Chapter 12
Useful Tables

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12.1 Dielectric Properties of Cable Insulation Material

	Dielectric loss factor tan δ	Dielectric constant ε_r
Source: Anders [2] in Chap. 3		
IEC 60287		
XLPE ≤ 18/30 kV	0.004	2.5
XLPE > 18/30 kV	0.001	2.5
EPR	0.005–0.020	3
Oil/paper >87 kV	0.0033	3.6
Mass-impregnated	0.01	4
Source: Allister [8], p. 100 in Chap. 3		
XLPE	0.008	2.5
EPR	0.04	3
Oil/paper >87 kV	0.004	3.3
Mass-impregnated	0.01	4
Source: Bartnikas [9], p. 99 in Chap. 3		
XLPE 20°C	0.002	2.3
EPR	0.0013–0.0023	2.7–2.8

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(*continued*)

	Dielectric loss factor tan δ	Dielectric constant ε_r
Source: Deschamps [1]		
LDPE	8.10^{-4}	2.3
HDPE	8.10^{-4}	2.3
Oil/paper	30.10^{-4}	

Note: Tan δ is depending on temperature.

12.2 Lead Alloys

Alloy designation acc. to		Alloy elements and percentage (by weight). Min and max values						
EN50307	Convention	As	Bi	Cd	Cu	Sb	Sn	Te
PK008S	PbSb-0.5					0.45 0.55		
PK012S	½C			0.06 0.09			0.17 0.23	
PK021S	E					0.15 0.25	0.35 0.45	
PK022S	EL					0.06 0.10	0.35 0.45	
PK023S	½E					0.08 0.12	0.17 0.23	
PK031S	F3	0.15 0.18	0.08 0.12				0.10 0.13	
PK041S	Cu-Te				0.030 0.045			0.035 0.045
PK042S	½Cu-Te				0.014 0.020			0.014 0.020
PK043S	¼Cu-Te				0.006 0.009			0.006 0.009
PK049S	PbTeCu				0.03 0.045			0.03 0.045
PK071S / PK079S	Pb-Te							0.035 0.045

Note: Lead alloys and their constituents suitable for submarine cables. The table shows the designation according to EN 50307, and the conventional names for the nearest related alloy.

12.3 Non-metric Conductor Size: kcmil

The unit is based on the concept of a circular Mil. A Mil is 1/1000's of an inch (= 0.0254 mm), and a circular Mil is the area of a circle with a diameter of 1 Mil. Now, 1 cmil = 0.0005064 mm^2 and 1 kcmil is 1000 cmil = 0.5064 mm^2. Sometimes the acronym MCM is used for kcmil.

kcmils	mm^2	kcmils	Mm^2
300	152.01	800	405.37
350	177.35	900	456.04
400	202.68	1000	506.71
450	228.02	1250	633.38
500	253.35	1500	760.06
600	304.03	1750	886.74
700	354.70	2000	1013.42
750	380.03		

12.4 Non-metric Wire Diameter

In Anglo-Saxon markets the wire size is sometimes specified in non-metric units. Various "wire gauge" scales are deducted from the wire making process where the wire is drawn through consecutive dies each reducing the wire diameter. A higher wire gauge number indicates more wire drawing steps and a smaller wire. Some gauge scales are described here but there are more scales around.

AWG (American Wire Gauge)

Used in the United States since at least the 1880s for wires in all metals except iron and steel. Number 0000 wire is 0.4600 inch in diameter. The diameter of each succeeding size is 0.890525 times the diameter of the previous size.

BWG (Birmingham Wire Gage)

The steps are irregular. Departmental sanction by the United States government ended in 1914 but the scale is used widely even so.

SWG (Imperial Wire Gage, or British Standard Gage)

Legalized Standard Wire Gauge, Imperial Standard Wire Gauge, or in other countries, simply British Standard. Fixed by order of council August 23, 1883. It was constructed by improving the Birmingham wire gage. Made legal standard March 1, 1884.

Gauge	AWG American Wire Gauge	BWG Birmingham Iron Wire	SWG Imperial Wire Gauge	AWG American Wire Gauge	BWG Birmingham Iron Wire	SWG Imperial Wire Gauge
	inch	inch	inch	mm	mm	mm
7/0	–	–	0.5000	–	–	12.700
6/0	0.5800	–	0.4640	14.732	–	11.786
5/0	0.5165	0.500	0.4320	13.119	12.700	10.973
4/0	0.4600	0.454	0.4000	11.684	11.532	10.160
3/0	0.4096	0.425	0.3720	10.404	10.795	9.449
2/0	0.3648	0.380	0.3480	9.266	9.652	8.839
0	0.3249	0.340	0.3240	8.252	8.636	8.230
1	0.2893	0.300	0.3000	7.348	7.620	7.620
2	0.2576	0.284	0.2760	6.543	7.214	7.010
3	0.2294	0.259	0.2520	5.827	6.579	6.401
4	0.2043	0.238	0.2320	5.189	6.045	5.893
5	0.1819	0.220	0.2120	4.620	5.588	5.385
6	0.1620	0.203	0.1920	4.115	5.156	4.877
7	0.1443	0.180	0.1760	3.665	4.572	4.470
8	0.1285	0.165	0.1600	3.264	4.191	4.064
9	0.1144	0.148	0.1440	2.906	3.759	3.658
10	0.1019	0.134	0.1280	2.588	3.404	3.251
11	0.0907	0.120	0.1160	2.304	3.048	2.946
12	0.0808	0.109	0.1040	2.052	2.769	2.642
13	0.0720	0.095	0.0920	1.829	2.413	2.337
14	0.0641	0.083	0.0800	1.628	2.108	2.032
15	0.0571	0.072	0.0720	1.450	1.829	1.829
16	0.0508	0.065	0.0640	1.290	1.651	1.626
17	0.0453	0.058	0.0560	1.151	1.473	1.422
18	0.0403	0.049	0.0480	1.024	1.245	1.219
19	0.0359	0.042	0.0400	0.912	1.067	1.016
20	0.0320	0.035	0.0360	0.813	0.889	0.914
21	0.0285	0.032	0.0320	0.724	0.813	0.813

Note: Wire sizes under 0.7 mm diameter are omitted.

12.5 The Galvanic Series of Metals and Alloys in Seawater

Magnesium and magnesium alloys	–1.60 to –1.63
Zinc	–0.98 to –1.03
Aluminum alloys	–0.76 to –1.00
Mild steel	–0.60 to –0.71
Wrought iron	–0.60 to –0.71
Cast iron	–0.60 to –0.71
Type 410 (13% chromium) stainless steel – active	–0.46 to –0.58
Type 304 (18–8) stainless steel – active	–0.46 to –0.58
Type 316 (18–8.3% Mo) stainless steel – active	–0.43 to –0.54
Inconel (78% Ni; 13.5% Cr; 6% Fe) – active	–0.35 to –0.46
Aluminum bronze (92%Cu; 8% Al)	–0.31 to –0.42
Naval brass (60%Cu; 39%Zinc)	–0.30 to –0.40
Yellow brass (65%Cu; 35%Zn)	–0.30 to –0.40
Red brass (85%Cu; 15%Zn)	–0.30 to –0.40
Tin	–0.31 to –0.33
Copper	–0.30 to –0.57
Lead-tin solder (50%–50%)	–0.28 to –0.37
Admiralty brass (71%Cu; 28%Zn; 1%Sn)	–0.28 to –0.36
Aluminum brass (76%Cu; 22%Zn; 2%Al)	–0.28 to –0.36
Manganese bronze (58.5%Cu; 39%Zn; 1%Sn; 1%Fe; 0.3%Mn)	–0.27 to –0.34
Silicon bronze (96%Cu; 0.80%Fe; 1.50%Zn; 2%Si; 0.75%Mn; 1.60%Sn)	–0.26 to –0.29
Type 410 (13% chromium) stainless steel – passive	–0.26 to –0.35
Lead	–0.19 to –0.25
Inconel (78% Ni; 13.5% Cr; 6% Fe) – passive	–0.14 to –0.17
Nickel 200	–0.10 to –0.20
Type 304 (18–8) stainless steel – passive	–0.05 to –0.10
Monel 400 (70%Ni; 30%Cu)	–0.04 to –0.14
Type 316 (18–8, 3% Mo) stainless steel – passive	0.00 to –0.10
Titanium	–0.05 to +0.06
Platinium	+0.19 to +0.25

Note: Alloys are listed in order of the potential they exhibit in flowing seawater. Some alloys may become active and exhibit a potential near –0.5 V in low-velocity or poorly aerated water and at shielded areas.

12.6 Classification of Submarine Soil in Different Countries

US Dept. of Agric.	Germany DIN 4022	England BST 1377:1961	Sweden (Atterberg)	Denmark
Cobbles (>75)	Stein (>60)	Stone (>60)	Block (>200)	
Coarse gravel (8–75)	Grobkies (20–60)	Coarse gravel (20–60)	Sten (20–200)	Sten (>20)
Fine gravel (2–8)	Mittelkies (6–20)	Medium gravel (6–20)	Grovgrus (6–20)	Grus (2–20)
Very coarse sand (1–2)	Feinkies (2–6)	Fine gravel (2–6)	Fingrus (2–6)	
Coarse sand (0.5–1)	Grobsand (0.6–2)	Coarse sand (0.6–2)	Grovsand (0.6–2)	Grovsand (0.2–2)
Medium sand (0.25–0.5)	Mittelsand (0.2–0.6)	Medium sand (0.2–0.6)	Mellansand (0.2–0.6)	
Fine sand (0.1–0.25)	Feinsand (0.06–0.2)	Fine sand (0.06–0.2)	Grovmo (0.06–0.2)	
Very fine sand (0.05–0.1)	Grobschluff (0.02–0.06)	Coarse silt (0.02–0.6)	Finmo (0.02–0.06)	Finsand (0.02–0.2)
	Mittelschluff (0.006–0.02)	Medium silt (0.006–0.02)	Grov mjäla (0.006–0.02)	
Silt (0.002–0.05)	Feinschluff (0.002–0.006)	Fine silt (0.002–0.006)	Fin mjäla (0.002–0.006)	Silt (0.002–0.02)
Clay (<0.002)	Ton (<0.002)	Clay (<0.002)	Ler (<0.002)	Ler (<0.002)

Note: Denomination in local language. The grain size is given in mm.

Wentworth Scale

Grain size		Phi units	Sediment types
4–64	mm	–6 to –2	Pebble
2–4	mm	–2 to –1	Granule
1–2	mm	–1 to –0	Very coarse sand
0.5–1	mm	0–1	Coarse sand
250–500	µm	1–2	Medium sand
125–250	µm	2–3	Fine sand
63–125	µm	3–4	Very fine sand
<63	µm	>4	Silt

12.7 Non-metric Units

1 inch	= 25.4 mm
1 foot (U.S. and British)	= 12 inches = 0.3048 m
1 fathom	= 6 ft = 1.8288 m
1 cable	= 219.4560 m
1 nautical mile	= 1852 m
1 lbs	= 0.45359 kg
1 short ton	= 2000 lbs = 0.907185 MT
1 long ton	= 1.016047 MT
1 MT	= 1000 kg
1 cubic inch	= 16.387 cm^3
1 cubic foot	= 0.028317 m^3
1 register ton	= 100 cubic foot = 2.8317 m^3
1 hectopascal	= 1 mb
1 mm of mercury	= 1.3332 mb
1 pound per square inch (psi)	= 0.06895 bar
1 kn	= 1.852 km/h = 0.51444 m/s
1 m/s	= 3.6 km/h = 1.94384 kn

12.8 Tidal Terms

English	English abbreviation	German	German abbreviation
Tides		Gezeiten	
Height of tide		Gezeitenhub	
Tidal streams		Gezeitenstrom	
Highest astronomical tide	HAT	Höchstmöglicher Gezeiten-wasserstand	
High water	HW	Hochwasser	HW
High water heights	HW Hts.	Hochwasserhöhe	HWH
High water time	HW Time	Hochwasserzeit	HWZ
		Höhe der Gezeit	H
Chart datum	CD	Kartennull, Kartendatum (Seekarten)	KN
Mean tide level	ML	Mittelwasser, Mittlerer Wasserstand	MW
Mean high water	MHW	Mittleres Hochwasser	MHW
Mean low water	MLW	Mittleres Niedrigwasser	MNW
Mean high water neaps	MHWN	Mittleres Nip-phochwasser	MNpHW
Mean low water neaps	MLWN	Mittleres Nipp-niedrigwasser	MNpNW
Mean high water springs	MHWS	Mittleres Springhochwasser	MSpHW
Mean low water springs	MLWS	Mittleres Spring-niedrigwasser	MSpNW
Lowest astronomical tide	LAT	Niedrigstmöglicher Gezeiten-wasserstand	
Low water	LW	Niedrigwasser	NW
Low water heights	LW Hts.	Niedrigwasserhöhe	NWH
Low water time	LW Time	Niedrigwasserzeit	NWZ
High water neaps	HWN	Nipphochwasser	NpHW
Low water neaps	NWN	Nippniedrigwasser	NpNW
Neap tides	Np	Nipptide	Np
Ordnance datum	OD	Normalnull	NN
Spring tides	Sp	Springgezeiten	Sp
High water springs	HWS	Springhochwasser	SpHW
Low water springs	LWS	Springniedrigwasser	SpNW
Slack water		Stauwasser	
Admiralty tide tables	ATT		

Reference

1. Deschamps L et al. (1980). Development in France of High Voltage Cables with Synthetic Insulation, Paper Cigré 21–06.