



UL 1684

Underwriters Laboratories Inc. Standard for Safety

Reinforced Thermosetting Resin Conduit (RTRC) and Fittings



Documents
Document Sharing Hub

UL Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings, UL 1684

Third Edition, Dated March 17, 2000

Summary of Topics:

This editorial revision of UL 1684 removes the ANSI designation information from the title page since ANSI recognition for this standard has been withdrawn. As noted in the Commitment for Amendments statement located on the back side of the title page, UL and CSA are committed to updating this standard jointly. Since these revisions only effect UL, CSA will not be issuing revision pages.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revisions dated August 28, 2009 include a reprinted title page (page1) for this Standard.

UL 1684 will be superseded by UL 2420, Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings, and UL 2515, Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings, on November 16, 2011.

Please note that UL and CSA versions of this Standard are technically identical. Because of differences in publishing systems, UL has issued some pages with different dates.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the preface. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

No Text on This Page

Canadian Standards Association
CAN/CSA C22.2 No. 211.3-96
Fourth Edition

Underwriters Laboratories Inc.
UL 1684
Third Edition



Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

March 17, 2000

(Title Page Reprinted: August 28, 2009)

Commitment for Amendments

This Standard is issued jointly by Canadian Standards Association and Underwriters Laboratories Incorporated. Amendments to this Standard will be made only after processing according to the Standards writing procedures by both Canadian Standards Association and Underwriters Laboratories Incorporated.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

ISSN 0317-5669

**Copyright © 2009
Underwriters Laboratories Inc.**

**Copyright © 2004
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

Preface	4
Foreword (CSA)	5
Reinforced Thermosetting Resin Conduit (RTRC) and Fittings	
1 Scope	7
2 Definitions	7
3 Reference publications and units of measurement	8
4 Construction	9
4.1 General	9
4.4 Elbows	9
4.5 Adapters	10
4.6 Conduit bodies	10
5 Qualification tests	10A
5.2 Compression (conduit)	10A
5.4 Impact resistance at low temperature (conduit)	11
5.6 Water absorption (conduit)	12
5.7 Chemical resistance (optional)	12
5.8 Joint water tightness	14
5.9 Joint separation	14
5.10 Flattening resistance (conduit)	14
5.11 Resistance to sag (for above ground conduit only)	15
5.12 Flame retardant properties (for above ground conduit only)	15
5.13 Vertical flame (FT4) conduit on cable tray (not mandatory)	17
5.16 Weather resistance (for above ground conduit only)	20
5.17 Infrared spectroscopy	22
5.19 Durability of printing (all types with surface-applied markings of ink, dyes, etc.)	23
5.21 External icing (conduit bodies)	24
6 Marking	25
7 In factory tests	25

Appendix A – Guidelines

A3 Intake airflow	A1
-------------------------	----

Appendix B – Method to determine the halogen content of a low halogen material using the calculation method from pH and Acid Gas Evolution

B3 Test equipment	B1
B4 Test procedure	B3
B4.4 Acid gas measurement	B4
B5 Determination of halogen content	B4

Preface

This is the fourth edition of the Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings, published under the dual designation C22.2 No. 211.3 and the third edition of published UL 1684. This Standard supersedes the previous editions of C22.2 No. 211.3 published in 1993, 1990 and 1984, and also supersedes the previous edition of UL 1684.

The main changes from the 1993 edition of C22.2 No. 211.3 are:

- a) Definitions are added;
- b) Requirements for conduit bodies are included;
- c) Chemical resistance test becomes optional (to meet the requirements of the specific environment where the conduit is to be installed);
- d) Details of the tests for weather resistance and flame are included to ensure that the Standard is self-contained as much as possible;
- e) Infrared spectroscopy and durability of printing tests are added.

The main changes from the second edition of UL 1684 are:

- a) Editorial corrections for clarification;
- b) Revisions to Table 10 (Maximum vertical deflection of the diameter on the resistance to flattening test) to correct deflection values.

This common Standard was prepared by a Joint Task Force comprised of NEMA/CSA/UL members and includes:

Richard Candahl	United Fiberglass of America Inc., Springfield, Ohio, USA	<i>Chair</i>
Goran Haag	Champion Fiberglass Inc., Spring, Texas, USA	
Phil Ellsworth	Smith Fiberglass Products Inc., Wichita, Kansas, USA	
Dora Carter	National Electrical Manufacturers Association, Washington, D.C., USA	
Greg Nieminski	Underwriters Laboratories Inc., Melville New York, USA	
Steve Paniri	Canadian Standards Association, Etobicoke, Ontario	<i>Administrator</i>

This Standard was also approved by the CSA Technical Committee on Wiring Products and has been processed according to the method of development, revision, and implementation of UL Standards for safety.

Foreword (CSA)

The Canadian Standards Association (CSA) develops standards under the name Canadian Standards Association, and provides certification and testing under the name CSA International. CSA International provides certification services for manufacturers who, under license from CSA, wish to use the appropriate registered CSA Marks on certain products of their manufacture to indicate conformity with CSA Standards.

CSA Certification for a number of products is provided in the interest of maintaining agreed-upon standards of quality, performance, interchangeability and/or safety, as appropriate. Where applicable, certification may form the basis for acceptance by inspection authorities responsible for enforcement of regulations. Where feasible, programs will be developed for additional products for which certification is desired by producers, consumers, or other interests.

In performing its functions in accordance with its objectives, CSA does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of the Association represent its professional judgement given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed.

Products in substantial accord with this Standard but which exhibit a minor difference or a new feature may be deemed to meet the Standard providing the feature or difference is found acceptable utilizing appropriate CSA International Operating Procedures. Products that comply with this Standard shall not be certified if they are found to have additional features which are inconsistent with the intent of this Standard. Products shall not be certifiable if they are discovered to contravene applicable laws or regulations.

Testing techniques, test procedures, and instrumentation frequently must be prescribed by CSA International in addition to the technical requirements contained in Standards of CSA. In addition to markings specified in the Standard, CSA International may require special cautions, markings, and instructions that are not specified by the Standard.

Some tests required by CSA Standards may be inherently hazardous. The Association neither assumes nor accepts any responsibility for any injury or damage that may occur during or as the result of tests, wherever performed, whether performed in whole or in part by the manufacturer or the Association, and whether or not any equipment, facility, or personnel for or in connection with the test is furnished by the manufacturer or the Association.

Manufacturers should note that, in the event of the failure of CSA International to resolve an issue arising from the interpretation of requirements, there is an appeal procedure: the complainant should submit the matter, in writing, to the Secretary of the Canadian Standards Association.

If this Standard is to be used in obtaining CSA Certification please remember, when making application for certification, to request all current Amendments, Bulletins, Notices, and Technical Information Letters that may be applicable and for which there may be a nominal charge. For such information or for further information concerning CSA Certification, please address your inquiry to Applications and Customer Service, CSA International, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3.

This page intentionally left blank.

Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1 Scope

1.1 This Standard specifies the requirements for halogen-free reinforced thermosetting resin conduit (RTRC), and associated fittings for installation and use in accordance with the Rules of the Canadian Electrical Code, (CEC) Part I, and the National Electrical Code (NEC) for nonhazardous locations.

1.2 The products specified in this Standard are intended for use at, but not limited to, -40°C (-40°F) to 110°C (230°F) continuous operating temperature.

1.3 This Standard covers conduit Type AG for use above ground and/or below ground, and Type BG for use below ground only.

1.4 This Standard covers conduit Type ID (dimensions based on inside diameters) and Type IPS (dimensions based on outside diameters of iron pipe sizes). Trade sizes (metric designators) are 1/2 (16), 3/4 (21), 1 (27), 1-1/4 (35), 1-1/2 (41), 2 (53), 2-1/2 (63), 3 (78), 3-1/2 (91), 4 (103), 4 HW (103), 4-1/2 (116), 5 (129), and 6 (155).

Note: The values in parenthesis are metric size designations of conduits and fittings and do not necessarily reflect metric trade sizes.

1.5 Fittings specified in this Standard include, but are not limited to, straight couplings, 5° angle couplings, adapters, elbows with plain ends or integral belled ends at one or both ends, expansion joints and conduit bodies.

Note: A product that contains features, characteristics, components, materials, or systems new or different from those in use when the Standard was developed, and that involves a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this Standard.

2 Definitions

2.1 The following definitions apply in this Standard:

Integral belled end – a belled end installed at the factory, either integrally wound or a permanently attached coupling

Conduit body – a separate portion of a conduit system that provides access through a removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system.

Halogen-free – a material having not more than 0.2 percent by weight of total halogen content.

Note: For other definitions, refer to NEC and/or CEC.

3 Reference publications and units of measurement

3.1 Reference publications Where reference is made to other publications, such reference shall be considered to refer to the latest edition and all amendments published to that edition up to the time when this Standard was approved.

CSA Standards

C22.1-1994,
Canadian Electrical Code (CEC), Part 1

C22.2 No. 38-95,
Thermoset Insulated Wires and Cables

CAN/CSA-C22.2 No. 126-M91,
Cable Tray Systems

ANSI/ASTM¹ Standard

D256-93A,
Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials

ANSI/NFPA² Standard

70,
National Electrical Code (NEC)

ASTM³ Standards

D2105-90,
Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube

G23-93,
Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

G26-94,
Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

CAN/CGSB⁴ Standard

3.14-M88,
Liquefied Petroleum Gas (Propane)

UL⁵ Standard

44-1991

Rubber Insulated Wires and Cables.

¹American National Standards Institute/American Society for Testing and Materials.

²American National Standards Institute/National Fire Protection Association.

³American Society for Testing and Materials.

⁴Canadian General Standards Board.

⁵Underwriters Laboratories Inc.

3.2 Units of measurement Where a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

4 Construction

4.1 General

4.1.1 Only materials that are acceptable for the particular use shall be employed.

4.1.2 Conduit and fittings shall be fiber impregnated with a cured thermosetting resin compound. The conduit shall have a uniform wall, a smooth interior, and shall not contain any features that can damage wiring installed in the conduit.

4.1.3 Conduit shall be straight and both ends of each length of conduit shall be perpendicular to the longitudinal axis of the conduit.

4.1.4 Integral and nonintegral connections shall provide a mechanically secure and watertight joint.

4.2 Conduit with an integral belled end The dimensions of conduit with an integral coupling on one end shall be in accordance with the values specified in Tables 1 and 2. They shall also meet the requirements of Clause 5.8.

4.3 Couplings Couplings shall be straight with belled ends, or 5° angle couplings. Dimensions of couplings are shown in Tables 3 and 4. Couplings shall also meet the requirements of Clause 5.8.

4.4 Elbows

4.4.1 Elbows shall be provided with plain ends or have an integral belled end at one or both ends. Elbows shall also meet the requirements of Clause 5.8.

4.4.2 The radius and dimension of an elbow are shown in Table 5 and Figure 1.

4.4.3 The straight end portions (see dimension L_s on Figure 1) of an elbow shall be at least 13 mm (1/2 in) longer than the socket depth.

4.5 Adapters

4.5.1 **Threaded adapters and threaded box connectors** Adapters for joining conduit to other threaded systems shall be as specified in Table 6.

4.5.2 **Other adapters** Other adapters shall meet the joint separation requirements specified in Clause 5.8. They shall also meet the requirements of Clause 5.8.

4.5.3 **Bore of conduit and elbows** The internal diameter of a finished elbow shall be such that a round ball or an equivalent mandrel will pass freely through the bore of the conduit and elbow. The diameter of the ball or equivalent mandrel shall be 90 percent of the original internal diameter for conduit and 85 percent of the original internal diameter for elbows.

As an alternative to using a ball to check the bore of conduit and bends, an inside micrometer gauge or a telescopic gauge and a micrometer caliper may be used.

4.6 Conduit bodies

4.6.1 **Material** Conduit bodies shall be of reinforced thermosetting resin material which provides flame and mechanical properties consistent with the conduit system.

4.6.2 **Covers** Conduit bodies shall be furnished with a blank cover. Threaded inserts may be molded into or assembled into the body.

4.6.3 **Capacity** Conduit bodies constructed to permit a change in direction of axis of conduit system shall have a minimum distance inside the body L_m , not less than 3 times the trade size of the largest conduit for which the body is designed when measured along the centroid axis from hub to hub. (See Figure 2.)

4.6.4 **Performance** Conduit bodies are intended for use in indoor and outdoor applications, and to provide protection against corrosion, dust, rain, hose directed water and ice. They are not intended to provide protection against internal condensation or internal icing. They shall be subjected to the hosedown test specified in Clause 5.20, and the external icing test specified in Clause 5.21.

5 Qualification tests

5.1 **Conditioning** Unless specified otherwise in the description of the test, all specimens shall be preconditioned for at least 24 hours in still air at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$).

5.2 Compression (conduit)

5.2.1 **General** The internal diameter of conduit shall not decrease by more than 25 percent during application of the force specified in Table 7 when tested in accordance with Clauses 5.2.2 to 5.2.4. The conduit shall show no evidence of cracking or buckling after removal from the compression machine.

5.2.2 **Apparatus** The apparatus for this test shall consist of:

- a) An inside micrometer or telescopic gauges and a micrometer caliper;
- b) a compression machine having 2 steel platens at least 150 mm (6.0 in) long and 10 mm (0.4 in) thick, and capable of running at a speed within the range of 10 – 15 mm/min (0.4 – 0.6 in/min).

No Text on This Page

5.2.3 Specimens The specimens shall consist of three 150 ± 3 mm (6.0 ± 0.125 in) lengths of conduit.

5.2.4 Procedure The inside diameter of the specimen shall be measured and recorded. The specimen shall be placed between the plates of the compression machine such that the measured inside diameter is perpendicular to the platens. The machine shall be set in motion until the force specified in Table 7 has been applied to the specimen. The machine shall be stopped and the inside diameter remeasured. The percent decrease in the internal diameter shall be calculated and recorded.

5.3 Beam strength (conduit) The ultimate beam strength of conduit shall not be less than that specified in Table 8 when tested in accordance with Clauses 5.3.1 and 5.3.2.

5.3.1 Apparatus The apparatus for this test shall consist of:

- a) Two rigidly supported V-blocks carefully aligned on a free span. (See Figure 3). The angle of the "V" shall be $120 \pm 3^\circ$;
- b) A suitable testing machine having a speed of 10 – 15 mm/min (0.4 – 0.6 in/min); and
- c) A flexible strap having a width of 50 ± 3 mm (2.0 ± 0.125 in).

5.3.2 Procedure

5.3.2.1 The flexible strap shall be placed around the conduit specimen at the center of the span and attached to the testing machine.

5.3.2.2 The testing machine shall be set in motion, and the force at initial yield shall be recorded.

5.4 Impact resistance at low temperature (conduit)

5.4.1 When tested in accordance with Clauses 5.4.2 and 5.4.3, there shall not be any fracture or break in the laminate surface of seven out of ten 200 mm (8.0 in) specimens of the finished conduit. A fracture or break is considered to have occurred where a broken section of the laminate forms a protrusion within the inside diameter or extends beyond the outside diameter of the conduit. The portions of the conduit within 50 mm (2.0 in) from the cut ends of the specimen shall not be examined.

5.4.2 The specimens are to be cut from finished lengths of each trade size of conduit. The specimens, the test apparatus, and the surrounding air are to be in thermal equilibrium with one another at a temperature of $-40 \pm 1^\circ\text{C}$ ($-40 \pm 1^\circ\text{F}$) during the test. Each specimen is to be tested separately while resting on a solid, flat steel plate that is at least 13 mm (1/2 in) thick and is firmly anchored with its upper surface horizontal. A protective cage is to surround the plates and the specimen to reduce the likelihood of injury.

Exception: When it is necessary to remove the specimen from the low temperature chamber due to handling difficulties, the impact test shall commence as soon as possible and shall be completed within 15 seconds from the time of removal.

5.4.2 revised March 17, 2000

5.4.3 The impact energy is to be provided by a weight of 9 kg (20 lbs) in the form of a 51 mm (2.0 in) solid right-circular, steel cylinder with a flat impact face having rounded edges, as shown in Figure 4, falling freely through a vertical guide with the impact force as specified in Table 9. The flat face of the weight is to strike the center of the specimen. Provision is to be made for keeping the weight from striking the specimen more than once.