

Depth of laying (cm)	1.1 KV Cables	3.3, 6.6 KV & 11 KV Cables	22 & 33 KV Cables
75	1.0	--	--
90	0.99	1.0	--
105	0.98	0.99	1.0
120	0.97	0.98	0.99
150	0.96	0.97	0.98
180	0.95	0.96	0.97
270	0.92	0.93	0.94
360	0.91	0.92	0.92
450	0.90	0.91	0.91
540 or more	0.89	0.90	0.90

TABLE 58

GROUP RATING FACTORS
FOR SINGLE CORE CABLES LAID IN TREFOIL FORMATION

A) Cables laid in ground in horizontal formation.

No. of Trefoils in group	Spacing between Trefoils			
	Touching	15 cm.	30 cm.	45 cm.
2	0.78	0.81	0.85	0.88
3	0.68	0.71	0.77	0.81
4	0.61	0.65	0.72	0.76
5	0.56	0.61	0.68	0.73

B) Cables laid in Trefoil Ducts in horizontal formation.

No. of Trefoils In group	Spacing between Trefoils		
	Touching	45 cm.	60 cm.
2	0.87	0.90	0.91
3	0.79	0.83	0.86
4	0.74	0.79	0.82
5	0.71	0.76	0.80

C) Cables laid on RacksfTrays in covered trench with removable covers where air circulation is restricted, Trefoils are separated by two cable dia horizontally and the trays are in tiers with 30 cm. gap between them.

No. of racks/ tray in tier	No. of trefoils in Horizon formation		
	1	2	3
1	0.95	0.90	0.88
2	0.90	0.85	0.83
3	0.88	0.83	0.81
6	0.86	0.81	0.79

D) Cables laid as in 'C' but in open air.

1	1.0	0.98	0.96
2	1.0	0.95	0.93
3	1.0	0.94	0.92
6	1.0	0.93	0.90

TABLE 59

GROUP RATING FACTORS FOR MULTICORE CABLES

A) Cables laid inside concrete trench with removable covers, on cable trays where air circulation is restricted.
The cables spaced by one cable diameter and trays in tiers by 300 mm. The clearance of the cable from the wall is 25 mm.

No. of cable trays in tier	No. of cables				
	1	2	3	6	9
1	0.95	0.90	0.88	0.85	0.84
2	0.90	0.85	0.83	0.81	0.80
3	0.88	0.83	0.81	0.79	0.78
6	0.86	0.81	0.79	0.77	0.76

B) Cables laid on cable trays exposed to air, the cables spaced by one cable diameter and trays in tiers by 300 mm.
The clearance between the wall and the cable is 25 mm.

No. Of cable trays in tier	No. of cables				
	1	2	3	6	9
1	1	0.98	0.96	0.93	0.92
2	1	0.95	0.93	0.90	0.89
3	1	0.94	0.92	0.89	0.88
6	1	0.93	0.90	0.87	0.86

C) Cables laid on cable trays exposed to air, the cables touching and trays in tiers by 300 mm. The clearance between the wall and the cable 25 mm.

No. of trays	No. of cables per tray				
	1	2	3	6	9
1	**1.0**	0.84	0.80	0.75	0.73
2	1.0	0.80	0.76	0.71	0.69
3	1.0	0.78	0.74	0.70	0.68
6	1.0	0.76	0.72	0.68	0.66

D) Cables laid direct in ground in horizontal formation.

No. of cables in group	Spacing of cables			
	Touching	15 cm.	30 cm.	45 cm.
2	0.79	82	0.87	0.90
3	0.69	0.75	0.79	0.83
4	0.62	0.69	0.74	0.79
5	0.58	0.65	0.72	0.76
6	0.54	0.61	0.69	0.75

E) Cables laid in single way ducts/pipes in horizontal formation.

No. of cables in group	Spacing of cables			
	Touching	30 cm.	45 cm.	60 cm.
2	0.88	0.90	0.92	0.94
3	0.82	0.84	0.87	0.89
4	0.77	0.80	0.84	0.87
5	0.74	0.78	0.82	0.85
6	0.71	0.76	0.81	0.84

PAGE 73

TABLE 60

SHORT CIRCUIT RATING OF CONDUCTOR (KILO AMPS)

Nominal Area of Conductor (sq. mm)	PVC CABLES		HR PVC CABLES		XLPE CABLES		PILC CABLES					
							11 KV belted type 22 KV & 33 KV Screened		11 KV Screened		Up to 6.6 KV	
	Copper	Alumin-ium	Copper	Alumin-ium	Copper	Alumin-ium	Copper	Alumin-ium	Copper	Alumin-ium	Copper	Alumin-ium
1.5	0.17	0.11	0.16	0.10	0.21	0.14	--	--	--	--	--	--
2.5	0.29	0.19	0.26	0.17	0.36	0.24	--	--	--	--	--	--
4	0.46	0.30	0.42	0.28	0.57	0.38	--	--	--	--	--	--
6	0.69	0.46	0.63	0.41	0.86	0.57	--	--	--	--	0.64	0.42
10	1.2	0.76	1.0	0.69	1.4	0.94	--	--	--	--	1.1	0.70
16	1.8	1.2	1.7	1.1	2.3	1.5	1.9	1.3	1.8	1.2	1.7	1.1
25	2.9	1.9	2.6	1.7	3.6	2.4	3.0	2.0	2.9	1.9	2.7	1.8
35	4.0	2.7	3.6	2.4	5.0	3.3	4.2	2.7	4.0	2.7	3.7	2.5
50	5.8	3.8	5.2	3.4	7.1	4.7	6.0	3.9	5.8	3.8	5.3	3.5
70	8.1	5.3	7.3	4.8	10.0	6.6	8.3	5.5	8.1	5.3	7.5	4.9
95	10.9	7.2	9.9	6.6	13.6	9.0	11.3	7.4	10.9	7.2	10.1	6.7
120	13.8	9.1	12.5	8.3	17.1	11.3	14.3	9.4	13.8	9.1	12.8	8.5
150	17.2	11.4	15.6	10.4	21.4	14.2	17.9	11.7	17.2	11.4	16.0	10.6
185	21.3	14.0	19.3	12.8	26.4	17.5	22.0	14.6	21.3	14.0	19.7	13.0
240	27.6	18.2	25.0	16.6	34.3	22.6	28.6	18.8	27.6	18.2	25.5	16.9
300	34.5	22.7	31.3	20.7	42.9	28.3	35.7	23.4	34.5	22.7	31.9	21.1
400	46.0	30.3	41.7	27.6	57.1	37.7	47.6	31.3	46.0	30.3	42.6	28.2
500	57.5	37.9	52.1	34.5	71.4	47.2	59.5	39.1	57.5	37.9	53.2	35.2
630	72.4	47.7	65.6	43.5	90.0	59.4	75.0	49.2	72.4	47.7	67.0	44.4
800	92.0	60.6	83.3	55.2	114.3	75.5	95.2	62.5	92.0	60.6	85.1	56.3
1000	114.9	75.8	104.2	69.0	142.9	94.3	119.1	78.1	114.9	75.8	106.4	70.4

TABLE 61

SHORT CIRCUIT RATING OF FLEXIBLE CABLES WITH COPPER CONDUCTOR (KILO AMPS)

Nominal Area of Conductor (sq.mm)	Natural Rubber (VIR) insulated Cables	Synthetic Rubber (EPR) insulated Cables	Silicone / CSP Cables	Silicone / G.F. Braided & lacquered Cables
1.5	0.21	0.21	0.25	0.22
2.5	0.35	0.36	0.42	0.37
4	0.57	0.57	0.67	0.59
6	0.85	0.86	1.0	0.88
10	1.4	1.4	1.7	1.5
16	2.3	2.3	2.7	2.4
25	3.5	3.6	4.2	3.7
35	5.0	5.0	5.9	5.1
50	7.1	7.1	8.4	7.3
70	9.9	10.0	11.7	10.3
95	13.4	13.6	15.9	13.9
120	17.0	17.1	20.1	17.6
150	21.2	21.4	25.1	22.0
185	26.2	26.4	30.9	27.2
240	33.9	34.3	40.1	35.2
300	42.4	42.9	50.1	44.0
400	56.6	57.1	66.8	58.7
500	70.7	71.4	83.6	73.4
630	89.1	90.0	105.3	92.5

Note :- Short Circuit Current ratings given in tables 60 and 61 are based on following assumptions

1) Max Conductor temp. before Short Circuit

a)	For PVC Cables	70 °C
b)	For HR PVC Cables	85 °C
c)	For XLPE Cables	90 °C
d)	For PILC Cables	
i)	11 KV belted type 22 KV & 33 KV Cables	65 °C
ii)	11 KV Screened Cables	70 °C
iii)	Up to 6.6 KV Cables	80 °C
e)	For Natural rubber (VIR) insulated cables	60 °C
f)	For Synthetic rubber (EPR) insulated Cables	90 °C
g)	For Silicone /CSP Cables	105 °C
h)	For Silicone /GF braided Cables	150 °C

2) Max. Conductor temp at the termination of Short Circuit

a)	For PVC Cables	160 °C
b)	For HR PVC Cables	160 °C
c)	For XLPE Cables	250 °C
d)	For PILC Cables	
i)	11 KV belted type 22 KV & 33 KV Cables	160 °C
ii)	11 KV Screened Cables	160 °C
iii)	Up to 6.6 KV Cables	160 °C
e)	For Natural rubber (VIR) insulated cables	200 °C
f)	For Synthetic rubber (EPR) insulated Cables	250 °C
g)	For Silicone /CSP Cables	350 °C
h)	For Silicone /GF braided Cables	

3) Duration of Short Circuit 1 Second

Formula for calculating the Short Circuit rating for other durations : -

$$I_k = \frac{I_1}{\sqrt{K}}$$

Where

I_k = Short Ckt Current for 'K' Seconds

I_1 = Short Ckt Current for '1' Second

K = Duration in Seconds

(The above formula is valid for K from 0.2 to 5 Seconds)

PAGE 75

TABLE 62

APPROXIMATE A.C. RESISTANCE OF CONDUCTOR (OHM/KM) AT MAX. OPERATING CONDUCTOR TEMPERATURE PVC, HR PVC & XLPE CABLES

Nominal area of conductor (sq.mm)	PVC CABLES (70°C)		HR PVC CABLES (85°C)		XLPE CABLES (90°C)	
	Aluminium	Copper	Aluminium	Copper	Aluminium	Copper
1.5	21.72	14.52	22.81	15.25	23.2	15.5
2.5	14.52	8.89	15.25	9.34	15.5	9.5
4	8.89	5.53	9.34	5.81	9.5	5.9
6	5.53	3.70	5.81	3.88	5.9	3.94
10	3.70	2.20	3.88	2.31	3.94	2.34
16	2.29	1.38	2.41	1.45	2.44	1.47
25	1.44	0.873	1.51	0.916	1.53	0.931
35	1.04	0.629	1.09	0.661	1.11	0.671
50	0.770	0.465	0.808	0.488	0.818	0.496
70	0.532	0.322	0.559	0.338	0.565	0.344
95	0.384	0.233	0.404	0.244	0.409	0.248
120	0.304	0.185	0.328	0.194	0.323	0.197
150	0.248	0.150	0.261	0.158	0.264	0.160
185	0.198	0.121	0.208	0.127	0.210	0.129
240	0.152	0.094	0.159	0.098	0.161	0.099
300	0.122	0.075	0.128	0.079	0.129	0.080
400	0.096	0.061	0.101	0.063	0.102	0.064
500	0.076	0.049	0.079	0.051	0.082	0.052
630	0.061	0.040	0.063	0.042	0.065	0.043

TABLE 63

APPROXIMATE REACTANCE AT 50 HZ (OHMS/KM) 1.1 KV PVC, HR PVC AND XLPE CABLES

Nominal Area of conductor (sq. mm)	PVC and HR PVC Cables			XLPE Cables		
	Single Core		Multicore	Single Core		Multicore
	Unarmoured	Armoured *		Unarmoured	Armoured *	
1.5	0.157	--	0.110	0.155	--	0.107
2.5	0.145	--	0.106	0.142	--	0.0985
4	0.136	--	0.102	0.132	--	0.0927
6	0.128	--	0.0962	0.123	--	0.0884
1.0	0.118	0.137	0.0908	0.114	0.134	0.0837
1.6	0.110	0.128	0.0859	0.108	0.125	0.0808
25	0.107	0.122	0.0849	0.103	0.120	0.0805
35	0.106	0.116	0.0823	0.0986	0.114	0.0783
50	0.0973	0.110	0.0765	0.0937	0.108	0.0750
70	0.0924	0.107	0.0769	0.0900	0.102	0.0740
95	0.0900	0.103	0.0766	0.0865	0.100	0.0724
120	0.0880	0.0989	0.0741	0.0841	0.0968	0.0712
150	0.0862	0.0960	0.0743	0.0839	0.0941	0.0716
185	0.0857	0.0950	0.0742	0.0836	0.0932	0.0718
240	0.0837	0.0929	0.0737	0.0813	0.0900	0.0710
300	0.0828	0.0922	0.0733	0.0795	0.0881	0.0705
400	0.0810	0.0893	0.0729	0.0787	0.0873	0.0704
500	0.0807	0.0890	0.0732	0.0779	0.0859	0.0702
630	0.0803	0.0876	0.0731	0.0765	0.0843	0.0698
800	0.0782	0.0862	--	0.0755	0.0826	--
1000	0.0772	0.0849	--	0.0752	0.0829	--

* Round wire armoured

TABLE 64
APPROXIMATE REACTANCE AT 50 HZ (OHMS/KM) SINGLE CORE HV XLPE CABLES

Nominal Area of Conductor (sq.mm)	3.3 KV (E) & (UE)		6.6 KV (E)		11 KV (E)		11 KV (UE)		22 KV (E)		33 KV (E)	
	Un-armoured	* Armoured	Un-armoured	* Armoured	Un-armoured	* Armoured	Un-armoured	* Armoured	Un-armoured	* Armoured	Un-armoured	* Armoured
25	0.116	0.125	0.130	0.138	0.136	0.143	0.148	0.153	--	--	--	--
35	0.110	0.119	0.125	0.131	0.130	0.136	0.140	0.145	0.143	0.146	--	--
50	0.103	0.112	0.119	0.123	0.124	0.127	0.134	0.137	0.136	0.139	0.140	0.153
70	0.0930	0.107	0.110	0.116	0.115	0.120	0.124	0.129	0.126	0.131	0.133	0.145
95	0.0945	0.102	0.105	0.110	0.109	0.114	0.117	0.122	0.120	0.126	0.127	0.137
120	0.0912	0.0981	0.102	0.106	0.105	0.110	0.115	0.119	0.117	0.121	0.122	0.132
150	0.089	0.0953	0.099	0.103	0.102	0.107	0.111	0.115	0.113	0.117	0.117	0.128
185	0.0865	0.0925	0.095	0.100	0.099	0.105	0.107	0.112	0.108	0.113	0.116	0.124
240	0.0835	0.0897	0.092	0.0976	0.095	0.101	0.102	0.107	0.104	0.109	0.111	0.121
300	0.0816	0.0874	0.091	0.0961	0.093	0.0982	0.099	0.105	0.102	0.106	0.106	0.117
400	0.080	0.0862	0.089	0.0940	0.090	0.0949	0.097	0.101	0.098	0.102	0.103	0.112
500	0.0787	0.0843	0.087	0.0921	0.088	0.0917	0.093	0.0974	0.0952	0.100	0.0994	0.109
630	0.0774	0.0830	0.085	0.0890	0.085	0.0892	0.091	0.0956	0.092	0.0967	0.0960	0.106
800	0.0764	0.0815	0.082	0.0891	0.083	0.0893	0.088	0.0937	0.0889	0.0948	0.0925	0.101
1000	0.0761	0.0818	0.081	0.0874	0.081	0.0874	0.086	0.0913	0.0871	0.0926	0.0907	0.100

* Round wire armoured (without inner sheath construction)

TABLE 65

APPROXIMATE REACTANCE AT 50 HZ (OHMS/KM) THREE CORE HV XLPE CABLES

Nominal Area of Conductor (sq. mm)	3.3 KV (E) & (U E)	6.6 KV (E)	11 KV (E)	11 KV (UE)	22 KV (E)	33 KV (E)
25	0.0981	0.118	0.125	0.139	--	--
35	0.0940	0.113	0.118	0.132	0.135	---
50	0.0878	0.105	0.111	0.123	0.127	0.140
70	0.0842	0.100	0.105	0.116	0.119	0.132
95	0.0813	0.095	0.101	0.111	0.113	0.125
120	0.0785	0.092	0.0964	0.106	0.109	0.120
150	0.0769	0.090	0.0952	0.103	0.105	0.117
185	0.0755	0.087	0.0913	0.100	0.102	0.113
240	0.0737	0.084	0.0879	0.096	0.0980	0.108
300	0.0725	0.083	0.0866	0.094	0.0960	0.105
400	0.0712	0.081	0.0839	0.091	0.0925	0.101
500	0.0688	0.079	--	--	--	--
630	0.0678	0.077	--	--	--	--

TABLE 66

APPROXIMATE REACTANCE AT 50 HZ (OHMSIKM) PILC CABLES

Nominal Area of Conductor (sq.mm)	11 KV (E)			11 KV (U.E.)			22 KV (E)		33 KV (E)	
	Single Core un-armoured	Three Core		Single Core un-armoured	Three Core		Single Core un-armoured	Three Core	Single Core un-armoured	Three Core
		belted	screened		belted	screened				
16	0.141	0.110	0.118	--	0.110	0.131	--	--	--	--
25	0.132	0.100	0.109	0.141	0.100	0.120	0.145	0.130	--	--
35	0.125	0.0990	0.105	0.134	0.0990	0.116	0.138	0.125	--	--
50	0.118	0.0920	0.0973	0.126	0.0920	0.107	0.131	0.118	--	--
70	0.112	0.0870	0.0918	0.119	0.0870	0.101	0.124	0.108	0.134	0.119
95	0.107	0.0850	0.0893	0.114	0.0850	0.0974	0.118	0.104	0.126	0.113
120	0.103	0.0810	0.0853	0.109	0.0810	0.0928	0.114	0.0990	0.121	0.107
150	0.0989	0.0800	0.0837	0.105	0.0800	0.0908	0.109	0.0967	0.115	0.103
185	0.0968	0.0782	0.0817	0.103	0.0782	0.0883	0.107	0.0938	0.112	0.100
240	0.0937	0.0756	0.0787	0.0991	0.0756	0.0845	0.103	0.0894	0.108	0.0943
300	0.0907	0.0747	0.0776	0.0961	0.0747	0.0830	0.0998	0.0877	0.104	0.0924
400	0.0880	0.0726	0.0751	0.0928	0.0726	0.0799	0.0962	0.0840	0.100	0.0880
500	0.0865	0.0718	--	0.0910	0.0718	--	0.0943	--	0.0982	--
630	0.0843	0.0704	--	0.0884	0.0704	--	0.0914	--	0.0950	--
800	0.0818	--	--	0.0855	--	--	0.0882	--	0.0915	--
1000	0.0808	--	--	0.0842	--	--	0.0868	--	0.0898	--

TABLE 67

APPROXIMATE CAPACITANCE (MICROFARADS/KM) 1.1 KV PVC, HR PVC AND XLPE CABLES

Nominal Area of Conductor (sq.mm)	PVC and HR PVC Cables				XLPE Cables			
	Single Core		Two Core	Three, three and half and four cores	Single Core		Two Core	Three, three and half and four cores
	Unarmoured	Armoured			Unarmoured	Armoured		
1.5	0.43	--	0.12	0.35	0.19	--	0.051	0.15
2.5	0.52	--	0.13	0.41	0.24	--	0.058	0.18
4	0.57	--	0.14	0.46	0.29	--	0.065	0.22
6	0.67	--	0.16	0.52	0.34	--	0.071	0.25
1.0	0.83	0.67	0.18	0.63	0.43	0.32	0.081	0.31
1.6	0.97	0.80	0.19	0.82	0.51	0.38	0.088	0.36
25	1.00	0.83	0.22	0.86	0.49	0.38	0.089	0.41
35	1.15	0.95	0.24	0.98	0.57	0.44	0.096	0.47
50	1.26	0.95	0.24	1.00	0.58	0.46	0.098	0.50
70	1.32	1.12	0.26	1.16	0.63	0.51	0.10	0.53
95	1.36	1.17	0.26	1.18	0.73	0.59	0.11	0.61
120	1.49	1.28	0.28	1.31	0.74	0.61	0.11	0.63
150	1.52	1.32	0.28	1.28	0.73	0.61	0.11	0.60
185	1.47	1.30	0.28	1.30	0.69	0.59	0.11	0.60
240	1.54	1.37	0.28	1.34	0.74	0.64	0.11	0.63
300	1.60	1.40	0.29	1.37	0.80	0.69	0.12	0.67
400	1.70	1.50	0.29	1.43	0.83	0.70	0.12	0.67
500	1.63	1.46	0.29	1.41	0.83	0.71	0.12	0.69
630	1.64	1.45	0.29	1.42	0.87	0.75	0.11	0.73
800	1.87	1.65	--	--	0.92	0.78	--	--
1000	2.05	1.76	--	--	0.94	0.81	--	--

TABLE 68

APPROXIMATE CAPACITANCE (MICROFARADS/KM) HV XLPE CABLES

Nominal Area Conduc-tor (sq.mm)	3.3 KV (E) & (UE)			6.6 KV (E)		11 KV (E)		11 KV (UE)		22 KV (E)		33 KV (E)	
	Single Core		Three Core	Single Core	Three Core	Single Core	Three Core	Single Core	Three Core	Single Core	Three Core	Single Core	Three Core
	Un-armoured	Armoured											
25	0.23	0.21	0.21	0.22	0.23	0.18	0.19	0.14	0.14	--	--	--	--
35	0.27	0.24	0.24	0.25	0.25	0.20	0.21	0.15	0.15	0.14	0.15	--	--
50	0.30	0.27	0.27	0.27	0.28	0.22	0.23	0.16	0.17	0.16	0.16	0.12	0.13
70	0.34	0.31	0.31	0.31	0.32	0.26	0.26	0.19	0.19	0.17	0.18	0.14	0.14
95	0.39	0.35	0.35	0.36	0.36	0.29	0.29	0.21	0.21	0.20	0.20	0.15	0.16
120	0.43	0.39	0.39	0.38	0.39	0.31	0.32	0.22	0.23	0.21	0.21	0.16	0.16
150	0.49	0.44	0.42	0.42	0.42	0.34	0.34	0.24	0.24	0.22	0.23	0.17	0.18
185	0.52	0.46	0.46	0.45	0.46	0.36	0.37	0.26	0.26	0.24	0.25	0.18	0.19
240	0.59	0.53	0.51	0.51	0.52	0.41	0.42	0.29	0.29	0.27	0.27	0.20	0.21
300	0.67	0.59	0.57	0.53	0.57	0.45	0.46	0.31	0.32	0.29	0.30	0.22	0.22
400	0.76	0.65	0.63	0.54	0.64	0.50	0.51	0.35	0.35	0.33	0.33	0.25	0.24
500	0.77	0.67	0.68	0.57	0.72	0.56	--	0.39	--	0.36	--	0.27	--
630	0.81	0.70	0.68	0.64	0.80	0.62	--	0.43	--	0.40	--	0.29	--
800	0.86	0.74	--	0.75	--	0.73	--	0.50	--	0.46	--	0.34	--
1000	0.88	0.76	--	0.80	--	0.80	--	0.54	--	0.50	--	0.36	--

TABLE 69

APPROXIMATE CAPACITANCE (MICROFARADS/KM) PILC CABLES

Nominal Area of Conductor (sq. mm)	11 KV (E)			11 KV (UE)			22 KV (E)		33 KV (E)	
	Single Core Un-armoured	Three Core		Single Core Un-armoured	Three Core		Single Core Un-armoured	Three Core	Single Core Un-armoured	Three Core
		Belted	Screened		belted	Screened				
16	0.23	0.22	0.25	--	0.20	0.18	--	--	--	--
25	0.27	0.29	0.30	0.22	0.26	0.24	0.19	0.20	--	--
35	0.31	0.31	0.33	0.24	0.28	0.26	0.22	0.22	--	--
50	0.34	0.35	0.37	0.26	0.31	0.29	0.23	0.24	--	--
70	0.39	0.41	0.44	0.30	0.37	0.34	0.26	0.29	0.21	0.23
95	0.44	0.45	0.48	0.34	0.40	0.37	0.29	0.31	0.24	0.26
120	0.48	0.50	0.54	0.37	0.44	0.41	0.32	0.35	0.26	0.28
150	0.54	0.54	0.58	0.41	0.47	0.44	0.35	0.37	0.30	0.32
185	0.57	0.58	0.64	0.43	0.52	0.48	0.37	0.40	0.32	0.34
240	0.65	0.66	0.75	0.49	0.59	0.56	0.41	0.46	0.35	0.40
300	0.72	0.72	0.79	0.55	0.63	0.59	0.46	0.49	0.39	0.42
400	0.82	0.84	0.93	0.62	0.74	0.69	0.51	0.57	0.44	0.48
500	0.90	0.91	--	0.67	0.79	--	0.56	--	0.47	--
630	1.01	1.00	--	0.75	0.88	--	0.62	--	0.53	--
800	1.16	--	--	0.86	--	--	0.70	--	0.59	--
1000	1.26	--	--	0.93	--	--	0.76	--	0.64	--

TABLE 70

APPROXIMATE THREE PHASE VOLTAGE DROP (VOLTS/AMP/KM) 1.1 KV PVC. HR PVC. AND XLPE CABLES

Nominal Area of Conductor (sq. mm)	PVC Cables		HR PVC Cables		XLPE Cables	
	Aluminium	Copper	Aluminium	Copper	Aluminium	Copper
1.5	37.6	25.1	39.5	26.4	40.2	26.8
2.5	25.1	15.4	26.4	16.2	26.8	16.5
4	15.4	9.6	16.2	10.1	16.5	10.2
6	9.6	6.4	10.1	6.7	10.2	6.8
10	6.4	3.8	6.7	4.0	6.8	4.1
16	4.0	2.4	4.2	2.5	4.2	2.5
25	2.5	1.5	2.6	1.6	2.7	1.6
35	1.8	1.1	1.9	1.2	1.9	1.2
50	1.3	0.82	1.4	0.86	1.4	0.87
70	0.93	0.57	0.98	0.60	0.99	0.61
95	0.68	0.42	0.71	0.44	0.72	0.45
120	0.54	0.35	0.57	0.36	0.58	0.36
150	0.45	0.29	0.47	0.30	0.48	0.30
185	0.37	0.25	0.38	0.26	0.39	0.26
240	0.29	0.21	0.30	0.22	0.31	0.22
300	0.25	0.18	0.26	0.19	0.26	0.19
400	0.21	0.16	0.22	0.17	0.22	0.17
500	0.18	0.15	0.19	0.16	0.19	0.16
630	0.16	0.14	0.17	0.15	0.17	0.15

TABLE 71

APPROXIMATE THREE PHASE VOLTAGE DROP (VOLTS/AMP/KM) HV XLPE CABLES

Nominal Area of Conductor (sq. mm)	3.3 KV (E) & (UE)		6.6 KV (E)		11 KV (E)		11 KV (UE)		22 KV (E)		33 KV (E)	
	AL	CU	AL	CU	AL	CU	AL	CU	AL	CU	AL	CU
25	2.7	1.6	2.7	1.6	2.7	1.6	2.7	1.6	--	--	--	--
35	1.9	1.2	1.9	1.2	1.9	1.2	1.9	1.2	1.9	1.2	--	--
50	1.4	0.87	1.4	0.88	1.4	0.88	1.4	0.89	1.4	0.89	1.4	0.89
70	0.99	0.61	0.99	0.62	1.0	0.62	1.0	0.63	1.0	0.63	1.0	0.64
95	0.72	0.45	0.73	0.46	0.73	0.46	0.73	0.47	0.73	0.47	0.74	0.48
120	0.58	0.37	0.58	0.38	0.58	0.38	0.59	0.39	0.59	0.39	0.60	0.40
150	0.48	0.31	0.48	0.32	0.49	0.32	0.49	0.33	0.49	0.33	0.50	0.34
185	0.39	0.26	0.39	0.27	0.40	0.27	0.41	0.29	0.40	0.28	0.41	0.30
240	0.31	0.21	0.31	0.22	0.32	0.23	0.32	0.24	0.33	0.24	0.34	0.25
300	0.26	0.19	0.27	0.20	0.27	0.20	0.28	0.21	0.28	0.22	0.29	0.23
400	0.22	0.17	0.23	0.18	0.23	0.18	0.24	0.19	0.24	0.19	0.25	0.21
500	0.19	0.15	0.20	0.16	--	--	--	--		--	--	--
630	0.16	0.14	0.17	0.15	--	--	--	--	--	--	--	--

GUIDELINES FOR CABLE LAYING

1) Minimum permissible bending radii of cables for fixed installations: -

Voltage Rating (KV)	PILC Cables		Elastomer PVC and XLPE Cables	
	Single Core	Multi Core	Single Core	Multi Core
Up to 1.1 KV	20 D	15 D	15 D	12 D
Above 1.1 KV to 11 KV	20 D	15 D	15 D	15 D
Above 11 KV	25 D	20 D	20 D	15 D

Where D = outer diameter of Cable

2) Maximum permissible tensile strength for Cables: -

a) For Cables pulled with Stocking: -

PVC and XLPE insulated armoured power cables $P = 9\ D^2$
PVC and XLPE insulated unarmoured power cables $P = 5\ D^2$
Paper insulated armoured Power cables
Belted & H type Cables $P = 3\ D^2$
HSL type Cables $P = 1\ D^2$

Where P = pulling force in Newton's.
D = outer diameter of Cables in mm.

b) For Cables pulled by pulling eye: - If the Cables are pulled by gripping the Conductor directly with pulling eye, the maximum permissible tensile stress depends on the material of the Conductor and on their cross section as given below: -

For aluminium conductors $30\ N/mm^2$
For copper conductors $50\ N/mm^2$

RECOMMENDATION AND CHECKLIST FOR SUPERVISING CABLE LAYING WORK

1 . Check that the cable trench is dry, (not water logged) clean and dressed, and there are no sharp stones or hard particle that may damage the cable outer sheath. If required pumps should be used to drain out water from the trench.

2. Check that the rollers are placed properly in the trench at a distance of 2 - 3 meters. Also check that at bends special corner rollers are placed so that the cable does not touch the edge of the trench at the bends.

3. Check that the drum is mounted on the cable jacks properly anchored and rotating freely. Keep a man stationed near the drum with a plank wedged against the flange so that over running of the drum could be prevented if pulling stops.

4. Ensure that drum is rolled against the direction of marked "ROLL THIS WAY" on the drum, and the cable is laid out from the top of the drum.

5. Lay a strong rope from the other end of trench to the cable drum on the route from where the cable has to pass. Attach the end of the pulling rope to the leading end of the cable using a cable stocking or pulling eye to pull the cable. One man should be provided at each roller and a gang of men should be provided at the pulling rope attached to pulling eye/cable stocking. All the persons should be facing towards the drum site. The total numbers of persons required for pulling should be decided depending upon weight per meter of cable and route conditions and complexity.

6. The gang man should be positioned near the drum. He should make evenly timed calls for pulling or stopping the pulling operation. If required, and local body allows, two to three loudspeakers could be used by the gang man for making the call. There should be signal men carrying red and green flags placed at every 50 meters. These signal men should show green flag when the pulling of cable has to be done and red flag when the pulling of cable has to be stopped. Ensure that when the gang man gives call for pulling the cable, all the men grip and pull the cable simultaneously.

7. If possible, three to four foreman/supervisor equipped with walkie-talkie sets should be placed at cable laying area. One of them should be placed near the drum and one should walk along with the cable pulling eye/cable stockings when the cable laying is being done, while others at vulnerable bends, road crossings etc to ensure that cable pulled is not getting damaged or bent at shorter radius at bends.
8. For heavy cables especially single core cables and for complicated route, apply graphite grease on the cable at the end of the ramp and before cable goes into the trench. If the site conditions requires it, the graphite grease should be applied by the men at rollers during the course of pulling.
9. During laying if any outer sheath damage is observed, the portion of cable, which is damaged, should be marked with PVC tape. After laying of the cable when the cable is still on the rollers, visual check for any outer sheath damage should be done. The bottom portion of the cable should be checked with the help of a mirror. The damaged sheath should be repaired before outer sheath testing and back filling, etc.
10. Remove rollers and other pulling equipment from site.
11. Dress the cable after providing a proper bedding of minimum 1 00 mm sand. Provide proper spacing if there is more than one cable.
12. During back filling, supervisor should be present at site, to ensure that no unwanted rejected backfill with boulders and stones are not dropped in the trench.

INSTRUCTIONS FOR SAFE HANDLING OF CABLES DRUMS

1 . As received at Stores, check the cable drums for any physical damage to the drum and outer wooded laggings. Also check that the cable end seals are proper and in position. In case of any damage quickly inform Sales Manager, Universal Cables Ltd., Satna or nearest Branch office. Then take open delivery from Transporter.
2. Loading/unloading of the drum to or from truck should be done by crane or use of a ramp. Flanges shall be kept always in up-right position during storage and handling and paying off or during transportation of drum. Use pair of jacks and shaft for mounting cable drums before paying off.
3. Roll the drum only in the direction of painted arrow on the drum flanges and only for short distances.
4. Do not lay the damaged gables before repair and testing.
5. Conduct megger and or D.C. High Voltage test on cable before laying.
6. While paying off cable from mounted drum, the cable drum shall rotate in the direction opposite to that of the arrow marked on the drum flanges. Cable end shall be taken out from the top side of the mounted drum of cable, and never from the bottom side-
7. Ensure proper security for cable from damage and fire during storage.

MAINTENANCE OF ELECTRIC CABLES AND FAULT LOCATION

Cable forms an important integral part of any Electrical network. Although bulk power is transmitted by overhead lines, in densely populated areas and for connection of any electrical apparatus, cables form an essential link. After installation, network has to be maintained.

MAINTENANCE:

After the cable has been properly installed, cables require minimum maintenance. Normally the maintenance of cable installation includes inspection, routine checking of current loading, periodic insulation tests, marks of over heating zones, maintenance history of cable feeders and prevent other agencies to work in the cable laying route without permission and proper supervision.

1. **INSPECTION:**

Whenever cables or joints are accessible in manholes, ducts, distribution pillars, terminal boxes, etc. periodic inspection should be made so that timely repair could be done before the cable or joints actually cause interruption of power supply. The frequency of inspection is determined by maintenance authority and loading of the cables. Important and heavily loaded cables require more frequent attention.

Cables laid direct in ground are not accessible for routine inspection as such cables are exposed when ground is excavated by other utilities for installing or repairing their property. When the cables are exposed because of excavation by other utilities the cable should be temporarily supported at certain intervals until the work is completed.

In case there is any joint in the excavated areas, special attention should be given for@ proper support at both the ends of the joints. In case the depth of the excavation is considerably below the cable it is necessary to buildup permanent masonary support below the cable before refilling the trench.

Preventive maintenance in the form of regular inspection of all digging operation by other utilities or persons carried out in the areas where the cables are laid.

2. CHECKING OF THE CURRENT LOADING:

The life of the cable is considerably reduced through overloading. It is therefore essential to check the loads as frequently as possible to ensure that the cables are not loaded beyond the safe current carrying capacity. The derating factor due to grouping of several cables, higher ambient temperature and higher thermal resistivity of soil should not be neglected. Whenever the current meters are installed in the feeders and substation, periodic current reading of the cables should be recorded.

3. MAINTENANCE OF CABLES AND END TERMINATIONS:

Maintenance of cables require generally replacement of section of defective cable by a length of new cable and two straight through joints. In some cases where insulation have been damaged, the defective cable piece has to be removed and joints have to be made. In case outer sheath has damaged, this can be repaired by using M-Seal pufty or by applying self-bonding rubber tapes.

At the end terminations, the periodic checking of the terminations after opening the terminal box should be carried out. In case of termination filled with liquid insulating compound the required compound level in the termination box should be maintained if required by extra filling of compound. In case of dry type termination (where the air is insulating medium between phases and between phase and earth) the cable cores exposed to air should be cleaned for dust, coal or other polluted material.

FAULT LOCATION:

Althoughacableisdesignedwithlotsofsafetyfactorandmanufacturedwithlotsofprecautions, it is exposed to many hazards, which sometimes, results in cable failure. The cause of cable failure could be accidental contact, ageing/wear, faulty installation, lightning, defective earthing system etc and damages.

Irrespective of the voltage level, efficient fault location require systematic approach if the time and cost are to be kept to a minimum. Four stages of systematic fault location are following:

1. Diagonise : To confirm existence of a fault and type of fault and whether activities at stage (2) is required before (3).

2. Precondition Change fault characteristics to suit equipment available for stage (3).
3. Prelocate To test the cable from the end to obtain approximate distance of the fault region from either cable end.
4. Pin point To confirm precise location of fault.

Faults can be divided into two types:

1. Series type cable fault.
2. Shunt type cable fault.

Series type cable faults:

Series fault occur where the continuity one or more of metallic element (i.e. conductor or sheath) of cable is impaired. Usually series faults only become apparent when continuity has been completely lost at least in one conductor, to cause an open cicuit fault.

Shunt type cable faults:

Shunt fault occur where the insulation of one or more conductor is damaged. The most common type of shunt fault is single phase to earth fault. On screened cables, all shunt faults are earth faults. Depending on the degree of carbonisation of the dielectric, the shunt fault could be of following types:

1. High Resistance fault.
2. Low Resistance fault.
3. Flashing fault.

DIAGONISIS:

Usually the first indication of the possible existence of a fault is given by the automatic operation of the circuit protection. The faulty cable should be disconnected from the other electrical equipments and is retested for confirmation of fault in insulation by applying D.C. High voltage or by Megger. If the insulation indicates a "healthy" result, cable continuity should be checked. In case the insulation shows a faulty cable, the value of fault resistance should be measured with a multimeter.

PRECONDITIONING:

Depending on the type of equipment available for fault prelocation, it may be necessary to attempt to alter the fault characteristics from, say, high resistance to a low resistance or from a flashing condition to a stable resistive fault. The fault characteristics can be changed by passing current through the fault to carbonise the insulation by fault burners. A fault burner must be sole to produce sufficient voltage to initiate breakdown of a high resistance fault but must then be able to supply increasing amount of current as the fault resistance falls to burn the fault region in order to achieve fault resistance below ten ohms.

PRELOCATING:

Cable fault prelocating is done by using:

1. Murray loop test and other bridge methods.
2. Pulse Echo method using travelling wave principle.

In the bridge method, murray loop gives very accurate results provided the power pack is capable of driving a reasonable current through the fault resistance. Where a cable route is composed of a number of different cable conductor sizes or materials it is necessary to calculate the equivalent length before using any bridge technique. The equivalent length of conductor 1 of cross-section SI with material of resistivity PI in terms of conductor 2 of cross-section S2 with material of resistivity P2 is given by:

$$\frac{\text{Equivalent length core 1 - S2Pl}}{\text{Actual length core 1 - S1P2}}$$

The pulse echo method of fault location avoid the problems of equivalent length calculations on cable routes of mixed cross-section, provided the cable dielectric is the same through out the route. In this travelling wave principle is used for finding out the time interval taken for the low voltage pulse to travel from the pulse generator to fault & back again.

For prelocating series type cable fault (open circuit), the capacitance of the healthy core is compared with the faulty one and so the fault location is calculated. Pulse Echo method could also be used for locating an open fault.

PIN POINTING:

Pin pointing is essential on direct burried cables so that the minimum portion of excavation is to done. The most common method of pin pointing is to detect the acoustic signal produced at the fault by the application of a surge voltage to the cable. In some cases, the acoustic signal can be detected above ground without any special equipment but in general it is an advantage to use a ground microphone and amplifier to pickup the mechanical shock wave. During fault burning prolonged fault burning should be avoided as it may develop a very low resistance “welded" condition and may make it impossible to generate acoustic signal.

The maintenance and fault location of electrical cables are two important aspects which should be properly understood by the operational and maintenance personnel.

TESTING OF CABLE INSTALLATION

1) DC TEST VOLTAGES AFTER INSTALLATION (BEFORE COMMISSIONING) Ref IS:1255-83

Rated voltage Of Cable (U/U) KV	Test voltage between		Duration Minutes
	Any Conductor and Metalic Sheath/ Screen/ Armour KV	Conductor to Conductor (for Unscreened Cables) KV	
0.65/1.1	3	3	
1.9/3.3	5	9	
3.3/3.3	9	9	
3.8/6.6	10.5	18	
6.6/6.6	1.8	18	5
6.35/11	18	30	
11/11	30	30	
12.7/22	37.5	--	
19/33	60	--	

Note:-D.C. test voltage for old cables is 1.5 times rated voltage or less depending on the age of the cables ,repair work or nature of Jointing Work carried out etc.]n any case the test voltage should not be less than the rated voltage.

2) INSULATION RESISTANCE TEST ON NEWLY INSTALLED CABLES BEFORE JOINTING (Ref IS:1255-83)

All new cables should be tested for insulation resistance before Jointing. After satisfactory results are obtained cable Jointing and termination work should commence. It should be noted here that insulation resistance test gives only approximate insulation resistance and the test is meant to reveal gross insulation fault(s). A fairly low insulation resistance reading compared to the values obtained at factory testing should not be a cause of worry since the insulation resistance varies greatly with parameters such as length and temperature, this is particularly more pronounced in the case of PVC cables, the voltage rating of insulation resistance tester for cables of different voltage grade should be chosen from the following table:-

Voltage grade of cable	Voltage Rating of IR Tester
1.1 KV	500 V
3.3 KV	1000 V
6.6 KV	1000 V
11 KV	1000 V
22 KV	2.5 KV
33 KV	2.5 KV

TABLE 72

TEMPERATURE CORRECTION FACTOR FOR INSULATION RESISTANCE

Temperature °C	Correction Factors		
	PVC Cables upto 3.3 KV	PVC Cables above 3.3 KV	EPR Cables
20	1.00	100	1.00
21	1.26	1.13	1.07
22	1.49	1.35	1.15
23	1.82	1.50	1.23
24	2.16	1.75	1.32
25	2.62	1.98	1.41
26	3.14	2.30	1.52
27	3.90	2.65	1.62
28	4.67	2.95	1.74
29	5.61	3.50	1.87
30	6.81	4.00	2.00
31	8.20	4.55	2.15
32	9.70	5.20	2.30
33	11.60	6.10	2.45
34	14.00	6.95	2.62
35	16.60	8.10	2.82
36	20.00	9.15	3.04
37	23.70	10.65	3.25
38	28.30	12.50	3.48
39	33.70	14.40	3.70
40	40.00	16.80	3.96
41	46.40	19.30	4.23
42	55.20	21 .80	4.50
43	64.60	25.10	4.83
44	77.10	28.80	5.20
45	91.40	33.00	5.55
46	108.00	38.00	5.90
47	128.00	42.50	6.30
48	152.00	49.00	6.75
49	178.00	56.00	7.30
50	209.00	65.00	7.80

UNISTAR CAPACITORS

ADVANTAGES OF POWER CAPACITORS

Advantages of using shunt power capacitors are as follows:-

a) Power factor improvement thereby reduction in maximum demand.
b) Improvement in bus voltage.
c) Reduction in line losses.
d) Release of transmission line capacity.
e) Release of transformer capacity.

CONSTRUCTION OF UNISTAR CAPACITORS

HT Capacitors:- Unistar High Voltage Capacitors consist of element wound from high purity soft annealed aluminium foil and layers of biaxially oriented hazy polypropylene. Aluminium foil electrode edges are folded on automatic winding machines. The elements are assembled in parallel combination to form a block giving desired capacitance and voltage rating.Connections are taken out from extended Aluminium foil by special soldering method. After providing insulation from all sides the block is inserted in a metal container. The leads are taken out through suitable voltage class bushings and the unit is subjected to fine vacuum drying and impregnated with highly purified non-PCB oil and then hermetically sealed. The unit is put through series of physical, electrical & endurance tests as per the relevant standards. The container is given a coat of red oxide primer and then two coats of finish paint of light grey enamel shade 631 of IS:5. Capacitors are made either with internal element fuses or are made suitable for external fuses as per the requirement. Unit is also provided with internal discharge resistors to discharge the capacitors in less than 300 seconds to 50 volts or less.

All PP (FILM + FOIL) Medium Voltage Capacitors (400 to 100OV):- Single layer All PP capacitor 415/440 V and double layer All PP capacitors are manufactured with extended Aluminium foil, double hazy PP film, internal element fuses and same sophistication as high voltage capacitors. They are electrically stronger than mixed dielectric capacitor. Winding on fully automatic machine in ultra clean atmosphere result in long life capacitors. The Capacitors are impregnated with PXE oil.

415/440 V MPP Capacitors:- Vapour deposited Metallized polypropylene sheets are wound tightly together on a fully automatic winding machine fitted with memorized programme sequencer and electro pneumatic controls in an air conditioned humidity controlled and absolutely dust free room. Special air showers have been installed so that dust particles do not hang around the winding machine. Extremely hard elements thus formed are stabilised in drying oven, and sprayed with sophisticated spray gun, passed through automatic short clearing machine. These sealed elements are assembled to make capacitor unit which are Routine & Type tested including special tests like endurance tests.

ADVANTAGES OF SELF HEALING MPP CAPACITORS

MPP capacitors are also called 'self healing capacitors'. In the figure below metallized PP film is shown. Across the two aluminium coating, a voltage of 415 or 440 V is applied. If there is an impurity (conducting particle) or a pin hole, then dielectric fails to withstand the voltage and puncture of dielectric takes place, this produces an arc between the electrodes. High current flows through the arc which vaporizes thin coating of aluminium around failure leaving bare polypropylene film.

1
Metallized film with conducting particle

2
Dielectric breakdown

3
Vaporization of aluminium electrode around breakdown point

Thus the arc extinguishes by itself. This phenomena is called self healing. The capacitor keeps working with a loss of very minute capacity, the fault is cleared almost instantaneously. It may take just 0.5 microsecond from initial fault current flow to completely clear the fault.

Other advantages of Metallized Polypropylene capacitors are:

1. Oil impregnated.
2. Runs cooler - temperature rise less than 7,C.
3. Self healing - fault clears instantaneously through self-healing.
4. Very low losses - Losses of elements are less than 0.5 watt per KVAR.
5. Super tropical - suitable for 50,C ambient condition.

APPLICATION OF UNISTAR CAPACITORS

Capacitors are generally used by Industries, State Electricity Boards, Utilities, etc. There are 3 types of compensation most widely used:

a) Direct compensation of motors, transformers:- Capacitors in such cases are connected direct to the motors or transformers and are switched in and out together. Separate switching unit is therefore not required. While connecting capacitors to the motor, care should be taken that capacitor KVAR does not exceed 90% of the no load KVA of the motor. This avoids over voltage on capacitors as well as motor windings due to possible self excitation. Special care should be exercised while selecting and connecting capacitors for motors connected with star delta or autotransformers, starters, inching duty motors and reversible and variable speed motors.

b) Group compensation:- When the load on a bus consist of small motors etc. direct compensation may not be feasible and economical. In such cases group compensation is provided. In case the load is varying, then more than one capacitor bank is provided through separate switching devices. In such cases problem of paralled switching is involved, which should be taken care of.

c) Central compensation:- In this type of compenation all the reactive requirement is clubbed together and one capacitor bank is provided on the main bus to take care the reactive needs of the load. This type of compensation is economical where the load is fairly constant.

Depending upon the prevailing conditions judicious combination of direct, group or central compensation can be chosen. While selecting capacitors for high voltage systems following should be considered:-

Rated voltage:- Capacitors are normally designed to with-stand 1. 1 times the rated voltage for prolonged period. It should be ensured that system voltage does not exceed this limit as capacitors are susceptible to over voltages, Whenever reactors are used in series with capacitors due allowance for the voltage rise should be considered while selecting the capacitor voltage.

Switching devices:- Breakers used for capacitors should be suitable for capacitor duty. This should be ascertained from the manufacturers of the Breakers beforehand.

Unit protection:- Capacitors are provided with either internal fuses or made suitable for external fuse protection. Both types of fuses have their own advantages and limitations. In general, it is advisable to go in for capacitors with internal element fuses for small banks as the choice of higher economical unit sizes are available. In case of large banks capacitors with external fuses are preferred because of easy identification of failed units.

TABLE 73

RECOMMENDED POWER CAPACITOR RATINGS FOR DIRECT CONNECTION TO

(A) INDUCTION MOTORS

MotorH.P	3000 rpm	1500 rpm	1000 rpm	750 rpm	600 rpm	500 rpm
	KVAr	KVAr	KVAr	KVAr	KVAr	KVAr
5	2	2	2	3	3	3
7.5	2	2	3	3	4	4
10	3	3	4	5	5	6
15	3	4	5	7	7	7
20	5	6	7	8	8	10
25	6	7	8	9	9	12
30	7	8	9	10	10	15
40	9	10	12	15	16	20
50	10	12	15	18	20	22
60	12	14	15	20	22	25
75	15	16	20	22	25	30
100	20	22	25	26	32	35
125	25	26	30	32	35	40
150	30	32	35	40	45	50
200	40	45	45	50	55	60
250	45	50	55	60	65	70

Note: The table is based on average conditions and efficiency to maintain a p.f. of 0.95 to 0.97 between 33.3% load to 125% and is applicable to motors of 220, 400/440, 2.200 and 3,300 volts. 50 c/s.

(B) WELDING TRANSFORMERS

Single phase Single operator			Three Phase	Multi Operator
Welding Transformer continuous rating KVA	Required Capacitor rating KVAr	Type	Welding Transformer continuous rating KVA	Required Capacitor rating KVAr
9	4	300/3	54	16.5
12	6	300/6	90	30
18	8	300/9	122	45
24	12	300/12	153	60
30	15			
36	18			

(C) POWER TRANSFORMERS

National rating of transformer KVA.	5/10 KV	Required capacitor rating in KVAr	
		15/20 KV	25/30 KV
25	2	2.5	
50	3.5	5	
75	5	6	
100	6	8	10
250	15	18	22
400	20	22	28
1000	45	50	55

TABLE 74

CAPACITOR SELECTION CHART

Original Power Factor	FINAL POWER FACTOR															
	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
0.60	0.713	0.740	0.766	0.793	0.821	0.849	0.877	0.907	0.938	0.970	1.004	1.041	1.082	1.130	1.190	1.333
0.65	0.549	0.576	0.602	0.629	0.657	0.685	0.713	0.743	0.774	0.806	0.840	0.877	0.918	0.966	1.026	1.169
0.70	0.400	0.427	0.453	0.480	0.508	0.536	0.564	0.594	0.625	0.657	0.691	0.728	0.769	0.817	0.877	1.020
0.75	0.262	0.289	0.315	0.342	0.370	0.398	0.426	0.456	0.487	0.519	0.553	0.590	0.631	0.679	0.739	0.882
0.76	0.235	0.262	0.288	0.315	0.343	0.371	0.399	0.429	0.460	0.492	0.526	0.563	0.604	0.652	0.712	0.855
0.77	0.209	0.236	0.262	0.289	0.317	0.345	0.373	0.403	0.434	0.466	0.500	0.537	0.578	0.626	0.686	0.829
0.78	0.182	0.209	0.235	0.262	0.290	0.318	0.346	0.376	0.407	0.439	0.473	0.510	0.551	0.599	0.659	0.802
0.79	0.156	0.183	0.209	0.236	0.264	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.633	0.776
0.80	0.130	0.157	0.183	0.210	0.238	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.609	0.750
0.81	0.104	0.131	0.157	0.184	0.212	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581	0.724
0.82	0.078	0.105	0.131	0.158	0.186	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.555	0.698
0.83	0.052	0.079	0.105	0.132	0.160	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.529	0.672
0.84	0.026	0.053	0.079	0.106	0.134	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503	0.646
0.85	0.000	0.027	0.053	0.080	0.108	0.136	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477	0.620
0.86	- -	0.000	0.026	0.053	0.081	0.109	0.137	0.167	0.198	0.230	0.264	0.301	0.342	0.390	0.450	0.593

TABLE 74 (contd.)

CAPACITOR SELECTION CHART

Original Power Factor	FINAL POWER FACTOR															
	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
0.87	--	--	0.000	*0.027*	0.055	0.083	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424	0.567
0.88	--	--	--	0.000	0.028	0.056	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397	0.540
0.89	--	--	--	--	0.000	0.028	0.056	0.086	0.117	0.149	0.183	0.220	0.261	0.309	0.369	0.512
0.90	--	--	--	--	--	0.000	0.028	0.058	0.089	0.121	0.155	0.192	0.233	0.281	0.341	0.484
0.91	--	--	--	--	--	--	0.000	0.030	0.061	0.093	0.127	0.164	0.205	0.253	0.313	0.456
0.92	--	--	--	--	--	--	--	0.000	0.031	0.063	0.097	0.134	0.175	0.223	0.283	0.426
0.93	--	--	--	--	--	--	--	--	0.000	0.032	0.066	0.103	0.144	0.192	0.252	0.395
0.94	--	--	--	--	--	--	--	--	--	0.000	0.034	0.071	0.112	0.160	0.220	0.363
0.95	--	--	--	--	--	--	--	--	--	--	0.000	0.037	0.079	0.126	0.186	0.329
0.96	--	--	--	--	--	--	--	--	--	--	--	0.000	0.041	0.089	0.149	0.292
0.97	--	--	--	--	--	--	--	--	--	--	--	--	0.000	0.048	0.108	0.251
0.98	--	--	--	--	--	--	--	--	--	--	--	--	--	0.000	0.060	0.203
0.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.000	0.143

EXAMPLE:

TOTAL LOAD ON THE BUS	= 200 KW
MULTIPLYING FACTOR TO IMPROVE P.F. FROM INITIAL 0.8 TO DESIRED 0.9	= 0.266
CAPACITOR REQUIRED	= LOAD IN KW "MULTIPLYING FACTOR
	= 200 ".266 KVAr
	= 53.2 KVAr