NUAL® BRAND

INSTALLER'S GUIDE FOR WIRE AND CABLES

General Cable

About This Guide

This guide is intended to provide introductory technical data to aid in the correct selection of wire and cable for permanent installation in commercial, institutional and industrial premises. Such installations are governed by the requirement of the Canadian Electrical Code Part I, and enforced by the appointed authority having jurisdiction in this area under provincial law (federal law in the case of federal territories), with or without Code amendments as the case may be.

Wires and cables in installations falling under the jurisdiction of the provincial and territorial inspection authorities are almost invariably required to be certified to the requirements of CSA standards under the approval of the CSA group.

This guide provides information on standard products stocked by General Cable's distributors. General Cable also manufactures a wide range of additional products in various sizes which can be supplied by special order.

For more information, contact your distributor or visit **www.nual.com** for the most current list of product offerings.

Wire and cable products supplied by General Cable comply with the codes, standards and product specifications as indicated in this guide.

Weights and measurements are subject to manufacturing tolerances and product design changes. Consequently, General Cable does not accept responsibility for costs incurred by a purchase as a result of weights and measurements not conforming exactly to those indicated.

About General Cable

General Cable is a name people know and trust. For over a century, our products have helped supply communities with power from coast to coast across the continent. And in that time we've become synonymous not only with aluminum, but with the latest technology and highest standards of quality and service.

We offer a full range of bare and insulated wires to both the utility and distribution markets, and support them with technical experts specifically trained to help our customers achieve their desired end results.

We believe our customers' satisfaction relies entirely on the quality of our products. That's why we work hard to ensure they are consistently superior to anything else on the market. Our distribution centre, technical centre and manufacturing facilities have attained ISO certifications 9001-2008 (Quality Management System) and 14001 (Environmental Management System) and OHSAS certification 18001 (Occupational Health & Safety Management).

We're committed to the success of our products, and to the satisfaction of our customers. That's why General Cable will continue to be a name people know and trust.

WE BELIEVE OUR CUSTOMERS' SATISFACTION RELIES ENTIRELY ON THE QUALITY OF OUR PRODUCTS.

Table of Contents

Allowable Ampacities

Application Rules

Section 4: Conductors

Section 8: Circuit Loading and Demand Factors

Section 12: Wiring Methods

Tables

Engineering Information

NUAL® Brand

The term NUAL® Brand refers to General Cable manufactured aluminum alloy conductor material, designated as "ACM" in the CSA Standard C22.2 No. 38. NUAL Brand is produced in rod form and afterwards drawn to the appropriate wire diameter for fabricating building wire and cable.

NUAL Brand is CSA-certified in finished building wire form. Meeting all of the physical and electrical requirements of aluminum to CSA standards, NUAL Brand in addition provides superior connectability.

NUAL Brand cables are CSA-certified up to 2000 kcmil and are used in all General Cable thermoset-insulated conductors certified to CSA Standard C22.2 No. 38. NUAL Brand conductors are supplied by General Cable in sizes 8 AWG and larger, neutral-supported cables which have AA-1350 phase conductors and an ACSR neutral/messenger conductor that is manufactured in accordance with CSA Standard C22.2 No. 129.

- Thermosetting wires (RW90 XLPE, RWU90 XLPE) to CSA Standard C22.2 No. 38
- Photovoltaic conductors (RPV90, RVPU90) to CSA Standard C22.2 No. 271
- Nonmetallic sheathed cable (NMD90) to CSA Standard C22.2 No. 48
- Armoured cable (AC90, ACWU90*) to CSA Standard C22.2 No. 51 and CSA22.2 No. 174
- TECK* cable to CSA Standard C22.2 No. 131 and CSA22.2 No. 174
- Service cables for underground installations (USEI, USEB) to CSA Standard C22.2 No. 52
- Service cables (neutral-supported) for overhead installations (NS75, NS90) to CSA Standard C22.2 No. 129

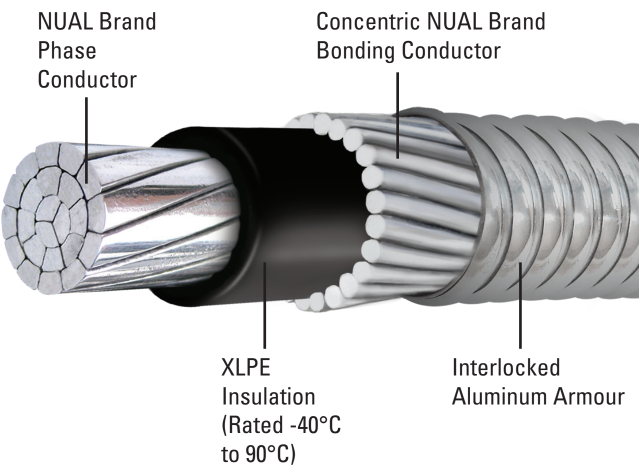
Wiring methods described for NUAL Brand are equally applicable to aluminum and copper conductors.

** With supplementary HL ratings for all hazardous locations.*

AC90

Available Sizes	NUAL® Brand
Single-conductor	1/0 AWG to 2000 kcmil
Multi-conductor	6 AWG to 750 kcmil

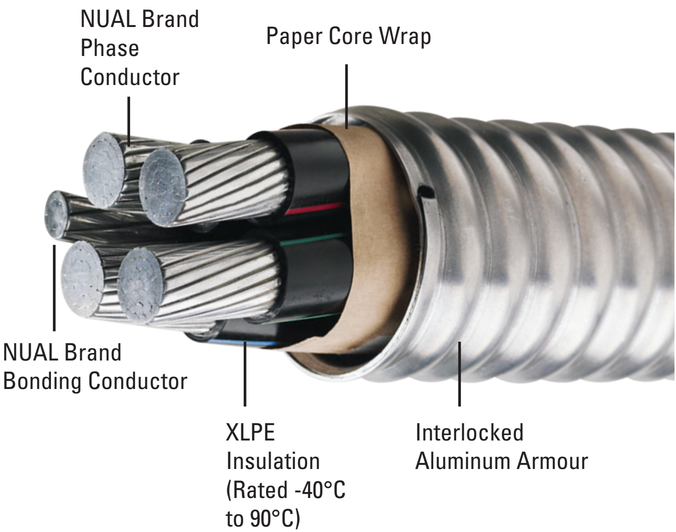
General Cable AC90 Single-conductor Cable



Specifications

CSA C22.2 No. 51
Suitable for use in cable tray in dry locations

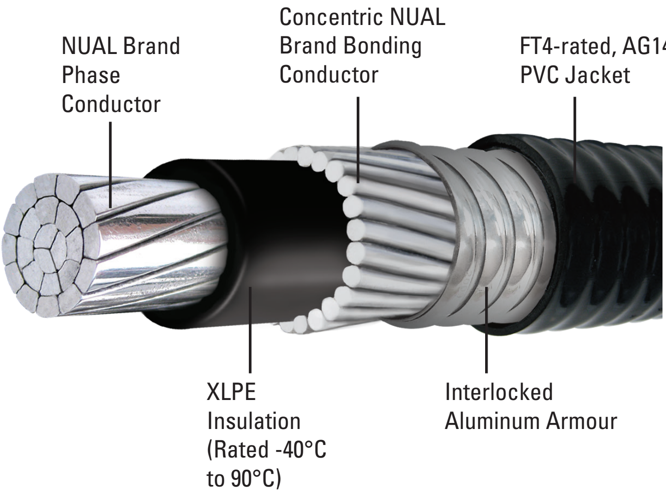
General Cable AC90 Multi-conductor Cable



ACWU90

Available Sizes	NUAL Brand
Single-conductor	1/0 AWG to 2000 kcmil
Multi-conductor	6 AWG to 750 kcmil

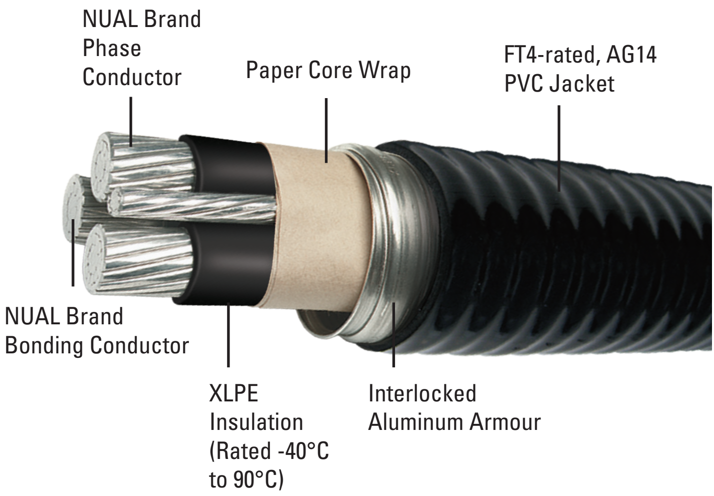
General Cable ACWU90 Single-conductor Cable



Specifications

CSA C22.2 No. 51
FT4-Rated: Vertical Cable Tray Test
CSA C22.2 No. 174 Hazardous Locations

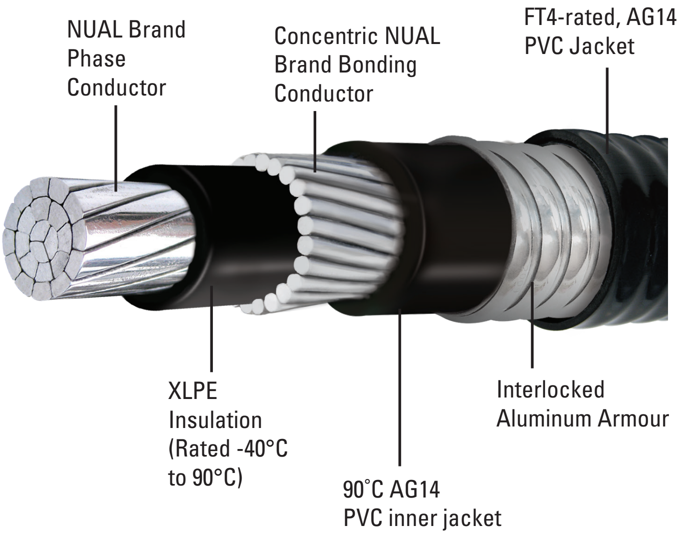
General Cable ACWU90 Multi-conductor Cable



TECK90

Available Sizes	NUAL Brand
Single-conductor	1/0 AWG to 1000 kcmil
Multi-conductor	6 AWG to 750 kcmil

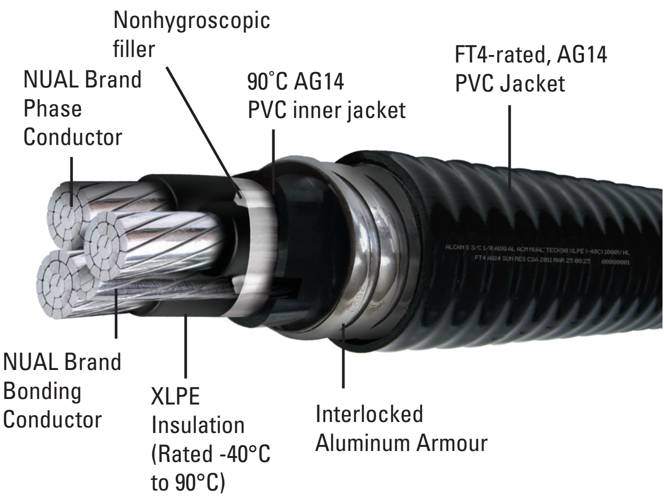
General Cable TECK90 Single-conductor Cable



Specifications

CSA C22.2 No. 131 (TECK)
CSA C22.2 No. 174 (Hazardous Locations)
FT4-Rated: Vertical Cable Tray Test

General Cable TECK90 Multi-conductor Cable



FT1 and FT4 Ratings

The CSA Standard for AC90, ACWU90 and TECK90 cables requires that all cables meet the Vertical Flame Test (FT1 Bunsen burner test) to CSA Standard C22.2 No. 2556. In addition, a much tougher level of performance is specified in the Vertical Flame Test – Cables in Cable Tray to CSA Standard C22.2 No. 2556.

All General Cable ACWU90 and TECK90 conductors meet both these levels of flammability performance. Compliance is indicated by the designation "FT4" printed on the outer PVC jacket and on shipping tags.

PVC-jacketed cables meeting the FT4 standard are accepted by the National Building Code for installation in all parts of noncombustible buildings, including vertical shafts and return air plenums. The 2012 Canadian Electrical Code Part I reflects an equivalent performance level requirement, harmonizing the two major installation codes.

Note: Check with your provincial building code officials to ensure compliance with local amendments.

The unjacketed construction, type AC90, is not required to meet the FT4 test, but is fully compliant. Its interlocked aluminum armour is considered equivalent to insulated conductors in metal conduit and is highly resistant to flame spread.

Appendix "B", Rule 2-126 of the CEC explains the application of cables bearing the FT1 and FT4 designations.

FT1 – Wires and cables that are suitable for installation in buildings of combustible construction

FT4 – Wires and cables that are suitable for installation in:

(a) buildings of noncombustible and combustible construction; and (b) spaces between a ceiling and floor, or ceiling and roof, that may be used as a plenum in buildings of combustible or noncombustible construction. Wires and cables with

combustible insulation, outer jackets or sheaths that do not meet the above classifications should be located in enclosed noncombustible raceways, masonry walls or concrete slabs.

Wire and cable passing these tests will be marked FT1 or FT4 directly on their jackets. They will be suitable for installation in buildings as shown above.

Rule 2-126 and Appendix B and G of the Canadian Electrical Code Part I, Twenty-second Edition, 2012, provides cross-reference to the National Building Code of Canada.

NOTICE

Purchasers, installers and end-users of cables with nonmetallic coverings should note the following:

WARNING

FLAMMABLE: Nonmetallic coverings of electric cable will burn and may transmit fire when ignited.

TOXIC: Burning nonmetallic coverings may emit acid gases which are highly toxic, and dense smoke.

CORROSIVE: Emission of acid gases may corrode metal in the vicinity, such as sensitive instruments and reinforcing rods in concrete.

Splicing and Terminating Conductors

General

When splicing and terminating either an aluminum or copper conductor, care should be taken to ensure service continuity. General Cable recommends the following procedures for all cable connections:

1. Fittings

Use only terminal lugs and connectors certified and marked "AL9CU" and "AL7CU" which are suitable for both aluminum and copper. If the equipment is not approved for aluminum, an approved adapter may be used.

2. Insulation

Remove insulation from the conductor in a manner that avoids nicking, ringing or otherwise damaging the conductor.

3. Cleaning

Wire brush the exposed conductor end to remove any oxide film. Coat with a suitable joint compound to inhibit its reformation, thus protecting the contact surfaces from air and moisture.

4. Installation

Insert the prepared cable end into the connector or terminal lug and secure the connection. Ensure that the correct tool, die and compression sequence are used for compression fittings and that appropriate torque is applied to all threaded hardware including bolted and mechanical set screw type connectors.

5. Binding Head Screws

When connecting solid conductor with a binding head screw, make a 3/4 loop under the screw head and secure.

Outdoor Armoured Cable Terminations

For outdoor terminations on General Cable's ACWU90 and TECK90 cables such as connections to overhead lines or outdoor bus, or where it is permitted to discontinue the bonding conductor, we recommend the method shown on page 20.

Typical examples are 1) in service entrances, in both single- and multi-conductor constructions, where the neutral conductor also serves as the ground path, and 2) in single-conductor feeders rated over 425 amps, where the bonding circuit is discontinuous in order to avoid sheath circulating currents. Care must be taken to seal the cable ends properly and to solidly bond the armour and bonding conductor wires at the other end of the cable using an AL9CU or AL7CU-rated connector bolted to the equipment enclosure.

CARE SHOULD BE TAKEN TO ENSURE SERVICE CONTINUITY.

Note: Lugs and connectors for NUAL Brand conductors are typically certified to CSA 22.2 No. 65.

Single-conductor Cables

1. Strip back armour and PVC jacket.

2. Fold the bonding conductor strands back over the armour.

3. Waterproof the whole termination by using CSA-approved wet-rated heat shrink tubing.

Multi-conductor Cables

1. Follow step 1 above.

2. Cut off the bonding conductor flush with the armour.

3. Follow step 3 above.

Note: Care must be taken to seal the exposed conductor by taping it with a self-sealing rubber tape or heat shrink tubing. The goal is to prevent water getting inside the insulation and the cable assembly.

Services Above & Below Ground

General Cable type ACWU90 and TECK90 cable may be used for services both in the single-and multi-conductor form. Single-conductor services should have all the bonding conductor wires attached to a common lug bolted to the service equipment using a AL9CU connector.

Parallel Circuits

For very large loads it is sometimes economical to parallel two or more cables. When this is done, we strongly recommend that the lengths, size and construction of the cables and connectors be identical. Refer to Code Rule 12-108 for CEC requirements for parallel conductors. In order to obtain reasonably good load-sharing among the single-conductor cables, it is important that the impedance of each cable be almost identical to that of the other cables of the same phase, and for this reason we recommend the configurations shown on pages 30-31.

Single vs. Multi-Conductor Constructions

General

It is well known and understood that installations of armoured cable are more economical than pipe and wire installations. This is due largely to the fact that the activities of conduit installation and wire pulling are not required with armoured cable. Armoured cables are readily available in single-and multi-conductor constructions. There are various aspects that should be taken into consideration when choosing between these two. The attractions of first-cost savings of single-conductor cable may need to be tempered with other technical considerations. The first-cost savings may be much less than they first appear, and the integrity of the circuit is subject to some potential pitfalls.

- The cost savings from smaller conductors, sized in accordance with Tables 1 and 3 of the code, are diminished by increased armour, bonding conductor, or metal sheath, extra jacket cost, and the addition of an external bonding conductor in large single-conductor cables.

- The 70% derating for single-conductors may call for a higher equipment and cable cost than expected, when compared with the 80% derating for multi-conductor cables. (Code Rule 8-104).
- When comparing single-conductor to multi-conductor cables, fully account for the end-user energy conservation needs, and ensure that all code rules, equipment limitations and health concerns have been fully addressed.

Some of these technical concerns are outlined below. If assistance is needed, do not hesitate to contact your nearest General Cable sales office.

Cost of Material

Recent analyses demonstrate that multi-conductor armoured cables can be more cost-effective than single-conductor constructions for many installations. While single-conductors can often save first-costs, due to higher ampacity ratings, this advantage is partially offset by the extra cost of additional armour or sheath on singles as compared to only one on multi-conductor cable.

Cost of Labour

Labour is often higher in single-conductor installations. Each phase being an individual cable requires all the same handling procedures as multi-conductor cables which contain all of the phases.

Voltage Drop

A further effect of single-conductors in longer feeder circuits can be increased voltage drop. This arises not only on account of the higher resistance of the smaller conductors, but also on account of the increased spacing between conductors in single-conductor systems.
It is a fact that greater spacing increases impedance and inductive reactance, which is the main contribution to voltage drop. The tables presented in the Code appendices are nominal ampacities which in no way account for voltage drop.

General Cable provides upon request a program which can be used for precise calculation of voltage drop.

Magnetic Fields and Harmonics

The magnetic fields surrounding single-conductors can extend much farther than those surrounding multi-conductor cables. The nuisance effects of the magnetic fields can be both elusive and expensive to correct. Typical nuisance effects involve the actions of the magnetic fields on sensitive electronic equipment, such as computers. In extreme cases, shielding and filtering of power supplies may be the only way to remedy the situation.

The magnetic field from each conductor is cancelled by those of the neighbouring conductors in a three-phase system with a pure sine wave form. In a four-conductor cable, the magnetic fields neutralize almost totally within the cable. However, the fields of single-conductors can extend much farther, depending on the spacing between the conductors.

Magnetic fields are amplified in circuits with high levels of third harmonic currents and multiples of the third harmonic. These currents are common today due to electronic devices which chop the wave form of the voltage. One of the unexpected results is that third harmonic magnetic fields in each of the three phases are additive, so the magnetic field surrounding a group of three conductors can be much greater than would be expected. This amplified magnetic field is cancelled only by the field from the neutral conductor. In large single-conductor feeders, the neutral conductor is often located a significant distance from some of the phase conductors, leading to propagation of third harmonic magnetic fields to greater distances. The use of multi-conductor cables will eliminate this concern, owing to their close proximity.

Special precautions are necessary with single-conductor systems, in addition to those previously mentioned. Accessories which totally surround single-conductor cables, such as clamps and connectors, must be non-ferrous to avoid magnetic hysteresis and eddy current losses, which could lead to serious overheating. Third harmonic currents will greatly increase the magnetic losses in such components. The current sharing between parallel conductors of the same phase must be ensured by attention to phase configurations. Sometimes imbalances in the current sharing can be present due to inherent difficulties in complying with spacing requirements. It is virtually impossible to balance the third harmonic currents equally with any type of single-conductor phase configuration, although this is automatically achieved with four-conductor cables.

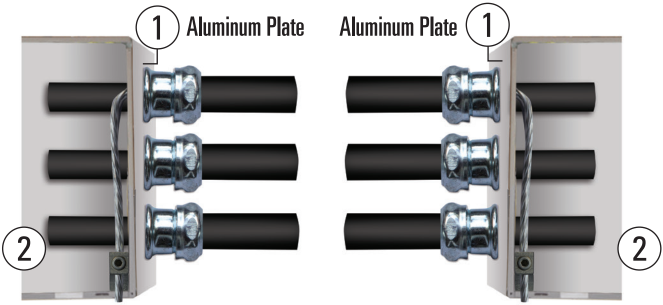
Circulating Currents

An explanation of circulating currents in metallic sheaths and armour of single-conductor cables, including their causes and effects, is provided in the Appendix B notes to Rule 4-010 of the 2012 Canadian Electrical Code Part I. They can be prevented by rigid attention to methods explained in the following pages.

Circuits Rated Up to 425 Amps Inclusive

On any AC system, currents flowing in the center conductor will induce small currents in the concentrically applied bonding wires and in the interlocked armour. For circuit ampacities up to and including 425 amps these induced currents do not affect the cable ampacity and may be neglected. We recommend terminating the cables as follows: the bonding wires of all cables entering the equipment enclosure should be bunched and connected to the bonding screw of the terminal; (2) the armour of each cable should be attached to the entry plate by means of an approved connector, and the entry plate should be aluminum or some other nonmagnetic conducting material (1).

Circuits Rated Over 425 Amps Inclusive



Note: In the 2012 Canadian Electrical Code Part 1, Rule 4-010 has added direction regarding single-conductor cables carrying more than 200 amps. See the full text under "Application Rules" in this handbook.

Circuits Rated Over 425 Amps

For single-conductor cables rated over 425 amps, the induced current in the concentric bonding conductor is potentially large and precautions must be taken to interrupt it. It is recommended that the cable at one end, preferably the supply end, enter the panel by means of an aluminum plate thick enough to properly support cables and withstand any bending moments (3) and that the bonding wires from each cable be connected together in a common lug and bonded to the metallic enclosure or grounding bus of the equipment (4). At the other end, the cables should enter the panel through a non-conducting plate at least 6mm thick (5) and the bonding wires cut off as in (6). It may be necessary to run an external bonding conductor to bond the equipment at each end to comply with code rules.

Note 1:

Single-conductor type AC90 cables, in circuits rated over 425 amps and sized according to Table 3, C.E. Code Part I, ampacities are not recommended due to the excessive risk of overheating caused by circulating armour and bonding conductor currents. A PVC jacket (as in ACWU90 or TECK90) is the only practical, effective means of armour isolation from grounded metal parts.

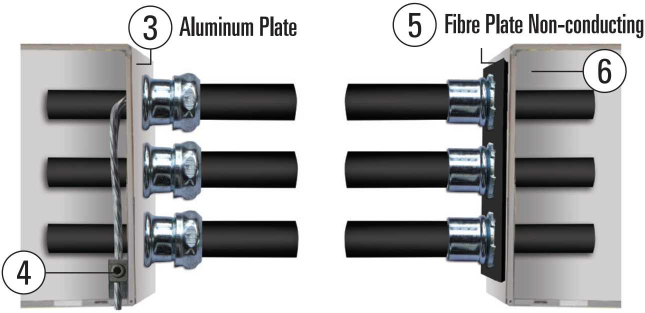
Note 2:

To avoid the heating effect caused by eddy currents, make certain that individual single-conductor cables are not surrounded by magnetic material. Avoid the use of steel or iron cable connectors or steel clips onto steel supports.

Note 3:

When conductor lengths are selected to meet the CEC's maximum 3% voltage drop requirement, standing voltages on concentric bonding wires for 600 volt systems will remain below 25 volts during normal operating conditions.

Circuits Rated Over 425 Amps



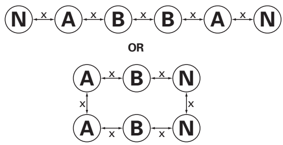
Note: In the 2012 Canadian Electrical Code Part 1, Rule 4-010 has added direction regarding single-conductor cables carrying more than 200 amps. See the full text under "Application Rules" in this handbook.

Recommended Configuration for Parallel Operation of

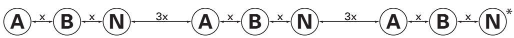
Single Phase

X = One cable diameter (above ground).
A,B,C = Phase conductor designation.
N = Neutral conductor designation.

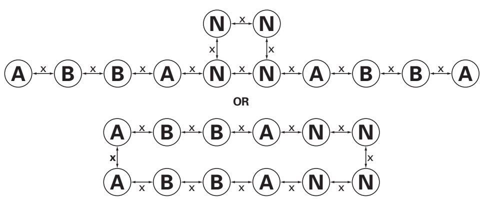
Two Conductors per Phase



Three Conductors per Phase*



Four conductors per Phase



** Precise load sharing is difficult with three conductors per phase and the configurations shown represent the most practical compromise.*

General Cable strongly recommends the use of one-, two-or four-conductors per phase due to the ease of achieving equal current sharing in practical installations.

Note:

(1) Neutral conductors may be located outside the above groups in the most convenient manner or as shown.

(2) Not all the configurations shown provide precisely equal load sharing. The imbalance is decreased as the separation of the groups is increased relative to the spacing of conductors within the group.

Three Phase

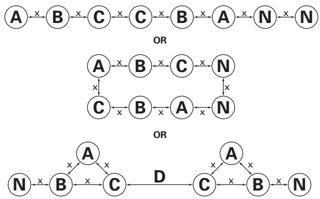
D = Separation of groups equal to width of one group.

X = One cable diameter (above ground).

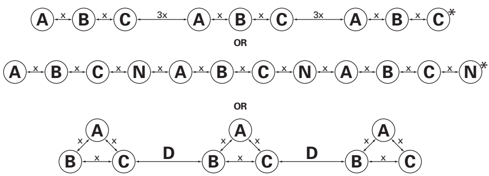
A,B,C = Phase conductor designation.

N = Neutral conductor designation.

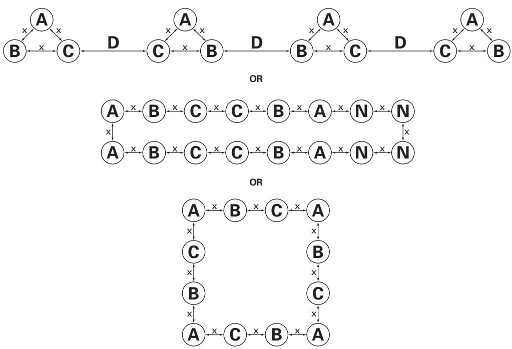
Two Conductors per Phase



Three Conductors per Phase*



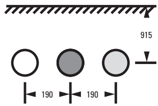
Four Conductors per Phase



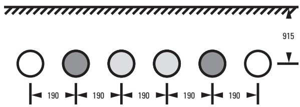
Applicable Installation Configurations for Single-Cond

Diagram 1

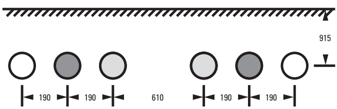
DETAIL 1: 1 cable per phase



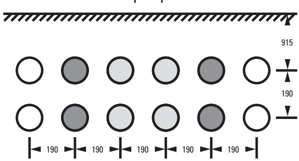
DETAIL 2: 2 cables per phase



DETAIL 3: 2 cables per phase

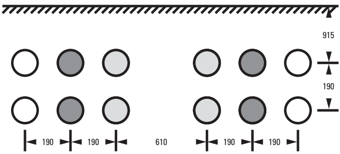


DETAIL 4: 4 cables per phase

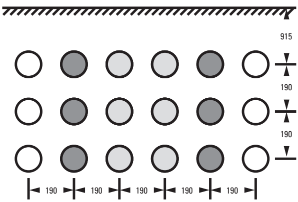


Note: All dimensions in mm.

DETAIL 5: 4 cables per phase



DETAIL 6: 6 cables per phase



DETAIL 7: 6 cables per phase

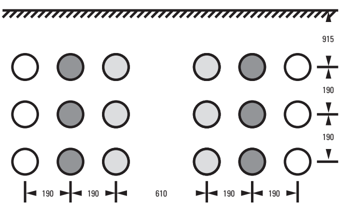


Table 5-5

Allowable Ampacities for Single-Conductor Cable Directly Buried in the Earth — Non-Continuous Loads (See Diagram 1)

Size, AWG or kcmil	1/Phase Detail 1		2/Phase Detail 2		2/Phase Detail 3	
	9A	8A	9A	8A	9A	8A
1/0	190	245	190	245	190	245
2/0	220	285	220	285	220	285
3/0	255	330	255	330	255	330
4/0	300	385	300	385	300	385
250	330	425	328	421	330	425
350	415	530	390	500	410	520
500	515	660	471	605	495	630
600	585	740	513	659	541	682
750	665	845	580	745	610	775
1000	780	980	659	846	710	890
1250	868	1083	750	935	790	985
1500	952	1176	821	1011	865	1068
1750	1027	1257	880	1078	932	1140
2000	1094	1325	934	1133	991	1200

The ampacities of this table are those contained in Tables D8A and D9A of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 1, and the following conditions:

(a) For any load, the cable terminates at equipment of any type other than a fusible switch or circuit breaker; or

(b) The load is NON-CONTINUOUS and either end of the cable terminates at a fusible switch or circuit breaker.

4/Phase Detail 4		4/Phase Detail 5		6/Phase Detail 6		6/Phase Detail 7	
9A	8A	9A	8A	9A	8A	9A	8A
158	203	171	220	129	165	140	179
178	229	193	248	145	186	157	202
201	258	218	280	163	210	178	228
227	291	246	315	183	236	200	256
247	317	267	343	200	256	217	278
292	375	318	408	237	304	258	331
352	452	383	489	284	365	309	396
382	491	419	534	308	397	340	433
431	554	469	596	348	447	379	482
488	627	542	683	393	505	437	551
554	691	604	753	446	556	487	607
605	746	660	813	487	600	531	655
647	793	706	865	520	637	568	696
686	832	749	909	552	669	602	730

Table 5-6

Allowable Ampacities for Single-Conductor Cable Directly Buried in the Earth — Continuous Loads (See Diagram 1)

Size, AWG or kcmil	1/Phase Detail 1				2/Phase Detail 2				2/Phase Detail 3			
	9B		8B		9B		8B		9B		8B	
	100%	80%	100%	80%	100%	80%	100%	80%	100%	80%	100%	80%
1/0	162	133	208	172	162	133	208	172	162	133	208	172
2/0	187	154	242	200	187	154	242	200	187	154	242	200
3/0	217	179	280	231	217	179	280	231	217	179	280	231
4/0	255	210	327	270	255	210	327	270	255	210	327	270
250	281	231	361	298	281	231	361	298	281	231	361	298
350	353	291	450	371	353	291	450	371	353	291	450	371
500	438	361	561	462	438	361	561	462	438	361	561	462
600	498	410	629	518	498	410	629	518	498	410	629	518
750	570	469	718	592	570	469	718	592	570	469	718	592
1000	680	560	850	700	659	560	846	700	680	560	846	700
1250	770	634	960	791	750	634	935	791	770	634	935	791
1500	867	714	1071	882	821	714	1011	882	865	714	1011	882
1750	956	788	1165	959	880	788	1078	959	932	788	1078	959
2000	1037	854	1250	1029	934	854	1133	1029	991	854	1133	1029

The ampacities of this table are those contained in Tables D8B and D9B of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 1, and the following conditions:

(a) The load is CONTINUOUS, and

(b) either end terminates at a fusible switch or circuit breaker.

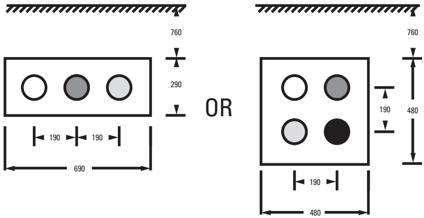
4/Phase Detail 4				4/Phase Detail 5				6/Phase Detail 6		6/Phase Detail 7			
9B		8B		9B		8B		9B	8B	9B		8B	
100%	80%	100%	80%	100%	80%	100%	80%	-	-	100%	80%	100%	80%
158	133	203	172	162	133	208	172	129	165	140	133	179	172
178	154	229	200	187	154	242	200	145	186	157	154	202	200
201	179	258	231	217	179	280	231	163	210	178		228	
227	210	291	270	246	210	315	270	183	236	200		256	
247	231	317	298	267	231	343	298	200	256	217		278	
292	291	375	371	318	291	408	371	237	304	258		331	
352		452		383	361	489	462	284	365	309		396	
382		491		419	410	534	518	308	397	340		433	
431		554		469		596	592	348	447	379		482	
488		627		542		683		393	505	437		551	
554		691		604		753		446	556	487		607	
605		746		660		813		487	600	531		655	
647		793		706		865		520	637	568		696	
686		832		749		909		552	669	602		730	

The columns with the heading 80% denote that equipment identified in (b) above is **not marked** as certified to carry its nameplate ampere rating continuously.

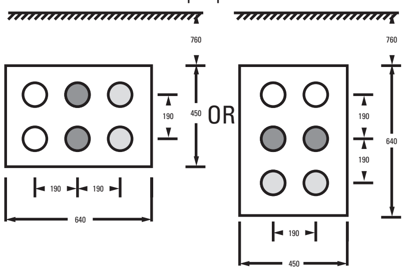
The columns with the heading 100% denote that equipment identified in (b) above is **marked** as certified to carry its nameplate ampere rating continuously.

Diagram 2

DETAIL 1: 1 conductor per phase

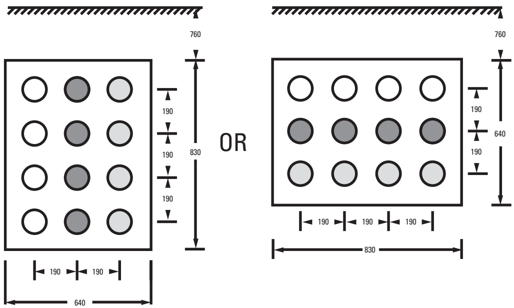


DETAIL 2: 2 conductors per phase



Note: All dimensions in mm.

DETAIL 3: 4 conductors per phase



DETAIL 4: 6 conductors per phase

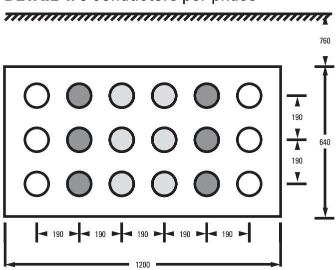


Table 5-7

Allowable Ampacities for Single-Conductor Cable in Underground Raceways — Non-Continuous Loads (See Diagram 2)

Size, AWG or kcmil	1/Phase Detail 1		2/Phase Detail 2	
	11A	10A	11A	10A
1/0	180	231	157	201
2/0	205	264	178	228
3/0	235	301	203	260
4/0	269	345	231	296
250	296	379	253	325
350	360	461	306	391
500	442	564	372	475
600	488	621	409	521
750	556	706	464	589
1000	653	823	541	682
1250	738	920	608	759
1500	813	1004	667	824
1750	880	1077	719	880
2000	940	1139	766	928

The ampacities of this table are those contained in Tables D10A and D11A of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 2 and the following conditions:

(a) For any load, the cable terminates at equipment of any type other than a fusible switch or circuit breaker; or

(b) The load is NON-CONTINUOUS and either end of the cable terminates at a fusible switch or circuit breaker.

4/Phase Detail 3		6/Phase Detail 4	
11A	10A	11A	10A
123	159	114	146
140	180	128	164
158	204	145	186
180	231	164	211
197	252	179	230
236	303	213	275
283	364	257	330
314	404	284	365
349	448	315	406
409	526	370	474
457	571	413	515
501	618	452	556
538	659	484	592
571	692	513	622

Table 5-8

Allowable Ampacities for Multi-Conductor Cable Directly Buried in the Earth — Non-Continuous Loads (See Diagram 2)

Size, AWG or kcmil	1/Phase Detail 1					
	11B		10B		11B	
	100%	80%	100%	80%	100%	
1/0	162	133	208	172	157	
2/0	187	154	242	200	178	
3/0	217	179	280	231	203	
4/0	255	210	327	270	231	
250	281	231	361	298	253	
350	353	291	450	371	306	
500	438	361	561	462	372	
600	488	410	621	518		409
750	556	469	706	592		464
1000	653	560	823	700		541
1250	738	634	920	791		608
1500	813	714	1004	882		667
1750	880	788	1077	959		719
2000	940	854	1139	1029		766

The ampacities of this table are those contained in Tables D10B and D11B of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 2 and the following conditions:

(a) The load is CONTINUOUS, and

(b) either end terminates in at a fusible switch or circuit breaker.

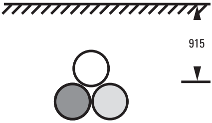
2/Phase Detail 2			4/Phase Detail 3		6/Phase Detail 4	
	10B		11B	10B	11B	10B
80%	100%	80%	-	-	-	-
133	201	172	123	159	114	146
154	228	200	140	180	128	164
179	260	231	158	204	145	186
210	296	270	180	231	164	211
231	325	298	197	252	179	230
291	391	371	236	303	213	275
361	475	462	283	364	257	330
	521	518	314	404	284	365
	589		349	448	315	406
	682		409	526	370	474
	759		457	571	413	515
	824		501	618	452	556
	880		538	659	484	592
	928		571	692	513	622

The columns with the heading 80% denote that the equipment identified in (b) above is **not marked** as certified to carry its nameplate ampere rating continuously.

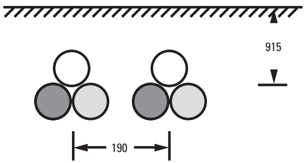
The columns with the heading 100% denote that the equipment identified in (b) above is **marked** as certified to carry its nameplate ampere rating continuously.

Diagram 3

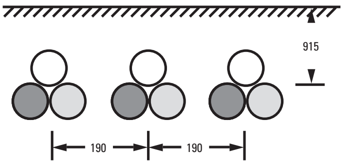
DETAIL 1: 1 cable per phase



DETAIL 2: 2 cables per phase

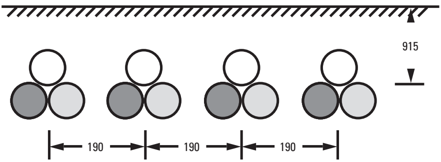


DETAIL 3: 3 cables per phase

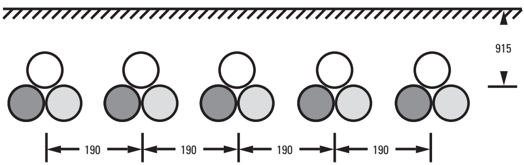


Note: All dimensions in mm.

DETAIL 4: 4 cables per phase



DETAIL 5: 5 cables per phase



DETAIL 6: 6 cables per phase

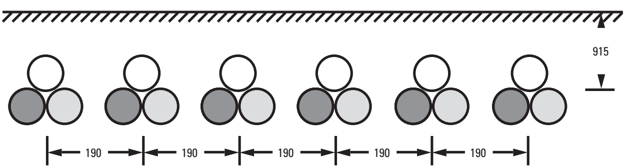


Table 5-9

Allowable Ampacities for Multi-Conductor Cable Directly Buried in the Earth — Continuous Loads (See Diagram 3)

Size, AWG or kcmil	1/Phase Detail 1		2/Phase Detail 2		3/Phase Detail 3	
	13A	12A	13A	12A	13A	12A
1/0	190	243	164	209	146	186
2/0	217	274	186	235	166	209
3/0	242	311	207	266	184	236
4/0	280	360	238	306	211	271
250	304	383	258	326	229	288
350	366	470	309	397	273	350
500	440	548	370	460	325	404
600	486	600	406	502	356	440
750	540	667	450	556	393	486
1000	613	758	508	628	444	548
1250	684	831	562	682	488	593
1500	734	889	600	727	520	630
1750	774	927	631	755	545	653
2000	809	962	657	781	567	674

The ampacities of this table are those contained in Tables D12A and D13A of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 3, and the following conditions:

(a) For any load, the cable terminates at equipment of any type other than a fusible switch or circuit breaker; or

(b) The load is NON-CONTINUOUS and either end of the cable terminates at a fusible switch or circuit breaker.

4/Phase Detail 4		5/Phase Detail 5		6/Phase Detail 6	
13A	12A	13A	12A	13A	12A
137	174	129	164	124	157
155	195	146	184	140	176
171	220	161	207	154	198
197	253	185	237	177	227
213	268	200	252	192	242
254	326	238	306	228	293
302	375	283	352	271	337
330	408	309	383	296	366
364	450	341	421	326	403
411	508	384	475	367	454
451	547	421	511	402	488
480	581	448	542	427	517
503	602	469	561	447	535
522	621	487	578	464	552

Table 5-10

Allowable Ampacities for Multi-Conductor Cable Directly Buried in the Earth — Continuous Loads (See Diagram 3)

Size, AWG or kcmil	1/Phase Detail 1				2/Phase Detail 2			
	13B		12B		13B		12B	
	100%	80%	100%	80%	100%	80%	100%	80%
1/0	162	133	208	172	162	133	208	172
2/0	187	154	242	200	186	154	235	200
3/0	217	179	281	231	207	179	266	231
4/0	255	210	327	270	238	210	306	270
250	281	231	361	298	258	231	326	298
350	353	291	451	371	309	291	397	371
500	438	361	561	462	370	361	460	
600	486	410	629	518	406		502	
750	540	469	667	592	450		556	
1000	613	560	758	700	508		628	
1250	684	634	831	791	562		682	
1500	734	714	889	882	600		727	
1750	774		927		631		755	
2000	809		962		657		781	

The ampacities of this table are those contained in Tables D12B and D13B of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 3, and the following conditions:

(a) The load is CONTINUOUS, and

(b) either end terminates in at a fusible switch or circuit breaker.

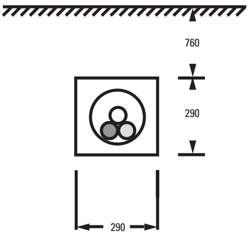
3/Phase Detail 3				4/Phase Detail 4				5/Phase Detail 5		6/Phase Detail 6	
13B		12B		13B		12B		13B	12B	13B	12B
100%	80%	100%	80%	100%	80%	100%	80%	-	-	-	-
146	133	186	172	137	133	174	172	129	164	124	157
166	154	209	200	155	154	195		146	184	140	176
184	179	236	231	171		220		161	207	154	198
211	210	271	270	197		253		185	237	177	227
229		288		213		268		200	252	192	242
273		350		254		326		238	306	228	293
325		404		302		375		283	352	271	337
356		440		330		408		309	383	296	366
393		486		364		450		341	421	326	403
444		548		411		508		384	475	367	454
488		593		451		547		421	511	402	488
520		630		480		581		448	542	427	517
545		653		503		602		469	561	447	535
567		674		522		621		487	578	464	552

The columns with the heading 80% denote that the equipment identified in (b) above is **not marked** as certified to carry its nameplate ampere rating continuously.

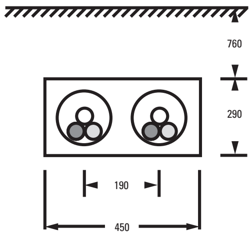
The columns with the heading 100% denote that the equipment identified in (b) above is **marked** as certified to carry its nameplate ampere rating continuously.

Diagram 4

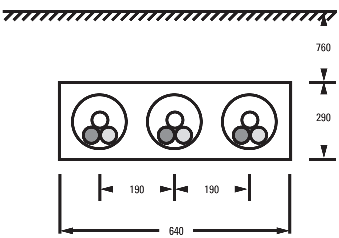
DETAIL 1: 1 cable per phase



DETAIL 2: 2 cables per phase



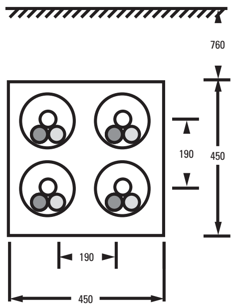
DETAIL 3: 3 cables per phase



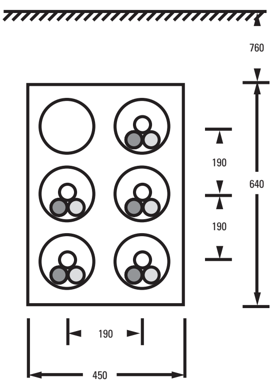
Note: All dimensions in mm.

The 2012 Code has a new 2x4 ductbank configuration; detail 8-8 cable per phase from 2012 CEC.

DETAIL 4: 4 cables per phase



DETAIL 5: 5 cables per phase



DETAIL 6: 6 cables per phase

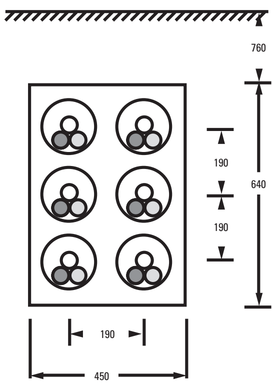


Table 5-11

Allowable Ampacities for Multi-Conductor Cable in Underground Raceways — Non-Continuous Loads (See Diagram 4)

Size, AWG	1/Phase or kcmil Detail 1		2/Phase Detail 2		3/Phase Detail 3	
	15A	14A	15A	14A	15A	14A
1/0	142	180	129	164	119	152
2/0	163	206	148	187	136	172
3/0	186	235	168	213	155	196
4/0	214	269	192	242	177	223
250	236	298	212	267	194	244
350	288	361	256	321	233	293
500	351	437	310	386	281	350
600	388	480	341	423	309	383
750	435	538	381	471	344	425
1000	502	620	437	540	392	485
1250	556	676	480	583	429	521
1500	589	724	514	623	458	555
1750	632	756	541	648	481	576
2000	660	785	564	671	501	596

The ampacities of this table are those contained in Tables D14A and D15A of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 4, and the following conditions:

(a) For any load, the cable terminates at equipment of any type other than a service box, fusible switch or circuit breaker.

(b) The load is NON-CONTINUOUS and either end of the cable terminates at a service box, fusible switch or circuit breaker.

4/Phase Detail 4		5/Phase Detail 5		6/Phase Detail 6		8/Phase Detail 8	
15A	14A	15A	14A	15A	14A	15A	14A
111	141	103	131	99	125	91	116
126	160	117	149	112	142	103	131
143	181	132	168	126	160	114	148
163	205	151	190	143	181	130	168
178	225	165	208	157	198	144	183
214	268	198	248	187	235	172	217
257	319	237	294	224	279	206	258
281	349	259	321	245	303	226	281
313	386	287	355	271	335	248	310
355	439	326	400	307	380	282	353
389	472	356	433	336	408	308	378
415	502	379	459	358	434	328	402
435	521	397	476	375	449	344	416
452	538	413	491	389	463	357	429

Table 5-12

Allowable Ampacities for Multi-Conductor Cable in Underground Raceways — Continuous Loads (See Diagram 4)

Size, AWG or kcmil	1/Phase Detail 1				2/Phase Detail 2		3/Phase Detail 3	
	15B		14B		15B	14B	15B	14B
	100%	80%	100%	80%	-	-	-	-
1/0	142	133	180	172	129	164	119	152
2/0	163	154	206	200	148	187	136	172
3/0	186	179	235	232	168	213	155	196
4/0	214	210	269		192	242	177	223
250	236	231	298		212	267	194	244
350	288		361		256	321	233	293
500	351		437		310	386	281	350
600	388		480		341	423	309	383
750	435		538		381	471	344	425
1000	502		620		437	540	392	485
1250	556		676		480	583	429	521
1500	589		724		514	623	458	555
1750	632		756		541	648	481	576
2000	660		785		564	671	501	596

The ampacities of this table are those contained in Tables D14B and D15B of the Canadian Electrical Code Part I, 22nd Edition, 2012.

Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 4, and the following conditions:

a) The load is CONTINUOUS, and

b) either end terminates at a service box, fusible switch or circuit breaker.

4/Phase Detail 4		5/Phase Detail 5		6/Phase Detail 6		8/Phase Detail 8	
15B	14B	15B	14B	15B	14B	15B	14B
-	-	-	-	-	-	-	-
111	141	103	131	99	125	91	116
126	160	117	149	112	142	103	131
143	181	132	168	126	160	114	148
163	205	151	190	143	181	130	168
178	225	165	208	157	198	144	183
214	268	198	248	187	235	172	217
257	319	237	294	224	279	206	258
281	349	259	321	245	303	226	281
313	386	287	355	271	335	248	310
355	439	326	400	307	380	282	353
389	472	356	433	336	408	308	378
415	502	379	459	358	434	328	402
435	521	397	476	375	449	344	416
452	538	413	491	389	463	357	429

The columns with the heading 80% denote that the equipment identified in (b) above is **not marked** as certified to carry its nameplate ampere rating continuously.

The columns with the heading 100% denote that the equipment identified in (b) above **is marked** as certified to carry its nameplate ampere rating continuously.

Notes and Corrections

Tables 5-5 to 5-12 Inclusive

General

The following notes and corrections are based on notes in Appendix B of the Canadian Electrical Code. Ampacities of underground installations based on conditions of use not as set out in the following notes should either be justified by precise calculation according to the method of paragraph 4-004(1)(d) or (2)(d) or derived in accordance with paragraph 4-004(1)(b) or (2)(b) of the Canadian Electrical Code. The ampacities shown in Tables 5-5 to 5-12 inclusive have been determined using the calculation in IEEE Standard 835, Standard Power Cable Ampacity Tables, for the cable arrangements shown in Diagrams 1 to 4 inclusive. It is recommended that ampacities for single-conductor cables directly buried in the earth be selected from Table 5-5 or 5-6 for installation configurations shown in Diagram 1, and those for cables in separate underground raceways be selected from Table 5-7 or 5-8 for installation configurations shown in Diagram 2. It is recommended that ampacities for three-conductor cables directly buried in the earth be selected from Table 5-9 or 5-10 for installation configurations shown in Diagram 3, and those for cables in separate underground raceways be selected from Table 5-11 or 5-12 for installation configurations shown in Diagram 4.

Voltage Drop

The allowable ampacities of Tables 5-5 to 5-12 inclusive are based on temperatures alone and do not take voltage drop into consideration. For voltage drop information, refer to rule 8-102.

Conductor Temperature

Underground ampacities for conductor temperatures of 75°C and 60°C respectively may be obtained by multiplying the appropriate ampacity at 90°C conductor temperature from Tables 5-5 to 5-12 inclusive by 0.866 (for 75°C) or 0.756 (for 60°C). General Cable NUAL Brand conductors for underground use are all rated for 90°.

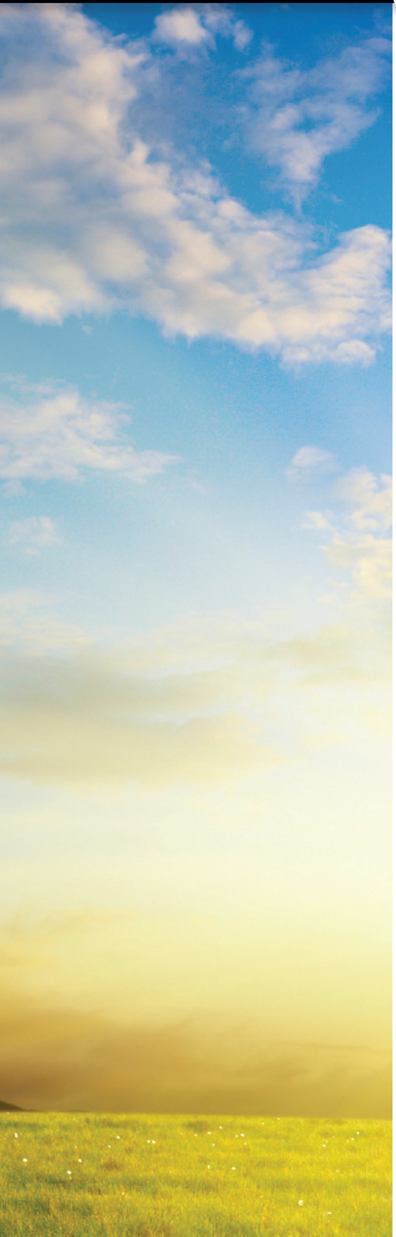
Ambient Earth Temperature

Ampacities for underground installations at ambient earth temperatures other than the assumed value of 20°C may be obtained by multiplying the appropriate underground ampacity obtained from Tables 5-5 to 5-12 by the factor: SQRT[(90-Tæ)/70] where Tæ is the new ambient earth temperature.

Stacked Arrangements

For "Stacked" arrangements of two single-conductors per phase in parallel (one row located vertically over another row), it is recommended that they be obtained from Detail 5 of Tables 5-5 and 5-6 for directly buried cables, or from Detail 2 of Tables 5-7 and 5-8 for cables in underground raceways.

Notes and Corrections (continued)



Deratings Due to Sheath Circulating Currents

For single-conductor metal armoured and metal sheathed cables in which the sheath, armour, or bonding conductors are bonded at more than one point, the derating factors of Canadian Electrical Code Rule 4-010 apply, unless the ampacity has been determined by detailed calculation according to the method outlined in paragraphs (1)(e), (1)(f), (2)(e) or (2)(f) of Canadian Electrical Code Rule 4-004.

Recommendations for 3, 5 and 7 Single-Conductors/Phase in Parallel

It is recommended that ampacities for three single-conductors per phase in parallel, and for five single-conductors per phase in parallel, with spacings, directly buried in the earth, be selected from Table 5-5 or 5-6 for installation configurations shown in Diagram 1, Detail 5 and Detail 7, respectively. It is recommended that ampacities for three single-conductors per phase in parallel installed in separate underground raceways be selected from Table 5-7 or 5-8 for installation configurations shown in Diagram 2, Detail 3 and Detail 4, respectively. It is recommended that ampacities for seven three-conductor cables in seperate underground raceways be selected from Table 5-11 or 5-12, Detail 7.

Recommendations for Groups of Conductors in Twos

It is recommended that the ampacities of groups of conductors in twos and two-conductor cables, be obtained from ampacity Tables 5-9 to 5-12, inclusive, as for groups of three conductors, and three-conductor cables, respectively, for the appropriate spacings between groups and numbers of conductors in parallel. The neutral conductor of a single phase, three wire system need not be counted in the determination of ampacities.

Note: The concept of "Load Factor" was introduced into code ampacities for the first time in the 2002 Code. Load Factor is usually expressed as a percentage of the average load/rated load. Cyclical changes in demand on the cable during the day can lower expected temperature rise in insulated cables in the earth, and consequently some jurisdictions may permit smaller conductor sizes based on load factors less than 100%, when it can be shown or readily predicted that the load factor is justified. The application of load factors less than 100% can be found in the source reference for underground ampacities, IEEE Standard 835, Standard Power Cable Ampacity Tables.

Section 4: Conductors

4-004 Ampacity of Wires and Cables (see Appendices B and I)*

(1) The maximum current that a copper conductor of a given size and insulation may carry shall be as follows:

(a) single-conductor and single-conductor metal-sheathed or armoured cable, in a free air run, with a cable spacing not less than 100% of the larger cable diameter, as specified in Table 1;

(b) one, two, or three conductors in a run of raceway, or 2- or 3-conductor cable, except as indicated in Subrule (1)(d), as specified in Table 2;

(c) four or more conductors in a run of raceway or cable, as specified in Table 2 with the correction factors applied as specified in Table 5C;

(d) single-conductor and 2-, 3-, and 4-conductor cables and single-conductor and 2-, 3-, and 4-conductor metal-armoured and metal-sheathed cables, in conductor sizes No. 1/0 AWG and

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendices B and 1

larger, installed in accordance with configurations described in Diagrams B4-1 to B4-4 in an underground run, directly buried or in a raceway, as specified in Tables D8A through D15B.

(e) underground configurations not specified in Item (d), in conductor sizes No. 1/0 AWG and larger, as calculated by the IEEE 835 calculation method; and

(f) underground configurations in conductor sizes smaller than No. 1/0 AWG, as specified in Item (b) or as calculated by the IEEE 835 calculation method.

(2) The maximum current that an aluminum conductor of a given size and insulation may carry shall be as follows:

(a) single-conductor and single-conductor metal-sheathed or armoured cable, in a free air run, with a cable spacing not less than 100% of the larger cable diameter, as specified in Table 3;

(b) one, two, or three conductors in a run of raceway, or 2- or 3-conductor cable, except as indicated in Subrule (2)(d), as specified in Table 4;

(c) four or more conductors in a run of raceway or cable, as specified in Table 4 with the correction factors applied as specified in Table 5C; and

(d) single-conductor and 2-, 3-, and 4-conductor cables and single-conductor and 2-, 3-, and 4-conductor metal-armoured and metal-sheathed cables, in conductor sizes No. 1/0 AWG and larger, in an underground run, directly buried or in a raceway, as calculated by the method of IEEE 835.

(3) A neutral conductor that carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of three or more conductors, shall not be counted in determining ampacities as provided for in Subrules (1) and (2).

(4) When a load is connected between a single-phase conductor and the neutral, or between each of two phase conductors and the neutral, of a three-phase, 4-wire system, the common conductor carries a current comparable to that in

the phase conductors and shall be counted in determining the ampacities as provided for in Subrules (1) and (2).

(5) The maximum allowable ampacity of neutral supported cable shall be as specified in Tables 36A and 36B.

(6) A bonding conductor shall not be counted in determining the ampacities as provided for in Subrules (1) and (2).

(7) The correction factors specified in this Rule (a) shall apply only to, and shall be determined from, the number of power and lighting conductors in a cable or raceway; and (b) shall not apply to conductors installed in auxiliary gutters.

(8) The ampacity correction factors of Table 5A shall apply where conductors are installed in an ambient temperature exceeding or anticipated to exceed 30°C.

(9) Where the free air spacing between adjacent single-conductor cables is maintained at not less than 25% nor more than 100% of the diameter of the largest cable, the ampacity shall be obtained from Subrules (1)(a) and (2)(a) for copper and aluminum conductors respectively, multiplied by the correction factor obtained from Table 5D.

(10) Where up to and including four single-conductor cables in free air are spaced at less than 25% of the diameter of the largest conductor or cable, the ampacity shall be the same as that obtained from Subrules (1)(b) and (2)(b) for copper and aluminum conductors respectively, multiplied by the correction factor obtained from Table 5B.

(11) Notwithstanding Subrule (10), where not more than four non-jacketed single-conductor mineral-insulated cables are grouped together in conformance with Rule 4-010(3) and are installed on a messenger or as open runs with a maintained free air space of not less than 2.15 times the diameter of the largest cable contained within the group and adjacent groups or cables, the

ampacity of each conductor in the group shall be permitted to be determined in accordance with Subrule (1)(a) without applying the factors of Table 5B.

(12) More than four single-conductor cables in free air, when spaced at less than 25% of the largest cable diameter, shall have an ampacity obtained from Tables 2 and 4 for copper and aluminum conductors respectively, multiplied by the correction factor obtained from Table 5C.

(13) Notwithstanding Subrule (12), when the length of a multiple conductor cable run is less than 600 mm, the correction factor from Table 5C shall not apply.

(14) The ampacity of conductors of different temperature ratings installed in the same raceway shall be determined on the basis of the conductor having the lowest temperature rating.

(15) The ampacity of conductors added to a raceway and the ampacity of the conductors already in the raceway shall be determined in accordance with the applicable Subrules.

(16) Where more than one ampacity could apply for a given circuit of single-conductor or multi-conductor cables as a consequence of a transition from an underground portion to a portion above ground, the lower value shall apply except as permitted in Subrule (17).

(17) Where the lower ampacity portion of a cable installation consisting of not more than four-conductors in total does not exceed 10% of the circuit length or 3 m, whichever is less, the higher ampacity shall be permitted.

(18) When the load factor of the load is less than 1.00 and is known or can be supported by documentation, the ampacity of conductors derived from Subrules (1)(d) and (2)(d) shall be permitted to be increased by application of that load factor in the calculation of the ampacity.

(19) In consideration of the increased ampacity of any

conductor derived in accordance with Subrule (16), no further factors based on load diversity shall be permitted.

(20) The ampacity of nickel or nickel-clad conductors shall be calculated using the method described in IEEE 835.

(21) The maximum allowable ampacity of bare or covered conductors in free air shall be as specified in Table 66.

4-006 Temperature Limitations (see Appendix B)*

(1) Where equipment is marked with a maximum conductor termination temperature, the maximum allowable ampacity of the conductor shall be based on the corresponding temperature column from Table 1, 2, 3 or 4.

(2) Where equipment is not marked with a maximum conductor termination temperature, 90°C shall be used by default.

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

4-010 Induced Voltages and Currents in Metal Armour or Sheaths of Single-Conductor Cables (see Appendix B)*

(1) Where sheath currents in single-conductor cables having continuous sheaths of lead, aluminum, stainless steel, or copper are likely to cause the insulation of the conductors to be subjected to temperatures in excess of the insulation ratings, the cables shall be

(a) derated to 70% of the current-carrying rating that would otherwise apply;

(b) derated in accordance with the manufacturer's recommendations and in compliance with Rule 2-030; or

(c) installed in a manner that prevents the flow of sheath currents.

(2) Circulating currents in single-conductor armoured cable shall be treated in the same manner as sheath currents in Subrule (1).

(3) Single-conductor cables carrying more than 200 A shall

not enter ferrous metal boxes through individual openings.

(4) Where single-conductor cables carrying more than 200 A enter ferrous metal boxes, precautions shall be taken to prevent overheating of the wall of the box by induction.

(5) Precautions to be taken to prevent overheating of the metal shall include the use of non-ferrous or non-metallic box connectors or cable glands, locknuts, bushings, and ground bushings.

(6) All cables making up a circuit shall enter the box through one common non-ferrous or insulating plate having a minimum thickness of 6.0 mm unless a deviation is allowed in accordance with Rule 2-030.

(7) Where single-conductor mineral-insulated cables are used, all current-carrying conductors shall be grouped together to minimize induced voltage on the sheath.

Section 8: Circuit Loading and Demand Factors

8-100 Current Calculations

When calculating currents that will result from loads, expressed in watts or volt amperes, to be supplied by a low-voltage alternating-current system, the voltage divisors to be used shall be 120, 208, 240, 277, 347, 416, 480, or 600 as applicable.

8-102 Voltage Drop

(1) Voltage drop in an installation shall

(a) be based upon the calculated demand load of the feeder or branch circuit;

(b) not exceed 5% from the supply side of the consumer's service (or equivalent) to the point of utilization; and

(c) not exceed 3% in a feeder or branch circuit.

(2) For the purposes of Subrule (1) the demand load on a branch circuit shall be the connected load, if known; otherwise it shall be 80% of the rating of the

overload or overcurrent devices protecting the branch circuit, whichever is smaller.

8-104 Maximum Circuit Loading (see Appendix B)*

(1) The ampere rating of a consumer's service, feeder, or branch circuit shall be the ampere rating of the overcurrent device protecting the circuit or the ampacity of the conductors, whichever is less.

(2) The calculated load in a circuit shall not exceed the ampere rating of the circuit.

(3) The calculated load in a consumer's service, feeder, or branch circuit shall be considered a continuous load unless it can be shown that in normal operation it will not persist for

(a) a total of more than 1 h in any two-hour period if the load does not exceed 225 A; or

(b) a total of more than 3 h in any six-hour period if the load exceeds 225 A.

(4) Where a fused switch or circuit breaker is marked for continuous operation at 100% of the ampere rating of its overcurrent devices, the continuous load as determined from the calculated load shall not exceed

(a) 100% of the rating of the circuit where the ampacity of the conductors is based on Column 2, 3, or 4 of Table 2 or 4; or

(b) 85% of the rating of the circuit where the ampacity of the conductors is based on Column 2, 3, or 4 of Table 1 or 3.

(5) Where a fused switch or circuit breaker is marked for continuous operation at 80% of the ampere rating of its overcurrent devices, the continuous load as determined from the calculated load shall not exceed

(a) 80% of the rating of the circuit where the ampacity of the conductors is based on Column 2, 3, or 4 of Table 2 or 4; or

(b) 70% of the rating of the circuit where the ampacity of the conductors is based on Column 2, 3, or 4 of Table 1 or 3.

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

(6) If other derating factors are applied to reduce the conductor ampacity, the conductor size shall be the greater of that so determined or that determined by Subrule (4) or (5).

(7) Notwithstanding the requirements of Rule 4-004(1)(d) and (2)(d), the ampacity of the underground conductors shall not exceed in any case those determined by Subrules (4)(b) and (5)(b) of this rule.

8-106 Use of Demand Factors

(1) The size of conductors and switches computed in accordance with this Section shall be the minimum used except that, if the next smaller standard size in common use has an ampacity not more than 5% less than this minimum, the smaller size conductor shall be permitted.

(2) In any case other than a service calculated in accordance with Rules 8-200 and 8-202, where the design of an installation is based on requirements in excess of those given in this Section, the service and feeder capacities shall be increased accordingly.

(3) Where two or more loads are installed so that only one can be used at any one time, the one providing the greatest demand shall be used in determining the calculated demand.

(4) Where it is known that electric space-heating and air-conditioning loads are installed and will not be used simultaneously, whichever is the greater load shall be used in calculating the demand.

(5) Where a feeder supplies loads of a cyclic or similar nature such that the maximum connected load will not be supplied at the same time, the ampacity of the feeder conductors shall be permitted to be based on the maximum load that may be connected at any one time.

(6) The ampacity of conductors of feeders or branch circuits shall be in accordance with the Section(s) dealing with the respective equipment being supplied.

(7) Notwithstanding the requirements of this Section, the ampacity of the conductors of a feeder or branch circuit need not exceed the ampacity of the conductors of the service or of the feeder from which they are supplied.

(8) Where additional loads are to be added to an existing service or feeder, the augmented load shall be permitted to be calculated by adding the sum of the additional loads, with demand factors as permitted by this Code to the maximum demand load of the existing installation as measured over the most recent 12-month period, but the new calculated load shall be subject to Rule 8-104(4) and (5).

Section 12: Conductors — Wiring Methods

12-012 Underground Installations (see Appendix B)*

(1) Direct buried conductors, cables, or raceways shall be installed to meet the minimum cover requirements of Table 53.

(2) The minimum cover requirements shall be permitted to be reduced by 150 mm where mechanical protection is placed in the trench over the underground installation.

(3) Mechanical protection shall consist of one of the following and, when in flat form, shall be wide enough to extend at least 50 mm beyond the conductor, cables, or raceways on each side

(a) treated planking at least 38 mm thick

(b) poured concrete at least 50 mm thick

(c) concrete slabs at least 50 mm thick

(d) concrete encasement at least 50 mm thick; or

(e) other suitable material.

(4) Direct buried conductors or cables shall be installed so that they run adjacent to each other and do not cross over each other and with a layer of screened sand with a maximum particle size of 4.75 mm or screened

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

earth at least 75 mm deep both above and below the conductors.

(5) Where conductors or cables rise for terminations or splices or where access is otherwise required, they shall be protected from mechanical damage by location or by rigid conduit terminated vertically in the trench and including a bushing or bell end fitting, or other acceptable protection, at the bottom end from 300 mm above the bottom of the trench to at least 2 m above finished grade, and beyond that as may be required by other Rules of the Code, and with sufficient slack provided in the conductors at the bottom end of the conduit so that the conductors enter the conduit from a vertical position.

(6) Where a deviation has been allowed in accordance with Rule 2-030, cables buried directly in earth shall be permitted to be spliced or tapped in trenches without the use of splice boxes, and such splices and taps shall be made by methods and with material approved for the purpose.

12-106 Multi- and Single-Conductor Cables

(1) Where multi-conductor cable is used, all conductors of a circuit shall be contained in the same multi-conductor cable except that, where it is necessary to run conductors in parallel due to the capacity of an ac circuit, additional cables shall be permitted to be used, provided that any one such cable

(a) includes an equal number of conductors from each phase and the neutral; and

(b) shall be in accordance with Rule 12-108.

(2) A multi-conductor cable shall not contain circuits of different systems except as permitted in Rule 12-3030.

(3) Where single-conductor cables are used, all single-conductor cables of a circuit shall be of the same type and temperature rating and, if run in parallel, shall be in accordance with Rule 12-108.

(4) Single-conductor armoured cable used as a current-carrying

conductor shall be of a type having non-magnetic armour.

(5) A single-conductor cable carrying a current over 200 A shall be run and supported in such a manner that the cable is not encircled by magnetic material.

12-108 Conductors in Parallel (see Appendix B)*

(1) Ungrounded and grounded circuit conductors of similar onductivity in sizes No. 1/0 AWG and larger, copper or aluminum, shall be permitted to be installed in parallel sets provided that each parallel phase or grounded conductor set is individually comprised of conductors that are

(a) free of splices throughout the total length;

(b) the same circular mil area;

(c) the same type of insulation;

(d) terminated in the same manner;

(e) the same conductor material; and

(f) the same length.

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

(2) Notwithstanding Subrule (1)(a), a single splice per conductor shall be permitted

(a) to meet the requirements of Rule 4-006; and

(b) where spliced in the same manner.

(3) In parallel sets, conductors of one phase, polarity, or grounded circuit conductor shall not be required to have the same characteristics as those of another phase, polarity, or grounded circuit conductor.

(4) The orientation of single-conductor cables in parallel, with respect to each other and to those in other phases, shall be such as to minimize the difference in inductive reactance and the unequal division of current.

(5) Conductors of similar conductivity in sizes smaller than No. 1/0 AWG copper shall be permitted in parallel to supply control power to indicating instruments and devices, contactors, relays, solenoids, and similar control devices, provided that

(a) they are contained within one cable;

(b) the ampacity of each individual conductor is sufficient to carry the entire load current shared by the parallel conductors; and

(c) the overcurrent protection is such that the ampacity of each individual conductor will not be exceeded if one or more of the parallel conductors becomes inadvertently disconnected.

(6) Where parallel conductors include grounded circuit conductors, each parallel set shall have a separate grounded circuit conductor.

(7) Where the size of neutral conductors is reduced in conformance with Rule 4-024, neutral conductors smaller than No. 1/0 AWG shall be permitted in circuits run in parallel, provided that they are installed in conformance with the requirements of Subrule (1)(a), (b), (c), (d), and (e).

12-118 Termination and Splicing of Aluminum Conductors

(1) Adequate precaution shall be given to the termination and splicing of aluminum conductors, including the removal of insulation and separators, the cleaning (wire brushing) of stranded conductors, and the compatibility and installation of fittings.

(2) A joint compound, capable of penetrating the oxide film and preventing its reforming, shall be used for terminating or splicing all sizes of stranded aluminum conductors, unless the termination or splice is approved for use without compound and is so marked.

(3) Equipment connected to aluminum conductors shall be specifically approved for the purpose and be so marked, except

(a) where the equipment has only leads for connection to the supply; and

(b) equipment such as outlet boxes having only grounding terminals.

(4) Aluminum conductors shall not be terminated or spliced in wet locations unless the termination or splice is adequately protected against corrosion.

(5) Field-assembled connections between aluminum lugs and aluminum or copper busbars or lugs, involving bolts or studs 9.5 mm diameter or larger, shall include as part of the joint any of the following means of allowing for expansion of the parts:

(a) a conical spring washer;

(b) a helical spring washer of the heavy series, provided that a flat steel washer of thickness not less than one-sixth of the nominal diameter of the bolt or stud is interposed between the helical washer and any aluminum surface against which it would bear; or

(c) aluminum bolts or studs, provided that all the elements in the assembled connection are of aluminum.

(6) Connection of aluminum conductors to wiring devices having wire-binding terminal screws, around which conductors can be looped under the head of the screw, shall be made by forming the conductor in a clockwise direction around the screw into three-fourths of a complete loop, and only one conductor shall be connected to any one screw.

Armoured Cable

12-600 Armoured Cable Work Rules

Rules 12-602 to 12-618 apply only to armoured cable work.

12-602 Use (see Appendix B)*

(1) Armoured cable shall be permitted to be installed in or on buildings or portions of buildings of either combustible or non-combustible construction.

(2) Armoured cable shall be of the type listed in Table 19 as suitable for direct burial if used

(a) for underground runs;

(b) for circuits in masonry or concrete, provided that the cable is encased or embedded in at least 50 mm of the masonry or concrete; or

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

(c) in locations where it will be exposed to weather, continuous moisture, excessive humidity, or to oil or other substances having a deteriorating effect on the insulation.

(3) Notwithstanding Subrule (2), armoured cable in which the armouring is made wholly or in part of aluminum shall not be embedded in concrete containing reinforcing steel, unless

(a) the concrete is known to contain no chloride additives; or

(b) the armour has been treated with a bituminous base of paint or other means to prevent galvanic corrosion of the aluminum.

(4) Where armoured cables are laid in or under cinders or cinder concrete, they shall be protected from corrosive action by a grouting of non-cinder concrete at least 25 mm thick entirely surrounding them unless they are 450 mm or more under the cinders or cinder concrete.

(5) In buildings of non-combustible construction, armoured cables having conductors not larger than No. 10 AWG copper or aluminum shall be permitted to be laid on the face of the masonry or other material of which the walls and ceiling are constructed and shall be permitted to be buried in the plaster finish for extensions from existing outlets only.

(6) Armoured cable with overall jacket shall be permitted for use in a raceway when it is installed in accordance with Rule 12-902(2).

12-604 Protection for Armoured Cables in Lanes

If subject to mechanical injury and unless otherwise protected, steel guards of not less than No. 10 MSG, adequately secured, shall be installed to protect armoured cables less than 2 m above grade in lanes and driveways.

12-606 Use of Thermoplastic-Covered Armoured Cable

Armoured cable of the type listed in Table 19 as suitable for direct earth burial and having a thermoplastic outer covering shall be used only where the outer covering will not be subjected to mechanical injury.

12-608 Continuity of Armoured Cable

Armoured cable shall be run in a manner such that the mechanical and electrical continuity of the armour is maintained throughout the run, and the armour of cables shall be mechanically and electrically secured to all equipment to which it is attached.

12-610 Terminating Armoured Cable

(1) Where conductors issue from armour, they shall be protected from abrasion by bushings of insulating material or equivalent devices.

(2) Where conductors are No. 8 AWG or larger, copper or aluminum, such protection shall consist of

(a) insulated-type bushings, unless the equipment is equipped with a hub having a smoothly rounded throat; or

(b) insulating material fastened securely in place that will separate the conductors from the armoured cable fittings and afford adequate resistance to mechanical injury.

(3) Where armoured cable is fastened to equipment, the connector or clamp shall be of such design as to leave the insulating bushing or its equivalent visible for inspection.

(4) Where conductors connected to open wiring issue from the ends of armouring, they shall be protected with boxes or with fittings having a separately bushed hole for each conductor.

12-612 Proximity to Knob-and-Tube and Non-Metallic-Sheathed Cable Systems

Where armoured cable is used in a building in which concealed knob-and-tube wiring or concealed non-metallic-sheathed cable wiring is installed, the cable shall not be fished if there is a possibility of damage to the existing wiring.

12-614 Radii of Bends in Armoured Cables

(1) Where armoured cables are bent during installation, the radius of the curve of the inner edge of the bends shall be at least 6 times the external diameter of the armoured cable.

(2) Bends shall be made without undue distortion of the armour and without injury to its inner or outer surfaces.

12-616 Concealed Armoured Cable Installation

(1) Where armoured cable is run through studs, joists, or other members, it shall be

(a) located so that its outer circumference is at least 32 mm from the nearest edge of the members; or

(b) protected from mechanical injury where it passes through the holes in the members.

(2) Where armoured cable is installed immediately behind baseboards, it shall be protected from mechanical injury from driven nails.

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

12-618 Running of Cable Between Boxes, etc.

Armoured cable shall be supported between boxes and fittings in accordance with Rule 12-510.

Cable Trays

12-2200 Method of Installation (see Appendix B)*

(1) Cable trays shall be installed as a complete system using fittings or other means to provide adequate cable support and bending radius before the conductors are installed.

(2) The maximum design load and associated support spacing shall not exceed the load/span ratings of the cable tray.

(3) Cable trays shall not pass through walls except where the walls are constructed of non-combustible material.

(4) Cable trays shall be permitted to extend vertically through floors in dry locations, if provided with fire stops in accordance with Rule 2-124, and if totally enclosed where passing through

and for a minimum distance of 2 m above the floor to provide adequate protection from mechanical injury.

(5) Cable trays shall be adequately supported by non-combustible supports.

(6) The minimum clearances for cable trays shall be

(a) 150 mm vertical clearance, excluding depth of cable trays, between cable trays installed in tiers except that, where cables of 50 mm diameter or greater may be installed, the clearance shall be 300 mm;

(b) 300 mm vertical clearance from the top of the cable tray to all ceilings, heating ducts, and heating equipment and 150 mm for short length obstructions;

(c) 600 mm horizontal clearance on one side of cable trays mounted adjacent to one another or to walls or other obstructions, where the width of the cable tray installation does not exceed 1 m; and

(d) 600 mm horizontal clearance on each side of cable trays mounted adjacent to one another, where the width of the cable tray installation exceeds 1 m.

(7) At least one expansion joint shall be installed in any cable tray run where the expansion of the cable tray due to the maximum probable temperature change during and after installation can damage the cable tray.

12-2202 Conductors in Cable Trays (see Appendix B)*

(1) Conductors for use in cable trays shall be as listed in Table 19 and, except as permitted in Subrules (2) and (3), shall have a continuous metal sheath or interlocking armour.

(2) Type TC tray cable shall be permitted in cable trays in areas of industrial establishments that are inaccessible to the public, provided that the cable is

(a) installed in conduit, other suitable raceway, or direct buried, when not in cable tray;

(b) provided with mechanical protection where subject to damage either during or after installation;

* Please reference the Canadian Electrical Code (CEC) Part 1, Appendix B

(c) no smaller than No. 1/0 AWG if a single-conductor is used; and

(d) installed only where qualified persons service the installation.

(3) Conductors having moisture-resistant insulation and flame-tested non-metal coverings or sheaths of a type listed in Table 19 shall be permitted in ventilated or non-ventilated cable trays where not subject to damage during or after installation in

(a) electrical equipment vaults and service rooms; and

(b) other locations that are inaccessible to the public and are constructed as a service room where a deviation has been allowed in accordance with Rule 2-030.

(4) Single-conductors shall be fastened to prevent excessive movement due to fault-current magnetic forces.

(5) Where single-conductors are fastened to cable trays, precautions shall be taken to prevent overheating of the fasteners due to induction.

12-2204 Joints and Splices within Cable Trays

Where joints and splices are made on feeders or branch circuits within cable trays, the connectors shall be insulated and shall be accessible.

12-2206 Connection to Other Wiring Methods

Where cable trays are connected to other wiring methods, the arrangement shall be such that the conductors will not be subject to mechanical damage or abrasion, and such that effective bonding will be maintained.

12-2208 Provisions for Bonding

(1) Where metal supports for metal cable trays are bolted to the tray and are in good electrical contact with the grounded structural metal frame of a building, the tray shall be deemed to be bonded to ground.

(2) Where the conditions of Subrule (1) do not apply, the metal cable tray shall be adequately bonded at intervals

not exceeding 15 m and the size of bonding conductors shall be based on the ampacity of the largest ungrounded conductor as specified in Rule 10-814 in the circuits carried by the cable tray.

12-2210 Ampacities of Conductors in Cable Trays

(1) In ventilated and ladder-type cable trays, where the air space between adjacent conductors, cables, or both is maintained at greater than 100% of the diameter of the larger conductor or cable, the ampacity of the conductors or cables shall be the value specified in Item (a) or (b):

(a) single-conductors, single-conductor metal-sheathed or armoured cable, and single-conductor mineral-insulated cable, as specified in Tables 1 and 3; and

(b) multi-conductor cables as specified in Tables 2 and 4, multiplied by the correction factor in Table 5C for the number of conductors in each cable.

(2) In ventilated and ladder-type cable trays, where the air space

between adjacent conductors, cables, or both is maintained at not less than 25% nor more than 100% of the diameter of the larger conductor or cable, the ampacity of the conductors or cables shall be the value specified in Subrule (1), multiplied by the correction factor specified in Table 5D for the arrangement and number of conductors or cables involved, unless a deviation has been allowed in accordance with Rule 2-030 for other correction factors.

(3) In ventilated and ladder-type cable trays, where the air space between adjacent conductors, cables, or both is less than 25% of the diameter of the larger conductor or cable, and for any spacing in a non-ventilated cable tray, the ampacity of the conductors or cables shall be the value as specified in Table 2 or 4 multiplied by the correction factor specified in Table 5C for the total number of conductors in the cable tray.

(4) In determining the total number of conductors in the cable tray in Subrule (3), Rule 4-004(7) shall apply.

(5) Where cable trays are located in room temperatures above 30°C, the temperature correction factor of Table 5A shall be applied to the ampacities determined from Subrules (1), (2), and (3) as applicable.

NUAL Brand Conductor Ampacities in Air and Maximum Permissible Number of Conductors in Conduit

RW90 600V					
AWG or KCMIL	Ampacities				
	Table 3	Table 4	1/2"	3/4"	1"
8	60	45	2	5	8
6	85	55**	1	3	6
4	115	75	1	2	4
3	130	85	1	1	3
2	150	100	1	1	3
1	175	115	1	1	1
1/0	205	135		1	1
2/0	235	150		1	1
3/0	270	175		1	1
4/0	315	205		1	1
250	355	230			1
300	395	260			1
350	445	280			1
400	480	305			
500	545	350			
600	615	385			
750	700	435			
1000	845	500			
1500	1070	585			

†For 3-wire 120/240 V and 120/208 V service conductors for single dwellings, or for feeder conductors supplying single dwelling units of row housing of apartment and similar buildings, and sized in accordance with Rules 8-200(1), 8-200(2), and 8-202(1), the allowable ampacity for No. 6 AWG shall be 60 A. In this case, the 5% adjustment of Rule 8-106(1) cannot be applied.

Maximum Permissible Number of Conductors in Conduit †						
Nominal Diameter of Conduit						
1-1/4″	1-1/2″	2″	2-1/2″	3″	3-1/2″	4″
14	19	32	46	72	96	124
11	14	24	35	54	72	93
8	11	18	25	39	53	68
6	9	15	21	33	44	57
5	7	12	18	28	38	49
4	5	9	14	21	28	37
3	4	8	11	18	24	31
3	4	6	9	15	20	26
2	3	5	8	12	17	22
1	2	4	6	10	14	18
1	1	3	5	8	11	14
1	1	3	4	7	10	12
1	1	2	4	6	8	11
1	1	2	3	5	7	10
1	1	1	3	4	6	8
1	1	1	1	3	5	6
	1	1	1	3	4	5
		1	1	1	3	4
			1	1	1	1

Copper Conductor Ampacities in Air and Maximum Permissible Number of Conductors in Conduit

RW90 600V					
AWG or KCMIL	Ampacities				
	Table 1	Table 2	1/2″	3/4″	1″
14	35	25	9	16	25
12	40	30	7	12	20
10	55	40	5	9	15
8	80	55	2	4	7
6	105	75	1	3	5
4	140	95	1	2	4
3	165	115	1	1	3
2	190	130	1	1	3
1	220	145	1	1	1
1/0	260	170		1	1
2/0	300	195††		1	1
3/0	350	225		1	1
4/0	405	260			1
250	455	290			1
300	500	320			1
350	570	350			
400	615	380			
500	700	430			
600	780	475			
750	885	535			
1000	1055	615			

†For 3-wire 120/240 V and 120/208 V service conductors for single dwellings, or for feeder conductors supplying single dwelling units of row housing of apartment and similar buildings, and sized in accordance with Rules 8-200(1), 8-200(2), and 8-202(1), the allowable ampacity for sizes No. 6 and No. 2/0 AWG shall be 60 A and 200 A, respectively. In this case, the 5% adjustment of Rule 8-106(1) cannot be applied.

Maximum Permissible Number of Conductors in Conduit †						
Nominal Diameter of Conduit						
1-1/4"	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"
45	61	101	144	200	200	200
35	48	79	113	175	200	200
27	37	61	87	134	179	200
13	18	30	43	67	90	116
10	13	23	32	50	67	87
7	10	16	23	36	49	63
6	8	14	20	31	41	53
5	7	11	17	26	35	45
3	5	8	12	19	25	33
3	4	7	10	16	22	28
2	3	6	8	13	18	23
1	3	5	7	11	15	19
1	2	4	6	9	12	16
1	1	3	5	7	10	13
1	1	3	4	6	8	11
1	1	2	3	5	7	10
1	1	1	3	5	7	9
1	1	1	2	4	5	7
	1	1	1	3	4	6
		1	1	2	3	4
		1	1	1	3	3

Table 5A — Correction Factors Applying to Tables 1, 2, 3, & 4

(Ampacity Correction Factors for Ambient Temperatures Above 30°C)
(See Rules 4-004(8) and 12-2210 and Tables 1 To 4, 57, And 58)

Ambient Temp. C°	60°	75°	90°	105°
35	0.91	0.94	0.96	0.97
40	0.82	0.88	0.91	0.93
45	0.71	0.82	0.87	0.89
50	0.58	0.75	0.82	0.86
55	0.41	0.67	0.76	0.82
60	—	0.58	0.71	0.77
65	—	0.47	0.65	0.73
70	—	0.33	0.58	0.68
75	—	—	0.5	0.63
80	—	—	0.41	0.58
90	—	—	—	0.45
100	—	—	—	0.26
110	—	—	—	—
120	—	—	—	—
130	—	—	—	—
140	—	—	—	—

Correction Factor				
110°	125°	150°	200°	250°
0.97	0.97	0.98	0.99	0.99
0.94	0.95	0.96	0.97	0.98
0.9	0.92	0.94	0.95	0.97
0.87	0.89	0.91	0.94	0.95
0.83	0.86	0.89	0.92	0.94
0.79	0.83	0.87	0.91	0.93
0.75	0.79	0.84	0.89	0.92
0.71	0.76	0.82	0.87	0.9
0.66	0.73	0.79	0.86	0.89
0.61	0.69	0.76	0.84	0.88
0.5	0.61	0.71	0.8	0.85
0.35	0.51	0.65	0.77	0.83
—	0.4	0.58	0.73	0.8
—	0.23	0.5	0.69	0.77
—	—	0.41	0.64	0.74
—	—	0.29	0.59	0.71

Table 5B — Correction Factors for Tables 1 & 3 (Where from 2 to 4 Single-Conductors are Present and in Contact) (See Rules 4-004(9) and Tables 1, 3 and D3)

Number of Conductors	Correction Factors
2	0.90
3	0.85
4	0.80

Notes:

1) Where four-conductors form a three-phase-with-neutral system, the values for three-conductors may be used. Where three Conductors form a single-phase, three-wire system, the values for two-conductors may be used.

2) Where more than four-conductors are in contact, the ratings for conductors in raceways shall be used.

Table 5C — Ampacity Correction Factors for Tables 2 & 4 (See Rule 4-004 and Tables 2 and 4)

Number of Conductors	Ampacity Correction Factors
1-3	1.00
4-6	0.80
7-24	0.70
25-42	0.60
43 & up	0.50

Table 5D — Current Rating Correction Factors Where Spacings are Maintained (Ventilated and Ladder-Type Cable Trays) (See Rule 12-2210)

Number of Conductors or Cables Horizontally	1	2	3	4	5	6
Vertically (Layers) 1	1.00	0.93	0.87	0.84	0.83	0.82
2	0.89	0.83	0.79	0.76	0.75	0.74

Table 8 — Maximum Allowable Percent Conduit and Tubing Fill (See Rule 12-1014 & 38-032)

Construction	Number of Conductors or Multi-conductor Cables				
	1	2	3	4	Over 4
Conductors or multi-conductor cables (not lead-sheathed)	53	31	40	40	40
Lead-sheathed conductors or multi-conductor cables	55	30	40	38	35

Table 9 — Cross-Sectional Areas of Conduit and Tubing
(See Rule 12-1014)

Normal Conduit Size	Internal Diameter (mm)			
		100%	55%	53%
16 (1/2)	15.8	107.8	4.13	103.9
21 (3/4)	20.9	189.2	4.6	182.3
27 (1)	26.6	306.7	5.23	295.5
35 (1-1/4)	35.1	530.7	5.99	511.4
41 (1-1/2)	40.9	722.4	7.71	696.1
53 (2)	52.5	1191	8.93	1147
63 (2-1/2)	62.7	1699	9.64	1637
78 (3)	79.9	2623	10.46	2528
91 (3-1/2)	90.1	3508	12.49	3381
103 (4)	102.3	4517	13.51	4353
116 (4-1/2)	114.5	5659	14.68	5453
129 (5)	128.2	7099	16	6841
155 (6)	154.1	10 251	17.47	9879

Note:
The dimensions shown are typical of metallic conduit and tubing. Other figures more accurately representing the actual dimensions of a particular product may be substituted, when known. Dimensions of other circular raceways may be obtained from the approved standard to which they are manufactured.

Cross-sectional Area of Conduit and Tubing (mm^2)				
40%	38%	35%	31%	30%
78.41	74.49	68.61	60.77	58.81
137.6	130.7	120.4	106.7	103.2
223	211.9	195.2	172.9	167.3
386	366.7	337.7	299.1	289.5
525.4	499.1	459.7	407.2	394
866	822.7	757.7	671.1	649.5
1236	1174	1081	957.5	926.7
1908	1812	1669	1479	1431
2551	2424	2233	1977	1914
3285	3121	2875	2546	2464
4115	3910	3601	3189	3086
5163	4905	4517	4001	3872
7456	7083	6524	5778	5592

Table 10A — Dimensions of Cable for Calculating Conduit and Tubing Fill

(When dimensions are not otherwise available.) (See Rule 12-1014)

Conductor Size AWG KCMIL	R90XLPE*, RW75XLPE*, RW90XLPE*, 600 V		R90XLPE*, RW75XLPE*, RW90XLPE*, 1000 V		R90XPLE†, RW75XPLE†, R90EP†, RW75EP†, RW90XLPE‡, RW90EP‡, 600 V	
	Diameter (mm)	Area (mm^2)	Diameter (mm)	Area (mm^2)	Diameter (mm)	Area (mm^2)
14	3.36	8.89	4.12	13.36	4.12	13.36
12	3.84	11.61	4.60	16.65	4.60	16.75
10	4.47	15.67	5.23	21.45	5.23	21.45
8	5.99	28.17	5.99	28.17	6.75	35.77
6	6.95	37.98	7.71	46.73	8.47	56.39
4	8.17	52.46	8.93	62.67	9.96	73.79
3	8.88	61.99	9.64	73.05	10.40	85.01
2	9.70	73.85	10.46	85.88	11.22	98.82
1	11.23	99.10	12.49	112.6	13.51	143.4

*Unjacketed
†Jacketed
††Includes EPCV

R90XLPE*, RW75XLPE*, RW90XLPE*, 1000 V		TW, TW75		TWU,TWU75, RWU90XLPE*	
Diameter (mm)	Area (mm^2)	Diameter (mm)	Area (mm^2)	Diameter (mm)	Area (mm^2)
2.80	6.18	3.36	8.89	4.88	18.70
3.28	8.47	3.84	11.61	5.36	22.56
4.17	13.63	4.47	16.57	5.97	27.99
5.49	23.66	5.99	28.17	7.76	47.29
6.45	32.71	7.71	46.73	8.72	59.72
8.23	53.23	8.93	62.67	9.95	77.76
8.94	62.83	9.64	73.05	10.67	89.42
9.76	74.77	10.46	85.88	11.48	103.5
11.33	100.9	12.49	122.6	13.25	137.9

Continued on Next Page

Table 10A Continued (See Rule 12-1014)

Conductor Size AWG KCMIL	R90XLPE*, RW75XLPE*, RW90XLPE*, 600 V		R90XLPE*, RW75XLPE*, RW90XLPE*, 1000 V		R90XPLE†, RW75XPLE†, R90EP, RW75EP†, RW90XLPE‡, RW90EP, 600 V	
	Diameter (mm)	Area (mm²)	Diameter (mm)	Area (mm²)	Diameter (mm)	Area (mm²)
1/0	12.27	118.3	13.53	143.9	14.55	166.4
2/0	13.44	141.9	14.70	169.8	15.72	194.2
3/0	14.74	170.6	16.00	201.0	17.02	227.5
4/0	16.21	206.4	17.47	239.7	18.49	268.5
250	17.90	251.8	19.17	288.5	21.21	353.2
300	19.30	292.6	20.56	332.1	22.60	401.2
350	20.53	331.0	21.79	372.9	23.83	446.0
400	21.79	373.0	23.05	417.3	25.09	494.5
450	22.91	412.2	24.17	458.8	26.21	539.5
500	23.95	450.5	25.21	499.2	27.25	583.2
600	26.74	561.7	27.24	582.9	30.04	708.8
700	28.55	640.0	29.05	662.6	31.85	796.5
750	29.41	679.3	29.91	702.6	32.71	840.3
800	30.25	718.7	30.75	742.6	33.55	884.0
900	31.85	796.6	32.35	821.8	35.15	970.2
1000	32.32	872.0	33.82	898.4	36.62	1053
1250	37.56	1108	38.32	1153	42.38	1411
1500	40.68	1300	41.44	1349	45.50	1626
1750	43.58	1492	44.34	1544	48.40	1840
2000	46.27	1681	47.03	1737	51.09	2050

Note:

Dimensions for aluminum conductors are subjected to the range of sizes to which they are certified. Data is for compressed stranded conductos.

*Unjacketed
†Jacketed
††Includes EPCV

R90XLPE*, RW75XLPE*, RW90XLPE*, 1000 V		TW, TW75		TWU,TWU75, RWU90XLPE*	
Diameter (mm)	Area (mm^2)	Diameter (mm)	Area (mm^2)	Diameter (mm)	Area (mm^2)
12.37	120.3	13.53	143.9	14.28	160.2
13.54	144.0	14.70	169.8	15.45	187.5
14.84	172.9	16.00	201.0	16.76	220.6
16.31	209.0	17.47	239.7	18.28	262.4
18.04	255.7	19.43	296.4	20.20	320.5
19.44	296	9.20.82	340.5	21.54	364.4
20.67	335.6	22.05	381.9	22.81	408.6
21.93	337.8	23.31	426.8	24.07	455.0
23.05	417.3	24.43	468.7	25.19	498.4
24.09	455.8	25.47	509.5	26.24	540.8
—	—	28.26	627.3	29.02	661.4
—	—	30.07	710.0	30.82	746.0
—	—	30.93	751.3	31.69	788.7
—	—	31.77	792.7	32.53	831.1
—	—	33.37	874.5	34.13	914.9
—	—	34.84	953.4	35.60	995.4
—	—	39.08	1200	39.08	1199
—	—	42.20	1399	42.96	1449
—	—	45.10	1598	45.86	1652
—	—	47.79	1794	48.55	1851

Table 10B — Dimensions of Photovoltaic Cable for Calculating Conduit and Tubing Fill (See Rule 12-1014)

Conductor size AWG or kcmil	RPV*, 600 V		RPV*, 1000 V		RPV*, 2000 V	
	Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2
14	3.37	8.92	4.13	13.4	4.89	18.78
12	3.84	11.58	4.6	16.62	5.36	22.56
10	4.47	15.69	5.23	21.48	5.99	28.18
8	5.99	28.18	5.99	28.18	7.27	41.51
6	6.95	37.94	7.71	46.69	8.23	53.2
4	8.17	52.42	8.93	62.63	9.45	70.14
3	8.88	61.93	9.64	72.99	10.16	81.07
2	9.7	73.9	10.46	85.93	10.98	94.69
1	11.23	99.05	12.49	122.5	13.01	132.9
1/0	12.25	117.9	13.51	143.4	14.03	154.6
2/0	13.42	141.4	14.68	169.3	15.2	181.5
3/0	14.74	170.6	16	201.1	16.52	214.3
4/0	16.21	206.4	17.47	239.7	17.99	254.2
250	17.9	251.6	19.16	288.3	19.94	312.3
300	19.3	292.6	20.56	332	21.34	357.7

*Unjacketed
†Jacketed

RPV†, 600 V		RPV†, 1000 V		RPV†, 2000 V		RPVU*, 1000 V 2000 V		RPVU†, 1000 V 2000 V	
Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2
4.13	13.4	4.89	18.78	5.65	25.07	4.89	18.78	5.65	25.07
4.6	16.62	5.36	22.56	6.12	29.42	5.36	22.56	6.12	29.42
5.23	21.48	5.99	28.18	7.51	44.3	5.99	28.18	6.75	35.78
7.51	44.3	7.51	44.3	8.79	60.68	7.77	47.42	9.29t	67.78
8.47	56.35	9.23	66.91	9.75	74.66	8.73	59.86	10.25	82.52
9.69	73.75	10.45	85.77	10.97	94.52	9.95	77.76	11.47	103.3
10.4	84.95	11.16	97.82	11.68	107.1	10.66	89.25	12.18	116.5
11.22	98.87	11.98	112.7	13.26	138.1	11.48	103.5	13.76	148.7
13.51	143.4	14.77	171.3	15.29	183.6	13.25	137.9	15.53	189.4
14.53	165.8	15.79	195.8	16.31	208.9	14.27	159.9	16.55	215.1
15.7	193.6	16.96	225.9	17.48	240	15.44	187.2	17.72	246.6
17.02	227.5	18.28	262.4	18.8	277.6	16.76	220.6	19.04	284.7
18.49	268.5	19.75	306.4	21.29	356	18.23	261	21.53	364.1
21.2	353	22.46	396.2	23.24	424.2	20.18	319.8	23.48	433
22.6	401.1	23.86	447.1	24.64	476.8	21.58	365.8	24.88	486.2

Table 10B Continued (See Rule 12-1014)

Conductor size AWG or kcmil	RPV*, 600 V		RPV*, 1000 V		RPV*, 2000 V	
	Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2
350	20.6	333.3	21.86	375.3	22.64	402.6
400	21.79	372.9	23.05	417.3	23.83	446
450	22.91	412.2	24.17	458.8	24.95	488.9
500	23.95	450.5	25.21	499.2	25.99	530.5
600	26.74	561.6	27.24	582.8	28.78	650.5
700	28.55	640.2	29.05	662.8	30.59	734.9
750	29.41	679.3	29.91	702.6	31.45	776.8
800	30.22	717.3	30.72	741.2	32.26	817.4
900	31.85	796.7	32.35	821.9	33.89	902.1
1000	33.32	872	33.82	898.3	35.36	982
1250	37.56	1108	38.32	1153	39.86	1248
1500	40.68	1300	41.44	1349	42.98	1451
1750	43.58	1492	44.34	1544	45.88	1653
2000	46.27	1681	47.03	1737	48.57	1853

*Unjacketed
†Jacketed

Note:

Aluminum conductors may not be available in the same range as copper conductors.

RPV†, 600 V		RPV†, 1000 V		RPV†, 2000 V		RPVU*, 1000 V 2000 V		RPVU†, 1000 V 2000 V	
Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2	Dia., mm	Area, mm2
23.9	448.6	25.16	497.2	25.94	528.5	22.88	411.2	26.18	538.3
25.09	494.4	26.35	545.3	27.13	578.1	24.07	455	27.37	588.4
26.21	539.5	27.47	592.7	28.25	626.8	25.19	498.4	28.49	637.5
27.25	583.2	28.51	638.4	29.29	673.8	26.23	540.4	29.53	684.9
30.04	708.7	30.54	732.5	32.08	808.3	29.04	662.3	32.34	821.4
31.85	796.7	32.35	821.9	33.89	902.1	30.85	747.5	34.15	915.9
32.71	840.3	33.21	866.2	34.75	948.4	31.71	789.7	35.01	962.7
33.52	882.5	34.02	909	35.56	993.1	32.52	830.6	35.82	1008
35.15	970.4	35.65	998.2	37.19	1086	34.15	915.9	37.45	1102
36.62	1053	37.12	1082	38.66	1174	35.62	996.5	38.92	1190
42.38	1411	43.14	1462	44.68	1568	39.86	1248	44.68	1568
45.5	1626	46.26	1681	47.8	1795	42.98	1451	47.8	1795
48.4	1840	49.16	1898	50.7	2019	45.88	1653	50.7	2019
51.09	2050	51.85	2111	53.39	2239	48.57	1853	53.39	2239

Table 16 — Minimum Size Conductors for Bonding Conductors (See Rules 10-204, 10-626, 10-814, 10-816, 10-906, 12-1814, 24-104, 24-202, 30-1030, 68-058 and 68-406)

Ampacity A, of largest ungrounded conductor in the circuit or equivalent for multiple parallel conductors not exceeeding	Size of Bonding Conductor	
	Copper Wire AWG	Aluminum Wire AWG
20	14	12
30	12	10
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	0
600	1	00
800	0	000
1000	00	0000
1200	000	250 kcmil
1600	0000	350 kcmil
2000	250 kcmil	400 kcmil
2500	350 kcmil	500 kcmil
3000	400 kcmil	600 kcmil
4000	500 kcmil	800 kcmil
5000	700 kcmil	1000 kcmil
6000	800 kcmil	1250 kcmil

Note:

1) The ampacity of the largest ungrounded conductor, or the equivalent if multiple conductors are used, shall be determined from the appropriate Table in the Code, taking into consideration the number of conductors in the raceway or cable and the type of insulation.

Table 18 – Minimum Size of Grounding Conductor for Service Raceway and Service Equipment

(See Rule 10-812)

Ampacity of largest service conductor or equivalent for multi-conductors not exceeeding – amperes	Size of Grounding Conductor				
	Copper Wire AWG	Metal Conduit or Pipe		Electrical Metallic Tubing	
		(mm)	(in)	(mm)	(in)
60	8	21	3/4	27	1
100	8	27	1	35	1 1/4
200	6	35	1 1/4	41	1 1/2
400	3	63	2 1/2	63	2 1/2
600	1	78	3	103	4
800	0	103	4	103	4
Over 800	00	155	6	–	–

Table 21 – Supporting of Conductors in Vertical Runs of Raceways (See Rule 12-120)

Conductor Size AWG & kcmil	Maximum Distance – Metres	
	Copper	Aluminum
14 to 8	30	30
6 to 0	30	60
00 to 0000	24	55
250 to 350	18	40
Over 350 to 500	15	35
Over 500 to 750	12	30
Over 750	10	25

Note:

For installation of armoured cables in vertical raceways please contact General Cable for assistance. See the General Cable Armoured Cable Canadian Catalogue for additional information.

Dimensions of Stranded Aluminum Conductors

Conductor				Wires		
Size AWG	Area			No.	Diameter	
	Circ. Mils	mm^2	sq. in.		mm	in.
8	16510	8.37	.01297	7(6)*	1.23	.0486
6	26240	13.30	.02061	7(6)*	1.55	.0612
4	41740	21.15	.03278	7(6)*	1.96	.0772
3	52620	26.66	.04133	7(6)*	2.30	.0867
2	66360	33.62	.05212	7(6)*	2.47	.0974
1	83690	42.41	.06573	19(7)*	1.69	.0664
0/1	105600	53.51	.08291	19(7)*	1.89	.0745
2/0	133100	67.44	.1045	19(11)*	2.13	.0837
3/0	167800	85.02	.1318	19(15)*	2.39	.0940
4/0	211600	107.22	.1662	19(17)*	2.68	.1055
250 kcmil		126.68	.1963	37(18)*	2.09	.0822
300		152.01	.2356	37(18)*	2.31	.0900
350		177.34	.2749	37(24)*	2.47	.0973
400		202.68	.3142	37(24)*	2.64	.1040
500		253.36	.3927	37(30)*	2.95	.1162
600		304.02	.4712	61(34)*	2.52	.0992
750		380.03	.5980	61(53)*	2.82	.1109
1000		506.70	.7854	61(53)*	3.25	.1280
1250		633.38	.9817	90	2.98	.1172
1500		760.05	1.178	90	3.26	.1284
1750		886.70	1.374	127	2.98	.1174
2000		1013.40	1.571	127	3.19	.1255

*Reduced minimum number of wires for compact strandings shown in parentheses.

Nominal Conductor Diameter					
Class "B" Standard		Compressed Round		Compact Round	
mm	in	mm	in	mm	in
3.71	.146	3.60	.142	3.40	.134
4.67	.184	4.53	.178	4.29	.169
5.89	.232	5.71	.225	5.41	.213
6.60	.260	6.40	.252	6.05	.238
7.42	.292	7.20	.283	6.81	.268
8.43	.332	8.18	.322	7.59	.299
9.47	.373	9.19	.362	8.53	.336
10.64	.418	10.32	.406	9.55	.376
11.94	.470	11.58	.456	10.7	.423
13.41	.528	13.00	.512	12.1	.475
14.60	.575	14.16	.558	13.2	.520
16.00	.630	15.52	.611	14.5	.570
17.30	.681	16.78	.661	15.6	.6161
18.49	.728	17.94	.706	16.7	.659
20.65	.813	20.03	.789	18.7	.736
22.68	.893	22.00	.866	20.7	.813
25.35	.998	24.59	.968	23.1	.908
29.26	1.152	23.38	1.117	26.9	1.060
32.47	1.289	31.76	1.250	—	—
35.86	1.412	34.78	1.370	—	—
38.76	1.526	37.60	1.479	—	—
41.45	1.632	40.21	1.583	—	—

DC Resistance Values and Weights of Stranded Copper and Aluminum Conductors

mm2		ASTM B800* /ASTM B801[1]		ASTM B8[1]	
		APPROXIMATE NET WEIGHT			
		Aluminum		Copper	
	AWG or kcmil	lbs/1000ft	kg/km	lbs/1000ft	kg/km
0.519	*20 AWG	–	–	3.154	4.694
0.519	*18	–	–	5.015	7.464
0.823	*16	–	–	7.974	11.868
2.08	*14	3.795	5.648	12.68	18.87
3.31	*12	6.03	8.974	20.16	30
5.26	*10	9.501	14.27	32.06	47.72
8.37	8	15.5	29.1	50.97	75.86
13.3	6	24.7	36.8	81.05	120.63
21.2	4	39.3	58.5	128.9	191.8
26.7	3	49.5	73.7	162.5	241.9
33.6	2	62.5	93	204.9	304.9
42.4	1	78.8	117	258.4	384.6
53.5	1/0	99.4	148	325.8	484.9
67.4	2/0	126	186	410.9	611.5

* Solid conductors

[1] Reference standard used

* Approximate weights and average DC resistances are considered to apply to all types of strands. Conductor data and metric equivalents in these tables are based where possible on CSA Standard 22.2 No. 38

CSA 22.2 no. 38[1]		CSA 22.2 no.38[1]	
AVERAGE DC RESISTANCE[1] 20°C			
Aluminum		Bare Copper	
Ohms /km	Ohms /Kft	Ohms/km	Ohms /K
–	–	33.8	10.3
–	–	21.46	6.54
–	–	13.45	4.1
–	–	8.46	2.58
8.88	2.71	5.35	1.63
5.59	1.7	3.35	1.02
3.52	1.07	2.1	0.64
2.21	0.674	1.32	0.403
1.39	0.424	0.83	0.253
1.1	0.336	0.659	0.201
0.875	0.267	0.522	0.159
0.693	0.211	0.413	0.126
0.55	0.168	0.328	0.1
0.436	0.133	0.261	0.0795

DC Resistance Values and Weights of Stranded Copper and Aluminum Conductors (Continued)

mm2		ASTM B800* /ASTM B801[1]		ASTM B8[1]	
		APPROXIMATE NET WEIGHT			
		Aluminum		Copper	
	AWG or kcmil	lbs/100ft	kg/km	lbs/100ft	kg/km
85	3/0	158	235	518.1	771.1
107	4/0	199	296	653.1	972
127	250kcmil	235	350	771.9	1148.8
152	300	282	420	926.3	1378.6
177	350	329	490	1081	1609
203	400	376	559	1235	1838
253	500	471	701	1544	2298
304	600	565	841	1853	2758
380	750	706	1050	316	3447
456	900	847	1260	2779	4136
507	1000	941	1400	3088	4596
633	1250	1170	1750	3859	5743
760	1500	1410	2100	4631	6892
887	1750	1640	2440	5403	8041
1010	2000	1880	2790	6175	9190

* Solid conductors

[1] Reference standard used

* Approximate weights and average DC resistances are considered to apply to all types of strands. Conductor data and metric equivalents in these tables are based where possible on CSA Standard 22.2 No. 38

CSA 22.2 no. 38[1]		CSA 22.2 no.38[1]	
AVERAGE DC RESISTANCE[1] 20°C			
Aluminum		Bare Copper	
Ohms /km	Ohms /Kft	Ohms/km	Ohms /K ft
0.346	0.106	0.207	0.063
0.274	0.0836	0.164	0.05
0.232	0.0708	0.139	0.0423
0.194	0.059	0.116	0.0353
0.166	0.0505	0.0991	0.0302
0.145	0.0442	0.0866	0.0264
0.116	0.0354	0.0695	0.0212
0.0967	0.0295	0.0578	0.0176
0.0774	0.0236	0.0462	0.0141
0.0645	0.0197	0.0387	0.0118
0.058	0.0177	0.0348	0.0106
0.0464	0.0142	0.0278	0.00846
0.0387	0.0118	0.0231	0.00705
0.0332	0.0101	0.0198	0.00604
0.029	0.00884	0.0174	0.00529

Table D6 — Recommended* Tightening Torques for Wire-binding Screws, Connectors with Slotted Screws, and Connectors for External Drive Wrenches (See Table D7)

Type of connection	Wire size, AWG or kcmil	Tightening torque, N•m
Wire-binding screws	14-10	1.4
Connectors with slotted screws (slot width — 1.2 mm or less and slot length — 6.4 mm or less)	30-10	2.3
	8	2.8
	6-4	4.0
	3	4.0
	2	4.0
Connectors with slotted screws (slot width over 1.2 mm and slot length over 6.4 mm)	30–10	4
	8	4.5
	6–4	5.1
	3	5.6
	2	5.6
	1	5.6
	1/0–2/0	5.6
	3/0–4/0	5.6
	250–350	5.6
	400	5.6
	500	5.6
	600–750	5.6
	800–1000	5.6

Type of connection	Wire size, AWG or kcmil	Tightening torque, N•m
Connectors for hexagonal head — External drive wrench (split-bolt connectors)	30–10	9
	8	9
	6–4	18.6
	3	31.1
	2	31.1
	1	31.1
	1/0–2/0	43.5
	3/0–4/0	56.5
	250–350	73.4
	400	93.2
	500	93.2
	600–750	113
	800–1000	124.3
	1250–2000	124.3

* For proper termination of conductors, it is very important that field connections be properly tightened. In the absence of manufacturer's instructions on the equipment, the torque values given in Tables D6 and D7 are recommended.

Because it is normal for some relaxation to occur in service, checking torque values some time after installation is not a reliable means of determining the values of torque applied at installation.

Note: The values in this table are correlated for consistency with the harmonized Standard CAN/CSA-C22.2 No. 65.

Table D6 — Recommended* Tightening Torques for Wire-binding Screws, Connectors with Slotted Screws, and Connectors for External Drive Wrenches (Continued)

(See Table D7)

Type of connection	Wire size, AWG or kcmil	Tightening torque, N•m
Connectors for hexagonal head — External drive wrench (other connectors)	30–10	8.5
	8	8.5
	6–4	12.4
	3	16.9
	2	16.9
	1	16.9
	1/0–2/0	20.3
	3/0–4/0	28.2
	250–350	36.7
	400	36.7
	500	42.4
	600–750	42.4
	800–1000	56.5
	1250–2000	67.8

*For proper termination of conductors, it is very important that field connections be properly tightened. In the absence of manufacturer's instructions on the equipment, the torque values given in Tables D6 and D7 are recommended.

Because it is normal for some relaxation to occur in service, checking torque values some time after installation is not a reliable means of determining the values of torque applied at installation.

Note: The values in this table are correlated for consistency with the harmonized Standard CAN/CSA-C22.2 No. 65.

Table D7 — Recommended Tightening Torques (See Table D6)

Usage	Connection type and size		Tightening torque, N•m
	Socket (across flats) mm (inches)		
Screws with recessed allen or square drives	3.2	(1/8)	5.1
	4	(5/32)	11.3
	4.8	(3/16)	13.6
	5.6	(7/32)	16.9
	6.4	(1/4)	22.6
	7.9	(5/16)	31.1
	9.5	(3/8)	42.4
	12.7	(1/2)	56.5
	14.3	(9/16)	67.8
Connecting hardware	Screw or bolt metric (SAE)		
	No. 8 or smaller		2
	No. 10		3
	M6 (1/4)		8
	5/16		15
	M10 (3/8)		26
	5/16		41
	M12 (1/2)		54
	9/16, 5/8, or larger		75

Table D7 — Recommended* Tightening Torques (Continued)
(See Table D6)

Usage	Connection type and size	Tightening torque, N•m
Slotted head screws smaller than No. 10 intended for use with No. 8 AWG or smaller conductors	"Slot width of screw less than 1.2 mm (3/64 inch) — Slot length mm (inches)"	
	< 4 (< 5/32)	7
	4 (5/32)	7
	4.8 (3/16)	7
	5.6 (7/32)	7
	6.4 (1/4)	9
	Slot width of screw 1.2 mm (3/64 inch) and larger — Slot length mm (inches)	
	< 4 (< 5/32)	9
	4 (5/32)	12
	4.8 (3/16)	12
	5.6 (7/32)	12
	6.4 (1/4)	12
	7.1 (9/32)	15
	> 7.1 (> (9/32)	20

*For proper termination of conductors, it is very important that field connections be properly tightened. In the absence of manufacturer's instructions on the equipment, the torque values given in Tables D6 and D7 are recommended.

Because it is normal for some relaxation to occur in service, checking torque values some time after installation is not a reliable means of determining the values of torque applied at installation.

Note: The values in this table are correlated for consistency with the harmonized Standard CAN/CSA-C22.2 No. 65.

Closest AWG or kcmil Size(s) to Metric Conductor Size(s)

Metric conductor size, mm2	Closest AWG or kcmil size(s) for selection of insulation and jacket thickness requirement
2.5	14
4	12
6	10
10	8
16	6
25	4
35	2
50	1/0
70	2/0
95	3/0
120	250
150	300
240	500
300	600
400	800
500	1000
630	1250
800	1500
1000	2000

Basic Metric Conversion Factors

Convert	Into	Multiply By
circular mils	square mils	0.7854
cubic inches	litres	0.01639
feet	metres	0.3048
inches	centimetres	2.540
kcmil	square millimetres	0.5067
kilograms	pounds	2.205
kilograms per kilometre	pounds per foot	0.00067197
kilometres	miles	0.6214
kilometres	yards	1 094
metres	feet	3.281
metres	yards	1.094
millimeters	inches	0.03937
pounds	kilograms	0.4536
pounds per foot	kilograms per kilometre	1488.16
square inches	circular mils	1273.23
square inches	square millimetres	645.16
square millimetres	circular mils	1973.55
square millimetres	square inches	1.550 x 10-3
tons (long)	kilograms	1016
tons (long)	pounds	2240
tons (metric)	pounds	2205
tons (short)	kilograms	907.18
tons (short)	pounds	2000

Temperature
˚C = (˚F -32) x 5/9
˚F = (˚C x 9/5) + 32

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