CANADIAN ELECTRICAL CODE

SUBJECT: Section 4 - Conductors

Rule 4-004 Ampacity of Wire and Cables

Underground Installations

The Appendix B note on this item makes reference to "defined assumptions"…

> *Ampacities of underground installations based on conditions of use not as set out in the foregoing notes or the defined assumptions preceding them should either be justified by precise calculation according to the method of Paragraph (1)(d) or (2)(d), or derived in accordance with Paragraph (1)(b) or (2)(b).*

…but nowhere are those assumptions apparent. However, if we refer to the 1994 (seventeenth edition), the Appendix B note does provide the assumptions as follows:

Assumptions used in the Calculation of Cable Ampacity Rating for Direct Buried and Underground Conduit Installations

General	
Load factor	– *100%*
Ambient Soil Temperature	– 20°C
Conductor Temperature	– 90°C
Soil Thermal Resistivity	– 90°C - *CM* / *Watt*
Insulation/Jacket Thermal Resistivity	– 400°C - *CM* / *Watt*
Shield or Sheath Operation	– *Open Circuit*
Voltage Rating	– 0 *to* 5 kV
Direct Buried Installation	
Cable Depth of Burial	– 915 mm *(36")*
Cable Types	– *RWU90* – *RA90* – *TECK90* – *ACWU90*
Conduit Installation	
Diameter of Conduit	– 127 mm *(5")*
Depth of Concrete from Surface	– 760 mm *(30")*
Concrete Thermal Resistivity	– 85°C - *CM*

Cable Type	*Watt – RW90*

In determining the maximum current which copper or aluminum conductors may carry in underground runs, Paragraphs (1)(d) *[for copper]* & (2)(d) *[for aluminum]* of Rule 4-004 require that the method of calculation of IEEE Standard 835 be used for conductors 1/0 AWG and larger. Accordingly, the Appendix B diagrams and the Appendix D tables D8 to D15 assist the code user in determining the maximum conductor ampacity. The result arrived at when using the Appendix B diagrams and the Appendix D tables are based on the foregoing assumptions. Therefore, to determine precise maximum ampacities, the detailed calculations in IEEE Standard 835 should be applied as advised in the Appendix B note to this Rule (see above).

Alternatively, as the Appendix B note suggests, the methods of calculation permitted by Paragraphs (1)(b) and (2)(b) of Rule 4-004 also provide for adequate determination of maximum current where a precise calculation in accordance with IEEE 835 is not practicable. Consequently, Alberta continues to recognize the use of Paragraphs (1)(b) and (2)(b) to calculate the maximum current for conductors in underground runs.

Where the load is expected to be continuous, the detailed application of IEEE Standard 835 is strongly recommended.

Cable Arrangements

The Appendix B Note for this Rule indicates where Tables D8A to D11B and D12A to D15B may be used to determine ampacities of conductors for the cable arrangements shown in diagrams B4-1 to B4-4. Where other cable configurations are used, you should consult the cable manufacturer or a professional engineer to verify the cable ampacities.

Metallic vs. Non-metallic Raceway

Note (1) of Tables D10A to D11B refers to non-metallic underground raceways. These tables apply to an installation configuration of a single conductor per raceway. The values in the table do not take into consideration heating effects of circulating currents that would be imposed on metallic conduit, hence the reference to only non-metallic raceways.

Rules 4-006 Insulated Conductors

Types of Conductors Acceptable for Direct Earth Burial

Direct buried conductors in contact with the earth are to be of the types listed in Table 19.

Conductors installed underground in a protective raceway, or plastic pipe, are not considered to be in contact with the earth, therefore types such as RW75, RW90, TW or TW75 listed in Table 19 for use in "wet locations" are acceptable.

For more information on underground conductors, see Rule 12-012 in the Canadian Electrical Code and the information bulletin in STANDATA CEC-12.

Rule 4-010 Uses of Flexible Cord

Portable Multi-outlet Assemblies

Approved indoor power poles of the portable type are available with a flexible supply cord. The installation of receptacle outlets above suspended ceilings for the connection of cord connected portable indoor power poles is considered acceptable. The installation however, is normally concealed in the ceiling space resulting in a potential for proper maintenance to be overlooked. Therefore, the use of extension cords or "cube" taps are discouraged and the power pole flexible supply cord should be plugged directly into the receptacle outlet.

Rule 4-022 Size of Neutral Conductor

Reduced Neutral Conductor Size for Single Family Dwellings

For a single family dwelling with provision for a 120/240 V electric range, or a 120/240 V electric dryer, the neutral conductor of the consumer's service, or feeder, may be reduced to a size having not less than 70% of the ampacity of the ungrounded conductors.

This concept may be equally applied to a feeder or service supplying more than one unit of row housing or similar installations.

As explained in Rule 4-004 (4), the common conductor of a consumer's service or feeder connected to 2-phase wires and the neutral of a 4-wire, 3-phase system carries approximately the same current as the other conductors and therefore shall not be reduced.

Neutral Overload from the Effect of Harmonics on a System

When designing an installation that will incorporate a number of electronic devices, a professional engineer should review the design to ensure that conductors will not be subject to an overload condition due to harmonic effect.

> **Note:** The standard averaging type clamp-on ammeter cannot measure the overload imposed on a system from the effect of harmonics accurately. A "true RMS" type must be used.

Rule 4-028 Identification of Insulated Neutral Conductors Up To and Including No. 2 AWG Copper or Aluminum

Conductors Suitable for Exposed Wiring Where Exposed to Weather

When exposed conductors are installed outdoors, such as service entrance installations, they are required to be suitable for exposure to weather in accordance with Rule 2-024, 4-006 and 12-100. Note #30 of Table 19 reinforces this requirement

Because of the cold weather we experience in Alberta, the common choice for service entrance conductors is usually a thermoset conductor manufactured in accordance with CSA C22.2 No. 38-05. Clause 4.8 of this standard requires that conductors used where exposed to weather have a minimum of 2.5% by weight of suitable carbon black, well dispersed. Because of the high carbon content, this requirement essentially eliminates the ability of the manufacturer to introduce coloured insulations that would be suitable for exposure to weather.

Rule 4-028(1) requires that the neutral conductor of consumer services up to and including No. 2 AWG copper and aluminum be identified with a white or natural grey covering or by three continuous white stripes along the entire length of the conductor. When only black conductors are available, the identified (neutral) conductor should be permanently marked as outlined in Subrule (4) of Rule 4-028.