



CSA C68.5:20
National Standard of Canada



Primary shielded and concentric neutral cable for distribution utilities



scc  ccn

Legal Notice for Standards

Canadian Standards Association (operating as “CSA Group”) develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document’s fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party’s intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document’s compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group’s and/or others’ intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by treaty or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF form.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way, or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.



Revision History

CSA C68.5:20, Primary shielded and concentric neutral cable for distribution utilities

Update No. 1 — May 2023	Revision symbol (in margin)
Clauses 3.1 , 4.5 , 7.3 , 8.4 , 9.1.1 , 9.1.7 , 9.2.1 , 10.2.1.1 , 11.3.1 , 11.4.11 , 11.4.12.2 , 11.4.12.4 , 11.14.4 , and 12.4.2 Tables 3 , 6 , 11 , 12 , 13 , 18 , 19 , 24 , 27 , 29 , 34 , B.3 , B.5 , C.2 , C.3 , and C.4 Figure 2	①

Currently in preview, click buy full version

Standards Update Service

CSA C68.5:20

February 2020

Title: *Primary shielded and concentric neutral cable for distribution utilities*

To register for e-mail notification about any updates to this publication

- go to www.csagroup.org/store/
- click on **Product Updates**

The **List ID** that you will need to register for updates to this publication is **2427-09**.

If you require assistance, please e-mail techsupport@csagroup.org or call 416-747-2233.

Visit CSA Group's policy on privacy at www.csagroup.org/legal to find out how we protect your personal information.

Canadian Standards Association (operating as “CSA Group”), under whose auspices this National Standard has been produced, was chartered in 1919 and accredited by the Standards Council of Canada to the National Standards system in 1973. It is a not-for-profit, nonstatutory, voluntary membership association engaged in standards development and certification activities.

CSA Group standards reflect a national consensus of producers and users — including manufacturers, consumers, retailers, unions and professional organizations, and governmental agencies. The standards are used widely by industry and commerce and often adopted by municipal, provincial, and federal governments in their regulations, particularly in the fields of health, safety, building and construction, and the environment.

More than 10 000 members indicate their support for CSA Group’s standards development by volunteering their time and skills to Committee work.

CSA Group offers certification and testing services in support of and as an extension to its standards development activities. To ensure the integrity of its certification process, CSA Group regularly and continually audits and inspects products that bear the CSA Group Mark.

In addition to its head office and laboratory complex in Toronto, CSA Group has regional branch offices in major centres across Canada and inspection and testing agencies in fourteen countries. Since 1919, CSA Group has developed the necessary expertise to meet its corporate mission: CSA Group is an independent service organization whose mission is to provide an open and effective forum for activities facilitating the exchange of goods and services through the use of standards, certification and related services to meet national and international needs.

For further information on CSA Group services, write to
CSA Group
178 Rexdale Boulevard
Toronto, Ontario, M9W 1R3
Canada

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited Standards Development Organization, in compliance with requirements and guidance set out by SCC. More information on National Standards of Canada can be found at www.scc.ca.

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada’s economic competitiveness and social wellbeing, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at www.scc.ca.

Standards Council of Canada
600-55 Metcalfe Street
Ottawa, Ontario, K1P 6L5
Canada



La Norme Nationale du Canada est disponible en versions française et anglaise.

Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users to judge its suitability for their particular purpose.

®A trademark of the Canadian Standards Association, operating as “CSA Group”

National Standard of Canada

CSA C68.5:20

***Primary shielded and concentric
neutral cable for distribution
utilities***



*®A trademark of the Canadian Standards Association,
operating as "CSA Group"*



*Published in February 2020 by CSA Group
A not-for-profit private sector organization
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3*

*To purchase standards and related publications, visit our Online Store at
www.csagroup.org/store/ or call toll-free 1-800-463-6727 or 416-747-4044.*

*ICS 29.240.20
ISBN 978-1-4883-2134-4*

*© 2020 Canadian Standards Association
All rights reserved. No part of this publication may be reproduced in any form whatsoever
without the prior permission of the publisher.*

Contents

Technical Committee on Insulated Power Cable	6
Subcommittee on Shielded and Concentric Neutral Power Cables Rated 5–46 kV	8
Preface	10
1 Scope	12
2 Reference publications	12
3 Definitions and abbreviations	16
3.1 Definitions	16
3.2 Abbreviations	18
4 Conductors	19
4.1 General	19
4.2 Physical and electrical properties	19
4.2.1 General	19
4.2.2 Copper conductors	19
4.2.3 Aluminum conductors	20
4.3 Optional water-blocking components for stranded conductors	20
4.4 Conductor size units	20
4.5 Conductor dc resistance per unit length	20
4.6 Conductor diameter	20
5 Conductor shield (stress control layer)	21
5.1 Material	21
5.2 Extruded shield thickness	21
5.2.1 General	21
5.2.2 Reduced extruded shield thickness	21
5.3 Protrusions and convolutions	21
5.4 Voids	21
5.5 Physical requirements	21
5.6 Electrical requirements	22
5.6.1 Extruded semiconducting material	22
5.6.2 Semiconducting tape	22
5.7 Cross-linked (thermoset) requirements	22
6 Insulation	22
6.1 Material	22
6.2 Insulation thickness	22
6.2.1 General	22
6.2.2 Selection of insulation thickness	23
6.2.3 Insulation eccentricity	23
6.2.4 Insulation diameter	23
6.3 Physical and aging requirements	23
6.4 Electrical requirements	23

6.4.1	Partial-discharge extinction level	23
6.4.2	Voltage tests	24
6.4.3	Dielectric constant and dissipation factor	24
6.5	Voids, ambers, gels, agglomerates, and contaminants	24
6.5.1	TRXLPE insulation	24
6.5.2	EPR insulation	24
6.6	Shrinkback — TRXLPE	24
7	Extruded insulation shield	24
7.1	Material	24
7.2	Thickness and indent requirements	24
7.3	Protrusions and convolutions	25
7.3.1	Protrusions	25
7.3.2	Convolutions	25
7.4	Removability	25
7.5	Voids	25
7.6	Physical requirements	25
7.7	Electrical requirements	25
7.8	Cross-linked (thermoset) requirements	25
7.9	Semiconducting tape	26
8	Metallic shielding	26
8.1	General	26
8.2	Concentric neutral conductor	26
8.2.1	Material	26
8.2.2	Cross-sectional area	26
8.2.3	Lay length	27
8.2.4	Concentric wires	27
8.2.5	Flat straps	27
8.3	Other metallic shields	27
8.3.1	Helically applied tape(s)	27
8.3.2	Combination of tape and wire	28
8.3.3	Longitudinally applied corrugated tape	28
8.3.4	Lead sheath	28
8.4	Optional water-blocking components for metallic shield/concentric neutral	28
9	Jacket	29
9.1	Material	29
9.1.1	General	29
9.1.2	Linear low density polyethylene, black (LLDPE)	29
9.1.3	Polyvinyl chloride, black (PVC)	29
9.1.4	Polypropylene, black (PP)	29
9.1.5	High-density polyethylene, black (HDPE)	29
9.1.6	Cross-linked polyethylene, black (XLPE)	29
9.1.7	Semi-conducting SC-PE copolymer, black (Type I or Type II)	30
9.2	Jacket application and thickness	30
9.2.1	Extruded-to-fill jacket	30
9.2.2	Overlaying jacket	30
9.2.3	Jacket thickness	30

9.2.4	Jackets with identification stripes (optional)	30
10	Cable assembly and identification	31
10.1	Multiplex cable assemblies	31
10.2	Cable identification	31
10.2.1	Jacketed cable	31
10.2.2	Marking of unjacketed concentric neutral cable	31
10.2.3	Sequential length marking	31
10.3	Marking on reel	32
11	Production tests	32
11.1	Testing	32
11.2	Sampling frequency	32
11.3	Conductor test methods	32
11.3.1	Method for dc resistance determination	32
11.3.2	Diameter determination	33
11.4	Test samples and specimens for physical and aging tests	33
11.4.1	General	33
11.4.2	Measurement of thickness	33
11.4.3	Number of test specimens	33
11.4.4	Size of specimens	33
11.4.5	Preparation of specimens of insulation and jacket	34
11.4.6	Specimen for aging test	34
11.4.7	Calculation of area of test specimens	34
11.4.8	Unaged sample test procedures	35
11.4.9	Aged sample test procedures	35
11.4.10	Hot creep test	36
11.4.11	Wafer boil test for conductor and insulation shields	36
11.4.12	Amber, agglomerate, gel, contaminant, cut-trusion, convolution, and void test	36
11.4.13	Internal irregularity test procedure for XLPE insulation	37
11.4.14	Physical tests for semiconducting material intended for extrusion	38
11.4.15	Retests for physical and aging properties	38
11.4.16	Retest for thickness	39
11.5	Dimensional measurements of the metallic shield	39
11.5.1	Tape shield	39
11.5.2	Concentric neutral	39
11.5.3	Lead sheath	39
11.6	Diameter measurement of insulation	39
11.7	Tests for jackets	40
11.7.1	Deformation test	40
11.7.2	Cold bend test on finished cable (No. 4/0 and smaller with extruded-to-fill jackets)	40
11.8	Volume resistivity	40
11.8.1	Conductor shield	40
11.8.2	Insulation shield	40
11.8.3	Test equipment	41
11.8.4	Test procedure	41
11.9	Adhesion (insulation shield removability) test	41
11.10	Shrinkback test	42
11.10.1	Sample preparation	42

11.10.2	Test procedure	42
11.10.3	Acceptance criteria and procedure	42
11.11	Sample retests	42
11.12	AC voltage test	43
11.12.1	General	43
11.12.2	Test procedure	43
11.13	Partial-discharge test procedure	43
11.14	Other tests	43
11.14.1	Water content	43
11.14.2	Longitudinal water penetration test — Optional water-blocking component for stranded conductors	44
11.14.3	Longitudinal water penetration test — Optional water-blocking components for metallic shield/concentric neutral	45
11.14.4	Jacket spark test	45
11.15	CV extrusion qualification test	45
11.15.1	General	45
11.15.2	Thermal conditioning	45
11.15.3	Dissipation factor verification	45
11.15.4	AC withstand verification	45
12	Qualification tests	46
12.1	General	46
12.2	Core qualification tests	46
12.2.1	General	46
12.2.2	Core material qualification requirements	46
12.2.3	Manufacturing qualification requirements	47
12.2.4	HVTT procedure	48
12.2.5	Hot impulse test procedure	49
12.2.6	Cyclic aging	50
12.2.7	AWTT procedure	50
12.2.8	Qualification test electrical measurements	54
12.2.9	Qualification test physical measurements	54
12.3	Jacket material qualification tests	54
12.3.1	General	54
12.3.2	Deformation test	54
12.3.3	Weather resistance of jacket and striping material	55
12.3.4	Environmental stress cracking test of polyethylene and polypropylene jackets	55
12.4	Other qualification tests	56
12.4.1	Dielectric constant and dissipation factor	56
12.4.2	Compatibility of optional water-blocking components	56
12.4.3	Resistance stability test	56
12.4.4	Brittleness temperature for semiconducting shields	56
12.4.5	Cold impact test on finished cable	56
12.4.6	Cold bend test on finished cable	56
12.4.7	Dry electrical test for 105 °C rated insulations	57
12.4.8	Dissipation factor characterization test	58
12.4.9	Longitudinal water penetration test — Optional water-blocking components for stranded conductors	59

- 12.4.10 Longitudinal water penetration test — Optional water-blocking components for metallic shield/
concentric neutral 59
- 12.4.11 Thermomechanical qualification test 59
- 12.4.12 Heat shock — Thermoplastic jacket or covering other than polyethylene 60
- 12.4.13 Flame test on finished cable (optional) 61

13 Information to be supplied by purchaser 61

- 13.1 General 61
- 13.2 Characteristics of systems on which cable is to be used 61
- 13.3 Quantities and description of cable 61
- 13.4 Packaging 62

-
- Annex A (informative) — Operating limits 90
 - Annex B (informative) — Calculated insulation diameters for common sizes based on AEIC CS8-00 92
 - Annex C (normative) — Calculated insulation diameters for common sizes based on ICEA
Standards 102
 - Annex D (informative) — Shielding 111
 - Annex E (informative) — Handling and installation parameters 114
 - Annex F (informative) — Ethylene alkene copolymer (EAM) 117
 - Annex G (normative) — Insulation compound inspection 118
 - Annex H (informative) — Typical concentric neutral copper conductor 120
 - Annex I (informative) — Connectability test for blocked strand conductor 122
 - Annex J (informative) — Concentric neutral cables rated less than 15 kV 123

Technical Committee on Insulated Power Cable

E. H. Wiebe	Innovative Solutions Engineering Inc., Winnipeg, Manitoba, Canada <i>Category: General Interest</i>	<i>Chair</i>
S. K. Alibhay	Hydro-Québec, Montréal, Québec, Canada <i>Category: User Interest</i>	
M. D. Bell	Hydro One Networks Inc., Toronto, Ontario, Canada <i>Category: User Interest</i>	
E. Cometa	CSA Group Testing & Certification Inc., Toronto, Ontario, Canada <i>Category: General Interest</i>	
J. Conrad	RSCC Wire & Cable LLC, East Granby, Connecticut, USA <i>Category: Producer Interest</i>	
W. A. Crawford	The Okonite Company, Ramsey, New Jersey, USA <i>Category: Producer Interest</i>	
K. C. Hamilton	Manitoba Hydro, Winnipeg, Manitoba, Canada <i>Category: User Interest</i>	
M. Hartley	Toronto, Ontario, Canada	<i>Non-voting</i>
A. S. Jones	Toronto, Ontario, Canada	<i>Non-voting</i>
C. Mateo	FortisAlberta Inc., St. Albert, Alberta, Canada <i>Category: User Interest</i>	
J. A. McFadgen	Nova Scotia Power Inc., Halifax, Nova Scotia, Canada <i>Category: User Interest</i>	

M. Moradi	Prysmian Power Cables and Systems Canada, Richmond Hill, Ontario, Canada <i>Category: Producer Interest</i>	
K. M. Nuckles	Southwire Company, Carrollton, Georgia, USA <i>Category: Producer Interest</i>	
D. S. Parikh	Hydro One Networks Inc., Toronto, Ontario, Canada <i>Category: User Interest</i>	
S. Sahota	Prysmian Power Cables and Systems Canada Ltd., Johnstown, Ontario, Canada	<i>Non-voting</i>
W. S. Temple	General Cable Industries, Inc., Highland Heights, Kentucky, USA <i>Category: Producer Interest</i>	
S. Attarde	CSA Group, Toronto, Ontario, Canada	<i>Project Manager</i>

Subcommittee on Shielded and Concentric Neutral Power Cables Rated 5–46 kV

L. J. Hiivala	Toronto, Ontario, Canada	<i>Chair</i>
S. K. Alibhay	Hydro-Québec, Montréal, Québec, Canada	
E. Cometa	CSA Group, Toronto, Ontario, Canada	
W. F. Constantine	Draka Cableteq USA, North Dighton, Massachusetts, USA	
W. A. Crawford	The Okonite Company, Ramsey, New Jersey, USA	
M. Côté	Hydro-Québec, Distribution, Montréal, Québec, Canada	
D. Drysdale	Nexans Canada Inc., Fergus, Ontario, Canada	
A. Filion	Marmon Utility LLC, Milford, New Hampshire, USA	
K. C. Hamilton	Manitoba Hydro, Winnipeg, Manitoba, Canada	
D. Harris	Northern Cables Inc., Brockville, Ontario, Canada	
M. Hartley	Toronto, Ontario, Canada	
G. Jones	The Okonite Company, Ramsey, New Jersey, USA	
E. Majdi	Toronto Hydro, Toronto, Ontario, Canada	

J. A. McFadgen	Nova Scotia Power Inc., Halifax, Nova Scotia, Canada	
M. Moradi	Prysmian Power Cables and Systems Canada, Richmond Hill, Ontario, Canada	
N. Moubed	Anixter Canada Inc., Mississauga, Ontario, Canada	
K. M. Nuckles	Southwire Company, Carrollton, Georgia, USA	
D. S. Parikh	Hydro One Networks Inc., Toronto, Ontario, Canada	
S. Sahota	Prysmian Power Cables and Systems Canada Ltd., Johnstown, Ontario, Canada	
A. Schimmoeller	Southwire, Brecksville, Ohio, USA	
G. Simion	Anixter Canada Inc., Mississauga, Ontario, Canada	
W. S. Temple	General Cable Industries, Inc., Highland Heights, Kentucky, USA	
S. Wetzel	Southwire Company, Cambridge, Wisconsin, USA	
E. H. Wiebe	Innovative Solutions Engineering Inc., Winnipeg, Manitoba, Canada	
C. Chan	CSA Group, Toronto, Ontario, Canada	<i>Project Manager</i>

Preface

This is the third edition of CSA C68.5, *Primary shielded and concentric neutral cable for distribution utilities*. It supersedes the previous editions published in 2013 and 2007.

The first edition of CSA C68.5 adapted the requirements of the following documents:

- a) ANSI/ICEA S-94-649;
- b) ANSI/ICEA S-97-682;
- c) CEA Purchasing Specification WCWG-01 (95), *XLPE Primary Cable up to #4/0 AWG*; and
- d) CEA Purchasing Specification WCWG-02 (95), *XLPE Primary Feeder Cable*.

The main revisions incorporated in the third edition of CSA C68.5 include the following:

- Clarification on the four classifications of ethylene propylene rubber insulation and applicable requirements;
- Removal of thermally strippable insulation shield;
- Addition of “WBS” for blocked strand or “WBC” blocked cable for constructions incorporating water-blocking component;
- Removal of the word “optional” for Thermomechanical qualification test to clarify that this test is mandatory on jacketed cables.

This Standard is arranged to allow for selection of the individual components, such as conductors, insulation type and thickness, metallic shield or concentric neutral, and jackets, that are required for a specific installation and service conditions. Clauses 4 to 9 specify the materials, material characteristics, dimensions, and tests applicable to the major components of cables and, if applicable, to the design concept.

Funding in support of the consensus process of this Standard was provided by the following funders, whose assistance is acknowledged with thanks: Canadian Electricity Association (CEA), S&C Electric Canada Ltd., Fortis BC, Fortis Alberta, Maritime Electric, Newfoundland Hydro, Newfoundland Power, Schneider Electric Canada Inc., and IFD Corporation.

This Standard is considered suitable for use for conformity assessment within the stated scope of the Standard.

This Standard was prepared by the Subcommittee on Shielded and Concentric Neutral Power Cables Rated 5–46 kV, under the jurisdiction of the Technical Committee on Insulated Power Cable and the Strategic Steering Committee on Power Engineering and Electromagnetic Compatibility, and has been formally approved by the Technical Committee.

This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Notes:

- 1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- 2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
- 3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as “substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity”. It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*