
Section K

Technical Reference

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NEC Scope

The National Electrical Code is revised approximately every three years and the NEC Code is the latest word on safety and acceptable procedures. It is a consensus standard and has therefore been adopted by OSHA.

The National Electrical Code is not a safety manual, nor a design manual; it is not law in and of itself. It is an accumulation of rules which if followed should produce a safe and reliable installation. It becomes law if adopted by individual authorities over specific jurisdictions (i.e., state, city federal construction agencies, etc.).

The NFPA Electrical Committee is organized to contain representatives from each national organization which have a legitimate interest in the NEC, to adopt orderly procedures for change.

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NEC 2002 / 1999 Cross Reference Table

<u>2002</u>	<u>1999</u>	<u>Article Title</u>
300	300	Wiring Methods
310	310	Conductors for General Wiring
312	373	Cabinets, Cutout Boxes, and Meter Socket Enclosures
314	370	Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Manholes
320	333	Armored Cable: Type AC
322	363	Flat Cable Assemblies: Type FC
324	328	Flat Conductor Cable: Type FCC
326	325	Integrated Gas Spacer Cable: Type IGS
328	326	Medium Voltage Cable: Type MV
330	334	Metal-Clad Cable: Type MC
332	330	Mineral-Insulated, Metal-Sheathed Cable: Type MI
334	336	Nonmetallic-Sheathed Cable: Types NM, NMC, and NMS
336	340	Power and Control Tray Cable: Type TC
338	338	Service-Entrance Cable: Types SE and USE
340	339	Underground Feeder and Branch-Circuit Cable: Type UF
342	345	Intermediate Metal Conduit: Type IMC
344	346	Rigid Metal Conduit: Type RMC
348	350	Flexible Metal Conduit: Type FMC
350	351 (Part A)	Liquidtight Flexible Metal Conduit: Type LFMC
352	347	Rigid Nonmetallic Conduit: Type RNC
354	343	Nonmetallic Underground Conduit with Conductors: Type NUCC
356	351 (Part B)	Liquidtight Flexible Nonmetallic Conduit: Type LFNC
358	348	Electrical Metallic Tubing: Type EMT
360	349	Flexible Metallic Tubing: Type FMT
362	331	Electrical Nonmetallic Tubing: Type ENT
366	374	Auxiliary Gutters
368	364	Busways
370	365	Cablebus
372	358	Cellular Concrete Floor Raceways
374	356	Cellular Metal Floor Raceways
376	362 (Part A)	Metal Wireways
378	362 (Part B)	Nonmetallic Wireways
380	353	Multioutlet Assembly
382	342	Nonmetallic Extensions
384	352 (Part C)	Strut-Type Channel Raceway
386	352 (Part A)	Surface Metal Raceways
388	352 (Part B)	Surface Nonmetallic Raceways
390	354	Underfloor Raceways
392	318	Cable Trays
394	324	Concealed Knob-and-Tube Wiring
396	321	Messenger Supported Wiring
398	320	Open Wiring on Insulators
404	380	Switches
406	410 (Part L)	Receptacles, Cord Connectors, and Attachment Plugs (Caps)
408	384	Switchboards and Panelboards
527	305	Temporary Installations

Technical Reference

NEC Table 392.3(A) Wiring Methods

<u>Wiring Method</u>	<u>Article</u>	<u>Section</u>
Armored cable	320	
Communication raceways	800	
Electrical metallic tubing	358	
Electrical nonmetallic tubing	362	
Fire alarm cables	760	
Flexible metal conduit.....	348	
Flexible metallic tubing	360	
Instrumentation tray cable	727	
Intermediate metal conduit	342	
Liquidtight flexible metal conduit	350	
Liquidtight flexible nonmetallic conduit	356	
Metal-clad cable	330	
Mineral-insulated, metal-sheathed cable	332	
Multiconductor service-entrance cable	338	
Multiconductor underground feeder and branch-circuit cable ..	340	
Multipurpose and communications cables	800	
Nonmetallic-sheathed cable	334	
Power and control tray cable	336	
Power-limited tray cable		725.61(C)
.....		725.71(F)
Optical fiber cables	770	
Optical fiber raceways	770	
Other factory-assembled, multiconductor control, signal, or power cables specifically approved for installation in cable trays		
Rigid metal conduit.....	344	
Rigid nonmetallic conduit	352	

NEC & CSA Designations

<u>NEC Wire Type</u>	<u>Description</u>
MV-HL	Suffix "-HL" indicates acceptable for hazardous locations
ITC	Instrumentation tray cable, several combinations for insulations and jacket compounds
MV-LS	Suffix "-LS" indicates acceptable for limited smoke applications
MC	Metal clad cable, THHN or XHHW individual conductors, aluminum or steel interlocked armor
MTW	Machine tool wire, thermoplastic insulation (PVC), with or without Nylon, 90°C, dry locations
MV-90	Medium voltage cable rated at 90°C
MV-105	Medium voltage cable rated at 105°C
PLTC	Power-limited tray cable, several combinations of insulations and jacket compounds
RHH	Rubber equivalent insulation, high heat resistant 90°C rating, dry or damp locations
RHW-2	Rubber equivalent insulation, heat resistant 90°C rating, wet locations
SF-2	Silicone insulated fixture wire, solid or 7-strand
SFF-2	Silicone insulated fixture wire, flexible strand
SIS	Flame retardant thermoset switchboard wire
TC	Tray cable, several combinations of insulation and jacket compounds, cable tray use
TFFN	Thermoplastic insulation (PVC), flexible fixture wire, 90°C, dry locations, Nylon jacket
TFN	Thermoplastic insulation (PVC), fixture wire, 90°C, dry locations, Nylon jacket
THHN	Thermoplastic insulation (PVC), high heat resistant, 90°C rating, dry or damp locations, Nylon jacket
THWN	Thermoplastic insulation (PVC), heat resistant 75°C rating, dry and wet locations, Nylon jacket
THHN-2	Thermoplastic insulation (PVC), high heat resistant 90°C rating, wet and dry locations, Nylon jacket
USE-2	Underground service entrance, cross-linked insulation, direct burial, 90°C rating
XHHW-2	Cross-linked insulation, high heat resistant 90°C rating, wet and dry locations
<u>CSA Wire Type</u>	<u>Description</u>
AC90	600 Volt XLPE insulation aluminum or steel interlocked armored cable
ACIC	300 or 600 Volt armored instrument and control cable. A CSA type designation used to describe armored instrumentation and control cable. Available in either 300 Volt or 600 Volt with thermoset or thermoplastic insulation, this cable can be supplied with an overall shield, shielded pairs, shielded triads or unshielded in multi-conductor constructions from 2 to 72 conductors. The overall interlocked armor and PVC jacket provide a (-40°C), HL, FT4 product (CDS reference standard C22.2 No. 239)
ACWU90 (-40°C)	600 Volt XLPE insulation aluminum or steel interlocked armored cable with PVC jacket
HL	Designation for hazardous locations (CSA STD C22.2 NO174)
NMD90	300 Volt non-metallic sheath cable with XLPE or PVC/Nylon insulation
NMWU	300 Volt non-metallic sheath cable with PVC insulation
RA90 (-40°C)	600 and 5000 Volt single and multiple conductor with seamless corrugated aluminum armor. A CSA type designation for single conductor of multi-conductor constructions similar to AC90 and ACWU90 except no bonding (grounding) conductor is required in the cable assembly. Also, the armor is a corrugated aluminum sheath that serves as a bonding (grounding) conductor. The overall PVC covering on RA90 is required for wet or direct burial applications (CSA reference standard C22.2 No. 123)
RW90 XLPE (-40°C)	600 and 5000 Volt thermoset insulation 90°C wet or dry locations
RWU90 XLPE (-40°C)	600 and 1000 Volt thermoset insulation 90°C direct burial
SEW-2	600 Volt silicone rubber insulated equipment wire solid or 7-strand
SEWF-2	600 Volt silicone rubber insulated equipment wire with flexible strand
TECK90 (-40°C)	600 and 5000 Volt single and multiple conductor cable with inner jacket, aluminum or steel interlocked armor with PVC jacket
TC	Tray cable certified for use in Class I Division 2 areas
TW75	600 Volt thermoplastic (PVC) insulated cable suitable for wet locations
TWU (-40°C)	600 Volt thermoplastic (PVC) insulated cable suitable for direct burial

Ampacity Calculations

Houston Wire & Cable Company recommends that wire and cable ampacities be determined using the latest NEC tables and text. In particular, attention should be given to Articles 310, 392, 400-5 (flexible cords), and 501-4 Class I, II and III, Divisions 1 and 2 hazardous locations. Remember to use the “Ampacity Correction Factors” when the Ambient Temperature is different than those indicated in the Tables. Also, derating is required when using more than three conductors in a Raceway or Cable. Appendix B also contains helpful tables for Ampacity.

ARTICLE 310: Conductors for General Wiring

NEC Table 310.15(B)(2)(a)

Table 310.15(B)(2)(a) Adjustment Factors for More Than Three Current-Carrying Conductors in a Raceway or Cable

Number of Current-Carrying Conductors	Percent of Values in Tables 310.16 through 310.19 as Adjusted for Ambient Temperature if Necessary
4-6	80
7-9	70
10-20	50
21-30	45
31-40	40
40 and above	35

ARTICLE 310: Conductors for General Wiring

NEC Table 310.16

Table 310.16 Allowable Ampacities of Insulated Conductors Rated 0 Through 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Size AWG or kcmil	Temperature Rating of Conductor						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14*	20	20	25	—	—	—	—
12*	25	25	30	20	20	25	12*
10*	30	35	40	25	30	35	10*
8	40	50	55	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	150	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	190	230	255	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	355	420	475	285	340	385	600
700	385	460	520	310	375	420	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	450	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	520	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	560	665	750	470	560	630	2000

CORRECTION FACTORS

Ambient Temp. (°C)	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. (°F)
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	123-131
56-60	—	0.58	0.71	—	0.58	0.71	132-140
61-70	—	0.33	0.58	—	0.33	0.58	141-158
71-80	—	—	0.41	—	—	0.41	159-176

* **Small Conductors.** Unless specifically permitted in 240.4(E) through (G), the overcurrent protection shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

ARTICLE 310: Conductors for General Wiring

NEC Table 310.17

Table 310.17 Allowable Ampacities of Single-Insulated Conductors Rated 0 Through 2000 Volts in Free Air, Based on Ambient Air Temperature of 30°C (86°F)

Size AWG or kcmil	Temperature Rating of Conductor						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	18	—	—	—	—
16	—	—	24	—	—	—	—
14*	25	30	35	—	—	—	—
12*	30	35	40	25	30	35	12*
10*	40	50	55	35	40	40	10*
8	60	70	80	45	55	60	8
6	80	95	105	60	75	80	6
4	105	125	140	80	100	110	4
3	120	145	165	95	115	130	3
2	140	170	190	110	135	150	2
1	165	195	220	130	155	175	1
1/0	195	230	260	150	180	205	1/0
2/0	225	265	300	175	210	235	2/0
3/0	260	310	350	200	240	275	3/0
4/0	300	360	405	235	280	315	4/0
250	340	405	455	265	315	355	250
300	375	445	505	290	350	395	300
350	420	505	570	330	395	445	350
400	455	545	615	355	425	480	400
500	515	620	700	405	485	545	500
600	575	690	780	455	540	615	600
700	630	755	855	500	595	675	700
750	655	785	885	515	620	700	750
800	680	815	920	535	645	725	800
900	730	870	985	580	700	785	900
1000	780	935	1055	625	750	845	1000
1250	890	1065	1200	710	855	960	1250
1500	980	1175	1325	795	950	1075	1500
1750	1070	1280	1445	875	1050	1185	1750
2000	1155	1385	1560	960	1150	1335	2000

CORRECTION FACTORS

Ambient Temp. (°C)	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. (°F)
21-25	1.081	.051	.041	.081	.051	0.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	123-131
56-60	—	0.58	0.71	—	0.58	0.71	132-140
61-70	—	0.33	0.58	—	0.33	0.58	141-158
71-80	—	—	0.41	—	—	0.41	159-176

* **Small Conductors.** Unless specifically permitted in 240.4(E) through (G), the overcurrent protection shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Table 310.18

Table 310.18 Allowable Ampacities of Insulated Conductors Rated 0 Through 2000 Volts, 150°C Through 250°C (302°F Through 482°F). Not More Than Three Current-Carrying Conductors in Raceway or Cable, Based on Ambient Air Temperature of 40°C (104°F)

Size AWG or kcmil	Temperature Rating of Conductor				Size AWG or kcmil
	150°C (302°F)	200°C (392°F)	250°C (482°F)	150°C (302°F)	
	Type Z	Types FEP, FEPB, PFA	Types PFAH, TFE	Type Z	
	COPPER		NICKEL OR NICKEL-COATED COPPER	ALUMINUM OR COPPER-CLAD ALUMINUM	
14	34	36	39	—	14
12	43	45	54	30	12
10	55	60	73	44	10
8	76	83	93	57	8
6	96	110	117	75	6
4	120	125	148	94	4
3	143	152	166	109	3
2	160	171	191	124	2
1	186	197	215	145	1
1/0	215	229	244	169	1/0
2/0	251	260	273	198	2/0
3/0	288	297	308	227	3/0
4/0	332	346	361	260	4/0

CORRECTION FACTORS

Ambient Temp. (°C)	For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities shown above by the appropriate factor shown below.				Ambient Temp. (°F)
41-50	0.95	0.97	0.98	0.95	105-122
51-60	0.90	0.94	0.95	0.90	123-140
61-70	0.85	0.90	0.93	0.85	141-158
71-80	0.80	0.87	0.90	0.80	159-176
81-90	0.74	0.83	0.87	0.74	177-194
91-100	0.67	0.79	0.85	0.67	195-212
101-120	0.52	0.71	0.79	0.52	213-248
121-140	0.30	0.61	0.72	0.30	249-284
141-160	—	0.50	0.65	—	285-320
161-180	—	0.35	0.58	—	321-356
181-200	—	—	0.49	—	357-392
201-225	—	—	0.35	—	393-437

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Table 310.19

Table 310.19 Allowable Ampacities of Single-Insulated Conductors, Rated 0 Through 2000 Volts, 150°C Through 250°C (302°F Through 482°F), in Free Air, Based on Ambient Air Temperature of 40°C (104°F).

Size AWG or kcmil	Temperature Rating of Conductor				Size AWG or kcmil
	150°C (302°F)	200°C (392°F)	250°C (482°F)	150°C (302°F)	
	Type Z	Types FEP, FEPB, PFA	Types PFAH, TFE	Type Z	
	COPPER		NICKEL OR NICKEL-COATED COPPER	ALUMINUM OR COPPER-CLAD ALUMINUM	
14	46	54	59	—	14
12	60	68	78	47	12
10	80	90	107	63	10
8	106	124	142	83	8
6	155	165	205	112	6
4	190	220	278	148	4
3	214	252	327	170	3
2	255	293	381	198	2
1	293	344	440	228	1
1/0	339	399	532	263	1/0
2/0	390	467	591	305	2/0
3/0	451	546	708	351	3/0
4/0	529	629	830	411	4/0

CORRECTION FACTORS

Ambient Temp. (°C)	For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities shown above by the appropriate factor shown below.				Ambient Temp. (°F)
41-50	0.95	0.97	0.98	0.95	105-122
51-60	0.90	0.94	0.95	0.90	123-140
61-70	0.85	0.90	0.93	0.85	141-158
71-80	0.80	0.87	0.90	0.80	159-176
81-90	0.74	0.83	0.87	0.74	177-194
91-100	0.67	0.79	0.85	0.67	195-212
101-120	0.52	0.71	0.79	0.52	213-248
121-140	0.30	0.61	0.72	0.30	249-284
141-160	—	0.50	0.65	—	285-320
161-180	—	0.35	0.58	—	321-356
181-200	—	—	0.49	—	357-392
201-225	—	—	0.35	—	393-437

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Table 310.20

Table 310.20 Ampacities of Not More Than Three Single Insulated Conductors, Rated 0 Through 2000 Volts, Supported on a Messenger, Based on Ambient Air Temperature of 40°C (104°F)

Size AWG or kcmil	Temperature Rating of Conductor				Size AWG or kcmil
	75°C (167°F)	90°C (194°F)	75°C (167°F)	90°C (194°F)	
	Types RHW, THHW, THW, THWN, XHHW, ZW	Types MI, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHHW, XHHW-2, ZW-2	Types RHW, THW, THWN, THHW, XHHW	Types THHN, THHW, RHH, XHHW, RHW-2, XHHW-2, THW-2, THWN-2, USE-2, ZW-2	
	COPPER		ALUMINUM OR COPPER-CLAD ALUMINUM		
8	57	66	44	51	8
6	76	89	59	69	6
4	101	117	78	91	4
3	118	138	92	107	3
2	135	158	106	123	2
1	158	185	123	144	1
1/0	183	214	143	167	1/0
2/0	212	247	165	193	2/0
3/0	245	287	192	224	3/0
4/0	287	335	224	262	4/0
250	320	374	251	292	250
300	359	419	282	328	300
350	397	464	312	364	350
400	430	503	339	395	400
500	496	580	392	458	500
600	553	647	440	514	600
700	610	714	488	570	700
750	638	747	512	598	750
800	660	773	532	622	800
900	704	826	572	669	900
1000	748	879	612	716	1000

CORRECTION FACTORS

Ambient Temp. (°C)	For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities shown above by the appropriate factor shown below.				Ambient Temp. (°F)
21-25	1.20	1.14	1.20	1.14	70-77
26-30	1.13	1.10	1.13	1.10	79-86
31-35	1.07	1.05	1.07	1.05	88-95
36-40	1.00	1.00	1.00	1.00	97-104
41-45	0.93	0.95	0.93	0.95	106-113
46-50	0.85	0.89	0.85	0.89	115-122
51-55	0.76	0.84	0.76	0.84	124-131
56-60	0.65	0.77	0.65	0.77	133-140
61-70	0.38	0.63	0.38	0.63	142-158
71-80	—	0.45	—	0.45	160-176

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Table 310.21

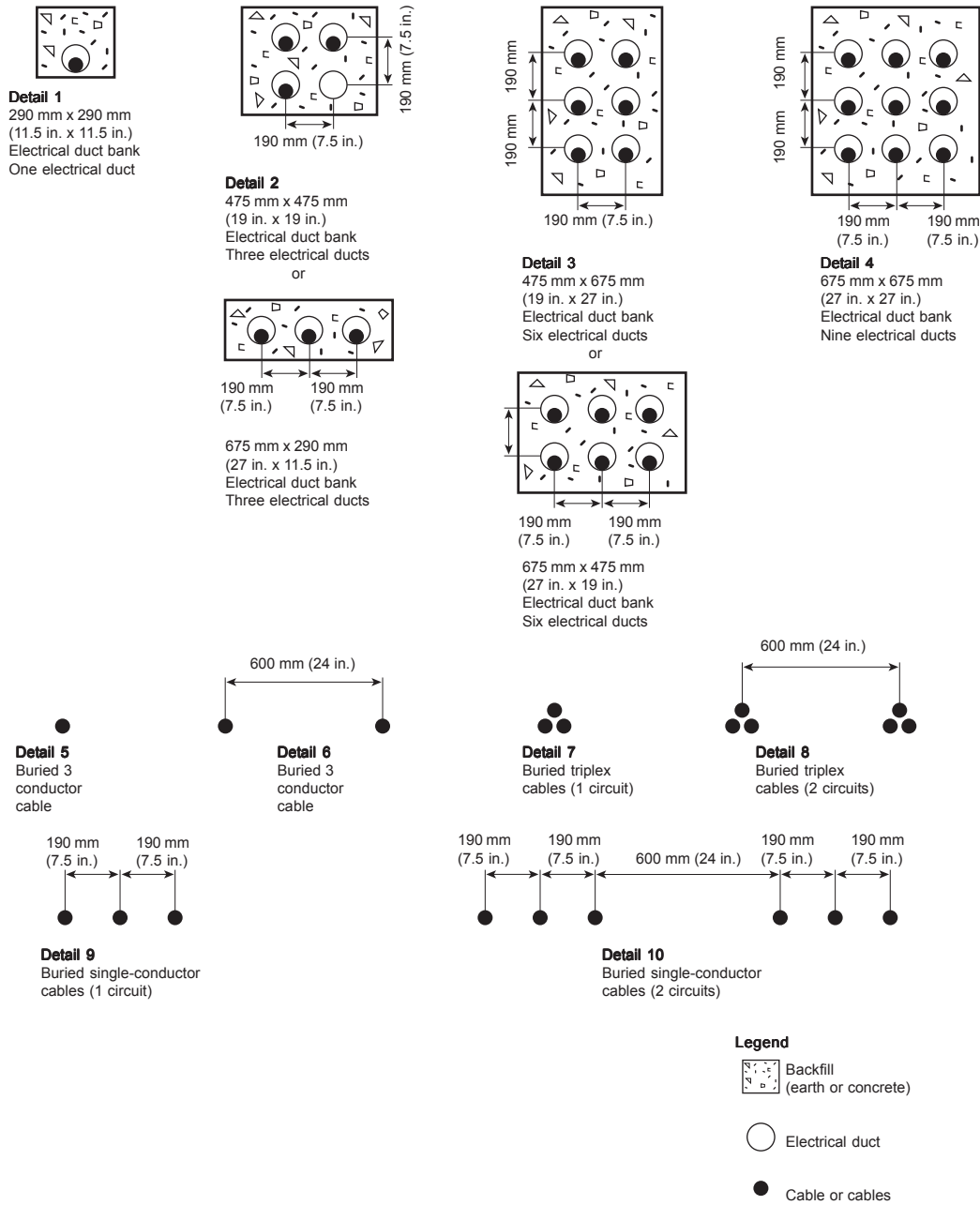
Table 310.21 Ampacities of Bare or Covered Conductors in Free Air, Based on 40°C (104°F) Ambient, 80°C (176°F) Total Conductor Temperature, 610 mm/sec (2 ft/sec) Wind Velocity

Copper Conductors			
Bare		Covered	
AWG or kcmil	Amperes	AWG or kcmil	Amperes
8	98	8	103
6	124	6	130
4	155	4	163
2	209	2	219
1/0	282	1/0	297
2/0	329	2/0	344
3/0	382	3/0	401
4/0	444	4/0	466
250	494	250	519
300	556	300	584
500	773	500	812
750	1000	750	1050
1000	1193	1000	1253

ARTICLE 310: Conductors for General Wiring

NEC Figure 310.60

Figure 310.60. Cable installation dimensions for use with Tables 310.77 through 310.86.



ARTICLE 310: Conductors for General Wiring

NEC Table 310.64

Table 310.64 Thickness of Insulation for Shielded Solid Dielectric Insulated Conductors Rated 2001 to 35,000 Volts

Conductor Size (AWG or kcmil)	2001 – 5000 Volts		5001 – 8000 Volts				8001 – 15,000 Volts				15,001 – 25,000 Volts				25,001 – 28,000 Volts				28,001 – 35,000 Volts			
			100 Percent Insulation Level 1		133 Percent Insulation Level 2		100 Percent Insulation Level 1		133 Percent Insulation Level 2		100 Percent Insulation Level 1		133 Percent Insulation Level 2		100 Percent Insulation Level 1		133 Percent Insulation Level 2		100 Percent Insulation Level 1		133 Percent Insulation Level 2	
	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils
8	2.29	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6-4	2.29	90	2.92	115	3.56	140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	2.29	90	2.92	115	3.56	140	4.45	175	5.46	215	—	—	—	—	—	—	—	—	—	—	—	—
1	2.29	90	2.92	115	3.56	140	4.45	175	5.46	215	6.60	260	8.76	345	7.11	280	8.76	345	—	—	—	—
1/0-2000	2.29	90	2.92	115	3.56	140	4.45	175	5.46	215	6.60	260	8.76	345	7.11	280	8.76	345	8.76	345	10.67	420

¹ **100 Percent Insulation Level.** Cables in this category shall be permitted to be applied where the system is provided with relay protection such that ground faults will be cleared as rapidly as possible but, in any case, within 1 minute. While these cables are applicable to the great majority of cable installations that are on grounded systems, they shall be permitted to be used also on other systems for which the application of cables is acceptable, provided the above clearing requirements are met in completely de-energizing the faulted section.

² **133 Percent Insulation Level.** This insulation level corresponds to that formerly designated for ungrounded systems. Cables in this category shall be permitted to be applied in situations where the clearing time requirements of the 100 percent level category cannot be met and yet there is adequate assurance that the faulted section will be de-energized in a time not exceeding 1 hour. Also, they shall be permitted to be used where additional insulation strength over the 100 percent level category is desirable.

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Tables 310.67 and 310.69

Table 310.67 Ampacities of Insulated Single Copper Conductor Cables Triplexed in Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	65	74	—	—
6	90	99	100	110
4	120	130	130	140
2	160	175	170	195
1	185	205	195	225
1/0	215	240	225	255
2/0	250	275	260	295
3/0	290	320	300	340
4/0	335	375	345	390
250	375	415	380	430
350	465	515	470	525
500	580	645	580	650
750	750	835	730	820
1000	880	980	850	950

Table 310.69 Ampacities of Insulated Single Copper Conductor Isolated in Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor					
	2001 – 5000 Volts Ampacity		5001 – 15,000 Volts Ampacity		15,001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	83	93	—	—	—	—
6	110	120	110	125	—	—
4	145	160	150	165	—	—
2	190	215	195	215	—	—
1	225	250	225	250	225	250
1/0	260	290	260	290	260	290
2/0	300	330	300	335	300	330
3/0	345	385	345	385	345	380
4/0	400	445	400	445	395	445
250	445	495	445	495	440	490
350	550	615	550	610	545	605
500	695	775	685	765	680	755
750	900	1000	885	990	870	970
1000	1075	1200	1060	1185	1040	1160
1250	1230	1370	1210	1350	1185	1320
1500	1365	1525	1345	1500	1315	1465
1750	1495	1665	1470	1640	1430	1595
2000	1605	1790	1575	1755	1535	1710

ARTICLE 310: Conductors for General Wiring

NEC Tables 310.71, 310.73 and 310.75

Table 310.71 Ampacities of an Insulated Three-Conductor Copper Cable Isolated in Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	59	66	—	—
6	79	88	93	105
4	105	115	120	135
2	140	154	165	185
1	160	180	185	210
1/0	185	205	215	240
2/0	215	240	245	275
3/0	250	280	285	315
4/0	285	320	325	360
250	320	355	360	400
350	395	440	435	490
500	485	545	535	600
750	615	685	670	745
1000	705	790	770	860

Table 310.73 Ampacities of an Insulated Triplexed or Three Single-Conductor Copper Cables in Isolated Conduit in Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	55	61	—	—
6	75	84	83	93
4	97	110	110	120
2	130	145	150	165
1	155	175	170	190
1/0	180	200	195	215
2/0	205	225	225	255
3/0	240	270	260	290
4/0	280	305	295	330
250	315	355	330	365
350	385	430	395	440
500	475	530	480	535
750	600	665	585	655
1000	690	770	675	755

Table 310.75 Ampacities of an Insulated Three-Conductor Copper Cable in Isolated Conduit in Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	52	58	—	—
6	69	77	83	92
4	91	100	105	120
2	125	135	145	165
1	140	155	165	185
1/0	165	185	195	215
2/0	190	210	220	245
3/0	220	245	250	280
4/0	255	285	290	320
250	280	315	315	350
350	350	390	385	430
500	425	475	470	525
750	525	585	570	635
1000	590	660	650	725

ARTICLE 310: Conductors for General Wiring

NEC Table 310.77 and 310.79

Table 310.77 Ampacities of Three Single-Insulated Copper Conductors in Underground Electrical Ducts (Three Conductors per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure 310.60, 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit (See Figure 310.60, Detail 1.)				
8	64	69	—	—
6	85	92	90	97
4	110	120	115	125
2	145	155	155	165
1	170	180	175	185
1/0	195	210	200	215
2/0	220	235	230	245
3/0	250	270	260	275
4/0	290	310	295	315
250	320	345	325	345
350	385	415	390	415
500	470	505	465	500
750	585	630	565	610
1000	670	720	640	690
Three Circuits (See Figure 310.60, Detail 2.)				
8	56	60	—	—
6	73	79	77	83
4	95	100	99	105
2	125	130	130	135
1	140	150	145	155
1/0	160	175	165	175
2/0	185	195	185	200
3/0	210	225	210	225
4/0	235	255	240	255
250	260	280	260	280
350	315	335	310	330
500	375	405	370	395
750	460	495	440	475
1000	525	565	495	535
Six Circuits (See Figure 310.60, Detail 3.)				
8	48	52	—	—
6	62	67	64	68
4	80	86	82	88
2	105	110	105	115
1	115	125	120	125
1/0	135	145	135	145
2/0	150	160	150	165
3/0	170	185	170	185
4/0	195	210	190	205
250	210	225	210	225
350	250	270	245	265
500	300	325	290	310
750	365	395	350	375
1000	410	445	390	415

Table 310.79 Ampacities of Three Insulated Copper Conductors Cabled Within an Overall Covering (Three-Conductor Cable) in Underground Electrical Ducts (One Cable per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure 310.60, 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°C)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit (See Figure 310.60, Detail 1.)				
8	59	64	—	—
6	78	84	88	95
4	100	110	115	125
2	135	145	150	160
1	155	165	170	185
1/0	175	190	195	210
2/0	200	220	220	235
3/0	230	250	250	270
4/0	265	285	285	305
250	290	315	310	335
350	355	380	375	400
500	430	460	450	485
750	530	570	545	585
1000	600	645	615	660
Three Circuits (See Figure 310.60, Detail 2.)				
8	53	57	—	—
6	69	74	75	81
4	89	96	97	105
2	115	125	125	135
1	135	145	140	155
1/0	150	165	160	175
2/0	170	185	185	195
3/0	195	210	205	220
4/0	225	240	230	250
250	245	265	255	270
350	295	315	305	325
500	355	380	360	385
750	430	465	430	465
1000	485	520	485	515
Six Circuits (See Figure 310.60, Detail 3.)				
8	46	50	—	—
6	60	65	63	68
4	77	83	81	87
2	98	105	105	110
1	110	120	115	125
1/0	125	135	130	145
2/0	145	155	150	160
3/0	165	175	170	180
4/0	185	200	190	200
250	200	220	205	220
350	240	270	245	275
500	290	310	290	305
750	350	375	340	365
1000	390	420	380	405

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Table 310.81 and 310.83

Table 310.81 Ampacities of Single Insulated Copper Conductors Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 310.60, 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°C)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit, Three Conductors (See Figure 310.60, Detail 9.)				
8	110	115	—	—
6	140	150	130	140
4	180	195	170	180
2	230	250	210	225
1	260	280	240	260
1/0	295	320	275	295
2/0	335	365	310	335
3/0	385	415	355	380
4/0	435	465	405	435
250	470	510	440	475
350	570	615	535	575
500	690	745	650	700
750	845	910	805	865
1000	980	1055	930	1005
Two Circuits, Six Conductors (See Figure 310.60, Detail 10.)				
8	100	110	—	—
6	130	140	120	130
4	165	180	160	170
2	215	230	195	210
1	240	260	225	240
1/0	275	295	255	275
2/0	310	335	290	315
3/0	355	380	330	355
4/0	400	430	375	405
250	435	470	410	440
350	520	560	495	530
500	630	680	600	645
750	775	835	740	795
1000	890	960	855	920

Table 310.83 Ampacities of Three Insulated Copper Conductors Cabled Within an Overall Covering (Three-Conductor Cable), Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 310.60, 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit (See Figure 310.60, Detail 5.)				
8	85	89	—	—
6	105	115	115	120
4	135	150	145	155
2	180	190	185	200
1	200	215	210	225
1/0	230	245	240	255
2/0	260	280	270	290
3/0	295	320	305	330
4/0	335	360	350	375
250	365	395	380	410
350	440	475	460	495
500	530	570	550	590
750	650	700	665	720
1000	730	785	750	810
Two Circuits (See Figure 310.60, Detail 10.)				
8	80	84	—	—
6	100	105	105	115
4	130	140	135	145
2	165	180	170	185
1	185	200	195	210
1/0	215	230	220	235
2/0	240	260	250	270
3/0	275	295	280	305
4/0	310	335	320	345
250	340	365	350	375
350	410	440	420	450
500	490	525	500	535
750	595	640	605	650
1000	665	715	675	730

Technical Reference

ARTICLE 310: Conductors for General Wiring

NEC Table 310.85

Table 310.85 Ampacities of Three Triplexed Single Insulated Copper Conductors Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 310.60, 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures 90°C (194°F) and 105°C (221°F)

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor			
	2001 – 5000 Volts Ampacity		5001 – 35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit, Three Conductors (See Figure 310.60, Detail 7.)				
8	90	95	—	—
6	120	130	115	120
4	150	165	150	160
2	195	205	190	205
1	225	240	215	230
1/0	255	270	245	260
2/0	290	310	275	295
3/0	330	360	315	340
4/0	375	405	360	385
250	410	445	390	410
350	490	580	470	505
500	590	635	565	605
750	725	780	685	740
1000	825	885	770	830
Two Circuits, Six Conductors (See Figure 310.60, Detail 8.)				
8	85	90	—	—
6	110	115	105	115
4	140	150	140	150
2	180	195	175	190
1	205	220	200	215
1/0	235	250	225	240
2/0	265	285	255	275
3/0	300	320	290	315
4/0	340	365	325	350
250	370	395	355	380
350	445	480	425	455
500	535	575	510	545
750	650	700	615	660
1000	740	795	690	745

ARTICLE 400: Flexible Cords and Cables

NEC Table 400.5(B)

Table 400.5(B) Ampacity of Cable Types SC, SCE, SCT, PPE, G, G-GC, and W. [Based on Ambient Temperature of 30°C (86°F).]

Size (AWG or kcmil)	60°C (140°F)			75°C (167°F)			90°C (194°F)		
	D ¹	E ²	F ³	D ¹	E ²	F ³	D ¹	E ²	F ³
12	—	31	26	—	37	31	—	42	35
10	—	44	37	—	52	43	—	59	49
8	60	55	48	70	65	57	80	74	65
6	80	72	63	95	88	77	105	99	87
4	105	96	84	125	115	101	140	130	114
3	120	113	99	145	135	118	165	152	133
2	140	128	112	170	152	133	190	174	152
1	165	150	131	195	178	156	220	202	177
1/0	195	173	151	230	207	181	260	234	205
2/0	225	199	174	265	238	208	300	271	237
3/0	260	230	201	310	275	241	350	313	274
4/0	300	265	232	360	317	277	405	361	316
250	340	296	259	405	354	310	455	402	352
300	375	330	289	445	395	346	505	449	393
350	420	363	318	505	435	381	570	495	433
400	455	392	343	545	469	410	615	535	468
500	515	448	392	620	537	470	700	613	536
600	575	—	—	690	—	—	780	—	—
700	630	—	—	755	—	—	855	—	—
750	655	—	—	785	—	—	885	—	—
800	680	—	—	815	—	—	920	—	—
900	730	—	—	870	—	—	985	—	—
1000	780	—	—	935	—	—	1055	—	—

¹The ampacities under subheading D shall be permitted for single-conductor Types SC, SCE, SCT, PPE, and W cable only where the individual conductors are not installed in raceways and are not in physical contact with each other except in lengths not to exceed 600 mm (24 in.) where passing through the wall of an enclosure.

²The ampacities under subheading E apply to two-conductor cables and other multiconductor cables connected to utilization equipment so that only two conductors are current carrying.

³The ampacities under subheading F apply to three-conductor cables and other multiconductor cables connected to utilization equipment so that only three conductors are current carrying.

ARTICLE 400: Flexible Cords and Cables NEC Tables 400.5 and 400.5(A)

Table 400.5 Adjustment Factors for More Than Three Current-Carrying Conductors in a Flexible Cord or Cable

Number of Conductors	Percent of Value in Tables 400.5(A) and 400.5(B)
4 – 6	80
7 – 9	70
10 – 20	50
21 – 30	45
31 – 40	40
41 and above	35

Table 400.5(A) Allowable Ampacity for Flexible Cords and Cables [Based on Ambient Temperature of 30°C (86°F). See 400.13.]

Size (AWG)	Thermoplastic Types TPT, TST	Thermoset Types C, E, EO, PD, S, SJ, SJO, SJOW, SJOO, SJOOW, SO, SOW, SOO, SOOW, SP-1, SP-2, SP-3, SRD, SV, SVO, SVOO		Types HPD, HPN, HSJ, HSJO, HSJOO
		A+	B+	
27*	0.5	—	—	—
20	—	5**	***	—
18	—	7	10	10
17	—	—	12	13
16	—	10	13	15
15	—	—	—	17
14	—	15	18	20
12	—	20	25	30
10	—	25	30	35
8	—	35	40	—
6	—	45	55	—
4	—	60	70	—
2	—	80	95	—

*Tinsel cord.

**Elevator cables only.

***7 amperes for elevator cables only; 2 amperes for other types.

+The allowable currents under subheading A apply to 3-conductor cords and other multiconductor cords connected to utilization equipment so that only 3 conductors are current-carrying. The allowable currents under subheading B apply to 2-conductor cords and other multiconductor cords connected to utilization equipment so that only 2 conductors are current carrying.

ARTICLE 402: Fixture Wires
NEC Table 402.5

Table 402.5 Allowable Ampacity for Fixture Wires

Size (AWG)	Allowable Ampacity
18	6
16	8
14	17
12	23
10	28

ANNEX B: Application Information for Ampacity Calculation Items B.310.15(B)(1) through B.310.15(B)(7)

B.310.15(B)(1) Formula Application Information. This annex provides application information for ampacities calculated under engineering supervision.

B.310.15(B)(2) Typical Applications Covered by Tables. Typical ampacities for conductors rated 0 through 2000 volts are shown in Table B.310.1 through Table B.310.10. Underground electrical duct bank configurations, as detailed in Figure B.310.3, Figure B.310.4, and Figure B.310.5, are utilized for conductors rated 0 through 5000 volts. In Figure B.310.2 through Figure B.310.5, where adjacent duct banks are used, a separation of 1.5 m (5 ft) between the centerlines of the closest ducts in each bank or 1.2 m (4 ft) between the extremities of the concrete envelopes is sufficient to prevent derating of the conductors due to mutual heating. These ampacities were calculated as detailed in the basic ampacity paper, AIEE Paper 57-660, *The Calculation of the Temperature Rise and Load Capability of Cable Systems*, by J. H. Neher and M. H. McGrath. For additional information concerning the application of these ampacities, see IEEE/ICEA Standard S-135/P-46-426, *Power Cable Ampacities*, and IEEE Standard 835-1994, *Standard Power Cable Ampacity Tables*.

Typical values of thermal resistivity (Rho) are as follows:

Average soil (90 percent of USA) = 90

Concrete = 55

Damp soil (coastal areas, high water table) = 60

Paper insulation = 550

Polyethylene (PE) = 450

Polyvinyl chloride (PVC) = 650

Rubber and rubber-like = 500

Very dry soil (rocky or sandy) = 120

Thermal resistivity, as used in this annex, refers to the heat transfer capability through a substance by conduction. It is the reciprocal of thermal conductivity and is normally expressed in the units °C-cm/watt. For additional information on determining soil thermal resistivity (Rho), see ANSI/IEEE Standard 442-1996, *Guide for Soil Thermal Resistivity Measurements*.

B.310.15(B)(3) Criteria Modifications. Where values of load factor and Rho are known for a particular electrical duct bank installation and they are different from those shown in a specific table or figure, the ampacities shown in the table or figure can be modified by the application of factors derived from the use of Figure B.310.1.

Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity can be used beyond the point of transition, a distance equal to 3 m (10 ft) or 10 percent of the circuit length figured at the higher ampacity, whichever is less.

The information given in B.310.15(B)(3) is the same as that found in the exception to 310.15(A)(2). See the commentary following that exception.

Where the burial depth of direct burial or electrical duct bank circuits are modified from the values shown in a figure or table, ampacities can be modified as shown in (a) and (b) as follows.

(a) Where burial depths are increased in part(s) of an electrical duct run to avoid underground obstructions, no

decrease in ampacity of the conductors is needed, provided the total length of parts of the duct run increased in depth to avoid obstructions is less than 25 percent of the total run length.

(b) Where burial depths are deeper than shown in a specific underground ampacity table or figure, an ampacity derating factor of 6 percent per increased 300 mm (foot) of depth for all values of Rho can be utilized. No rating change is needed where the burial depth is decreased.

B.310.15(B)(4) Electrical Ducts. The term electrical duct(s) is defined in 310.60.

B.310.15(B)(5) Tables B.310.6 and B.310.7.

(a) To obtain the ampacity of cables installed in two electrical ducts in one horizontal row with 190-mm (7.5-in.) center-to-center spacing between electrical ducts, similar to Figure B.310.2, Detail 1, multiply the ampacity shown for one duct in Table B.310.6 and Table B.310.7 by 0.88.

(b) To obtain the ampacity of cables installed in four electrical ducts in one horizontal row with 190-mm (7.5-in.) center-to-center spacing between electrical ducts, similar to Figure B.310.2, Detail 2, multiply the ampacity shown for three electrical ducts in Table B.310.6 and Table B.310.7 by 0.94.

B.310.15(B)(6) Electrical Ducts Used in Figure B.310.2. If spacing between electrical ducts, as shown in Figure B.310.2, is less than specified in Figure B.310.2, where electrical ducts enter equipment enclosures from underground, the ampacity of conductors contained within such electrical ducts need not be reduced.

B.310.15(B)(7) Examples Showing Use of Figure B.310.1 for Electrical Duct Bank Ampacity Modifications. Figure B.310.1 is used for interpolation or extrapolation for values of Rho and load factor for cables installed in electrical ducts. The upper family of curves shows the variation in ampacity and Rho at unity load factor in terms of I_1 , the ampacity for Rho = 60, and 50 percent load factor. Each curve is designated for a particular ratio I_2/I_1 , where I_2 is the ampacity at Rho = 120 and 100 percent load factor.

The lower family of curves shows the relationship between Rho and load factor that will give substantially the same ampacity as the indicated value of Rho at 100 percent load factor.

As an example, to find the ampacity of a 500 kcmil copper cable circuit for six electrical ducts as shown in Table B.310.5: At the Rho = 60, LF = 50, $I_1 = 583$; for Rho = 120 and LF = 100, $I_2 = 400$. The ratio $I_2/I_1 = 0.686$. Locate Rho = 90 at the bottom of the chart and follow the 90 Rho line to the intersection with 100 percent load factor where the equivalent Rho = 90. Then follow the 90 Rho line to I_2/I_1 ratio of 0.686 where $F = 0.74$. The desired ampacity = $0.74 \times 583 = 431$, which agrees with the table for Rho = 90, LF = 100.

To determine the ampacity for the same circuit where Rho = 80 and LF = 75, using Figure B.310.1, the equivalent Rho = 43, $F = 0.855$, and the desired ampacity = $0.855 \times 583 = 498$ amperes.

ANNEX B: Application Information for Ampacity Calculation

Tables B.310.1 and B.310.3

Table B.310.1 Ampacities of Two or Three Insulated Conductors, Rated 0 Through 2000 Volts, Within an Overall Covering (Multiconductor Cable), in Raceway in Free Air Based on Ambient Air Temperature of 30°C (86°F)

Size (AWG or kcmil)	Temperature Rating of Conductor.						Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHH, THHW, THW, THWN, XHHW, ZW	Types THHN, THHW, THW-2, THWN-2, RHH, RWH-2, USE-2, XHHW, XHHW-2, ZW-2	Type TW	Types RHW, THHW, THW, THWN, XHHW	Types RHW, THHW, THW, THWN, XHHW, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
14	16*	18*	21*	—	—	—	14
12	20*	24*	27*	16*	18*	21*	12
10	27*	33*	36*	21*	25*	28*	10
8	36	43	48	28	33	37	8
6	48	58	65	38	45	51	6
4	66	79	89	51	61	69	4
3	76	90	102	59	70	79	3
2	88	105	119	69	83	93	2
1	102	121	137	80	95	106	1
1/0	121	145	163	94	113	127	1/0
2/0	138	166	186	108	129	146	2/0
3/0	158	189	214	124	147	167	3/0
4/0	187	223	253	147	176	197	4/0
250	205	245	276	160	192	217	250
300	234	281	317	185	221	250	300
350	255	305	345	202	242	273	350
400	274	328	371	218	261	295	400
500	315	378	427	254	303	342	500
600	343	413	468	279	335	378	600
700	376	452	514	310	371	420	700
750	387	466	529	321	384	435	750
800	397	479	543	331	397	450	800
900	415	500	570	350	421	477	900
1000	448	542	617	382	460	521	1000

Correction Factors

Ambient Temp. (°C)	For ambient temperatures other than 30°C (86°F), multiply the ampacities shown above by the appropriate factor shown below.						Ambient Temp. (°F)
21–25	1.08	1.05	1.04	1.08	1.05	1.04	70–77
26–30	1.00	1.00	1.00	1.00	1.00	1.00	79–86
31–35	0.91	0.94	0.96	0.91	0.94	0.96	88–95
36–40	0.82	0.88	0.91	0.82	0.88	0.91	97–104
41–45	0.71	0.82	0.87	0.71	0.82	0.87	106–113
46–50	0.58	0.75	0.82	0.58	0.75	0.82	115–122
51–55	0.41	0.67	0.76	0.41	0.67	0.76	124–131
56–60	—	0.58	0.71	—	0.58	0.71	133–140
61–70	—	0.33	0.58	—	0.33	0.58	142–158
71–80	—	—	0.41	—	—	0.41	160–176

*Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for these conductor types shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 AWG amperes for 10 AWG aluminum and copper-clad aluminum.

Table B.310.3 Ampacities of Multiconductor Cables with Not More Than Three Insulated Conductors, Rated 0 Through 2000 Volts, in Free Air Based on Ambient Air Temperature of 40°C (104°F) (For Types TC, MC, MI, UF, and USE Cables)

Size (AWG or kcmil)	Temperature Rating of Conductor.								Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
18	—	—	—	11*	—	—	—	—	18
16	—	—	—	16*	—	—	—	—	16
14	18*	21*	24*	25*	—	—	—	—	14
12	21*	28*	30*	32*	18*	21*	24*	25*	12
10	28*	36*	41*	43*	21*	28*	30*	32*	10
8	39	50	56	59	30	39	44	46	8
6	52	68	75	79	41	53	59	61	6
4	69	89	100	104	54	70	78	81	4
3	81	104	116	121	63	81	91	95	3
2	92	118	132	138	72	92	103	108	2
1	107	138	154	161	84	108	120	126	1
1/0	124	160	178	186	97	125	139	145	1/0
2/0	143	184	206	215	111	144	160	168	2/0
3/0	165	213	238	249	129	166	185	194	3/0
4/0	190	245	274	287	149	192	214	224	4/0
250	212	274	305	320	166	214	239	250	250
300	237	306	341	357	186	240	268	280	300
350	261	337	377	394	205	265	296	309	350
400	281	363	406	425	222	287	317	334	400
500	321	416	465	487	255	330	368	385	500
600	354	459	513	538	284	368	410	429	600
700	387	502	562	589	306	405	462	473	700
750	404	523	586	615	328	424	473	495	750
800	415	539	604	633	339	439	490	513	800
900	438	570	639	670	362	469	514	548	900
1000	461	601	674	707	385	499	558	584	1000

Correction Factors

Ambient Temp. (°C)	For ambient temperatures other than 40°C (104°F), multiply the ampacities shown above by the appropriate factor shown below.								Ambient Temp. (°F)
21–25	1.32	1.20	1.15	1.14	1.32	1.20	1.15	1.14	70–77
26–30	1.22	1.13	1.11	1.10	1.22	1.13	1.11	1.10	79–86
31–35	1.12	1.07	1.05	1.05	1.12	1.07	1.05	1.05	88–95
36–40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	97–104
41–45	0.87	0.93	0.94	0.95	0.87	0.93	0.94	0.95	106–113
46–50	0.71	0.85	0.88	0.89	0.71	0.85	0.88	0.89	115–122
51–55	0.50	0.76	0.82	0.84	0.50	0.76	0.82	0.84	124–131
56–60	—	0.65	0.75	0.77	—	0.65	0.75	0.77	133–140
61–70	—	0.38	0.58	0.63	—	0.38	0.58	0.63	142–158
71–80	—	—	0.33	0.44	—	—	0.33	0.44	160–176

*Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for these conductor types shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum.

ANNEX B: Application Information for Ampacity Calculation

Tables B.310.5 and B.310.6

Table B.310.5 Ampacities of Single Insulated Conductors, Rated 0 through 2000 Volts, in Nonmagnetic Underground Electrical Ducts (One Conductor per Electrical Duct), Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure B.310.2, Conductor Temperature 75°C (167°F)

Size (kcmil)	3 Electrical Ducts (Fig. B.310.2, Detail 2)			6 Electrical Ducts (Fig. B.310.2, Detail 3)			9 Electrical Ducts (Fig. B.310.2, Detail 4)			Size (kcmil)
	Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			
	COPPER									
	RHO 60	RHO 90	RHO 120	RHO 60	RHO 90	RHO 120	RHO 60	RHO 90	RHO 120	
250	410	344	327	386	295	275	369	270	252	250
350	503	418	396	472	355	330	446	322	299	350
500	624	511	484	583	431	400	545	387	360	500
750	794	640	603	736	534	494	674	469	434	750
1000	936	745	700	864	617	570	776	533	493	1000
1250	1055	832	781	970	686	632	854	581	536	1250
1500	1160	907	849	1063	744	685	918	619	571	1500
1750	1250	970	907	1142	793	729	975	651	599	1750
2000	1332	1027	959	1213	836	768	1030	683	628	2000
Ambient Temp. (°C)	Correction Factors									Ambient Temp. (°F)
6–10	1.09			1.09			1.09			43–50
11–15	1.04			1.04			1.04			52–59
16–20	1.00			1.00			1.00			61–68
21–25	0.95			0.95			0.95			70–77
26–30	0.90			0.90			0.90			79–86

Table B.310.6 Ampacities of Three Insulated Conductors, Rated 0 through 2000 Volts, Within an Overall Covering (Three-Conductor Cable) in Underground Electrical Ducts (One Cable per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure B.310.2, Conductor Temperature 75°C (167°F)

Size AWG or (kcmil)	1 Electrical Duct (Fig. B.310.2, Detail 1)			3 Electrical Ducts (Fig. B.310.2, Detail 2)			6 Electrical Ducts (Fig. B.310.2, Detail 3)			Size AWG or (kcmil)
	Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			
	COPPER									
	RHO 60	RHO 90	RHO 120	RHO 60	RHO 90	RHO 120	RHO 60	RHO 90	RHO 120	
8	58	54	53	56	48	46	53	42	39	8
6	77	71	69	74	63	60	70	54	51	6
4	101	93	91	96	81	77	91	69	65	4
2	132	121	118	126	105	100	119	89	83	2
1	154	140	136	146	121	114	137	102	95	1
1/0	177	160	156	168	137	130	157	116	107	1/0
2/0	203	183	178	192	156	147	179	131	121	2/0
3/0	233	210	204	221	178	158	205	148	137	3/0
4/0	268	240	232	253	202	190	234	168	155	4/0
250	297	265	256	280	222	209	258	184	169	250
350	363	321	310	340	267	250	312	219	202	350
500	444	389	375	414	320	299	377	261	240	500
750	552	478	459	511	388	362	462	314	288	750
1000	628	539	518	579	435	405	522	351	321	1000
Ambient Temp. (°C)	Correction Factors									Ambient Temp. (°F)
6–10	1.09			1.09			1.09			43–50
11–15	1.04			1.04			1.04			52–59
16–20	1.00			1.00			1.00			61–68
21–25	0.95			0.95			0.95			70–77
26–30	0.90			0.90			0.90			79–86

ANNEX B: Application Information for Ampacity Calculation

Tables B.310.7 and B.310.8

Table B.310.7 Ampacities of Three Single Insulated Conductors, Rated 0 Through 2000 Volts, in Underground Electrical Ducts (Three Conductors per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure B.310.2, Conductor Temperature 75°C (167°F)

Size AWG or (kcmil)	1 Electrical Duct (Fig. B.310.2, Detail 1) Types RHW, THHW, THW, THWN, XHHW, USE			3 Electrical Ducts (Fig. B.310.2, Detail 2) Types RHW, THHW, THW, THWN, XHHW, USE			6 Electrical Ducts (Fig. B.310.2, Detail 3) Types RHW, THHW, THW, THWN, XHHW, USE			Size AWG or (kcmil)
	COPPER									
	RHO LF 50	RHO 90 100	RHO 120 100	RHO LF 50	RHO 90 100	RHO 120 100	RHO LF 50	RHO 90 100	RHO 120 100	
8	63	58	57	61	51	49	57	44	41	8
6	84	77	75	80	67	63	75	56	53	6
4	111	100	98	105	86	81	98	73	67	4
3	129	116	113	122	99	94	113	83	77	3
2	147	132	128	139	112	106	129	93	86	2
1	171	153	148	161	128	121	149	106	98	1
1/0	197	175	169	185	146	137	170	121	111	1/0
2/0	226	200	193	212	166	156	194	136	126	2/0
3/0	260	228	220	243	189	177	222	154	142	3/0
4/0	301	263	253	280	215	201	255	175	161	4/0
250	334	290	279	310	236	220	281	192	176	250
300	373	321	308	344	260	242	310	210	192	300
350	409	351	337	377	283	264	340	228	209	350
400	442	376	361	394	302	280	368	243	223	400
500	503	427	409	460	341	316	412	273	249	500
600	552	468	447	511	371	343	457	296	270	600
700	602	509	486	553	402	371	492	319	291	700
750	632	529	505	574	417	385	509	330	301	750
800	654	544	520	597	428	395	527	338	308	800
900	692	575	549	628	450	415	554	355	323	900
1000	730	605	576	659	472	435	581	372	338	1000
Ambient Temp. (°C)	Correction Factors									Ambient Temp. (°F)
6–10	1.09			1.09			1.09			43–50
11–15	1.04			1.04			1.04			52–59
16–20	1.00			1.00			1.00			61–68
21–25	0.95			0.95			0.95			70–77
26–30	0.90			0.90			0.90			79–86

Table B.310.8 Ampacities of Two or Three Insulated Conductors, Rated 0 Through 2000 Volts, Cabled Within an Overall (Two- or Three-Conductor) Covering, Directly Buried in Earth, Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure B.310.2, 100 Percent Load Factor, Thermal Resistance (Rho) of 90

Size (AWG or kcmil)	1 Cable (Fig. B.310.2, Detail 5)		2 Cables (Fig. B.310.2, Detail 6)		1 Cable (Fig. B.310.2, Detail 5)		2 Cables (Fig. B.310.2, Detail 6)		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
	RHW, THHW, THW, THWN, XHHW, USE		RHW, THHW, THW, THWN, XHHW, USE		RHW, THHW, THW, THWN, XHHW, USE		RHW, THHW, THW, THWN, XHHW, USE		
8	64	75	60	70	51	59	47	55	8
6	85	100	81	95	68	75	60	70	6
4	107	125	100	117	83	97	78	91	4
2	137	161	128	150	107	126	110	117	2
1	155	182	145	170	121	142	113	132	1
1/0	177	208	165	193	138	162	129	151	1/0
2/0	201	236	188	220	157	184	146	171	2/0
3/0	229	269	213	250	179	210	166	195	3/0
4/0	259	304	241	282	203	238	188	220	4/0
250	—	333	—	308	—	261	—	241	250
350	—	401	—	370	—	315	—	290	350
500	—	481	—	442	—	381	—	350	500
750	—	585	—	535	—	473	—	433	750
1000	—	657	—	600	—	545	—	497	1000
Ambient Temp. (°C)	Correction Factors								Ambient Temp. (°F)
6–10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43–50
11–15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70–77
26–30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79–86

Note: For ampacities of Type UF cable in underground electrical ducts, multiply the ampacities shown in the table by 0.74.

ANNEX B: Application Information for Ampacity Calculation

Tables B.310.9 and B.310.10

Table B.310.9 Ampacities of Three Triplexed Single Insulated Conductors, Rated 0 Through 2000 Volts, Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure B.310.2, 100 Percent Load Factor, Thermal Resistance (Rho) of 90

Size (AWG or kcmil)	See Fig. B.310.2, Detail 7		See Fig. B.310.2, Detail 8		See Fig. B.310.2, Detail 7		See Fig. B.310.2, Detail 8		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	USE	UF	USE	UF	USE	UF	USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
8	72	84	66	77	55	65	51	60	8
6	91	107	84	99	72	84	66	77	6
4	119	139	109	128	92	108	85	100	4
2	153	179	140	164	119	139	109	128	2
1	173	203	159	186	135	158	124	145	1
1/0	197	231	181	212	154	180	141	165	1/0
2/0	223	262	205	240	175	205	159	187	2/0
3/0	254	298	232	272	199	233	181	212	3/0
4/0	289	339	263	308	226	265	206	241	4/0
250	—	370	—	336	—	289	—	263	250
350	—	445	—	403	—	349	—	316	350
500	—	536	—	483	—	424	—	382	500
750	—	654	—	587	—	525	—	471	750
1000	—	744	—	665	—	608	—	544	1000
Ambient Temp. (°C)	Correction Factors								Ambient Temp. (°F)
6–10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43–50
11–15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70–77
26–30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79–86

Table B.310.10 Ampacities of Three Single Insulated Conductors, Rated 0 Through 2000 Volts, Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure B.310.2, 100 Percent Load Factor, Thermal Resistance (Rho) of 90

Size (AWG or kcmil)	See Fig. B.310.2, Detail 9		See Fig. B.310.2, Detail 10		See Fig. B.310.2, Detail 9		See Fig. B.310.2, Detail 10		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	USE	UF	USE	UF	USE	UF	USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
8	84	98	78	92	66	77	61	72	8
6	107	126	101	118	84	98	78	92	6
4	139	163	130	152	108	127	101	118	4
2	178	209	165	194	139	163	129	151	2
1	201	236	187	219	157	184	146	171	1
1/0	230	270	212	249	179	210	165	194	1/0
2/0	261	306	241	283	204	239	188	220	2/0
3/0	297	348	274	321	232	272	213	250	3/0
4/0	336	394	309	362	262	307	241	283	4/0
250	—	429	—	394	—	335	—	308	250
350	—	516	—	474	—	403	—	370	350
500	—	626	—	572	—	490	—	448	500
750	—	767	—	700	—	605	—	552	750
1000	—	887	—	808	—	706	—	642	1000
1250	—	979	—	891	—	787	—	716	1250
1500	—	1063	—	965	—	862	—	783	1500
1750	—	1133	—	1027	—	930	—	843	1750
2000	—	1195	—	1082	—	990	—	897	2000
Ambient Temp. (°C)	Correction Factors								Ambient Temp. (°F)
6–10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43–50
11–15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70–77
26–30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79–86

Bending Radii and Pulling Tensions

BENDING RADII AND PULLING TENSIONS

"Training" is the positioning of the cable when NOT under tension. "Bending" is under tension. The minimum bending radius applies to the inner surface of the cable and not to the cable axis. "Sidewall pressure" or loading is the radial force exerted on a cable when pulled around a bend or sheave. Excessive sidewall pressure will crush the cable.

SIDEWALL LOADING

Where **T** is tension out of a bend, in pounds and **R** is the radius of a bend, in feet

$$1/C \text{ per conduit: } SW = \frac{T}{R}$$

$$3-1/C \text{ cradled: } SW = \left[\frac{2n-2}{3} \right] \frac{T}{R}$$

$$3-1/C \text{ triangular: } SW = \left[\frac{n-1}{2} \right] \frac{T}{R}$$

Typical Sidewall Loadings	Lbs/Ft
600v nonshielded control	300
600v & 1kV nonshielded EP and XLP	500
5 & 15 kV Unishield & EP/XLP	500
25-35 kV power	300
Interlocked armored cable (All Voltage Classes)	300

MINIMUM BENDING RADII

Power Cables without Metallic Shielding, up to 600v

The minimum bending radii for both single and multiple-conductor cable with or without lead sheath and without metallic shielding are as follows:

Thickness of Conductor Insulation in Mils	Minimum Bending Radius As A Multiple of Cable Diameter		
	Overall Diameter of Cable in inches		
	1.000 and Less	1.001 to 2.000	2.001 and over
155 and less	4	5	6
170-310	5	6	7
325 and over	-	7	8

Power Cables with Metallic And Lead Covered Shielding (all voltages)

- For Tape Shielded Cables, the minimum bending radius is **twelve times (12)** the overall diameter of the completed cable.
- For Wire Shielded Cables, the minimum bending radius is **eight times (8)** the overall diameter of the completed cable.

Power Cables Over 600 Volts, Non-Shielded, Non-Armored

- The minimum bending radius for all cables is **eight times (8)** the overall cable diameter.

Interlocked Armored Cable, All Voltages

- The minimum bending radius for cables with non-shielded conductors is **seven times (7)** the armor O.D.
- The minimum bending radius for cables with shielded conductors is **twelve times (12)** the diameter of one phase conductor or **seven times (7)** the armor O.D., whichever is larger.

PULLING TENSIONS

The following recommendations are based on a study sponsored by the ICEA. These recommendations may

be modified if experience and more exact information so indicate.

A. Maximum Pulling Tension on Cable

- With pulling eye attached to copper conductors, the maximum pulling tension in pounds should not exceed 0.008 times cir-mil area.
- With pulling eye attached to aluminum conductors, the maximum pulling tension in pounds should not exceed 0.006 times cir-mil area.

$$T_u = 0.008 \times n \times CM$$

where

T_u = max. tension, lb.

n = number of conductors

CM = cir-mil area of each conductor

- With cable grip over a lead sheath, the maximum pulling tension in pounds should not exceed 1,500 lbs./sq. inch of lead sheath cross-sectional area for commercial lead

$$T_u = 4712t (D-t)$$

where

t = sheath thickness, inches

D = overall diameter of cable, inches

- With cable grip over a non-lead cable, the maximum pulling tension should not exceed 1,000 lbs. and may not exceed the maximum tension based on 0.008 or 0.006 x total conductor area.
- When more than three conductors are pulled together, reduce the pulling tension 20%.

B. Maximum Permissible Pulling Lengths

$$L_u = \frac{T_u}{CW}$$

where

L_u = pulling length, feet (straight section)

T_u = maximum tension, lb.

W = weight of cable per foot, lb.

C = coefficient of friction (usually 0.5)

C. Pulling Tension Requirements in Ducts or Conduits:

- For straight sections, the pulling tension in pounds equals the length of duct multiplied by the weight per foot of cable and the coefficient of friction (paragraph B, above).
- For curved sections, the following formula applies:

$$T_1 = T_2 + T_1 \epsilon^a$$

where

T_2 = tension for straight section at pulling end, lb.

T_1 = tension for straight section at feeding end, lb.

T_1 = total tension

a = angle of bend in radians (1 radian = 57.3 deg.)

F = coefficient of friction (usually 0.5)

$\epsilon^a = \log_{2.718} \frac{1}{1-2.718F}$

ϵ = Napierian logarithm base = 2.718

- The maximum pulling tension in pounds shall not exceed 300 times the radius of curvature of the duct expressed in feet.

Conductors in Parallel or as Assemblies Soft Drawn Copper or Hard Drawn Aluminum

The following maximum tensions are for direct attachment to the conductor. However, the pulling force must not exceed the smallest value of 1) conductor tension, or 2) pulling device tension, or 3) sidewall load.

# of Conductors =	1	2	3	4	5	6
AWG/kcmil	MAXIMUM ALLOWABLE CONDUCTOR TENSION (LBS)					
20	8	16	24	26	33	39
18	13	26	39	41	52	62
16	21	41	62	66	83	99
14	33	66	99	100	130	150
12	52	100	150	160	200	250
11	66	130	190	210	260	310
10	83	160	240	260	330	390
9	100	200	310	330	410	500
8	130	260	390	420	520	630
6	210	420	630	670	840	1000
4	330	660	1000	1060	1330	1600
3	420	840	1260	1340	1680	2020
2	530	1060	1590	1690	2120	2540
1	670	1330	2000	2140	2670	3210
1/0	840	1690	2530	2700	3370	4050
2/0	1060	2130	3190	3400	4250	5110
3/0	1340	2680	4020	4290	5370	6440
4/0	1690	3380	5070	5410	6500	6500
250	2000	4000	6000	6400	6500	6500
300	2400	4800	6500	6500	6500	6500
350	2800	5600	6500	6500	6500	6500
400	3200	6400	6500	6500	6500	6500
450	3600	6500	6500	6500	6500	6500
500	4000	6500	6500	6500	6500	6500
600	4800	6500	6500	6500	6500	6500
700	5000	6500	6500	6500	6500	6500
750	5000	6500	6500	6500	6500	6500
800	5000	6500	6500	6500	6500	6500
900	5000	6500	6500	6500	6500	6500
1000	5000	6500	6500	6500	6500	6500

This chart may also be used for hard tempered aluminum conductors. However, use 1/2 of these chart values for all other UL labeled cables having aluminum conductors, such as THW, XHHW wire, or SE cables.

Technical Reference

Multiconductor Cables Having Equal-Sized Conductors, Without Subassemblies; Soft Drawn Copper

The following maximum tensions are for direct attachment to the conductor. However, the pulling force must not exceed the smallest value of 1) conductor tension, or 2) pulling device tension, or 3) sidewall load.

AWG =	20	18	16	14	12	11	10	9
# Conductors	MAXIMUM ALLOWABLE CONDUCTOR TENSION (LBS)							
2	16	26	41	66	100	130	160	200
3	24	39	62	99	150	190	240	310
4	33	52	83	130	200	260	330	410
5	41	65	100	160	260	320	410	520
6	49	78	120	190	310	390	490	620
7	49	78	120	190	310	390	490	620
8	52	83	130	210	330	420	530	670
9	59	93	140	230	370	470	590	750
10	65	100	160	260	410	520	660	830
11	72	110	180	280	460	570	730	920
12	78	120	190	310	500	630	790	1000
13	85	130	210	340	540	680	860	1000
14	91	140	230	360	580	730	930	1000
15	98	150	240	390	620	790	990	1000
16	100	160	260	420	660	840	1000	1000
17	110	170	280	440	710	890	1000	1000
18	110	180	290	470	750	940	1000	1000
19	120	190	310	500	790	1000	1000	1000
20	130	200	330	520	830	1000	1000	1000
22	140	220	360	570	910	1000	1000	1000
24	150	240	390	630	1000	1000	1000	1000
26	170	270	420	680	1000	1000	1000	1000
28	180	290	460	730	1000	1000	1000	1000
30	190	310	490	780	1000	1000	1000	1000
32	200	330	520	840	1000	1000	1000	1000
34	220	350	560	890	1000	1000	1000	1000
36	230	370	590	940	1000	1000	1000	1000
38	240	390	620	1000	1000	1000	1000	1000
40	260	410	660	1000	1000	1000	1000	1000
42	270	430	690	1000	1000	1000	1000	1000
44	280	450	720	1000	1000	1000	1000	1000
46	300	470	760	1000	1000	1000	1000	1000
48	310	490	790	1000	1000	1000	1000	1000
50	320	510	820	1000	1000	1000	1000	1000

THE MAXIMUM LIMIT IS 1000 LBS.

Technical Reference

Copper Conductor and Stranding Data

Approx. O.D.	Pounds per 1000 ft.	Circular Miils	Size AWG/CM	CONCENTRIC STRAND					ROPE LAY Concentric Strand		ROPE LAY Bunch Strand	
				Class AA	Class A	Class B	Class C	Class D	Class G	Class H	Class K 30AWG (.010")	Class M 34AWG (.0063")
.0050	.0757	25.00	36									
.0056	.0954	31.52	35									
.0063	.1203	39.75	34									
.0071	.1517	50.13	33									
.0080	.1913	63.21	32									
.0089	.2413	79.70	30									
.0100	.3042	100.5	30									
.0113	.3836	126.7	29									
.0126	.4837	159.8	28									
.0142	.6100	201.5	27									
.0159	.7692	254.1	26									
.0179	.9699	320.4	25									
.0201	1.223	404.0	24									
.0226	1.542	509.5	23									
.0254	1.945	642.4	22									
.0285	2.452	810.1	21									
.0363	3.154	1,020	20			7	19				10	26
.0456	5.015	1,620	18			7	19				16	41
.0576	7.974	2,580	16			7	19				26	65
.0726	12.68	4,110	14			7	19	37	49		41	104
.0915	20.16	6,530	12			7	19	37	49		65	168
.1160	32.06	10,380	10			7	19	37	49		104	259
.1600	40.42	13,090	9			7	19	37	49	133		
.1460	51.0	16,510	8			7	19	37	49	133	168	420
.1840	80.9	26,240	6			7	19	37	49	133	266	665
.2320	129	41,740	4	3	7	7	19	37	49	133	420	1064
.2600	162	52,620	3	3	7	7	19	37	49	133	532	1323
.2990	205	66,630	2	3	7	7	19	37	49	133	665	1666
.3320	259	83,690	1	3	7	19	37	61	133	259	836	2107
.3730	326	105,600	1/0	7	7	19	37	61	133	259	1064	2646
.4190	411	133,100	2/0	7	7	19	37	61	133	259	1323	3325
.4700	518	167,800	3/0	7	7	19	37	61	133	259	1666	4256
.5280	653	211,600	4/0	7	7	19	37	61	133	259	2107	5320
.5750	772	250,000	250,000	12	19	37	61	91	259	427	2499	6384
.6300	925	300,000	300,000	12	19	37	61	91	259	427	2989	7581
.6810	1080	350,000	350,000	12	19	37	61	91	259	427	3458	8806
.7280	1236	400,000	400,000	19	19	37	61	91	259	427	3990	10,101
.8130	1542	500,000	500,000	19	37	37	61	91	259	427	5054	12,691
.8930	1850	600,000	600,000	37	37	61	91	127	427	703	5985	14,945
.9980	2316	750,000	750,000	37	61	61	91	127	427	703	7581	18,788
1.152	3086	1,000,000	1,000,000	37	61	61	91	127	427	703	10,101	25,193

Technical Reference

Copper Conductor and Stranding Data

Dimensions and Weights of Solid Copper Wire

Size AWG	Approx. Dia- meter	Circular Mils	Square Inches	Approx. Lbs/Mft
34	0.0063	39.7	0.0000312	0.120
32	0.0080	64.0	0.0000503	0.194
30	0.0100	100	0.0000785	0.303
29	0.0113	128	0.000100	0.387
28	0.0126	159	0.000125	0.481
27	0.0142	202	0.000158	0.610
26	0.0159	253	0.000199	0.765
25	0.0179	320	0.000252	0.970
24	0.0201	404	0.000317	1.22
23	0.0226	511	0.000401	1.55
22	0.0253	640	0.000503	1.94
21	0.0285	812	0.000638	2.46
20	0.0320	1020	0.000804	3.10
18	0.0403	1620	0.00128	4.92
16	0.0508	2580	0.00203	7.81
14	0.0641	4110	0.00323	12.4
12	0.0808	6530	0.00513	19.8
10	0.1019	10,380	0.00815	31.43
9	0.1144	13,090	0.01028	39.62
8	0.1285	16,510	0.01297	49.98
7	0.1443	20,820	0.01635	63.03
6	0.1620	26,240	0.02061	79.44
5	0.1819	33,090	0.02599	100.2
4	0.2043	41,740	0.03278	130.3
3	0.2294	52,620	0.04133	159.3
2	0.2576	66,360	0.05212	200.9

STRANDING-CLASS CONSTRUCTION AND USES

Concentric-lay Conductors

- Class B - Power cables
- Class C - Power cables where more flexible stranding from Class B is desired
- Class D - Power cables where extra flexible stranding is desired

Rope-lay and Bunch-stranded Conductors

- Class G - All cables for portable use
- Class H - All cables where extreme flexibility is required, e.g. take-up reels
- Class I - Apparatus cable and motor leads
- Class K - Cords and cables 30 AWG copper wires - Stationary service
- Class M - Cords and cables 34 AWG copper wires - Constant service

Note: Class G and H shall have concentric-lay stranded members and Class I, K and M shall have bunched stranded members.

Metric Conversion Chart AWG/Metric Preferred Sizes of Conductors

AWG / MCM	mm ²	circular mils	AWG / MCM	mm ²	circular mils
2000		2,000,000		6.0	11,800
	1000	1,970,000	10		10,380
1750		1,750,000		4.0	7,890
	800	1,580,000	12		6,530
1500		1,500,000		2.5	4,930
1250		1,250,000	14		4,110
	630	1,240,000		1.5	2,960
1000		1,000,000	16		2,580
	500	987,000		1.0	1,970
	400	789,000		0.90	1,773
750		750,000	18		1,620
600		600,000		0.80	1,576
	300	592,000		0.75	1,480
500		500,000		0.60	1,182
	240	474,000	20		1,020
400		400,000		0.50	987
	185	365,000	22		640
350		350,000	24	0.20	404
300		300,000	26		253
	150	296,000	28		159
250		250,000	30		100
	120	237,000	32	.05	64.0
4/0		211,600	34		39.7
	95	187,000	36	.02	25.0
3/0		167,000	38		16.0
	70	138,000	40	.005	9.61
2/0		133,100			
1/0		105,600			
	50	98,700			
1		83,690			
	35	69,100			
2		66,360			
3		52,620			
	25	49,300			
4		41,740			
	16	31,600			
6		26,240			
	10	19,700			
8		16,510			

Technical Reference

Electrical Conductors

International Standard Sizes Conversion Chart

Approved by IEEE Standard 754-1983

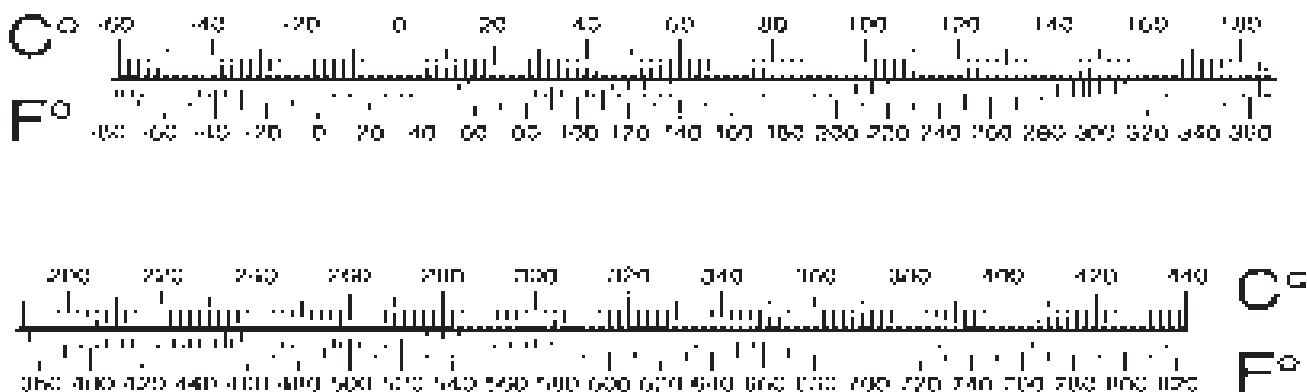
NOMINAL AREA (CM ²)	DIECT (MM)	NOMINAL AND MIN. DIAMETER (MM)	APPROXIMATE OVERALL TOLERANCE DIAMETER		CALCULATED ELECTRICAL AREA		NOMINAL WEIGHT		STANDARD RESISTANCE AT 20 C (MH)		NOMINAL AMPA
			MIN.	MAX.	CM ²	CM ²	KG/KM	LB/1000 FT	OHM/KM	OHM/1000 FT	
0.34	1.70	1.70	1.68	1.72	0.00042	0.0000	0.00	0.00	0.00	0.00	100
0.34	1.70	1.70	1.68	1.72	0.00042	0.0000	0.00	0.00	0.00	0.00	100
0.42	2.10	2.10	2.08	2.12	0.00051	0.0000	0.00	0.00	0.00	0.00	100
0.42	2.10	2.10	2.08	2.12	0.00051	0.0000	0.00	0.00	0.00	0.00	100
0.50	2.50	2.50	2.48	2.52	0.00060	0.0000	0.00	0.00	0.00	0.00	100
0.50	2.50	2.50	2.48	2.52	0.00060	0.0000	0.00	0.00	0.00	0.00	100
0.58	2.90	2.90	2.88	2.92	0.00069	0.0000	0.00	0.00	0.00	0.00	100
0.58	2.90	2.90	2.88	2.92	0.00069	0.0000	0.00	0.00	0.00	0.00	100
0.66	3.30	3.30	3.28	3.32	0.00078	0.0000	0.00	0.00	0.00	0.00	100
0.66	3.30	3.30	3.28	3.32	0.00078	0.0000	0.00	0.00	0.00	0.00	100
0.74	3.70	3.70	3.68	3.72	0.00087	0.0000	0.00	0.00	0.00	0.00	100
0.74	3.70	3.70	3.68	3.72	0.00087	0.0000	0.00	0.00	0.00	0.00	100
0.82	4.10	4.10	4.08	4.12	0.00096	0.0000	0.00	0.00	0.00	0.00	100
0.82	4.10	4.10	4.08	4.12	0.00096	0.0000	0.00	0.00	0.00	0.00	100
0.90	4.50	4.50	4.48	4.52	0.00105	0.0000	0.00	0.00	0.00	0.00	100
0.90	4.50	4.50	4.48	4.52	0.00105	0.0000	0.00	0.00	0.00	0.00	100
0.98	4.90	4.90	4.88	4.92	0.00114	0.0000	0.00	0.00	0.00	0.00	100
0.98	4.90	4.90	4.88	4.92	0.00114	0.0000	0.00	0.00	0.00	0.00	100
1.06	5.30	5.30	5.28	5.32	0.00123	0.0000	0.00	0.00	0.00	0.00	100
1.06	5.30	5.30	5.28	5.32	0.00123	0.0000	0.00	0.00	0.00	0.00	100
1.14	5.70	5.70	5.68	5.72	0.00132	0.0000	0.00	0.00	0.00	0.00	100
1.14	5.70	5.70	5.68	5.72	0.00132	0.0000	0.00	0.00	0.00	0.00	100
1.22	6.10	6.10	6.08	6.12	0.00141	0.0000	0.00	0.00	0.00	0.00	100
1.22	6.10	6.10	6.08	6.12	0.00141	0.0000	0.00	0.00	0.00	0.00	100
1.30	6.50	6.50	6.48	6.52	0.00150	0.0000	0.00	0.00	0.00	0.00	100
1.30	6.50	6.50	6.48	6.52	0.00150	0.0000	0.00	0.00	0.00	0.00	100
1.38	6.90	6.90	6.88	6.92	0.00159	0.0000	0.00	0.00	0.00	0.00	100
1.38	6.90	6.90	6.88	6.92	0.00159	0.0000	0.00	0.00	0.00	0.00	100
1.46	7.30	7.30	7.28	7.32	0.00168	0.0000	0.00	0.00	0.00	0.00	100
1.46	7.30	7.30	7.28	7.32	0.00168	0.0000	0.00	0.00	0.00	0.00	100
1.54	7.70	7.70	7.68	7.72	0.00177	0.0000	0.00	0.00	0.00	0.00	100
1.54	7.70	7.70	7.68	7.72	0.00177	0.0000	0.00	0.00	0.00	0.00	100
1.62	8.10	8.10	8.08	8.12	0.00186	0.0000	0.00	0.00	0.00	0.00	100
1.62	8.10	8.10	8.08	8.12	0.00186	0.0000	0.00	0.00	0.00	0.00	100
1.70	8.50	8.50	8.48	8.52	0.00195	0.0000	0.00	0.00	0.00	0.00	100
1.70	8.50	8.50	8.48	8.52	0.00195	0.0000	0.00	0.00	0.00	0.00	100
1.78	8.90	8.90	8.88	8.92	0.00204	0.0000	0.00	0.00	0.00	0.00	100
1.78	8.90	8.90	8.88	8.92	0.00204	0.0000	0.00	0.00	0.00	0.00	100
1.86	9.30	9.30	9.28	9.32	0.00213	0.0000	0.00	0.00	0.00	0.00	100
1.86	9.30	9.30	9.28	9.32	0.00213	0.0000	0.00	0.00	0.00	0.00	100
1.94	9.70	9.70	9.68	9.72	0.00222	0.0000	0.00	0.00	0.00	0.00	100
1.94	9.70	9.70	9.68	9.72	0.00222	0.0000	0.00	0.00	0.00	0.00	100
2.02	10.10	10.10	10.08	10.12	0.00231	0.0000	0.00	0.00	0.00	0.00	100
2.02	10.10	10.10	10.08	10.12	0.00231	0.0000	0.00	0.00	0.00	0.00	100
2.10	10.50	10.50	10.48	10.52	0.00240	0.0000	0.00	0.00	0.00	0.00	100
2.10	10.50	10.50	10.48	10.52	0.00240	0.0000	0.00	0.00	0.00	0.00	100
2.18	10.90	10.90	10.88	10.92	0.00249	0.0000	0.00	0.00	0.00	0.00	100
2.18	10.90	10.90	10.88	10.92	0.00249	0.0000	0.00	0.00	0.00	0.00	100
2.26	11.30	11.30	11.28	11.32	0.00258	0.0000	0.00	0.00	0.00	0.00	100
2.26	11.30	11.30	11.28	11.32	0.00258	0.0000	0.00	0.00	0.00	0.00	100
2.34	11.70	11.70	11.68	11.72	0.00267	0.0000	0.00	0.00	0.00	0.00	100
2.34	11.70	11.70	11.68	11.72	0.00267	0.0000	0.00	0.00	0.00	0.00	100
2.42	12.10	12.10	12.08	12.12	0.00276	0.0000	0.00	0.00	0.00	0.00	100
2.42	12.10	12.10	12.08	12.12	0.00276	0.0000	0.00	0.00	0.00	0.00	100
2.50	12.50	12.50	12.48	12.52	0.00285	0.0000	0.00	0.00	0.00	0.00	100
2.50	12.50	12.50	12.48	12.52	0.00285	0.0000	0.00	0.00	0.00	0.00	100
2.58	12.90	12.90	12.88	12.92	0.00294	0.0000	0.00	0.00	0.00	0.00	100
2.58	12.90	12.90	12.88	12.92	0.00294	0.0000	0.00	0.00	0.00	0.00	100
2.66	13.30	13.30	13.28	13.32	0.00303	0.0000	0.00	0.00	0.00	0.00	100
2.66	13.30	13.30	13.28	13.32	0.00303	0.0000	0.00	0.00	0.00	0.00	100
2.74	13.70	13.70	13.68	13.72	0.00312	0.0000	0.00	0.00	0.00	0.00	100
2.74	13.70	13.70	13.68	13.72	0.00312	0.0000	0.00	0.00	0.00	0.00	100
2.82	14.10	14.10	14.08	14.12	0.00321	0.0000	0.00	0.00	0.00	0.00	100
2.82	14.10	14.10	14.08	14.12	0.00321	0.0000	0.00	0.00	0.00	0.00	100
2.90	14.50	14.50	14.48	14.52	0.00330	0.0000	0.00	0.00	0.00	0.00	100
2.90	14.50	14.50	14.48	14.52	0.00330	0.0000	0.00	0.00	0.00	0.00	100
2.98	14.90	14.90	14.88	14.92	0.00339	0.0000	0.00	0.00	0.00	0.00	100
2.98	14.90	14.90	14.88	14.92	0.00339	0.0000	0.00	0.00	0.00	0.00	100
3.06	15.30	15.30	15.28	15.32	0.00348	0.0000	0.00	0.00	0.00	0.00	100
3.06	15.30	15.30	15.28	15.32	0.00348	0.0000	0.00	0.00	0.00	0.00	100
3.14	15.70	15.70	15.68	15.72	0.00357	0.0000	0.00	0.00	0.00	0.00	100
3.14	15.70	15.70	15.68	15.72	0.00357	0.0000	0.00	0.00	0.00	0.00	100
3.22	16.10	16.10	16.08	16.12	0.00366	0.0000	0.00	0.00	0.00	0.00	100
3.22	16.10	16.10	16.08	16.12	0.00366	0.0000	0.00	0.00	0.00	0.00	100
3.30	16.50	16.50	16.48	16.52	0.00375	0.0000	0.00	0.00	0.00	0.00	100
3.30	16.50	16.50	16.48	16.52	0.00375	0.0000	0.00	0.00	0.00	0.00	100
3.38	16.90	16.90	16.88	16.92	0.00384	0.0000	0.00	0.00	0.00	0.00	100
3.38	16.90	16.90	16.88	16.92	0.00384	0.0000	0.00	0.00	0.00	0.00	100
3.46	17.30	17.30	17.28	17.32	0.00393	0.0000	0.00	0.00	0.00	0.00	100
3.46	17.30	17.30	17.28	17.32	0.00393	0.0000	0.00	0.00	0.00	0.00	100
3.54	17.70	17.70	17.68	17.72	0.00402	0.0000	0.00	0.00	0.00	0.00	100
3.54	17.70	17.70	17.68	17.72	0.00402	0.0000	0.00	0.00	0.00	0.00	100
3.62	18.10	18.10	18.08	18.12	0.00411	0.0000	0.00	0.00	0.00	0.00	100
3.62	18.10	18.10	18.08	18.12	0.00411	0.0000	0.00	0.00	0.00	0.00	100
3.70	18.50	18.50	18.48	18.52	0.00420	0.0000	0.00	0.00	0.00	0.00	100
3.70	18.50	18.50	18.48	18.52	0.00420	0.0000	0.00	0.00	0.00	0.00	100
3.78	18.90	18.90	18.88	18.92	0.00429	0.0000	0.00	0.00	0.00	0.00	100
3.78	18.90	18.90	18.88	18.92	0.00429	0.0000	0.00	0.00	0.00	0.00	100
3.86	19.30	19.30	19.28	19.32	0.00438	0.0000	0.00	0.00	0.00	0.00	100
3.86	19.30	19.30	19.28	19.32	0.00438	0.0000	0.00	0.00	0.00	0.00	

Material Temperature Comparisons

Nominal Temperature Range/Insulating and Jacketing Compounds

Compound	Normal Low	Normal High	Special Low	Special High
Chlorosulfonated Polyethylene (Hypalon*)	-20°C	90°C	-40°C	105°C
EPDM (Ethylene-Propylene-Diene Monomer)	-55°C	105°C	---	150°C
Neoprene	-20°C	60°C	-55°C	90°C
Polyethylene (Solid and Cellular)	-60°C	80°C	---	---
Polypropylene (Solid and Cellular)	-10°C	105°C	---	---
Rubber (EPR, Hypalon)	-30°C	60°C	-55°C	75°C
FEP Teflon *	-70°C	200°C	---	---
PVC	-20°C	80°C	-55°C	105°C
Silicone Δ	-80°C	150°C	---	200°C
Halar ~	-70°C	150°C	---	---
Tefzel *	-65°C	150°C	---	---
TFE Teflon (Harsher Environments)	-70°C	260°C	---	---

* DuPont trademark.
 Δ General Electric trademark.
 ~ Ausimont Corporation trademark.



Technical Reference

Jacket & Insulation Materials Comparison Chart

Thermoplastic Properties

INSULATION OR JACKET MATERIAL	CHLORINATED POLYETHYLENE (CPE)	POLYVINYL CHLORIDE (PVC)	LOW DENSITY POLYETHYLENE (LDPE)	CELLULAR POLYETHYLENE	HIGH DENSITY POLYETHYLENE (HDPE)	POLYURETHANE	POLYPROPYLENE	NYLON	TEFLON®	TPE
Oxidation Resistance	E	E	E	E	E	E	E	E	O	E
Heat Resistance	G-E	G-E	G	G-E	E	E	G	E	O	G
Oil Resistance	E	E	G-E	G-E	G-E	G-E	E	E	O	P
Low Temp. Flexibility	G	P-G	G-E	E	E	E	G	G	O	E
Weather, Sun Resistance	E	G-E	E	E	E	E	F-G	E	O	E
Ozone Resistance	E	E	E	E	E	E	E	E	E	E
Abrasion Resistance	E	F-G	F-G	G	E	F-G	O	E	G-E	F
Electrical Properties	F	F-G	E	E	E	E	G	F	E	G
Flame Resistance	F	E	P	P	P	P	P	P	O	F-G
Nuclear Radiation Resistance	G-E	P-F	G	G	G	F	G	F-G	P-F	F
Water Resistance	G	E	E	E	E	E	P	P-F	E	E
Acid Resistance	G-E	G-E	G-E	G-E	G-E	E	F	P-F	E	G
Alkali Resistance	G-E	G-E	G-E	G-E	G-E	E	F	E	E	G
Gasoline, Kerosene, Etc. (Aliphatic Hydrocarbons) Resistance	F	G-E	P-F	P-F	P-F	P-F	F	G	E	P
Benzol, Toluol, Etc. (Aromatic Hydrocarbons) Resistance	F	P-F	P	P	P	P-F	P	G	E	P
Degreaser Solvents (Halogenated Hydrocarbons) Resistance	P	P-F	P	P	P	P	P	G	E	P
Alcohol Resistance	G	G-E	E	E	E	E	P	P	E	E

P = Poor F = Fair G = Good E = Excellent O = Outstanding

Any given property can generally be improved by the use of selective compounding.

Jacket & Insulation Materials Comparison Chart

Thermoset Properties

INSULATION OR JACKET MATERIAL	STYRENE BUTADIENE RUBBER (SBR)	NATURAL RUBBER	SYNTHETIC RUBBER	POLY BUTADIENE	NEOPRENE	HYPALON® CHLORO-SULFONATED POLYETHYLENE (CSPE)	NITRILE OR RUBBER BUTADIENE NITRILE (NBR)	NITRILE/ POLY-CHLORIDE (NBR/PVC)	ETHYLENE PROPYLENE RUBBER (EPR)	CROSS-LINKED POLY-ETHYLENE (XLPE)	CHLORINATED POLY-ETHYLENE (CPE)	SILICONE RUBBER
Oxidation Resistance	F	F	G	G	G	E	F	E	G	E	E	E
Heat Resistance	F-G	F	F	F	G	E	G	G	E	G	E	E
Oil Resistance	P	P	P	P	G	G	G-E	G	F	G	G-E	F-G
Low Temp. Flexibility	F-G	G	E	E	F-G	F	F	F	G-E	O	F	O
Weather, Sun Resistance	F	F	F	F	G	E	F-G	G	E	G	E	O
Ozone Resistance	P	P	P	P	G	E	P	G	E	E	G-E	O
Abrasion Resistance	G-E	E	E	E	G-E	G	G-E	E	G	F-G	G-E	F
Electrical Properties	E	E	E	E	F	G	P	F	E	E	F-G	O
Flame Resistance	P	P	P	P	G	G	P	G	P	F-G	G-E	O
Nuclear Radiation Resistance	F-G	F-G	F-G	P	F-G	G	F-G	P	G	E	G	E
Water Resistance	G-E	G-E	E	E	G	G-E	G-E	E	G-E	G-E	G-E	G-E
Acid Resistance	F-G	F-G	F-G	F-G	G	E	G	G	G-E	G-E	E	F-G
Alkali Resistance	F-G	F-G	F-G	F-G	G	E	F-G	G	G-E	G-E	E	F-G
Gasoline, Kerosene, Etc. (Aliphatic Hydrocarbons) Resistance	P	P	P	P	G	F	E	G-E	P	F	F	P-F
Benzol, Toluol, Etc. (Aromatic Hydrocarbons) Resistance	P	P	P	P	P-F	F	G	G	F	F	F	P
Degreaser Solvents (Halogenated Hydrocarbons) Resistance	P	P	P	P	P	P-F	P	G	P	F	P	P-G
Alcohol Resistance	F	G	G	F-G	F	G	E	G	P	E	G-E	G

P = Poor F = Fair G = Good E = Excellent O = Outstanding

Any given property can generally be improved by the use of selective compounding.

Technical Reference

Cable Flame Tests

Factory Mutual Cable Fire Propagation Test: A unique test standard whereby a Fire Propagation Index (FPI) is determined based upon a combination heat release and ignition test. The FPI is used to determine a 1, 2, or 3 Group rating. The lower Group ratings are the better performing cables.

ICEA T-29-520 Vertical-Tray Flame Test (210,000 BTU): Similar to 70,000 BTU per hour test but heat source increased to 210,000 BTU per hour.

IEEE 383 Vertical Flame Test: The Institute of Electrical and Electronic Engineers (IEEE) has established IEEE-383, "IEEE Standards for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Generation Stations". Although originally intended for cables essential for emergency operations in nuclear power plants, this test procedure is used for other non-nuclear installations.

In the IEEE-383 fire test cables are supported by a one-foot wide vertical rack eight feet high. The cables are positioned in the center six inches off the rack, spaced one-half cable diameter apart. The rack is centered in an eight foot cube enclosure recommended by Underwriters Laboratories. A ten inch ribbon burner fuel with an air-propane mixture ignites the cable with a 21 kW (70,000 BTU/hr) flame. The burner is positioned two feet above the floor and 9 to 12 inches of cable are exposed to the direct flames for 20 minutes. Cables on which flame extends above the top of the eight foot rack fail this test. NELPIA (ANI) test is a (210,000 BTU/hr) vertical flame test corner configuration.

UL Flammability Tests

	BTU/hr	Locations
IEEE 1202	70,000	General Purpose
UL 1581 (VW-1)	(Bunsen Burner)	Residential & Non-Residential in Conduit
UL 1581 (Vertical Tray)	70,000 (IEEE 383)	General Purpose
UL 1666 (Vertical Chamber)	527,500	Riser and General Purpose
UL 1685	70,000	General Purpose
UL 910 (Steiner Tunnel)	70,000	General Purpose

UL-910 Plenum Test: A plenum is defined as any space used as part of an air-handling system. This includes heating/air conditioning ducts and air returns, which frequently include the space between suspended ceilings and the floor above in modern office buildings. The National Electrical Code (NEC) requires that exposed cables (those not in conduit) in plenums be listed as "having adequate fire-resistant and low-smoke producing characteristics...".

A "Standard For Test Method For Fire and Smoke Characteristics of Cables Used in Air-Handling Spaces", was developed by Underwriters Laboratories (UL) to classify cables for this NEC requirement. This test is performed in a 25 foot Stein Tunnel test furnace (also specified in ASTM E-84 test for building materials). Designed to match the rigors of the application, this test is quite demanding.

In the UL-910 test, a single layer of 24 foot lengths of cable are supported by a one foot wide cable rack, which is filled with cables. The cables are ignited by an 88 kW (300,000 BTU/hr) methane flame. Flame spread is aided by a 240 ft/minute draft. During the 20 minute test, flame spread is observed through small windows spaced one foot apart. Smoke is measured by a photocell installed in the exhaust duct.

To qualify, cables must have a flame spread of less than 5 feet beyond the end of the 4-1/2 foot ignition flame, a peak optical density of 0.5 maximum (33% light transmission) and a maximum average optical density of 0.15 (70% light transmission).

UL Riser Test: Underwriters Laboratories (UL) has established a fire test facility for the purpose of listing cables that meet NEC requirements.

This test chamber is an eight by four simulated shaft, twelve feet high between the source of ignition and the floor above. A very large propane burner, 145 kW (495,000 BTU/hr) is ignited for a period of 30 minutes. Flames must not extend above the 12 foot mark if the cable is to be UL Classified for this duty.

UL VW-1 Vertical Wire Flame Test: The purpose of the UL VW-1 Vertical Wire Flame Test is to screen out flammable wires. The ignition source is small (under 1kW) and is applied for only 75 seconds.

In the UL VW-1 Flame Test, a tirrill burner (similar to a Bunsen burner) is used as the ignition source. The wire sample is mounted and the flame is applied for 15 seconds and then removed. The flame is then reapplied, either after 15 seconds or when the sample ceases to flame (whichever is longer), for a total of five 15-second applications. After the above procedure is completed, a wire sample that passes this test must not burn for more than one minute and must not burn more than 25% of the Kraft indicator flag. In addition, the surgical cotton at the base of the burner must not be ignited.

Color Code Charts

The following paragraphs detail ICEA/NEMA color code methods. Charts detailing ICEA/NEMA Methods 1 and 3, which are referenced in the product pages of this catalog, are included herein.

Industry standard generic Color Code Charts 1 through 5, which also are referenced in the product pages, follow the ICEA/NEMA charts.

ICEA/NEMA Method 1 - Colored insulation with contrasting ink tracers as required. Six different insulation colors and four different colored ink tracers are used to provide positive identification through 21 conductors. The same identification sequence may be repeated for cables containing more than 21 conductors.

ICEA/NEMA Method 2 - A neutral-colored compound is used with single or double spiral ink tracers as required to provide positive identification through 21 conductors. The identification sequence is repeated for cables containing more than 21 conductors.

ICEA/NEMA Method 3 - A neutral- or single-colored insulation compound is surface ink printed with both conductor number and color designation to provide positive identification through 21 conductors. The identification sequence is repeated for colors containing more than 21 conductors.

ICEA/NEMA Method 4 - A neutral- or single-colored insulation compound is surface ink printed with conductor number to provide positive conductor identification through 21 conductors. The identification sequence is repeated for cables containing more than 21 conductors.

ICEA/NEMA Method 5 - A color coding using braids. Also sometimes specified using colored insulation and contrasting tracers as an extension of Method 1 to eliminate duplicate conductors. Up to 127 positive conductor codings are available with this method.

ICEA/NEMA Method 9 - One conductor of each pair should be coded "white" or "black" and the other conductor should be coded with any other contrasting color. Pairs should be identified in sequence by printed numbers on at least one conductor in each pair, beginning with the number 1.

Color Code Charts

ICEA METHOD 1, Table E-1

Conductor No.	Background or Base Color	First Tracer Color	Second Tracer Color	Conductor No.	Background or Base Color	First Tracer Color	Second Tracer Color
1	Black	---	---	20	Red	Green	---
2	White	---	---	21	Orange	Green	---
3	Red	---	---	22	Black	White	Red
4	Green	---	---	23	White	Black	Red
5	Orange	---	---	24	Red	Black	White
6	Blue	---	---	25	Green	Black	White
7	White	Black	---	26	Orange	Black	White
8	Red	Black	---	27	Blue	Black	White
9	Green	Black	---	28	Black	Red	Green
10	Orange	Black	---	29	White	Red	Green
11	Blue	Black	---	30	Red	Black	Green
12	Black	White	---	31	Green	Black	Orange
13	Red	White	---	32	Orange	Black	Green
14	Green	White	---	33	Blue	White	Orange
15	Blue	White	---	34	Black	White	Orange
16	Black	Red	---	35	White	Red	Orange
17	White	Red	---	36	Orange	White	Blue
18	Orange	Red	---	37	White	Red	Blue
19	Blue	Red	---				

Color Code Charts

ICEA METHOD 1, Table E-2

Conductor No.	Base Color	Spiral Stripe	Conductor No.	Base Color	Spiral Stripe
1	Black	---	19	Orange	Blue
2	Red	---	20	Yellow	Blue
3	Blue	---	21	Brown	Blue
4	Orange	---	22	Black	Orange
5	Yellow	---	23	Red	Orange
6	Brown	---	24	Blue	Orange
7	Red	Black	25	Yellow	Orange
8	Blue	Black	26	Brown	Orange
9	Orange	Black	27	Black	Yellow
10	Yellow	Black	28	Red	Yellow
11	Brown	Black	29	Blue	Yellow
12	Black	Red	30	Orange	Yellow
13	Blue	Red	31	Brown	Yellow
14	Orange	Red	32	Black	Brown
15	Yellow	Red	33	Red	Brown
16	Brown	Red	34	Blue	Brown
17	Black	Blue	35	Orange	Brown
18	Red	Blue	36	Yellow	Brown

NOTE: Color code repeats after 36 conductors. No green or white conductors/stripes.

ICEA METHOD 3

Conductor No.	Printing	Conductor No.	Printing
1	1-Black	11	11-Blue-Black
2	2-White	12	12-Black-White
3	3-Red	13	13-Red-White
4	4-Green	14	14-Green-White
5	5-Orange	15	15-Blue-White
6	6-Blue	16	16-Black-Red
7	7-White-Black	17	17-White-Red
8	8-Red-Black	18	18-Orange-Red
9	9-Green-Black	19	19-Blue-Red
10	10-Orange-Black	20	20-Red-Green
		21	21-Orange-Green

NOTE: Color code repeats after 21 conductors.

Technical Reference

Color Code Charts 1-3

Chart 1

Conductor No.	Color
1	Black
2	Red
3	White
4	Light Green
5	Light Brown
6	Light Blue
7	Orange
8	Yellow
9	Violet
10	Gray
11	Pink
12	Tan

Chart 3

No. of Conductors	Color
2	Black, Red
4	Black, Red, Light Blue, Light Brown
6	Black, Red, Light Blue, Light Brown, Orange, Yellow
8	Black, Red, Light Blue, Light Brown, Orange, Yellow, Purple, Gray

Chart 2

Pair No.	Color	Pair No.	Color
1	Black with Red	14	Green with White
2	Black with White	15	Green with Blue
3	Black with Light Green	16	Green with Yellow
4	Black with Blue	17	Green with Brown
5	Black with Yellow	18	Green with Orange
6	Black with Brown	19	White with Blue
7	Black with Orange	20	White with Yellow
8	Red with White	21	White with Brown
9	Red with Light Green	22	White with Orange
10	Red with Blue	23	Blue with Yellow
11	Red with Yellow	24	Blue with Brown
12	Red with Brown	25	Blue with Orange
13	Red with Orange		

Technical Reference

Color Code Chart 4 Modified Western Electric

Chart 4

Pair No.	Color Combination	Pair No.	Color Combination
1	White/Blue Stripe Blue	14	Black/Brown Stripe Brown/Black Stripe
2	White/Orange Stripe Orange	15	Black/Gray Stripe Gray/Black Stripe
3	White/Green Stripe Green	16	Yellow/Blue Stripe Blue/Yellow Stripe
4	White/Brown Stripe Brown	17	Yellow/Orange Stripe Orange/Yellow Stripe
5	White/Gray Stripe Gray/White Stripe	18	Yellow/Green Stripe Green/Yellow Stripe
6	Red/Blue Stripe Blue/Red Stripe	19	Yellow/Brown Stripe Brown/Yellow Stripe
7	Red/Orange Stripe Orange/Red Stripe	20	Yellow/Gray Stripe Gray/Yellow Stripe
8	Red/Green Stripe Green/Red Stripe	21	Purple/Blue Stripe Blue/Purple Stripe
9	Red/Brown Stripe Brown/Red Stripe	22	Purple/Orange Stripe Orange/Purple Stripe
10	Red/Gray Stripe Gray/Red Stripe	23	Purple/Green Stripe Green/Purple Stripe
11	Black/Blue Stripe Blue/Black Stripe	24	Purple/Brown Stripe Brown/Purple Stripe
12	Black/Orange Stripe Orange/Black Stripe	25	Purple/Gray Stripe Gray/Purple Stripe
13	Black/Green Stripe Green/Black Stripe		

Technical Reference

Color Code Chart 5

Pair Identification Colors

For pairs numbering 1 through 25, the pair identification colors are outlined below. In cable constructions containing more than 25 pairs, the colors are repeated as necessary. Color coded binders are used to identify 25-pair groups of color.

Chart 5

Pair No.	Tip Color	Ring Color	Pair No.	Tip Color	Ring Color
1	White	Blue	14	Black	Brown
2	White	Orange	15	Black	Slate
3	White	Green	16	Yellow	Blue
4	White	Brown	17	Yellow	Orange
5	White	Slate	18	Yellow	Green
6	Red	Blue	19	Yellow	Brown
7	Red	Orange	20	Yellow	Slate
8	Red	Green	21	Violet	Blue
9	Red	Brown	22	Violet	Orange
10	Red	Slate	23	Violet	Green
11	Black	Blue	24	Violet	Slate
12	Black	Orange	25	Violet	Slate
13	Black	Green			

Associations and Reference Standards

Organizations Involved in Specifications for the Wire & Cable Industry

AAR	Association of American Railroads	IMSA	International Municipal Signal Association
AEIC	Association of Edison Illuminating Companies	ICEA	Insulated Power Cable Engineers Association
ANI	American Nuclear Insurers	MESA	Mine Environmental Safety Act
ASA	American Standards Association, Inc.	NEC	National Electrical Code (under auspices of NFPA)
ASTM	American Society for Testing Materials	NEMA	National Electrical Manufacturer's Association
CAA	Civil Aeronautics Administration	NBS	National Bureau of Standards
CSA	Canadian Standards Association	NBFU	National Board of Fire Underwriters
EIA	Electronic Industries Association	NFPA	National Fire Protection Association International
FAA	Federal Aviation Agency	REA	Rural Electrification Administration
IEEE	Institute of Electrical and Electronics Engineers	UL	Underwriters' Laboratories, Inc.

American Society for Testing and Materials (ASTM)

The ASTM is an organization which develops voluntary consensus standards for materials and material testing. The standards, written by professionals from a wide variety of industries, are recognized nationwide as the preferred materials-testing procedures.

ASTM Manufacturing Specifications in General Use by the Manufacturers of Electrical Wires and Cables:

B1	Hard drawn copper wire	B246	Tinned hard drawn and medium hard drawn copper wire
B3	Soft or annealed copper wire	B262	Three quarter hard aluminum wire
B8	Concentric-lay, stranded copper conductors	B496	Compact round concentric-lay stranded copper conductors
B33	Tinned soft or annealed copper wire	B574	Ozone-resisting insulation for wire and cable
B172	Rope-lay-stranded copper conductors (bunch stranded members)	B734	Insulated wire and cable: vinyl chloride insulating compound
B173	Rope-lay-stranded copper conductors (concentric-stranded members)	B752	Heavy duty black neoprene sheath for wire and cable
B174	Bunch stranded copper conductors	B754	Synthetic rubber insulation for wire and cable, 75°C operation
B189	Lead alloy coated soft copper wire	B1352	Ozone-resisting butyl rubber insulation for wire and cable
B230	Hard drawn aluminum wire		
B231	Concentric lay stranded aluminum conductors		
B232	Concentric-lay stranded aluminum conductors (ACSR)		

Canadian Standards Association (CSA)

The Canadian certification and test agency, which tests devices, materials and components for quality and safety, is comparable to UL in function, but CSA and UL do not necessarily recognize one another's approvals and their testing procedures differ. Like the UL label, the CSA seal is recognized in many countries throughout the world.

Electronic Industries Association (EIA)

The EIA is a non-profit organization representing manufacturers of electronic products. There are 300 member companies and approximately 200 committees and working groups in domestic and international standards development.

EIA RECOMMENDED STANDARDS

RS-214	Ampacity Calculations, method of calculation of current rating on hookup wire.
RS-232-C	Interface between data terminal equipment and data communication equipment employing serial binary data interchange. This is the most common type of microcomputer interface, typically employing a 25-position connector.
RS-422	Electrical characteristics of balanced digital interface circuits.
RS-423	Electrical characteristics of unbalanced digital interface circuits.
RS-449	General purpose 37-position and 9-position interfaces for data terminal equipment and data circuit-terminating equipment employing serial binary data interchange with control information on separate control circuits.

Associations and Reference Standards

Insulated Cable Engineers Association (ICEA) & National Electrical Manufacturers Association (NEMA)

This is a wire and cable manufacturer's organization which writes specifications for the telephone and power cable industries. ICEA publications are adopted in the public interest and are designed to eliminate misunderstandings between manufacturers and users, and to assist users in selecting and obtaining proper products for their particular needs.

ICEA S-75-381 / NEMA WC58	Portable & Power Feeder Cables for Use in Mines and Similar Applications
ICEA T-26-465 / NEMA WC54	Frequency of Sampling Extruded Dielectric Cables
ICEA S-76-474	Neutral-Supported Power Cable Assemblies With Weather-Resistant Extruded Insulation, 600 Volts
ICEA S-73-532 / NEMA WC57	Control Cables
ICEA S-70-547	Weather-Resistant Polyolefin-Covered Wire & Cable
ICEA S-82-552 / NEMA WC55	Instrumentation and Thermocouple Wire and Cable
ICEA T-27-581 / NEMA WC53	Standard Test Methods

The Insulated Cable Engineers Association (ICEA) has issued several new standards for solid-dielectric insulated power cables. Several of these standards are joint-standards with the National Electrical Manufacturers Association (NEMA). The new standards have been submitted to ANSI for recognition as National Standards.

The new ICEA standards reflect a change in ICEA's standards writing objective. They are written as "application standards" rather than the "insulation material-based standards" of the past. These new standards have been updated to reflect the latest conductor constructions, insulations and jacket materials being used to manufacture wires and cables. The advantage of having an application standard is that all insulations suitable for use on a specific product are contained in one document. With material-based standards, only one type of insulation and its requirements are defined. If a different insulation was to be considered, a separate standard would be required.

As a result of the new ICEA / NEMA application standards being issued, the older, more-familiar materials-based ICEA / NEMA standards are being withdrawn. This is necessary to eliminate duplication and because the materials-based standards are no longer being maintained. The withdrawn ICEA / NEMA standards are:

ICEA S-66-524 / NEMA WC7	Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable
ICEA S-68-516 / NEMA WC8	Ethylene-Propylene-Rubber Insulated Wire and Cable
ICEA S-61-402 / NEMA WC5	Thermoplastic-Insulated Wire and Cable
ICEA S-19-81 / NEMA WC3	Rubber-Insulated Wire and Cable

Associations and Reference Standards

WITHDRAWN STANDARD	TITLE	REPLACEMENT STANDARDS	TITLE
ICEA S-66-524 / NEMA WC7	Crosslinked-Thermosetting-Polyethylene Insulated Wire & Cable	ICEA S-95-658 / NEMA WC70 ICEA S-96-659 / NEMA WC71 ICEA S-93-639 / NEMA WC74 ICEA S-94-649 ICEA S-97-682 ICEA S-105-692 ICEA S-81-570	Nonshielded 0-2 KV Cables Nonshielded 2001-5 KV Cables Shielded Power Cable 5-46 KV Concentric Neutral Cables Rated 5-46 KV Utility Shielded Power Cable Rated 5-46 KV 600 V Single Layer Thermoset Insulated Utility Underground Distribution Cable Direct Burial, 600 Volt, Ruggedized Insulation
ICEA S-68-516 / NEMA WC8	Ethylene-Propylene-Rubber Insulated Wire & Cable	ICEA S-95-658 / NEMA WC70 ICEA S-96-659 / NEMA WC71 ICEA S-93-639 / NEMA WC74 ICEA S-94-649 ICEA S-97-682 ICEA S-105-692	Nonshielded 0-2 KV Cables Nonshielded 2001-5 KV Cables Shielded Power Cable 5-46 KV Concentric Neutral Cables Rated 5-46 KV Utility Shielded Power Cable Rated 5-46 KV 600 V Single Layer Thermoset Insulated Utility Underground Distribution Cable
ICEA S-61-402 / NEMA WC5	Thermoplastic-Insulated Wire & Cable	ICEA S-95-658 / NEMA WC70	Nonshielded 0-2 KV Cables
ICEA S-19-81 / NEMA WC3	Rubber-Insulated Wire & Cable	ICEA S-95-658 / NEMA WC70 ICEA S-96-659 / NEMA WC71 ICEA S-93-639 / NEMA WC74 ICEA S-94-649 ICEA S-97-682 ICEA S-105-692	Nonshielded 0-2 KV Cables Nonshielded 2001-5 KV Cables Shielded Power Cable 5-46 KV Concentric Neutral Cables Rated 5-46 KV Utility Shielded Power Cable Rated 5-46 KV 600 V Single Layer Thermoset Insulated Utility Underground Distribution Cable

NEMA

Adopted in the public interest and designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for its particular need.

<u>NEMA code</u>	<u>Same as ICEA</u>
WC53	T-27-581
WC54	T-26-465
WC55	S-82-552
WC57	S-73-532
WC58	S-75-381
WC70	S-95-658
WC71	S-96-659
WC74	S-93-639

Associations and Reference Standards

Institute of Electrical and Electronic Engineers (IEEE)

IEEE is the world's largest professional engineering society. One of its objectives is to provide standards for rating the performance of equipment and materials. The institute also offers courses to allow engineers to keep abreast of developments in the electrical and electronic engineering fields.

Military and Government Wire Specifications

J-C-90	Flexible cord and fixture wire	MIL-C-24643	Cable cord, electrical low smoke, for shipboard use
J-C-96	Neoprene jacketed telephone wire		
J-C-580	Flexible cord and fixture wire	MIL-C-25038	Cable, electrical, high temperature and fire resistant
J-C-741	Rubber and/or Neoprene welding cable	MIL-C-26468	(USAF) - Cables, guided missile, ground installation, general requirements
MIL-C-3078	Cable, electric, insulated, low tension, single conductor	MIL-C-27072	Multi-conductor ground support cable
MIL-C-3432	300 and 600 volt rubber insulated power and control cable	MIL-C-27212	Cable, power, electrical, airport lighting control
MIL-C-4912A (ASG)	Single conductor 8AWG 5,000 volt cable with butyl compound insulation and polychloroprene. For airport lighting.	MIL-C-38359	(USAF) - Power cable of two voltage range for airport lighting, 8AWG (3,000-5,000V) CCLP insulated
MIL-C-5136	Cable, power, electric, polychloroprene sheathed, buna compound insulated.	MIL-C-55021	Cables, twisted pairs and triples, internal hook-up, shielded and unshielded
MIL-C-5756	Low temperature rubber portable cords	MIL-C-55036	Cable, telephone, WM130# #/6
MIL-C-6166	Cord, head-set-microphone CX1301/AR	MIL-E-9085	(USAF) - Electrical cord - M-85/U
MIL-C-7078	600 volt aircraft wire using MIL-W-5086 components	MIL-E-9088	(USAF) - Electrical cord - WF-14/U
MIL-C-11097	Cable, telephone (Wire W-50-A)	MIL-R-8333	(USAF) - RF cable - RG122/U
MIL-C-11440	Cable, power electrical	MIL-STD-122	Color code for chassis wiring for electronic equipment
MIL-C-12064	Low temperature power cable and cords for arctic service	MIL-STD-681	Identification coding and application of hook-up wire
MIL-C-12423	Cable, telephone W-33/U	MIL-W-76	General purpose hook-up wire, vinyl insulated types LW, MW and HW
MIL-C-12881	Cables, telephone, switchboard (cables and cable assemblies)	MIL-W-538	Wire, magnet, electrical
MIL-C-13777	Multi-conductor missile ground support cable	MIL-W-5274	Spec for aircraft wire. Type I 600 volt, Type II 600 volt, Type III 300V rating
MIL-C-14189	Cable, power electrical, 3000 volt, for field use	MIL-W-6370	Wire, electrical, insulated antenna
MIL-C-18959	Cable, power, electrical, portable, Neoprene jacketed 600 volts	MIL-W-13074	Wire, electrical (W-27 and WS-19[U])
MIL-C-18962	Cable, power, electrical, direct burial, Neoprene jacketed 600 volt.	MIL-W-13075	Wire, electrical
MIL-C-19381 (SHIPS)	Cables, special purpose, electrical (nuclear plant)	MIL-W-13169	Wire, electrical (for instrument test leads)
MIL-C-19547	Cables, electrical, special purpose, shore use	MIL-W-13241	Wire, electrical
MIL-C-21609	Cable, electrical, shield, 600 V (non-flexing service)	MIL-W-16878	Electronic hook-up wire, includes vinyl (Types B, C and D); Teflon (Types ET, E, EE, KT, K and KK); and polyethylene (Type J)
MIL-C-24640	Cable, electrical, lightweight for shipboard use	MIL-W-19583	(Navy) - Wire, electrical, magnet, high temperature, film insulated

Associations and Reference Standards

National Electrical Code (NEC)

The NEC is intended to help protect people and property from electrical hazards. It is sponsored, controlled and published by the National Fire Protection Agency (NFPA). While compliance with the NEC is not mandatory, many municipalities have adopted it, in part or in the whole as their legal fire and building codes.

The NEC, revised every three years, is used by lawyers and insurance companies to determine liability, and by fire marshals and either a UL Listed or UL Classified rating is appropriate.

Rural Electrification Administration (REA)

The REA is a U.S. Government Agency, a unit of the U.S. Dept. of Agriculture; one area of which has responsibility for lending money to independent telephone companies. REA specifications control the type and quality of telecommunication products produced by the companies who receive these loans. Manufacturers must qualify their products per an REA specifications to be an approved supplier to one of these telephone companies. REA specifications carry the prefix RUS (rural underground service).

Underwriters Laboratories (UL)

UL is a non-profit organization chartered to establish, maintain and operate laboratories for the examination and testing of devices, systems, and materials. While UL's primary function is to conduct tests on products to determine if they are hazardous to life or property, they have established a number of UL standards. UL performs the tests specified in standards set by others, such as the National Fire Protection Agency (NFPA), and authors of the National Electrical Code (NEC).

Cable Standards

UL Standard	13	-	PLTC
UL Standard	4	-	Armored Cable
UL Standard	62	-	Flexible Cord
UL Standard	44	-	Rubber-Thermoset
UL Standard	83	-	Thermoplastic Insulated
UL Standard	719	-	Non-metallic

The UL labels of approval, detailed below, are recognized and respected by electrical inspectors, fire marshals, insurance underwriters, and regulatory personnel.

UL Listed

To be labeled UL Listed, a product must successfully complete a series of mechanical, electrical and thermal characteristic tests which simulate all reasonable, foreseeable hazards. A UL Listing is assigned exclusively for the specific application for which it was tested and is not valid for other applications.

UL Classified

For UL Classified labels, products are evaluated with respect to one or more of the following:

- Specific hazards only
- Performance under specific conditions
- Regulatory codes
- Other standards, including international standards

The UL "Classified" rating is generally restricted to industrial or commercial products.

UL Recognized

Products bearing UL Recognized labels have been tested for use as a component in a UL Listed package. These component products are tested for electrical, mechanical and thermal characteristics.

UL Recognized is a more general purpose approval than UL Listing in that it allows a product to be certified for a category of equipment uses. An example is hookup wire, which has been UL Recognized as appliance wiring material, a category of uses that includes data communications, telecommunications, and instrumentation.

Reference Standards

A

AAR S-501: Specification for Wire & Cables

AAR 581.3: Specification for Single Conductor, Clean Stripping Rubber Insulated, 0-600 Volts, Neoprene® Jacketed Cable for Locomotive and Car Equipment

AAR 589: Specification for Single Conductor Chlorosulfonated Polyethylene Integral Insulated-Jacketed, 0-300V, 0-600V Cable for Locomotive and Car Equipment

AEIC CS1: Specifications for Solid-Type Impregnated-Paper-Insulated Metallic Sheathed Cable

AEIC CS2: Specifications for Impregnated-Paper and Laminated Paper-Polypropylene Insulated Cable, High-Pressure Pipe-Type

AEIC CS3: Specifications for Impregnated-Paper-Insulated, Metallic Sheathed Cable, Low Pressure Gas-Filled Type

AEIC CS4: Specifications for Impregnated-Paper-Insulated Low and Medium Pressure Self Contained Liquid Filled Cable

AEIC CS5: Specifications for Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 69 kV

AEIC CS6: Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

AEIC CS7: Specifications for Crosslinked Polyethylene Insulated Shielded Power Cables Rated 46 Through 138 kV

AEIC CS8: Specification for Extended Dielectric, Shielded Power Cables Rated 5 through 46 kV

ANSI C2: National Electrical Safety Code

ANSI MC96.1: Thermocouple Extension Wire Calibration

ANSI N45.2: Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants

ASTM B1: Standard Specification for Hard-Drawn Copper Wire

ASTM B2: Standard Specification for Medium-Hard-Drawn Copper Wire

ASTM B3: Standard Specification for Soft or Annealed Copper Wire

ASTM B8: Standard Specification for Concentric-Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM B33: Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

ASTM B105: Standard Specification for Hard-Drawn Copper Alloy Wires for Electrical Conductors

ASTM B170: Standard Specification for Oxygen-Free Electrolytic Copper

ASTM B172: Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

ASTM B173: Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors

ASTM B174: Standard Specification for Bunch-Stranded Copper Conductors for Electrical Conductors

ASTM B189: Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes

ASTM B193: Standard Test Method for Resistivity of Electrical Conductor Materials

ASTM B226: Standard Specification for Cored, Annular, Concentric-Lay-Stranded Copper Conductors

ASTM B227: Standard Specification for Hard-Drawn Copper-Clad Steel Wire

ASTM B228: Standard Specification for Concentric-Lay-Stranded Copper-Clad Steel Conductors

ASTM B229: Standard Specification for Concentric-Lay-Stranded Copper and Copper-Clad Steel Composite Conductors

ASTM B230: Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes

ASTM B230M: Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes [Metric]

ASTM B231: Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors

ASTM B231M: Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors [Metric]

ASTM B232: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACACARSR)

ASTM B232M: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACSR) [Metric]

ASTM B233: Standard Specification for Aluminum 1350 Drawing Stock for Electrical Purposes

ASTM B246: Standard Specification for Tinned Hard-Drawn and Medium-Hard-Drawn Copper Wire for Electrical Purposes

ASTM B258: Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

ASTM B263: Standard Test Method for Determination of Cross-Sectional Area of Stranded Conductors

ASTM B286: Standard Specification for Copper Conductors for Use in Hookup Wire for Electronic Equipment

ASTM B298: Standard Specification for Silver-Coated Soft or Annealed Copper Wire

ASTM B324: Standard Specification for Nickel-Coated Soft or Annealed Copper Wire

ASTM B341: Standard Specification for Aluminum-Coated (Aluminized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR/AZ)

ASTM B341M: Standard Specification for Aluminum-Coated (Aluminized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR/AZ) [Metric]

ASTM B355: Standard Specification for Nickel-Coated Soft or Annealed Copper Wire

ASTM B397: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 5005-H19 Conductors

ASTM B398: Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes

ASTM B398M: Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes [Metric]

ASTM B399: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors

ASTM B399M: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors [Metric]

ASTM B400: Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors

Reference Standards

- ASTM B401:** Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum Conductors, Steel-Reinforced (ACSR/COMP)
- ASTM B416:** Standard Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
- ASTM B452:** Standard Specification for Copper-Clad Steel Wire for Electronic Application
- ASTM B470:** Standard Specification for Bonded Copper Conductors for Use in Hookup Wires for Electronic Equipment
- ASTM B496:** Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
- ASTM B498:** Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR)
- ASTM B498M:** Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR) [Metric]
- ASTM B500:** Standard Specification for Zinc-Coated (Galvanized), Zinc-5% Aluminum Mischmetal Alloy-Coated, and Aluminum-Coated (Aluminized) Stranded Steel Core for Aluminum Conductors, Steel-Reinforced (ACSR)
- ASTM B501:** Standard Specification for Silver-Coated, Copper-Clad Steel Wire for Electronic Application
- ASTM B502:** Standard Specification for Aluminum-Clad Steel Core Wire for Aluminum Conductors, Aluminum-Clad Steel Reinforced
- ASTM B520:** Standard Specification for Tin-Coated, Copper-Clad Steel Wire for Electronic Application
- ASTM B524:** Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201)
- ASTM B524M:** Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201) [Metric]
- ASTM B549:** Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced (ACSR/AW)
- ASTM B559:** Standard Specification for Nickel-Coated, Copper-Clad Steel Wire for Electronic Application
- ASTM B606:** Standard Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum Alloy Conductors, Steel Reinforced
- ASTM B609:** Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes
- ASTM B609M:** Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes [Metric]
- ASTM B624:** Standard Specification for High-Strength, High-Conductivity Copper-Alloy Wire for Electronic Application
- ASTM B682:** Standard Specification for Standard Metric Sizes of Electrical Conductors
- ASTM B701:** Standard Specification for Concentric-Lay-Stranded Self-Damping Aluminum Conductors, Steel-Reinforced (ACSR/SD)
- ASTM B711:** Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy Conductors, Steel Reinforced (AACSR) (6201)
- ASTM B738:** Standard Specification for Fine-Wire Bunch-Stranded and Rope-Lay Bunch Stranded Copper Conductors for Use as Electrical Conductors
- ASTM B778:** Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors (AAC/TW)
- ASTM B779:** Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Steel Reinforced (ACSR/TW)
- ASTM B784:** Standard Specification for Modified Concentric-Lay-Stranded Copper Conductors for Use in Insulated Electrical Cables
- ASTM B785:** Standard Specification for Compact Round Modified Concentric-Lay-Stranded Copper Conductors for Use in Insulated Electrical Cables
- ASTM B786:** Standard Specification for 19 Wire Combination Unilay-Stranded Aluminum 1350 Conductors for Subsequent Insulation
- ASTM B787:** Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation
- ASTM B801:** Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
- ASTM B802:** Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)
- ASTM B803:** Standard Specification for High-Strength Zinc-5% Aluminum-Mischmetal Alloy Coated Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced
- ASTM D149:** Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
- ASTM D470:** Method of Testing Crosslinked Insulations and Jackets for Wire and Cable
- ASTM D866:** Specification for Styrene-Butadiene (SBR) Synthetic Rubber Jacket for Wire and Cable
- ASTM D1047:** Specification for Polyvinyl Chloride (PVC) Jacket for Wire and Cable
- ASTM D1351:** Specification for Polyethylene Insulation for Wire and Cable
- ASTM D1352:** Specification for Ozone-Resisting Butyl Rubber Insulation for Wire and Cable
- ASTM D1523:** Method for Synthetic Rubber Insulation for Wire and Cable, 90°C Operation
- ASTM D1679:** Specification for Synthetic Rubber Heat and Moisture-Resisting Insulation for Wire and Cable, 75°C Operation
- ASTM D2219:** Specification for Polyvinyl Chloride (PVC) Insulation for Wire and Cable, 60°C Operation
- ASTM D2220:** Specification for Polyvinyl Chloride (PVC) Insulation for Wire and Cable, 75°C Operation
- ASTM D2308:** Specification for Polyethylene Jacket for Electrical Insulated Wire and Cable
- ASTM D2526:** Specification for Ozone-Resisting Silicone Rubber Insulation for Wire and Cable
- ASTM D2655:** Specification for Crosslinked Polyethylene Insulation for Wire and Cable Rated 0 to 2000V
- ASTM D2656:** Specification for Crosslinked Polyethylene Insulation for Wire and Cable Rated 2001 to 35000V

Reference Standards

ASTM D2768: Specification for General-Purpose Ethylene-Propylene Rubber Jacket for Wire and Cable

ASTM D2770: Specification for Ozone-Resisting Ethylene-Propylene Rubber Integral Insulation and Jacket for Wire and Cable

ASTM D2802: Specification for Ozone-Resistant Ethylene-Propylene Rubber Insulation for Wire and Cable

ASTM D3004: Specification for Extruded Thermosetting and Thermoplastic Semi-Conducting Conductor and Insulation Shields

ASTM D3485: Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable

ASTM D3554: Specification for Track-Resistant Black Thermoplastic High Density Polyethylene Insulation for Wire and Cable

ASTM D3555: Specification for Track-Resistant Black Crosslinked Thermosetting Polyethylene Insulation for Wire and Cable

ASTM D4244: Specification for General-Purpose, Heavy-Duty and Extra-Heavy Duty Acrylonitrile-Butadiene/ Polyvinyl Chloride (NBR/PVC) Jackets for Wire and Cable

ASTM D4245: Specification for Ozone-Resistant Thermoplastic Elastomer Insulation for Wire and Cable, 90°C C Dry - 75°C C Wet Operation

ASTM D4246: Specification for Ozone-Resistant Thermoplastic Elastomer Insulation for Wire and Cable, 90°C C Operation

ASTM D4247: Specification for General-Purpose Black Heavy-Duty and Black Extra-Heavy Duty Polychloroprene Jackets for Wire and Cable

ASTM D4313: Specification for General Purpose Heavy-Duty and Extra-Heavy-Duty Crosslinked Chlorinated Polyethylene Jackets for Wire and Cable

ASTM D4314: Specification for General Purpose Heavy-Duty and Extra-Heavy-Duty Crosslinked Chlorosulfonated Polyethylene Jackets for Wire and Cable

ASTM D4363: Specification for Thermoplastic Chlorinated Polyethylene Jacket for Wire and Cable

ASTM D4496: Test Method of DC Resistance or Conductance of Moderately Conductive Materials

ASTM D4568: Test Methods for Evaluating Compatibility Between Cable Filling and Flooding Compounds and Polyolefin Cable Materials

ASTM D4967: Guide for Selecting Materials to Be Used for Insulation, Jacketing, and Strength Components in Fiber Optic Cables

C

CAN3-Z299.0: Guide for Selecting and Implementing the CAN3-Z299 Quality Assurance Program Standards

CAN3-Z299.1: Standard for Quality Assurance Program - Category 1

CAN3-Z299.2: Standard for Quality Assurance Program - Category 2

CAN3-Z299.3: Standard for Quality Assurance Program - Category 3

CAN3-Z299.4: Standard for Quality Assurance Program - Category 4

CAN/CSA C22.2 No. 211: Standard for Cord Sets and Power-Supply Cords

CAN/CSA C22.2 No. 48: Standard for Nonmetallic Sheathed Cable

CAN/CSA C22.2 No. 49: Standard for Flexible Cords and Cables

CAN/CSA C22.2 No. 51: Standard for Armored Cable

CAN/CSA C22.2 No. 96: Standard for Portable Power Cables

CAN/CSA C22.2 No. 130.1: Standard for Heat-Tracing Cable Systems for Use in Industrial Locations

CAN/CSA C22.2 No. 131: Standard for Type TECK 90 Cable

CAN/CSA C22.2 No. 203: Standard for Modular Wiring Systems for Office Furniture

CAN/CSA C22.2 No. 210.2: Standard for Appliance Wiring Material Products

CAN/CSA C22.2 No. 214: Standard for Communications Cables

CAN/CSA C22.2 No. 233: Standard for Cords and Cord Sets for Communication Systems

CAN/CSA C22.2 No. 239: Standard for Control and Instrumentation Cables

CAN/CSA C22.2 No. 241: IEEE Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V Through 46,000V, and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V Through 500,000V (Adopted IEEE 404-1986)

CAN/CSA C22.3 No. 1: Standard for Overhead Systems

CAN/CSA C22.3 No. 8: Standard for Railway Electrification Guidelines

CAN/CSA C49.1: Standard for Round Wire, Concentric Lay, Overhead Electrical Conductors

CAN/CSA C68.3: Standard for Shielded and Concentric Neutral Power Cables Rated 5-46 kV

CAN/CSA T529: Standard Design Guide for Telecommunications Wiring Systems in Commercial Buildings

CSA C22.1: Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations

CSA C22.2 No. 0.3: Standard for Test Methods for Electrical Wires and Cables

CSA C22.2 No. 16: Standard for Insulated Conductors for Power-Operated Electronic Devices

CSA C22.2 No. 35: Standard for Extra-Low-Voltage Control Circuit Cables, Low-Energy Control Cable, and Extra-Low-Voltage Control Cable

CSA C22.2 No. 38: Standard for Thermoset Insulated Wires and Cables

CSA C22.2 No. 52: Standard for Service-Entrance Cables

CSA C22.2 No. 75: Standard for Thermoplastic-Insulated Wires and Cables

CSA C22.2 No. 116: Standard for Coil-Lead Wires

CSA C22.2 No. 123: Standard for Aluminum Sheathed Cables

CSA C22.2 No. 124: Standard for Mineral-Insulated Cable

CSA C22.2 No. 127: Standard for Equipment Wires

CSA C22.2 No. 129: Standard for Neutral Supported Cable

CSA C22.2 No. 130: Standard for Heating Cables and Heating Cable Sets

CSA C22.2 No. 138: Standard for Heat Tracing Cable and Cable Sets for Use in Hazardous Locations

CSA C22.2 No. 174: Standard for Cables and Cable Glands for Use in Hazardous Locations

Reference Standards

CSA C22.2 No. 179: Standard for Airport Series Lighting Cables
CSA C22.2 No. 188: Standard for Splicing Wire and Cable Connectors
CSA C22.2 No. 198.2: Standard for Underground Cable Splicing Kits
CSA C22.2 No. 208: Standard for Fire Alarm and Signal Cable
CSA C22.2 No. 222: Standard for Type FCC Under-Carpet Wiring System
CSA C22.2 No. 230: Standard for Tray Cable
CSA C22.2 No. 232: Standard for Optical Fiber Cables
CSA/CAN3 C22.3 No. 7: Standard for Underground Systems
CSA C49.2: Standard for Compact Aluminum Conductors Steel Reinforced (ACSR)
CSA C49.3: Standard for Aluminum Alloy 1350 Round Wire, All Tempers, for Electrical Purposes
CSA C49.4: Standard for Concentric-Lay Aluminum Stranded Conductors (ASC)
CSA C49.5: Standard for Compact Round Concentric-Lay Aluminum Stranded Conductors (Compact ASC)
CSA CAN3-C49.6: Standard for Zinc-Coated Steel Wires for Use in Overhead Electrical Conductors
CSA CAN3-C49.7: Standard for Aluminum Round Wires for Use in Overhead Electrical Conductors
CSA C68.1: Standard Specifications for Impregnated Paper-Insulated, Metallic-Sheathed Cable, Solid-Type
CSA C170.2: Standard for Polyethylene Protective Covering on Paper-Insulated Metallic Sheathed Power Cable
CSA C170.3: Standard for Polyvinyl-Chloride (PVC) Protective Covering on Paper-Insulated Metallic-Sheathed Power Cable
CSA M421: Standard for Use of Electricity in Mines

E

EIA/TIA-568: Commercial Building Telecommunications Wiring Standard
EIA/TIA-569: Commercial Building Standard for Telecommunications Pathways and Spaces
EIA/TIA-606: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA/TIA TSB-36: Additional Cable Specifications for Unshielded Twisted Pair Cables (Technical Systems Bulletin 36)
EIA/TIA TSB-40: Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware (Technical Systems Bulletin 40)

F

FP-4: TM-4 CSA CBC and UL CMR (Riser) Cable
FP-16: TD-16 Plastic Insulated, Two Parallel Conductor, Telephone Drop Wire
FP-28: Air Core, Solid PIC, ALPETH-DCAS Cable & PAP-DCAS Cable
FP-67: PHD Plastic Insulated and Jacketed, Four Conductor, Telephone Drop Wire
FP-68: TM-68 CSA PCC FT4, Shielded Inside Wiring Cable
FP-71: TM-28 CSA PCC FT4, Inside Wiring Cable

FP-75: PHILPLAST CSA PCC FT4, PVC Insulated and Jacketed, Switchboard Cable
FP-81: TM-81 CSA ZSW FT1, Telephone Station Wire
FP-90: CONCEL Cellular Polyethylene Insulated, Air Core, ALPETH-DCAS Sheathed, Telephone Cable
FP-93: TM-91, TM-92, TM-93 & TM-97, Filled, Buried Wire
FP-95: Quasi-Solid Polyethylene Insulated, Filled, Regular & Twin Core, ALPETH-DCAS Sheathed Cable
FP-98: CELSEAL Cellular Polyethylene Insulated, Filled, ALPETH-DCAS Sheathed Cable
FP-99: DUCTCEL Cellular Polyethylene Insulated, Air Core, ALPETH-DCAS Sheathed Telephone Cable
FP-8859: PHILSYM UL 444 CMR & CSA PCC FT4 Switchboard Cable

H

HP: See NEMA listing

I

ICEA P-32-382: ICEA Standards Publication for Short Circuit Characteristics of Insulated Cable
ICEA P-45-482: ICEA Standards Publication for Short-Circuit Performance of Metallic Shields and Sheaths of Insulated Cable
ICEA P-53-426: ICEA/NEMA Standards Publication for Ampacities, Including Effect of Shield Losses for Single-Conductor Solid-Dielectric Power Cable 15 kV through 69 kV (NEMA WC 50)
ICEA P-54-440: ICEA/NEMA Standards Publication for Ampacities of Cables in Open-Top Cable Trays (NEMA WC 51)
ICEA P-79-561: ICEA Guide for Selecting Aerial Cable Messengers & Lashing Wires
ICEA P-81-570: ICEA Standards Publication for Direct Burial 600 Volt Cable with Ruggedized Extruded Insulation
ICEA S-19-81: ICEA/NEMA Standards Publication for Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 3)
ICEA S-56-434: ICEA/ANSI Standards Publication for Polyolefin Insulated Communications Cables for Outdoor Use
ICEA S-61-402: ICEA/NEMA Standards Publication for Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 5)
ICEA S-66-524: ICEA/NEMA Standards Publication for Cross-Linked-Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 7)
ICEA S-67-401: ICEA/NEMA Standards Publication for Steel Armor and Associated Coverings for Impregnated-Paper-Insulated Cables (NEMA WC 2)
ICEA S-68-516: ICEA/NEMA Standards Publication for Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 8)
ICEA S-70-547: ICEA/ANSI Standards Publication for Weather-Resistant Polyolefin-Covered Wire and Cable
ICEA S-73-532: ICEA/NEMA/ANSI Standards Publication for Control Cables (NEMA WC 57)

Reference Standards

ICEA S-75-381: ICEA/NEMA/ANSI Standards Publication for Portable and Power Feeder Cables for Use in Mines and Similar Applications (NEMA WC 58)

ICEA S-76-474: ICEA/ANSI Standards Publication for Neutral-Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation, 600 Volts

ICEA S-77-528: ICEA/ANSI Standards Publication for Outside Plant Communications Cables, Specifying Metric Wire Sizes

ICEA S-80-576: ICEA/ANSI Standards Publication for Communications Wire and Cable for Wiring of Premises

ICEA S-81-570: Standard for Direct Burial 600 Volt Ruggedized Insulation

ICEA S-82-552: ICEA/NEMA Standards Publication for Instrumentation Cables and Thermocouple Wire (NEMA WC 55)

ICEA S-83-596: ICEA/ANSI Standards Publication for Fiber Optic Premises Distribution Cable

ICEA S-84-608: ICEA/ANSI Standards Publication for Telecommunications Cable, Filled Polyolefin Insulated, Copper Conductor

ICEA S-85-625: ICEA/ANSI Standards Publication for Aircore, Polyolefin Insulated, Copper Conductor Telecommunications Cable

ICEA S-86-634: ICEA/ANSI Standards Publication for Buried Distribution & Service Wire, Filled Polyolefin Insulated, Copper Conductor

ICEA S-87-640: ICEA/ANSI Standards Publication for Fiber Optic Outside Plant Communication Cable

ICEA S-93-639: ICEA/NEMA Standard for Shielded Power Cables Rated 5-46 KV for the Distribution of Electrical Energy (NEMA WC 74)

ICEA S-94-649: Standard for Concentric Neutral Cables Rated 5-46 KV

ICEA S-95-658: ICEA/NEMA Standard for Non-shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy (NEMA WC 70)

ICEA S-96-659: ICEA/NEMA Standard for Non-shielded Cables Rated 2001-5000 Volts for use in the Distribution of Electrical Energy (NEMA WC 71)

ICEA S-97-682: Standard for Utility Shielded Power Cable Rated 5-46 KV

ICEA S-105-692: Standard for 600 Volt Single Layer Thermoset Insulated Utility Underground Distribution Cable

ICEA T-22-294: ICEA Standard Test Procedures for Extended Time-Testing of Wire and Cable Insulations for Service in Wet Locations

ICEA T-25-425: ICEA Guide for Establishing Stability of Volume Resistivity for Conducting Polymeric Components of Power Cables

ICEA T-26-465: ICEA/NEMA Guide for Frequency of Sampling Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test (NEMA WC 54)

ICEA T-27-581: ICEA/NEMA Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables (NEMA WC 53)

ICEA T-28-562: ICEA Standard Test Method for Measurement of Hot Creep of Polymeric Insulations

ICEA T-29-520: ICEA Standard for Vertical Tray Flame Tests at 210,000 Btu

ICEA T-30-520: ICEA Standard for Vertical Tray Flame Tests at 70,000 Btu

ICEA T-31-610: ICEA Standard for Water Penetration Resistance Test, Sealed Conductor

ICEA T-32-645: ICEA Standards Publication for Compatibility of Sealed Conductor Filer Compounds

IEC 92-3: International Electrotechnical Commission Electrical Installation in Ships - Part 3 Cables (Constructions, Testing, and Installations)

IEEE 45: IEEE Recommended Practice for Electric Installations on Shipboard

IEEE 48: IEEE Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations

IEEE 100: IEEE Standard Dictionary of Electrical and Electronics Terms

IEEE 141: IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)

IEEE 142: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

IEEE 241: IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE Gray Book)

IEEE 242: IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

IEEE 323: IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations

IEEE 383: IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations

IEEE 400: IEEE Guide for Making High-Direct-Voltage Tests on PowerCable Systems in the Field

IEEE 404: IEEE Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V Through 46,000V, and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V Through 500,000V (Adopted as a National Standard of Canada, CAN/CSA-C22.2 No. 241)

IEEE 446: IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)

IEEE 493: IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book)

IEEE 515: IEEE Recommended Practice for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications

IEEE 524: IEEE Guide to the Installation of Overhead Transmission Line Conductors

IEEE 525: IEEE Guide for the Design and Installation of Cable Systems in Substations

IEEE 575: IEEE Guide for the Application of Sheath-Bonding Methods for Single-Conductor Cables and the Calculation of Induced Voltages and Currents in Cable Sheaths

IEEE 576: IEEE Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in the Petroleum and Chemical Industry

IEEE 590: IEEE Cable Plowing Guide

IEEE 602: IEEE Recommended Practice for Electric Systems in Health Care Facilities (IEEE White Book)

Reference Standards

IEEE 635: IEEE Guide for Selection and Design of Aluminum Sheaths for Power Cables

IEEE 644: IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines

IEEE 738: IEEE Standard for Calculation of Bare Overhead Conductor Temperature and Ampacity Under Steady-State Conditions

IEEE 789: IEEE Standard Performance Requirements for Communications and Control Cables for Application in High Voltage Environments

IEEE 802.3: IEEE Standard for Information Processing Systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications (ISO/IEC) (ANSI/IEEE Std 802.3)

IEEE 802.5: IEEE Standard for Information Technology - Local and Metropolitan Area Networks - Part 5: Token Ring Access Method and Physical Layer Specifications (ISO/IEC) (ANSI/IEEE Std 802.5)

IEEE 816: IEEE Guide for Determining the Smoke Generation of Solid Materials Used for Insulations and Coverings of Electric Wire and Cable

IEEE 844: IEEE Recommended Practice for Electrical Impedance, Induction, and Skin Effect Heating of Pipelines and Vessels

IEEE 1017: IEEE Recommended Practice for Field Testing Electric Submersible Pump Cable

IEEE 1018: IEEE Recommended Practice for Specifying Electric Submersible Pump Cable - Ethylene-Propylene Rubber Insulation

IEEE 1019: IEEE Recommended Practice for Specifying Electric Submersible Pump Cable - Polypropylene Insulation

IEEE 1120: IEEE Guide to the Factors to Be Considered in the Planning, Design, and Installation of Submarine Power and Communications Cables

IEEE 1202: IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies

IEEE/ICEA S-135: Power Cable Ampacities

M

Mil-C-17: General Specifications for Flexible and Semirigid Radio Frequency Cables

Mil-C-915F: General Specification for Electrical Cable and Conductors for Shipboard Use

Mil-C-13777: General Specification for Special Purpose Electrical Cable

Mil-C-24640: General Specification for Lightweight Electrical Cable for Shipboard Use

Mil-C-24643: General Specification for Low Smoke Electrical Cable and Conductors for Shipboard Use

Mil-C-27500: General Specification for Shielded and Unshielded Electrical Power Cable and Special Purpose Cable

Mil-C-85045: General Specification for Fiber Optic Cables [Metric]

Mil-W-16878: General Specification for Insulated Electrical Wire

Mil-W-22759: General Specification for Copper or Copper Alloy Fluoropolymer-Insulated Electrical Wire

Mil-W-81044: General Specification for Copper or Copper Alloy,

Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer or Polyalkene Insulated Electrical Wire

Mil-W-81381: General Specification for Replacement Wire

Mil-W-85485: General Specification for Radio Frequency Absorptive Filter Line Electrical Cable

N

NAVSEA 6710782: Fiber Optic & Multimode Cable

NEMA HP 3: Electrical and Electronic PTFE (Polytetrafluoroethylene) Insulated High Temperature Hook-Up Wire; Types (600 Volt), EE (1000 Volt), and ET (250 Volt)

NEMA HP 4: Electrical and Electronic FEP Insulated High Temperature Hook-Up Wire; Types K, KK, and KT

NEMA HP 100: High Temperature Instrumentation and Control Cables

NEMA HP 100.1: High Temperature Instrumentation and Control Cables Insulated and Jacketed with FEP Fluorocarbons

NEMA HP 100.2: High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers

NEMA HP 100.3: High Temperature Instrumentation and Control Cables Insulated and Jacketed with Cross-Linked (Thermoset) Polyolefin (XLPO)

NEMA HP 100.4: High Temperature Instrumentation and Control Cables Insulated and Jacketed with ECTFE Fluoropolymers

NEMA WC 2: Steel Armor and Associated Coverings for Impregnated-Paper-Insulated Cables (ICEA S-67-401)

NEMA WC 3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-19-81)

NEMA WC 5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-61-402)

NEMA WC 7: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-66-524)

NEMA WC 8: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)

NEMA WC 26: Wire and Cable Packaging

NEMA WC 50: Ampacities, Including Effect of Shield Losses for Single-Conductor Solid Dielectric Power Cable 15 kV through 69 kV (ICEA P-53-426)

NEMA WC 51: Ampacities of Cables in Open-Top Cable Trays (ICEA P-54-440)

NEMA WC 52: High Temperature and Electronic Insulated Wire-Impulse Dielectric Testing

NEMA WC 53: Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables (ICEA T-27-581)

NEMA WC 54: Guide for Frequency of Sampling Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test (ICEA T26-465)

NEMA WC 55: Instrumentation Cables and Thermocouple Wire (ICEA S-82-552)

NEMA WC 56: 3.0 kHz Insulation Continuity Proof Testing of

Reference Standards

Hook-Up Wire

NEMA WC 57: Standard for Control Cables (ICEA S-73-532)

NEMA WC 58: Standard for Portable and Power Feeder Cables for Use in Mines and Similar Applications (ICEA-S-75-381)

NEMA WC 61: Transfer Impedance Testing

NEMA WC 62: Repeated Spark/Impulse Dielectric Testing

NEMA WC 70: Standard for Non-shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy (ICEA S-95-668)

NEMA WC 71: Standard for Non-shielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electrical Energy (ICEA S-96-659)

NEMA WC 74: Standard for Shielded Power Cables Rated 5-46 KV for the Distribution of Electrical Energy (ICEA S-93-639)

NFPA 70: National Electrical Code

NFPA 70HB: National Electrical Code Handbook

NFPA 262: Test for Fire and Smoke Characteristics of Wires and Cables

O

ONT M-302-84: Cable, Secondary, for Direct Burial

ONT M-355-82: Cable, Primary Submarine

ONT M-538-84: Cable, For Use in Generating Stations (5 kV and Above)

ONT M-570-84: Cable, For Use in Generating Stations (600V)

ONT M-695-88: Cable, Primary and Subtransmission Submarine, Concentric Neutral

S

SAE 1560: Low Tension Thin Wall Primary Cable

SAE J1127: Battery Cable

SAE J1128: Low Tension Primary Cable

T

TIA: See EIA/TIA

U

UL 4: Standard for Armored Cable

UL 13: Standard for Power-Limited Circuit Cables

UL 44: Standard for Rubber-Insulated Wires and Cables

UL 62: Standard for Flexible Cord and Fixture Wire

UL 83: Standard for Thermoplastic-Insulated Wires and Cables

UL 183: Standard for Manufactured Wiring Systems

UL 444: Standard for Communications Cables

UL 486A: Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors

UL 486B: Standard for Wire Connectors and Soldering Lugs for Use With Aluminum Conductors

UL 486C: Standard for Splicing Wire Connectors

UL 486D: Standard for Insulated Wire Connectors for Use With

Underground Conductors

UL 486E: Standard for Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors

UL 493: Standard for Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables

UL 498: Standard for Attachment Plugs and Receptacles

UL 514B: Standard for Fittings for Conduit and Outlet Boxes

UL 719: Standard for Nonmetallic-Sheathed Cables

UL 758: Standard for Appliance Wiring Material - Component

UL 814: Standard for Gas-Tube-Sign and Ignition Cable

UL 817: Standard for Cord Sets and Power-Supply Cords

UL 854: Standard for Service-Entrance Cables

UL 910: Standard for Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

UL 1023: Standard for Household Burglar-Alarm System Units

UL 1063: Standard for Machine-Tool Wires and Cables

UL 1072: Standard for Medium-Voltage Power Cables

UL 1084: Standard for Hoistway Cables
UL 1263: Standard for Irrigation Cables

UL 1277: Standard for Electrical Power and Control Tray Cables With Optional Optical Fiber Members

UL 1309: Standard for Marine Shipboard Cable

UL 1424: Standard for Cables for Power-Limited Fire-Protective-Signaling Circuits

UL 1426: Standard for Cables for Boats

UL 1446: Standard for Systems of Insulating Materials - General

UL 1462: Standard for Mobile Home Pipe Heating Cable

UL 1569: Standard for Metal-Clad Cables

UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 1588: Standard for Roof and Gutter De-Icing Cable Units

UL 1666: Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

UL 1673: Standard for Electric Space Heating Cables

UL 1685: Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

UL 1690: Standard for Data Processing (DP) Cables

UL 1712: Standard Tests for Ampacity of Insulated Electrical Conductors Installed in the Fire Protective System

UL 1807: Standard for Fire Resistant Cable Coating Materials

UL 2023: Standard Test Method for Flame and Smoke Characteristics of Nonmetallic Wiring Systems (Raceway and Conductors) for Environmental Air-Handling Spaces

UL 2029: Standard for Gas/Vapor-Blocked Cable Classified for Use in Class 1 Hazardous (Classified) Locations

UL 2049: Standard for Residential Pipe Heating Cable

W

WC: See NEMA listing

Reference Standards

Standards are available from the following organizations:

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Association of Edison Illuminating Companies (AEIC)

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Birmingham, AL 35203

American National Standards Institute (ANSI)

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American Society for Testing and Materials (ASTM)

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Philadelphia, PA 19103
(215) 299-5454

Canadian Standards Association (CSA)

Standards Sales
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Fax: (416) 747-2475

Electronic Industries Association (EIA)

Engineering Publications Office
2001 Pennsylvania Ave., NW
Washington, DC
(202) 457-4963

FP Standards are available from:

Insulated Cable Engineers Association (ICEA)

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South Yarmouth, MA 02664

IEC Standards are available from **ANSI**.

Institute of Electrical and Electronic Engineers (IEEE)

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(908) 981-1392 (outside U.S. and Canada)
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(617) 770-3000
Fax: (800) 593-6372

Nuclear Regulatory Commission (NRC)

Washington, DC 20555

Ontario Hydro

700 University Avenue
Toronto, Ontario M5G 1X6, Canada

Rural Electrification Administration (REA)

U.S. Department of Agriculture
Washington, DC 20250
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