ALCAN CABLE

INSTALLER'S HANDBOOK FOR ALCAN

WIRE AND CABLES

grounded in service

wired to innovate™

ABOUT THIS GUIDE

This guide is intended to provide introductory technical data to aid 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 Technical Committee on Wiring Products.

This guide provides information on standard products stocked by Alcan's Distributors. Alcan 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.cable.alcan.com for the most current list of product offerings.

Wire and cable products supplied by Alcan 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, Alcan does not accept responsibility for costs incurred by a purchaser as a result of weights and measurements not conforming exactly to those indicated.

ABOUT ALCAN

Alcan 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're consistently superior to anything else on the market. Our distribution centre, technical centre and manufacturing facilities have all attained ISO 9000 certification, and we're proud to have the only North American manufacturing plant with the triple accreditation of ISO 9000, 14000 and 18000.

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

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ENGINEERING INFORMATION

NUAL®

The term NUAL refers to Alcan manufactured aluminum alloy conductor material, designated as "ACM" in the Canadian Electrical Code. NUAL is produced in rod form and afterwards drawn to the appropriate wire diameter for fabrication into solid or stranded conductor building wire and cable.

NUAL is CSA-certified in finished building wire form, as well as in raw material form as rolled rod for processing by cable fabricators into finished wire and cable. Meeting all of the physical and electrical requirements of aluminum to CSA and UL standards, NUAL in addition provides superior connectability in both solid and stranded conductor form.

NUAL is CSA-certified up to 2000 kcmil and is mandatory in sizes 12 and 10 AWG solid. NUAL conductors are supplied by Alcan in sizes 8 AWG and larger, other than Neutral-supported Cables, which have AA1350 phase conductors and an ACSR neutral/messenger conductor.

- Thermosetting wires (RW90 XLPE, RWU90 XLPE) to CSA Standard C22.2 No. 38
- Nonmetallic Sheathed Cable (NMD90) to CSA Standard C22.2 No. 48
- Armoured Cable (AC90, ACWU90*) to CSA Standard C22.2 No. 51
- TECK* Cable to CSA Standard C22.2 No. 131
- Service cables for underground installations (USEI, USEB) to CSA Standard C22.2 No. 52
- Service cables (neutral supported) for overhead installations (NS-1, NSF-2) to CSA Standard C22.2 No. 129

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

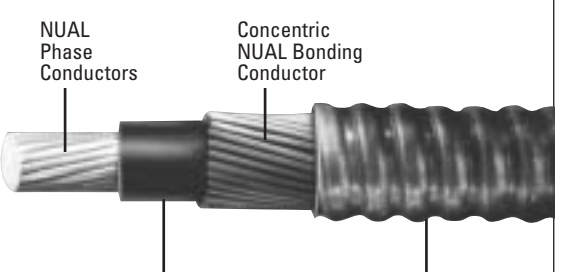
* With supplementary HL ratings for all hazardous locations.

ALCAN ARMOURED CABLES

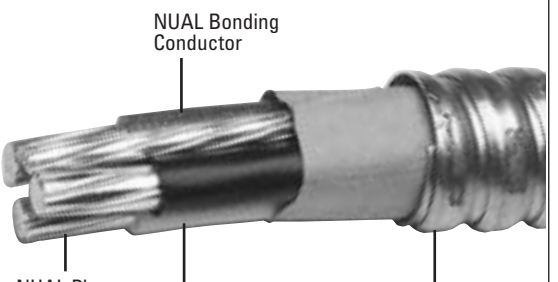
AC90

AVAILABLE SIZES	NUAL	SPECIFICATION
Single-conductor	1/0 AWG to 750 kcmil	CSA C22.1 No. 51
Multi-conductor	6 AWG to 750 kcmil	FT4 Rated: Vertical Cable Tray Test

Alcan AC90 Single-conductor Cable



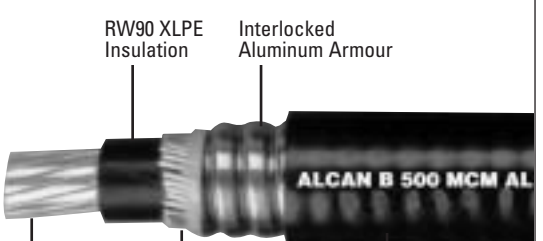
Alcan AC90 Multi-conductor Cable



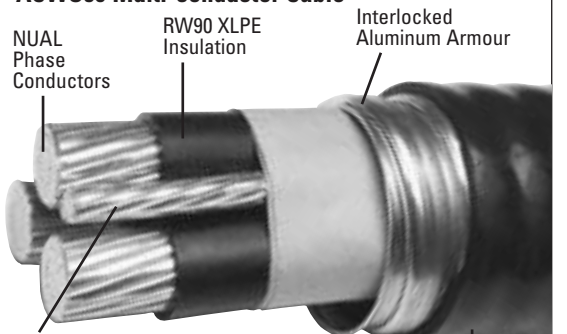
ACWU90

AVAILABLE SIZES	NUAL	SPECIFICATION
Single-conductor	1/0 AWG to 1500 kcmil	CSA C22.2 No. 51
Multi-conductor	6 AWG to 750 kcmil	FT4 Rated: Vertical Cable Tray Test
		CSA C22.2 No. 174 Hazardous Locations

ACWU90 Single-conductor Cable

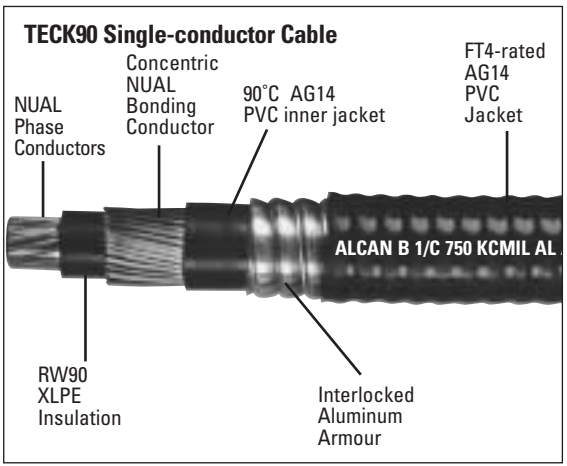


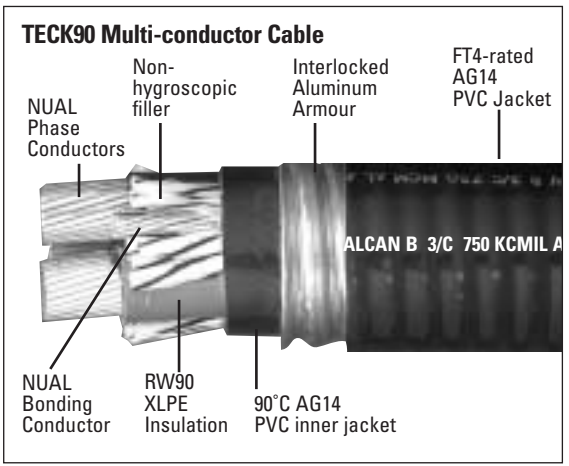
ACWU90 Multi-conductor Cable



TECK90

AVAILABLE SIZES	NUAL	SPECIFICATION
Single-conductor	1/0 AWG to 1000 kcmil	CSA C22.2 No. 131 (TECK)
Multi-conductor	6 AWG to 750 kcmil	CSA C22.2 No. 174 (Hazardous Locations)
		FT4 Rated: Vertical Cable Tray Test





FIRE TEST STANDARDS

FT1 & FT4 RATINGS

The CSA Standard for AC90, ACWU90 and TECK90 cables require that all cables meet the Vertical Flame Test (FT1 Bunsen burner test) to CSA Standard C22.2 No. 0.3. In addition, a much tougher level of performance is specified in the CSA Vertical Flame Test – Cables in Cable Tray to CSA Standard C22.2 No. 0.3.

All Alcan ACWU90 and TECK90 cables meet both these levels of flammability performance. Typical results are shown in the following table. 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 2002 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. Its interlocked aluminum armour is considered equivalent to insulated conductors in metal conduit and is highly resistant to flame spread.

Appendix "B" 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; and

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, Nineteenth Edition, 2002, 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:

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 aluminum or copper conductor, care should be taken to ensure service continuity. Alcan Cable recommends the following procedures for all cable connections:

1) **Fittings:** Use only CSA-approved terminal lugs and connectors 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 end by “pencilling”; “ringing” can nick the conductor.

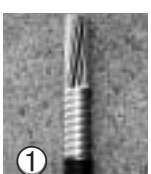
3) **Cleaning:** Wire brush the exposed conductor end to remove any oxide film. Coat with a suitable joint compound to inhibit its reformation, thus protecting the contact surfaces from air and moisture.

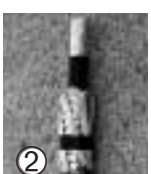
4) **Installation:** Insert the prepared cable end into the connector or terminal lug and secure the connection. Ensure that the correct tool and die are used for compression fittings and that appropriate torque is applied to bolted connectors.

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 Alcan 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 below. 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 a AL9CU or AL7CU rated connector bolted to the equipment enclosure.





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 As step 1 above.
2 Cut off the bonding conductor flush with the armour.
3 As 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 AND BELOW GROUND

Alcan 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 be identical and that multiple barrelled lugs or crimp type flat lugs with separate screws or studs be used.

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 17-18.

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 Alcan 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 currents which in no way account for voltage drop. Alcan Cable provides on request a program on diskette which can be used for precise calculation of voltage drop. Alternatively, the program can be downloaded from the Alcan Cable website.

MAGNETIC FIELDS AND HARMONICS

The magnetic fields surrounding single-conductors can extend much farther than those surrounding multi-conductor cables. Concerns have been expressed in some circles that magnetic fields may be linked with cancer. The cautious consultant or end-user may wish to exercise the option of minimizing magnetic field strengths until more definitive medical evidence is available.

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 nullified 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 major 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 4-conductor cables

CIRCULATING CURRENTS

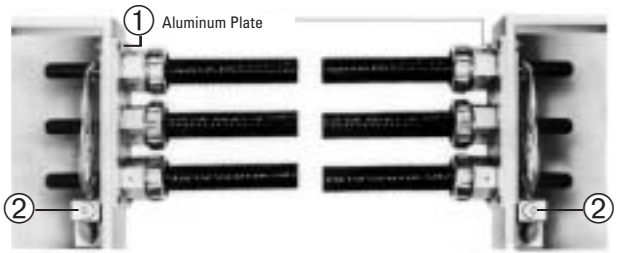
An explanation of circulating currents in metallic sheaths and armour of single-conductor cables, including their causes and effects, is provided in the Appendix B notes to Rule 4-008 of the Canadian Electrical Code Part I. They can be prevented by rigid attention to methods explained in the following pages.

INSTALLATION OF SINGLE-CONDUCTOR AC90, ACWU90 AND TECK90 CABLES

CIRCUITS RATED UP TO 425 AMPS INCLUSIVE

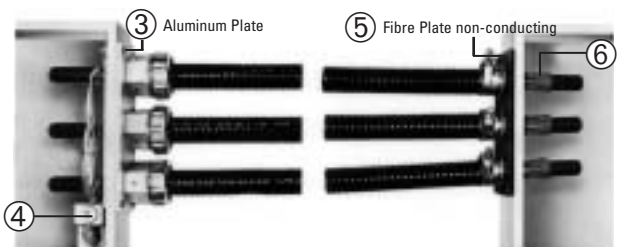
On any AC system, currents flowing in the centre conductor will induce small currents in the concentrically applied bonding wires and in the interlocked armour.

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

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 (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 (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. The PVC jacket is the only practical, effective means of armour isolation from grounded metal parts.

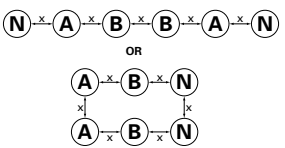
Note 2:

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 on to steel supports.

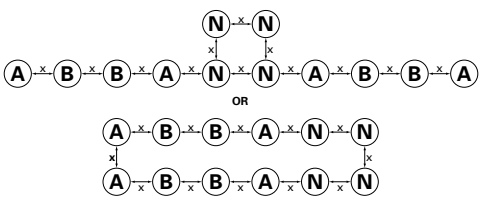
RECOMMENDED CONFIGURATION FOR PARALLEL OPERATION OF SINGLE-CONDUCTOR CABLES IN FREE AIR

Single Phase

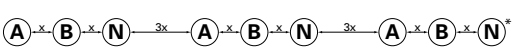
Two Conductors per Phase



Four Conductors per Phase



Three Conductors per Phase*



** Precise load sharing is difficult with 3 conductors per phase and the configurations shown represent the most practical compromise.*

Alcan 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.

X = One cable diameter (above ground).

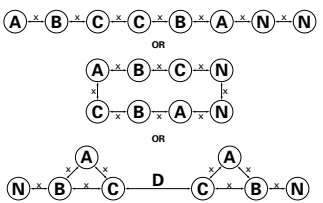
A,B,C = Phase conductor designation.

N = Neutral conductor designation.

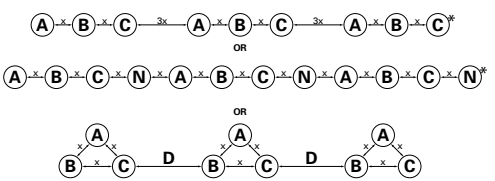
RECOMMENDED CONFIGURATION FOR PARALLEL OPERATION OF SINGLE-CONDUCTOR CABLES IN FREE AIR

Three Phase

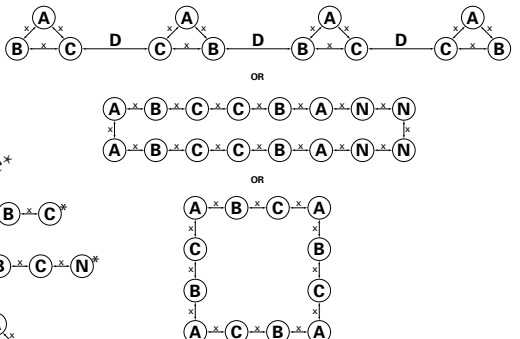
Two Conductors per Phase



Three Conductors per Phase*



Four Conductors per Phase



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Alcan 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.

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

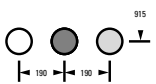
X = One cable diameter (above ground).

A,B,C = Phase conductor designation.

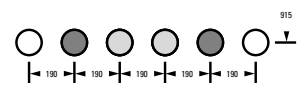
N = Neutral conductor designation.

APPLICABLE INSTALLATION CONFIGURATIONS FOR SINGLE-CONDUCTORS DIRECTLY BURIED IN THE EARTH **Diagram 1** **NOTE:** All dimensions in mm

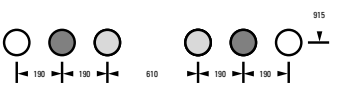
DETAIL 1: 1 cable per phase



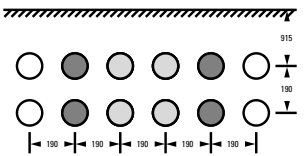
DETAIL 2: 2 cables per phase



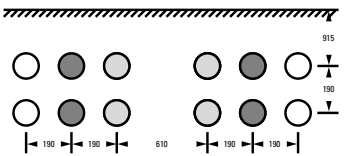
DETAIL 3: 2 cables per phase



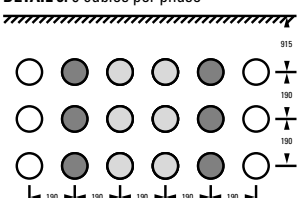
DETAIL 4: 4 cables per phase



DETAIL 5: 4 cables per phase



DETAIL 6: 6 cables per phase



DETAIL 7: 6 cables per phase

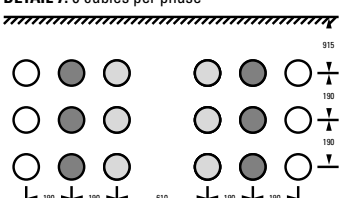


TABLE 5-5
ALLOWABLE AMPACITIES FOR SINGLE-CONDUCTOR CABLE DIRECTLY BURIED IN THE EARTH – NON-CONTINUOUS LOADS *(See Diagram 1)*

Size AWG KCMIL	Detail 1		Detail 2		Detail 3		Detail 4		Detail 5		Detail 6		Detail 7	
	NUAL	CU	**NUAL**	CU	**NUAL**	CU	**NUAL**	CU	**NUAL**	CU	**NUAL**	CU	**NUAL**	CU
1/0	**190**	245	**190**	245	**190**	245	**158**	203	**171**	220	**129**	165	**140**	179
2/0	**220**	285	**220**	285	**220**	285	**178**	229	**193**	248	**145**	186	**157**	202
3/0	**255**	330	**255**	330	**255**	330	**201**	258	**218**	280	**163**	210	**178**	228
4/0	**300**	385	**300**	385	**300**	385	**227**	291	**246**	315	**183**	236	**200**	256
250	**330**	425	**328**	421	**330**	425	**247**	317	**267**	343	**200**	256	**217**	278
350	**415**	530	**390**	500	**410**	520	**292**	375	**318**	408	**237**	304	**258**	331
500	**515**	660	**471**	605	**495**	630	**352**	452	**383**	489	**284**	365	**309**	396
600	**585**	740	**513**	659	**541**	682	**382**	491	**419**	534	**308**	397	**340**	433
750	**665**	845	**580**	745	**610**	775	**431**	554	**469**	596	**348**	447	**379**	482
1000	**780**	980	**659**	846	**710**	890	**488**	627	**542**	683	**393**	505	**437**	551
1250	**868**	1083	**750**	935	**790**	985	**554**	691	**604**	753	**446**	556	**487**	607
1500	**952**	1176	**821**	1011	**865**	1068	**605**	746	**660**	813	**487**	600	**531**	655
1750	**1027**	1257	**880**	1078	**932**	1140	**647**	793	**706**	865	**520**	637	**568**	696
2000	**1094**	1325	**934**	1133	**991**	1200	**686**	832	**749**	909	**552**	669	**602**	730

The ampacities of this table are those contained in Tables D8A and D9A of the Canadian Electrical Code Part I, 19th Edition, 2002.
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 service box, fusible switch, circuit breaker or panelboard; or
b) The load is NON-CONTINUOUS and either end of the cable terminates at a service box, fusible switch, circuit breaker or panelboard.

TABLE 5-6
ALLOWABLE AMPACITIES FOR SINGLE-CONDUCTOR CABLE DIRECTLY BURIED IN THE EARTH – CONTINUOUS LOADS *(See Diagram 1)*

Size	Detail 1				Detail 2				Detail 3			
AWG	NUAL		CU		NUAL		CU		NUAL		CU	
KCMIL	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

continued...

TABLE 5-6
ALLOWABLE AMPACITIES FOR SINGLE-CONDUCTOR CABLE DIRECTLY BURIED IN THE EARTH – CONTINUOUS LOADS – *continued* *(See Diagram 1)*

Size	Detail 4				Detail 5				Detail 6		Detail 7			
AWG	NUAL		CU		NUAL		CU		NUAL	CU	NUAL		CU	
KCMIL	100%	80%	100%	80%	100%	80%	100%	80%			100%	80%	100%	80%
1/0	**158**	**133**	203	172	**162**	**133**	208	172	**129**	165	**140**	**133**	179	172
2/0	**178**	**154**	229	200	**187**	**154**	242	200	**145**	186	**157**	**154**	202	200
3/0	**201**	**179**	258	231	**217**	**179**	280	231	**163**	210	**178**	**178**	228	228
4/0	**227**	**210**	291	270	**246**	**210**	315	270	**183**	236	**200**	**200**	256	256
250	**247**	**231**	317	298	**267**	**231**	343	298	**200**	256	**217**	**217**	278	278
350	**292**	**291**	375	371	**318**	**291**	408	371	**237**	304	**258**	**258**	331	331
500	**352**	**352**	452	452	**383**	**361**	489	462	**284**	365	**309**	**309**	396	396
600	**382**	**382**	491	491	**419**	**410**	534	518	**308**	397	**340**	**340**	433	433
750	**431**	**431**	554	554	**469**	**469**	596	592	**348**	447	**379**	**379**	482	482
1000	**488**	**488**	627	627	**542**	**542**	683	683	**393**	505	**437**	**437**	551	551
1250	**554**	**554**	691	691	**604**	**604**	753	753	**446**	556	**487**	**487**	607	607
1500	**605**	**605**	746	746	**660**	**660**	813	813	**487**	600	**531**	**531**	655	655
1750	**647**	**647**	793	793	**706**	**706**	865	865	**520**	637	**568**	**568**	696	696
2000	**686**	**686**	832	832	**749**	**749**	909	909	**552**	669	**602**	**602**	730	730

The ampacities of this table are those contained in Tables D8B and D9B of the Canadian Electrical Code Part I, 19th Edition, 2002.

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

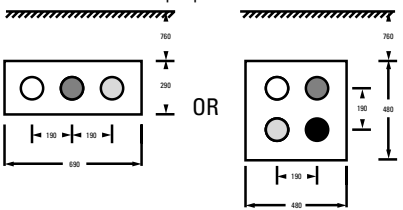
b) either end terminates at a service box, fusible switch, circuit breaker or panelboard.

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.

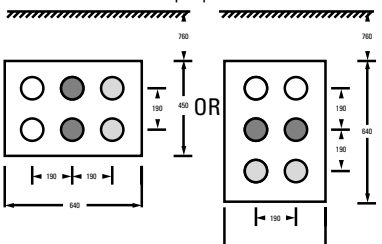
The columns with the heading 100% denote that equipment identified in b) above **is marked** as certified to carry its nameplate ampere rating continuously.

APPLICABLE INSTALLATION CONFIGURATIONS FOR SINGLE-CONDUCTORS IN UNDERGROUND RACEWAYS **Diagram 2** **NOTE:** All dimensions in mm

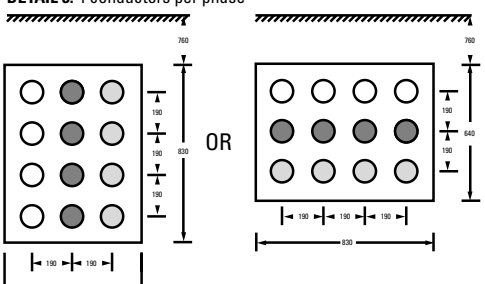
DETAIL 1: 1 conductor per phase



DETAIL 2: 2 conductors per phase



DETAIL 3: 4 conductors per phase



DETAIL 4: 6 conductors per phase

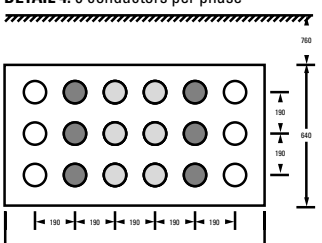


TABLE 5-7
ALLOWABLE AMPACITIES FOR SINGLE-CONDUCTOR CABLE IN UNDERGROUND RACEWAYS – NON-CONTINUOUS LOADS *(See Diagram 2)*

Size AWG KCMIL	Detail 1		Detail 2		Detail 3		Detail 4	
	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU
1/0	**180**	231	**157**	201	**123**	159	**114**	146
2/0	**205**	264	**178**	228	**140**	180	**128**	164
3/0	**235**	301	**203**	260	**158**	204	**145**	186
4/0	**269**	345	**231**	296	**180**	231	**164**	211
250	**296**	379	**253**	325	**197**	252	**179**	230
350	**360**	461	**306**	391	**236**	303	**213**	275
500	**442**	564	**372**	475	**283**	364	**257**	330
600	**488**	621	**409**	521	**314**	404	**284**	365
750	**556**	706	**464**	589	**349**	448	**315**	406
1000	**653**	823	**541**	682	**409**	526	**370**	474
1250	**738**	920	**608**	759	**457**	571	**413**	515
1500	**813**	1004	**667**	824	**501**	618	**452**	556
1750	**880**	1077	**719**	880	**538**	659	**484**	592
2000	**940**	1139	**766**	928	**571**	692	**513**	622

Assumptions:

- Load factor 100%
- Conductor temperature 90°C
- Ambient temperature 20°C
- Thermal resistivity (Deg. C-cm/watt) –
  Earth - 90
  Duct bank - 85
  Insulation/jacket - 400
- Shield/sheath open-circuit
- Nonmagnetic duct

The ampacities of this table are those contained in Tables D10A and D11A of the Canadian Electrical Code Part I, 19th Edition, 2002.
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 service box, fusible switch, circuit breaker or panelboard; or
b) The load is NON-CONTINUOUS and either end of the cable terminates at a service box, fusible switch, circuit breaker or panelboard.

TABLE 5-8
ALLOWABLE AMPACITIES FOR SINGLE-CONDUCTOR CABLE IN UNDERGROUND RACEWAYS – CONTINUOUS LOADS *(See Diagram 2)*

Size	Detail 1				Detail 2				Detail 3		Detail 4	
AWG	NUAL		CU		NUAL		CU		NUAL	CU	NUAL	CU
KCMIL	100%	80%	100%	80%	100%	80%	100%	80%				
1/0	**162**	**133**	208	172	**157**	**133**	201	172	**123**	159	**114**	146
2/0	**187**	**154**	242	200	**178**	**154**	228	200	**140**	180	**128**	164
3/0	**217**	**179**	280	231	**203**	**179**	260	231	**158**	204	**145**	186
4/0	**255**	**210**	327	270	**231**	**210**	296	270	**180**	231	**164**	211
250	**281**	**231**	361	298	**253**	**231**	325	298	**197**	252	**179**	230
350	**353**	**291**	450	371	**306**	**291**	391	371	**236**	303	**213**	275
500	**438**	**361**	561	462	**372**	**361**	475	462	**283**	364	**257**	330
600	**488**	**410**	621	518	**409**	**409**	521	518	**314**	404	**284**	365
750	**556**	**469**	706	592	**464**	**464**	589	589	**349**	448	**315**	406
1000	**653**	**560**	823	700	**541**	**541**	682	682	**409**	526	**370**	474
1250	**738**	**634**	920	791	**608**	**608**	759	759	**457**	571	**413**	515
1500	**813**	**714**	1004	882	**667**	**667**	824	824	**501**	618	**452**	556
1750	**880**	**788**	1077	959	**719**	**719**	880	880	**538**	659	**484**	592
2000	**940**	**854**	1139	1029	**766**	**766**	928	928	**571**	692	**513**	622

The ampacities of this table are those contained in Tables D10B and D11B of the Canadian Electrical Code Part I, 19th Edition, 2002.

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

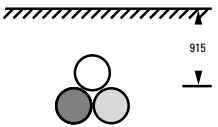
(b) either end terminates in at a service box, fusible switch, circuit breaker or panelboard.

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.

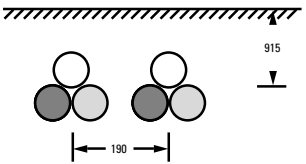
The columns with the heading 100% denote that the equipment identified in (b) above **is marked** as certified to carry its nameplate ampere rating continuously.

APPLICABLE INSTALLATION CONFIGURATIONS FOR MULTI-CONDUCTORS DIRECTLY BURIED IN THE EARTH **Diagram 3** **NOTE:** All dimensions in mm

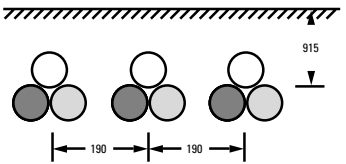
DETAIL 1: 1 cable per phase



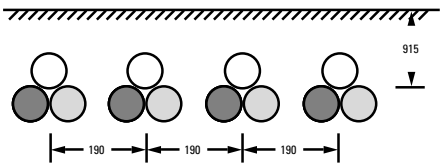
DETAIL 2: 2 cables per phase



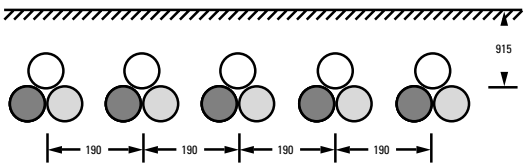
DETAIL 3: 3 cables per phase



DETAIL 4: 4 cables per phase



DETAIL 5: 5 cables per phase



DETAIL 6: 6 cables per phase

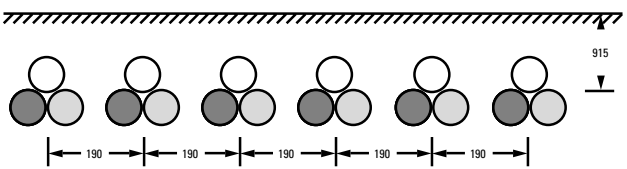


TABLE 5-9
ALLOWABLE AMPACITIES FOR MULTI-CONDUCTOR CABLE DIRECTLY BURIED IN THE EARTH – NON-CONTINUOUS LOADS *(See Diagram 3)*

Size AWG	Detail 1		Detail 2		Detail 3		Detail 4		Detail 5		Detail 6	
KCMIL	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU
1/0	**190**	243	**164**	209	**146**	186	**137**	174	**129**	164	**124**	157
2/0	**217**	274	**186**	235	**166**	209	**155**	195	**146**	184	**140**	176
3/0	**242**	311	**207**	266	**184**	236	**171**	220	**161**	207	**154**	198
4/0	**280**	360	**238**	306	**211**	271	**197**	253	**185**	237	**177**	227
250	**304**	383	**258**	326	**229**	288	**213**	268	**200**	252	**192**	242
350	**366**	470	**309**	397	**273**	350	**254**	326	**238**	306	**228**	293
500	**440**	548	**370**	460	**325**	404	**302**	375	**283**	352	**271**	337
600	**486**	600	**406**	502	**356**	440	**330**	408	**309**	383	**296**	366
750	**540**	667	**450**	556	**393**	486	**364**	450	**341**	421	**326**	403
1000	**613**	758	**508**	628	**444**	548	**411**	508	**384**	475	**367**	454
1250	**684**	831	**562**	682	**488**	593	**451**	547	**421**	511	**402**	488
1500	**734**	889	**600**	727	**520**	630	**480**	581	**448**	542	**427**	517
1750	**774**	927	**631**	755	**545**	653	**503**	602	**469**	561	**447**	535
2000	**809**	962	**657**	781	**567**	674	**522**	621	**487**	578	**464**	552

The ampacities of this table are those contained in Tables D12A and D13A of the Canadian Electrical Code Part I, 19th Edition, 2002.
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 service box, fusible switch, circuit breaker or panelboard; or
(b) The load is NON-CONTINUOUS and either end of the cable terminates at a service box, fusible switch, circuit breaker or panelboard.

TABLE 5-10
ALLOWABLE AMPACITIES FOR MULTI-CONDUCTOR CABLE DIRECTLY BURIED IN THE EARTH – CONTINUOUS LOADS *(See Diagram 3)*

Size	Detail 1				Detail 2				Detail 3			
AWG	NUAL		CU		NUAL		CU		NUAL		CU	
KCMIL	100%	80%	100%	80%	100%	80%	100%	80%	100%	80%	100%	80%
1/0	**162**	**133**	208	172	**162**	**133**	208	172	**146**	**133**	186	172
2/0	**187**	**154**	242	200	**186**	**154**	235	200	**166**	**154**	209	200
3/0	**217**	**179**	281	231	**207**	**179**	266	231	**184**	**179**	236	231
4/0	**255**	**210**	327	270	**238**	**210**	306	270	**211**	**210**	271	270
250	**281**	**231**	361	298	**258**	**231**	326	298	**229**	**229**	288	288
350	**353**	**291**	451	371	**309**	**291**	397	371	**273**	**273**	350	350
500	**438**	**361**	561	462	**370**	**361**	460	460	**325**	**325**	404	404
600	**486**	**410**	629	518	**406**	**406**	502	502	**356**	**356**	440	440
750	**540**	**469**	667	592	**450**	**450**	556	556	**393**	**393**	486	486
1000	**613**	**560**	758	700	**508**	**508**	628	628	**444**	**444**	548	548
1250	**684**	**634**	831	791	**562**	**562**	682	682	**488**	**488**	593	593
1500	**734**	**714**	889	882	**600**	**600**	727	727	**520**	**520**	630	630
1750	**774**	**774**	927	927	**631**	**631**	755	755	**545**	**545**	653	653
2000	**809**	**809**	962	962	**657**	**657**	781	781	**567**	**567**	674	674

TABLE 5-10
ALLOWABLE AMPACITIES FOR MULTI-CONDUCTOR CABLE DIRECTLY BURIED IN THE EARTH – CONTINUOUS LOADS – *continued* *(See Diagram 3)*

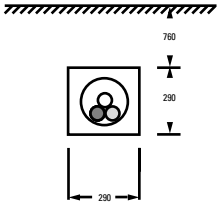
Size	Detail 4				Detail 5		Detail 6	
AWG	NUAL		CU		NUAL	CU	NUAL	CU
KCMIL	100%	80%	100%	80%				
1/0	**137**	**133**	174	172	**129**	164	**124**	157
2/0	**155**	**154**	195	195	**146**	184	**140**	176
3/0	**171**	**171**	220	220	**161**	207	**154**	198
4/0	**197**	**197**	253	253	**185**	237	**177**	227
250	**213**	**213**	268	268	**200**	252	**192**	242
350	**254**	**254**	326	326	**238**	306	**228**	293
500	**302**	**302**	375	375	**283**	352	**271**	337
600	**330**	**330**	408	408	**309**	383	**296**	366
750	**364**	**364**	450	450	**341**	421	**326**	403
1000	**411**	**411**	508	508	**384**	475	**367**	454
1250	**451**	**451**	547	547	**421**	511	**402**	488
1500	**480**	**480**	581	581	**448**	542	**427**	517
1750	**503**	**503**	602	602	**469**	561	**447**	535
2000	**522**	**522**	621	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.

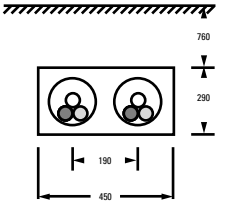
The ampacities of this table are those contained in Tables D12B and D13B of the Canadian Electrical Code Part I, 19th Edition, 2002.
Ampacities are based on 90°C conductor temperature, 20°C ambient earth temperature, configurations of Diagram 3, and the following conditions:
(a) The load is CONTINUOUS, and
(b) either end terminates in at a service box, fusible switch, circuit breaker or panelboard.

APPLICABLE INSTALLATION CONFIGURATIONS FOR MULTI-CONDUCTORS IN UNDERGROUND RACEWAYS **Diagram 4** **NOTE:** All dimensions in mm

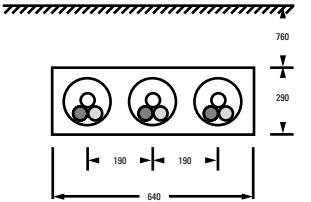
DETAIL 1: 1 cable per phase



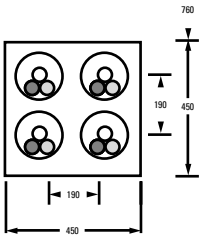
DETAIL 2: 2 cables per phase



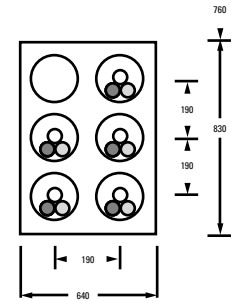
DETAIL 3: 3 cables per phase



DETAIL 4: 4 cables per phase



DETAIL 5: 5 cables per phase



DETAIL 6: 6 cables per phase

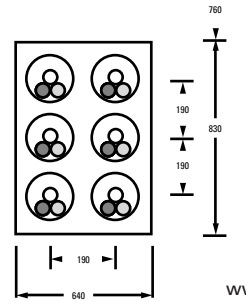


TABLE 5-11
ALLOWABLE AMPACITIES FOR MULTI-CONDUCTOR CABLE IN UNDERGROUND RACEWAYS – NON-CONTINUOUS LOADS *(See Diagram 4)*

Size AWG	Detail 1		Detail 2		Detail 3		Detail 4		Detail 5		Detail 6	
KCMIL	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU
1/0	**142**	180	**129**	164	**119**	152	**111**	141	**103**	131	**99**	125
2/0	**163**	206	**148**	187	**136**	172	**126**	160	**117**	149	**112**	142
3/0	**186**	235	**168**	213	**155**	196	**143**	181	**132**	168	**126**	160
4/0	**214**	269	**192**	242	**177**	223	**163**	205	**151**	190	**143**	181
250	**236**	298	**212**	267	**194**	244	**178**	225	**165**	208	**157**	198
350	**288**	361	**256**	321	**233**	293	**214**	268	**198**	248	**187**	235
500	**351**	437	**310**	386	**281**	350	**257**	319	**237**	294	**224**	279
600	**388**	480	**341**	423	**309**	383	**281**	349	**259**	321	**245**	303
750	**435**	538	**381**	471	**344**	425	**313**	386	**287**	355	**271**	335
1000	**502**	620	**437**	540	**392**	485	**355**	439	**326**	400	**307**	380
1250	**556**	676	**480**	583	**429**	521	**389**	472	**356**	433	**336**	408
1500	**589**	724	**514**	623	**458**	555	**415**	502	**379**	459	**358**	434
1750	**632**	756	**541**	648	**481**	576	**435**	521	**397**	476	**375**	449
2000	**660**	785	**564**	671	**501**	596	**452**	538	**413**	491	**389**	463

The ampacities of this table are those contained in Tables D14A and D15A of the Canadian Electrical Code Part I, 19th Edition, 2002.
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, circuit breaker or panelboard; or
(b) The load is NON-CONTINUOUS and either end of the cable terminates at a service box, fusible switch, circuit breaker or panelboard.

TABLE 5-12
ALLOWABLE AMPACITIES FOR MULTI-CONDUCTOR CABLE IN UNDERGROUND RACEWAYS – CONTINUOUS LOADS *(See Diagram 4)*

Size	Detail 1				Detail 2		Detail 3		Detail 4		Detail 5		Detail 6	
AWG	NUAL		CU		NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU	NUAL	CU
KCMIL	100%	80%	100%	80%										
1/0	**142**	**133**	180	172	**129**	164	**119**	152	**111**	141	**103**	131	**99**	125
2/0	**163**	**154**	206	200	**148**	187	**136**	172	**126**	160	**117**	149	**112**	142
3/0	**186**	**179**	235	232	**168**	213	**155**	196	**143**	181	**132**	168	**126**	160
4/0	**214**	**210**	269	269	**192**	242	**177**	223	**163**	205	**151**	190	**143**	181
250	**236**	**231**	298	298	**212**	267	**194**	244	**178**	225	**165**	208	**157**	198
350	**288**	**288**	361	361	**256**	321	**233**	293	**214**	268	**198**	248	**187**	235
500	**351**	**351**	437	437	**310**	386	**281**	350	**257**	319	**237**	294	**224**	279
600	**388**	**388**	480	480	**341**	423	**309**	383	**281**	349	**259**	321	**245**	303
750	**435**	**435**	538	538	**381**	471	**344**	425	**313**	386	**287**	355	**271**	335
1000	**502**	**502**	620	620	**437**	540	**392**	485	**355**	439	**326**	400	**307**	380
1250	**556**	**556**	676	676	**480**	583	**429**	521	**389**	472	**356**	433	**336**	408
1500	**589**	**589**	724	724	**514**	623	**458**	555	**415**	502	**379**	459	**358**	434
1750	**632**	**632**	756	756	**541**	648	**481**	576	**435**	521	**397**	476	**375**	449
2000	**660**	**660**	785	785	**564**	671	**501**	596	**452**	538	**413**	491	**389**	463

The ampacities of this table are those contained in Tables D14B and D15B of the Canadian Electrical Code Part I, 19th Edition, 2002.
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, circuit breaker or panelboard.

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.

NOTES AND CORRECTIONS TO 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 page 38 of this handbook.

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).

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:

$$SQRT[(90-T_{ae})/70]$$

where

T_{ae} 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.

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 4-008 apply, unless the ampacity has been determined by detailed calculation according to the method outlined in paragraphs (1)(d) and (2)(d) of Canadian Electrical Code Rule 4-004.

RECOMMENDATIONS FOR 3 AND 5 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.

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:

Note the concept of "Load Factor" has been 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.

APPLICATION RULES

SECTION 4 - CONDUCTORS
4-004 AMPACITY OF WIRES AND CABLES (SEE APPENDIX B OF CODE)

1) The maximum current which 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, as specified in Table 1; and
   b) 1, 2, or 3 conductors in a run of raceway, or 2- or 3-conductor cable, except as indicated in Subrule (l)(d), as specified in Table 2; and
   c) 4 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; and
   d) Single-conductor and 2-, 3-, and 4-conductor cables and single and 2-, 3-, and 4-conductor metal armoured and metal sheathed cables, in conductor sizes 1/0 AWG and larger, in an underground run, as calculated by the method of the IEEE Standard, *Standard Power Cable Ampacity Tables*, IEEE 835.

2) The maximum current which 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, as specified in Table 3; and
   b) 1, 2, or 3 conductors in a run of raceway, or 2- or 3-conductor cable, except as indicated in Subrule (2)(d), as specified in Table 4; and
   c) 4 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 and 2-, 3-, and 4-conductor metal armoured and metal sheathed cables, in conductor sizes 1/0 AWG and larger, in an underground run, as calculated by the method of the IEEE Standard, *Standard Power Cable Ampacity Tables*, IEEE 835.

3) A neutral conductor which 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, four-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 Table 36.

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

9) Where single-conductors having a free air rating are run in contact with each other, the ampacity shall be corrected by applying the factors in Table 5B for up to four conductors in contact, and by utilizing the ampacity of Table 2 or 4 where there are more than four in contact.

10) Where multi-conductor cables are run in contact with each other for distances exceeding 600 mm, the ampacity of the conductors shall be corrected by applying the factors in Table 5C.

11) 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.

12) 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.

13) 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 (14).

14) Where the lower ampacity portion of a cable installation comprised 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.

15) 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 (l)(d) and

2(d) shall be permitted to be increased by application of that load factor in the calculation of the ampacity.

16) In consideration of the increased ampacity of any conductor derived in accordance with Subrule (15), no further factors based on load diversity shall be permitted.

4-008 SHEATH CURRENTS IN SINGLE-CONDUCTOR METAL SHEATHED CABLES

1) Where sheath currents in single-conductor cables having continuous sheaths of lead, aluminum, 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 which would otherwise apply; or
   b) Derated in accordance with the manufacturer's recommendations and in compliance with Rule 2-030; or
   c) Installed in such a manner as to prevent 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).

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 AC 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; and
   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 80% of the rating of the overload or overcurrent devices protecting the branch circuit, whichever is smaller.

8-104 MAXIMUM CIRCUIT LOADING

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 to be 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 service box, fusible switch, circuit breaker, or panelboard 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 service box, fusible switch, circuit breaker, or panelboard 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.
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 Rules 4-004(1)(d) and 4-001(2)(d), the ampacity of the underground conductors shall not exceed those determined by Subrules 4(b) and 5(b) in any case.

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 so installed 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 Rules 8-104(4) and (5).

SECTION 12 - CONDUCTORS - WIRING METHODS

12-012 UNDERGROUND INSTALLATIONS (SEE APPENDIX B OF CODE)

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; or
   b) Poured concrete at least 50 mm thick; or
   c) Concrete slabs at least 50 mm thick; or
   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 6 mm (nominal) screened sand or screened 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.

7) Raceways or cables, if located in rock, shall be permitted to be installed at a lesser depth entrenched into the rock in a trench not less than 150 mm deep and grouted with concrete to the level of the rock surface.

8) Raceways shall be permitted to be installed directly beneath a concrete slab at grade level provided the concrete slab is not less than a nominal 100 mm in thickness, the location is adequately marked, and the raceway will not be subject to damage during or after installations.

9) Any form of mechanical protection that may adversely affect the conductors or cable assemblies shall not be used.

10) Backfill containing large rock, paving materials, cinders, large or sharply angular substances, or corrosive material shall not be placed in an excavation where such materials may damage cables, raceways, or other substructures, prevent adequate compaction of fill, or contribute to corrosion of cables, raceways, or other substructures.

11) The initial installation shall be provided with a suitable marking tape buried approximately halfway between the installation and grade level, or adequate marking in a conspicuous location to indicate the location and depth of the underground installation.

12) For installations not covered by the foregoing requirements of this Rule, the requirements of CSA Standard C22.3 No. 7, or the applicable standard, whichever is greater, shall apply.

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 alternating current circuit, additional cables shall be permitted to be used provided any one such cable includes an equal number of conductors from each phase and the neutral and 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 12-3032.

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-ferrous 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 ferrous material.

12-108 CONDUCTORS IN PARALLEL (SEE APPENDIX B OF CODE)

1) Conductors of similar conductivity in sizes No. 1/0 AWG copper or aluminum and larger shall be permitted in parallel provided they are:
   a) Free of splices throughout the total length; and
   b) The same circular mil area; and
   c) The same type of insulation; and
   d) The same length; and
   e) Terminated in the same manner.

2) 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.

3) 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; and
   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.

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 3/8-inch 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; or
   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, about 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 OF CODE)

1) Armoured cable shall be permitted to be installed in or on buildings or portions of buildings of either combustible or noncombustible construction.
2) Armoured cable shall be of the type listed in Table 19 as suitable for direct burial if used:

a) For underground runs; or
b) For circuits in masonry or concrete provided the cable is encased or embedded in at least 50 mm of the masonry or concrete; or
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 that has the armouring 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 noncombustible 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.

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 which has a thermoplastic outer covering shall only be used where the outer covering will not be subjected to mechanical injury.

12-608 CONTINUITY OF ARMOURED CABLE

The armour of cables shall be mechanically and electrically continuous throughout and 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 which 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 NONMETALLIC SHEATHED CABLE SYSTEMS

Where armoured cable is used in a building in which concealed knob-and-tube wiring or concealed nonmetallic 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.

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 OF CODE)

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 and support spacing shall not exceed the ratings specified by the manufacturer.
3) Cable trays shall not pass through walls except where the walls are constructed of noncombustible 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 noncombustible supports.
6) Dead-ends of cable trays shall be closed by the use of end fittings.
7) Minimum clearances for cable trays shall be:
   a) 150 mm vertical clearance, excluding depth of cable trays, between cable trays installed in tiers except, where cables of 50 mm diameter or greater may be installed, the clearance shall be 300 mm; and
   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; and
   c) 600 mm horizontal clearance on one side of cable trays mounted adjacent to one another or to walls or other obstructions.

12-2202 CONDUCTORS IN CABLE TRAYS (SEE APPENDIX B OF CODE)

1) Conductors for use in cable trays shall be 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 the cable is:
   a) Installed in conduit, other suitable raceway, or direct buried, when not in cable tray; and
   b) Provided with mechanical protection where subject to damage either during or after installation; and
   c) No smaller than 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 nonmetal 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 maximum rating or setting of an overcurrent device in the circuits carried by the cable tray in accordance with the requirements of Rule 10-814.

12-2210 AMPACITIES OF CONDUCTORS IN CABLE TRAYS

1) In ventilated and ladder-type cable trays, where the air space between conductors, cables, or both is maintained at greater than 100% of the largest conductor or cable diameter, the ampacity of the conductors or cables shall be the value specified in Paragraph (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 conductors, cables, or both is maintained at not less than 25% nor more than 100% of the largest conductor or cable diameter, 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 conductors, cables, or both is less than 25% of the largest conductor or cable diameter, 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 trays.

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 CONDUCTOR AMPACITIES IN AIR AND MAXIMUM PERMISSIBLE NUMBER OF CONDUCTORS IN CONDUIT

RW90 600V			MAXIMUM PERMISSIBLE NUMBER OF CONDUCTORS IN CONDUIT †									
AWG or KCMIL	Ampacities		NOMINAL DIAMETER OF CONDUIT									
	Table 3	Table 4	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"
8	45	30	2	5	8	14	19	32	46	72	96	124
6	80	*55	1	3	6	11	14	24	35	54	72	93
4	105	65	1	2	4	8	11	18	25	39	53	68
3	120	75	1	1	3	6	9	15	21	33	44	57
2	140	*95	1	1	3	5	7	12	18	28	38	49
1	165	105	1	1	1	4	5	9	14	21	28	37
1/0	190	120		1	1	3	4	8	11	18	24	31
2/0	220	145		1	1	3	4	6	9	15	20	26
3/0	255	165		1	1	2	3	5	8	12	17	22
4/0	300	**185		1	1	1	2	4	6	10	14	18
250	330	215			1	1	1	3	5	8	11	14
300	375	240			1	1	1	3	4	7	10	12
350	415	260			1	1	1	2	4	6	8	11
400	450	290				1	1	2	3	5	7	10
500	515	330				1	1	1	3	4	6	8
600	585	370				1	1	1	1	3	5	6
750	670	405					1	1	1	3	4	5
1000	800	480						1	1	1	3	4
1500	1020	580							1	1	1	1

* For 3-wire 120/240 and 120/208 V residential services or sub-services the allowable ampacity for size number 6 AWG shall be 60 amp and size 2 AWG shall be 100 amp. In this case the 5% adjustment per Rule 8-106(1) cannot be applied.

** Subject to the permission and conditions of the electrical inspection authority having jurisdiction, the conductors shall be allowed for 200 amp rated residential services.

† Source: Canadian Electrical Code Part I – Rule 12-1014(4). Table 3 ampacities are for Free Air Installations. Table 4 ampacities are for up to 3 conductors in conduit, not including neutral conductor for above ground installations.

COPPER CONDUCTOR AMPACITIES IN AIR AND MAXIMUM PERMISSIBLE NUMBER OF CONDUCTORS IN CONDUIT

RW90 600V			MAXIMUM PERMISSIBLE NUMBER OF CONDUCTORS IN CONDUIT †									
AWG or KCMIL	Ampacities		NOMINAL DIAMETER OF CONDUIT									
	Table 1	Table 2	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"
14	20	15	8	15	25	43	59	97	139	200	200	200
12	25	20	6	11	19	33	45	74	106	164	200	200
10	40	30	5	8	14	24	33	55	78	121	162	200
8	70	45	2	4	7	13	18	30	43	67	90	116
6	100	65	1	3	5	10	13	22	32	50	67	86
4	135	85	1	2	4	7	10	16	23	36	48	62
3	155	105	1	1	3	6	8	14	19	30	41	53
2	180	120	1	1	3	5	7	11	16	25	34	44
1	210	140	1	1	1	3	5	8	12	19	25	33
1/0	245	155		1	1	3	4	7	10	16	21	27
2/0	285	185		1	1	2	3	6	8	13	17	23
3/0	330	210		1	1	1	3	5	7	11	14	19
4/0	385	235			1	1	1	4	6	9	12	15
250	425	265			1	1	1	3	4	7	10	13
300	480	295			1	1	1	2	4	6	8	11
350	530	325				1	1	2	3	5	7	9
400	575	345				1	1	1	3	5	6	8
500	660	395				1	1	1	2	4	5	7
600	740	455					1	1	1	3	4	5
750	845	500					1	1	1	2	3	4
1000	1000	585						1	1	1	2	3

† Source: Canadian Electrical Code Part I – Rule 12-1014(5).
Table 1 ampacities are for Free Air Installations.
Table 2 ampacities are for up to 3 conductors in conduit, not including neutral conductor for above ground installations.

TABLE 5A

(See Rules 4-004(8), 12-2210 and Tables 1, 2, 3, 4, 57, 58, and D3)

CORRECTION FACTORS APPLYING TO TABLES 1, 2, 3 AND 4

AMPACITY CORRECTION FACTORS FOR AMBIENT TEMPERATURES ABOVE 30°C

(These correction factors apply, column for column, to Tables 1, 2, 3, and 4. The correction factors also apply to Table 57.)

	Correction Factor					
Ambient Temp. °C	60°C Type TW	75°C Types RW75, TW75	85-90°C Types R90, RW90, T90 NYLON	110°C See Note (2)	125°C See Note (2)	200°C See Note (2)
40	0.82	0.88	0.90	0.94	0.95	1.00
45	0.71	0.82	0.85	0.90	0.92	1.00
50	0.58	0.75	0.80	0.87	0.89	1.00
55	0.41	0.65	0.74	0.83	0.86	1.00
60	—	0.58	0.67	0.79	0.83	0.91
70	—	0.35	0.52	0.71	0.76	0.87
75	—	—	0.43	0.66	0.72	0.86
80	—	—	0.30	0.61	0.69	0.84
90	—	—	—	0.50	0.61	0.80
100	—	—	—	—	0.51	0.77
120	—	—	—	—	—	0.69
140	—	—	—	—	—	0.59
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7

Notes:

1) The ampacity of a given conductor type at these higher ambient temperatures is obtained by multiplying the appropriate value from Table 1, 2, 3 or 4 by the correction factor for that higher temperature.
2) These ampacities are only applicable under special circumstances where the use of insulated conductors having this temperature rating are acceptable.

TABLE 5B

(See Rules 4-004(9) and Tables 1, 3 and D3)
CORRECTION FACTORS FOR TABLES 1 AND 3
WHERE FROM 2 TO 4 SINGLE-CONDUCTORS ARE PRESENT AND IN CONTACT

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

(See Rules 4-004 and 12-2210 and Tables 2 and 4)
AMPACITY CORRECTION FACTORS FOR TABLES 2 AND 4

Number of Conductors	Ampacity Correction Factor
1 – 3	1.00
4 – 6	0.80
7 – 24	0.70
25 – 42	0.60
43 and up	0.50

TABLE 5D

(See Rule 12-2210)

CURRENT RATING CORRECTION FACTORS WHERE SPACINGS ARE MAINTAINED (VENTILATED AND LADDER-TYPE CABLE TRAYS)

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

(See Rule 12-1014 and 38-032)

MAXIMUM ALLOWABLE PER CENT CONDUIT AND TUBING FILL

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

(See Rule 12-1014)

CROSS-SECTIONAL AREAS OF CONDUIT AND TUBING

Nominal Conduit Size	Internal Diameter (mm)	Cross-sectional Area of Conduit and Tubing (mm^2)							
		100%	55%	53%	40%	38%	35%	31%	30%
16 (1/2)	15.8	196	107.8	103.9	78.41	74.49	68.61	60.77	58.81
21 (3/4)	20.9	344	189.2	182.3	137.6	130.7	120.4	106.7	103.2
27 (1)	26.6	557.6	306.7	295.5	223	211.9	195.2	172.9	167.3
35 (1-1/4)	35.1	965	530.7	511.4	386	366.7	337.7	299.1	289.5
41 (1-1/2)	40.9	1313	722.4	696.1	525.4	499.1	459.7	407.2	394
53 (2)	52.5	2165	1191	1147	866	822.7	757.7	671.1	649.5
63 (2-1/2)	62.7	3089	1699	1637	1236	1174	1081	957.5	926.7
78 (3)	79.9	4769	2623	2528	1908	1812	1669	1479	1431
91 (3-1/2)	90.1	6379	3508	3381	2551	2424	2233	1977	1914
103 (4)	102.3	8213	4517	4353	3285	3121	2875	2546	2464
116 (4-1/2)	114.5	10 288	5659	5453	4115	3910	3601	3189	3086
129 (5)	128.2	12 907	7099	6841	5163	4905	4517	4001	3872
155 (6)	154.1	18 639	10 251	9879	7456	7083	6524	5778	5592

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.

TABLE 10

(See Rule 12-1014)

DIMENSIONS OF CABLE FOR CALCULATING CONDUIT AND TUBING FILL

(When dimensions are not otherwise available.)

Conductor Size	R90XLPE*, RW75XLPE*, RW90XLPE*, 600 V		R90XLPE*, RW75XLPE*, RW90XLPE*, 1000 V		R90XPLE†, RW75XPLE†, R90EP†, RW75EP†, RW90XLPE‡, RW90EP‡, 600 V		TWN75, T90 Nylon		TW, TW75		TWU,TWU75, RWU90XLPE*	
AWG KCMIL	Dia. (mm)	Area (mm^2)	Dia. (mm)	Area (mm^2)	Dia. (mm)	Area (mm^2)	Dia. (mm)	Area (mm^2)	Dia. (mm)	Area (mm^2)	Dia. (mm)	Area (mm^2)
14	3.36	8.89	4.12	13.36	4.12	13.36	2.80	6.18	3.36	8.89	4.88	18.70
12	3.84	11.61	4.60	16.65	4.60	16.75	3.28	8.47	3.84	11.61	5.36	22.56
10	4.47	15.67	5.23	21.45	5.23	21.45	4.17	13.63	4.47	15.67	5.97	27.99
8	5.99	28.17	5.99	28.17	6.75	35.77	5.49	23.66	5.99	28.17	7.76	47.29
6	6.95	37.98	7.71	46.73	8.47	56.39	6.45	32.71	7.71	46.73	8.72	59.72
4	8.17	52.46	8.93	62.67	9.69	73.79	8.23	53.23	8.93	62.67	9.95	77.76
3	8.88	61.99	9.64	73.05	10.40	85.01	8.94	62.83	9.64	73.05	10.67	89.42
2	9.70	73.85	10.46	85.88	11.22	98.82	9.76	74.77	10.46	85.88	11.48	103.5
1	11.23	99.10	12.49	122.6	13.51	143.4	11.33	100.9	12.49	122.6	13.25	137.9

continued...

TABLE 10 *continued*

1/0	12.27	118.3	13.53	143.9	14.55	166.4	12.37	120.3	13.53	143.9	14.28	160.2
2/0	13.44	141.9	14.70	169.8	15.72	194.2	13.54	144.0	14.70	169.8	15.45	187.5
3/0	14.74	170.6	16.00	201.0	17.02	227.5	14.84	172.9	16.00	201.0	16.76	220.6
4/0	16.21	206.4	17.47	239.7	18.49	268.5	16.31	209.0	17.47	239.7	18.28	262.4
250	17.90	251.8	19.17	288.5	21.21	353.2	18.04	255.7	19.43	296.4	20.20	320.5
300	19.30	292.6	20.56	332.1	22.60	401.2	19.44	296.9	20.82	340.5	21.54	364.4
350	20.53	331.0	21.79	372.9	23.83	446.0	20.67	335.6	22.05	381.9	22.81	408.6
400	21.79	373.0	23.05	417.3	25.09	494.5	21.93	377.8	23.31	426.8	24.07	455.0
450	22.91	412.2	24.17	458.8	26.21	539.5	23.05	417.3	24.43	468.7	25.19	498.4
500	23.95	450.5	25.21	499.2	27.25	583.2	24.09	455.8	25.47	509.5	26.24	540.8
600	26.74	561.7	27.24	582.9	30.04	708.8	—	—	28.26	627.3	29.02	661.4
700	28.55	640.0	29.05	662.6	31.85	796.5	—	—	30.07	710.0	30.82	746.0
750	29.41	679.3	29.91	702.6	32.71	840.3	—	—	30.93	751.3	31.69	788.7
800	30.25	718.7	30.75	742.6	33.55	884.0	—	—	31.77	792.7	32.53	831.1
900	31.85	796.6	32.35	821.8	35.15	970.2	—	—	33.37	874.5	34.13	914.9
1000	33.32	872.0	33.82	898.4	36.62	1053	—	—	34.84	953.4	35.60	995.4
1250	37.56	1108	38.32	1153	42.38	1411	—	—	39.08	1200	39.08	1199
1500	40.68	1300	41.44	1349	45.50	1626	—	—	42.20	1399	42.96	1449
1750	43.58	1492	44.34	1544	48.40	1840	—	—	45.10	1598	45.86	1652
2000	46.27	1681	47.03	1737	51.09	2050	—	—	47.79	1794	48.55	1851

* Unjacketed. †Jacketed ‡ Includes EPCV

Note: Dimensions for aluminum conductors are subjected to the range of sizes for which they are certified.

TABLE 16

(See Rules 10-518, 10-814, 10-816, 10-906, 12-1814, 24-104, 24-202, 66-202, 68-058 and 68-406)

MINIMUM SIZE CONDUCTORS FOR BONDING RACEWAYS AND EQUIPMENT

Rating or Setting of Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc. Not Exceeding - Amperes	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

NOTES:

1) Refer to appendix "B" C.E.C. Rule 10 - 814(1) for sizing bonding conductors in factory assembled cables.

2) Refer to definitions in section "0" C.E.C. for:
   Grounding Conductor
   Bonding Conductor

TABLE 17

(See Rules 10-204, 10-206, 10-812)

MINIMUM SIZE OF GROUNDING CONDUCTOR FOR AC SYSTEMS OR COMMON GROUNDING CONDUCTOR

Ampacity of Largest Service Conductor or Equivalent for Multi-conductors	Size of Copper Grounding Conductor AWG
100 or less	8
101 to 125	6
126 to 165	4
166 to 200	3
201 to 260	2
261 to 355	0
356 to 475	00
Over 475	000

NOTE: The ampacity of the largest service conductor, or equivalent if multi-conductors are used, is to be determined from the appropriate Code table taking into consideration the number of conductors in the conduit and the type of insulation.

TABLE 18

(See Rule 10-812)

MINIMUM SIZE OF GROUNDING CONDUCTOR FOR SERVICE RACEWAY AND SERVICE EQUIPMENT

Ampacity of Largest Service Conductor or Equivalent for Multi-conductors Not Exceeding - 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

(See Rule 12-120)

SUPPORTING OF CONDUCTORS IN VERTICAL RUNS OF RACEWAYS

Conductor Size AWG and 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 Alcan Cable for assistance. See the Alcan Cable Armoured Cable Canadian Catalogue for additional information.

DIMENSIONS OF STRANDED BARE COPPER AND ALUMINUM CONDUCTORS

CONDUCTOR				WIRES			NOMINAL CONDUCTOR DIAMETER					
SIZE	AREA				DIAMETER		Class 'B' Standard		Compressed Round		Compact Round	
AWG	Circ. Mils	mm^2	sq. in.	NO.	mm	in.	mm	in.	mm	in.	mm	in.
20	1020	0.519	.00080	7	0.31	.0121	0.92	.036				
18	1620	0.823	.00128	7	0.39	.0152	1.16	.046				
16	2580	1.31	.00203	7	0.49	.0192	1.46	.058				
14	4110	2.08	.00323	7	0.61	.0242	1.84	.073	1.78	.071		
12	6530	3.31	.00513	7	0.77	.0305	2.32	.092	2.25	.089		
10	10380	5.26	.00816	7	0.98	.0385	2.95	.116	2.86	.113		
8	16510	8.37	.01297	7	1.23	.0486	3.71	.146	3.60	.142	3.40	.134
6	26240	13.30	.02061	7	1.55	.0612	4.67	.184	4.53	.179	4.29	.169
4	41740	21.15	.03278	7	1.96	.0772	5.89	.232	5.71	.225	5.41	.213
3	52620	26.66	.04133	7	2.30	.0867	6.60	.260	6.40	.252	6.05	.238
2	66360	33.62	.05212	7	2.47	.0974	7.42	.292	7.20	.282	6.81	.268
1	83690	42.41	.06573	19(18)	1.69	.0664	8.43	.332	8.18	.322	7.60	.299
1/0	105600	53.51	.08291	19(18)	1.89	.0745	9.47	.373	9.19	.362	8.53	.336
2/0	133100	67.44	.1045	19(18)	2.13	.0837	10.64	.418	10.32	.406	9.55	.376
3/0	167800	85.02	.1318	19(18)	2.39	.0940	11.94	.470	11.58	.456	10.8	.423
4/0	211600	107.22	.1662	19(18)	2.68	.1055	13.41	.528	13.00	.512	12.1	.475
250 kcmil		126.68	.1963	37(35)	2.09	.0822	14.60	.575	14.16	.558	13.2	.520
300		152.01	.2356	37(35)	2.31	.0900	16.00	.630	15.52	.611	14.5	.570
350		177.34	.2749	37(35)	2.47	.0973	17.30	.681	16.78	.661	15.7	.616
400		202.68	.3142	37(35)	2.64	.1040	18.49	.728	17.94	.706	16.7	.659
500		253.36	.3927	37(35)	2.95	.1162	20.65	.813	20.03	.789	18.7	.736
600		304.02	.4712	61(58)	2.52	.0992	22.68	.893	22.00	.866	20.7	.813
750		380.03	.5890	61(58)	2.82	.1109	25.35	.998	24.59	.968	23.0	.908
1000		506.70	.7854	61(58)	3.25	.1280	29.26	1.152	23.38	1.117	26.9	1.059
1250		633.38	.9817	91	2.98	.1172	32.47	1.289	31.76	1.250		
1500		760.05	1.178	91	3.26	.1284	35.86	1.412	34.78	1.370		
1750		866.73	1.374	127	2.98	.1174	38.76	1.526	37.60	1.479		
2000		1013.40	1.571	127	3.19	.1255	41.45	1.632	40.21	1.583		

Reduced number of wires for compact strandings shown in parentheses.

DC RESISTANCE VALUES AND WEIGHTS OF STRANDED COPPER AND ALUMINUM CONDUCTORS

Conductor Size AWG or kcmil	APPROXIMATE NET WEIGHT				AVERAGE DC RESISTANCE* +25°C			
	kg per 1000 m		Lbs per 1000 ft.		Ohms% 1000 m		Ohms% 1000 ft.	
	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum
20	4.70		3.15		34.6		10.5	
18	7.46		5.02		21.8		6.64	
16	11.9		7.97		13.7		4.18	
14	18.9		12.7		8.61		2.63	
12	30.0	9.12	20.2	6.13	5.42	8.89	1.65	2.71
10	47.7	14.5	32.1	9.75	3.41	5.59	1.04	1.70
8	75.9	23.1	51.0	15.5	2.14	3.52	.653	1.07
6	121	36.7	81.0	24.6	1.35	2.21	.411	.674
4	192	58.3	129	39.2	0.848	1.39	.258	.424
3	242	73.5	162	49.4	0.673	1.10	.205	.336
2	305	92.7	205	62.3	.0553	0.875	.163	.267
1	385	117	259	78.6	.0423	0.694	.129	.211
1/0	485	147	326	99.1	.0335	0.550	.102	.168
2/0	611	186	411	125	.0266	0.436	.0811	.133
3/0	771	234	518	157	0.211	0.436	.0643	.105
4/0	972	296	653	199	0.167	0.274	.0510	.0836
250	1150	349	772	235	0.142	0.232	.0432	.0708
300	1380	419	925	282	0.118	0.194	.0360	.0590
350	1610	489	1080	329	0.101	0.166	.0308	.0506
400	1840	559	1240	376	0.0885	0.145	.0270	.0442
500	2300	699	1540	469	0.0708	0.116	.0216	.0354
600	2760	838	1850	563	0.0590	0.0967	.0180	.0295
750	3450	1050	2320	705	0.0472	0.0774	.0144	.0236
1000	4590	1400	3090	939	0.0354	0.0580	.0108	.0177
1250	5740	1750	3860	1170	0.0283	0.0464	.00863	.0142
1500	6890	2100	4630	1410	0.0236	0.0387	.00719	.0118
1750	8040	2440	5400	1640	0.0202	0.0332	.00616	.0101
2000	9091	2790	6180	1880	0.0177	0.0290	.00539	.00885

** 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 EEMAC (Electro-Federation) recommendations current at time of compilation, otherwise on published ICEA standards.

TABLE D6

RECOMMENDED* TIGHTENING TORQUES FOR WIRE BENDING SCREWS, CONNECTORS WITH SLOTTED SCREWS AND CONNECTORS FOR EXTERNAL DRIVE WRENCH

Type of Connection	Wire Size AWG kcmil	Tightening Torques Pound-Inches
Wire Binding Screws	14-10	12
Connectors with Slotted Screws	14,12&10	20
	8	30
	6&4	35
	3 to 4/0 incl.	40
Connectors for External Drive Wrench	1/0	175
	2/0	175
	3/0	250
	4/0	250
	250	350
	300	350
	350	350
	400	350
	500	400
	600	400
	700	400
	750	400
	800	450
	900	450
	1000	450
	1250	600
	1500	600
	1750	600
	2000	600

NOTE:

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

TABLE D7

RECOMMENDED* TIGHTENING TORQUES FOR CONNECTORS WITH HEXAGONAL SOCKET SCREWS

Socket Size (across flats) Inches	Tightening Torque Pound-Inches
5/32	100
3/16	120
7/32	150
1/4	175
5/16	250
3/8	350
1/2	450
9/16	600

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

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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