

CAN/ULC-S604:2016

STANDARD FOR FACTORY- BUILT TYPE A CHIMNEYS

Prepared and Published by:



Approved by:



Standards Council of Canada
Conseil canadien des normes

Underwriters Laboratories of Canada (ULC) was established in 1920 by letters patent issued by the Canadian Government. It maintains and operates laboratories and certification services for the examination, testing and certification of appliances, equipment, materials, constructions and systems to determine their relation to life, fire and property hazards as well providing inspection services.

Underwriters Laboratories of Canada is accredited by the Standards Council of Canada as a Certification Organization, a Testing Organization, and an Inspection Body under the National Standards System of Canada.

ULC Standards develops and publishes standards and other related publications for building construction, security and burglar protection, environmental safety, electrical equipment, fire protection equipment, gas and oil equipment, thermal insulation products, materials and systems, energy use in the built environment and electrical utility safety.

ULC Standards is a not-for-profit organization and is accredited by the Standards Council of Canada as a Standards Development Organization.

National Standards of Canada developed by ULC Standards conform to the criteria and procedures established by the Standards Council of Canada. Such standards are prepared using the consensus principle by individuals who provide a balanced representation of interests relevant to the subject area on a national basis.

ULC is represented across Canada as well as many countries worldwide. For further information on ULC services, please contact:

Customer Service: 1-866-937-3852

National Standard of Canada

A National Standard of Canada is a standard developed by an SCC-accredited Standards Development Organization (SDO), and approved by the Standards Council of Canada (SCC), in accordance with SCC's: *Requirements and Guidance-Accreditation for Standards Development Organizations*, and *Requirements and Guidance-Approval of National Standards of Canada Designation*. More information on National Standard requirements can be found at www.scc.ca.

An SCC-approved standard reflects the consensus of a number of experts whose collective interests provide, to the greatest practicable extent, a balance of representation of affected stakeholders. National Standards of Canada are intended to make a significant and timely contribution to the Canadian interest.

SCC is a Crown corporation within the portfolio of Industry Canada. With the goal of enhancing Canada's economic competitiveness and social well-being, 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.

Users should always obtain the latest edition of a National Standard of Canada from the standards development organization responsible for its publication, as these documents are subject to periodic review.

CORPORATE HEADQUARTERS

Underwriters Laboratories of Canada
7 Underwriters Road
Toronto, Ontario M1R 3A9
Telephone: (416) 757-3611
Fax: (416) 757-9540

REGIONAL OFFICES

PACIFIC OFFICE

13775 Commerce Parkway, Suite 130
Richmond, British Columbia V6V 2V4
Telephone: (604) 214-9555
Fax: (604) 214-9550

EASTERN OFFICE

6505, Rte Transcanadienne, Suite 330
St-Laurent, Québec H4T 1S3
Telephone: (514) 363-5941
Fax: (514) 363-7014

For further information on ULC standards, please contact:

ULC STANDARDS

171 Nepean Street, Suite 400
Ottawa, Ontario K2P 0B4
Telephone: (613) 755-2729

To purchase ULC Standards, visit: www.ulc.ca/ulcstandards

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

Copies of this National Standard of Canada may be ordered from ULC Standards.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

STANDARD FOR FACTORY- BUILT TYPE A CHIMNEYS

ICS 91.060.40

Prepared and Published by:



Approved by:



First Edition. December 1978
Second Edition. October 1982
Third Edition. November 1991
Amended. August 1992
Amended. February 1994
Amended. June 1996
Amended. May 1997
Amended. October 1998
FOURTH EDITION. DECEMBER 2016

Copyright © 2016

ULC Standards

All rights reserved. No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without prior permission.

TABLE OF CONTENTS

ULC STANDARDS COMMITTEE ON FACTORY-BUILT FIREPLACES, CHIMNEYS AND VENTS	I
ULC STANDARDS SUBCOMMITTEE ON CHIMNEYS AND VENTS	II
PREFACE	III
1 SCOPE	1
2 REFERENCE PUBLICATIONS	1
3 CONSTRUCTION	1
3.1 MATERIALS	1
3.2 ASSEMBLY	3
3.3 JOINTS	4
3.4 FIRESTOP-SPACERS	4
3.5 SUPPORTS	4
3.6 RADIATION SHIELDS	5
3.7 ATTIC INSULATION SHIELDS	5
3.8 CAPS	6
3.9 ROOF ASSEMBLIES	6
3.10 DRAFT	6
4 PERFORMANCE	7
4.1 GENERAL	7
4.2 TEST INSTALLATION	7
4.3 TEMPERATURE MEASUREMENT	9
4.4 TEST NO. 1 - THERMAL SHOCK	11
4.5 TEST NO. 2 - TEMPERATURE – 540 °C FLUE GASES	12
4.6 TEST NO. 3 - TEMPERATURE – 760 °C FLUE GASES	12
4.7 TEST NO. 4 - TEMPERATURE - 925 °C FLUE GASES	12
4.8 TEST NO. 5 - DRAFT	13
4.9 TEST NO. 6 - SUPPORT	13
4.10 TEST NO. 7 – STRENGTH	13
4.10.1 General	13
4.10.2 Impact Test	14
4.10.3 Longitudinal Force Test	14
4.10.4 Chimney Joint Load Test	14
4.10.5 Chimney Tee Extension Test	15
4.11 TEST NO. 8 - WIND LOAD	15
4.12 TEST NO. 9 - RAIN	15
4.13 TEST NO. 10 - CRUSHING OF NONMETALLIC LINERS	16
4.14 TEST NO. 11 - RESISTANCE TO ACTION OF ACIDS OF NONMETALLIC LINERS	17
4.15 TEST NO. 12 - FREEZING AND THAWING OF NONMETALLIC MATERIALS ABSORBING WATER	17
4.16 TEST NO. 13 - CEMENTED JOINTS OF FLUE-GAS CONDUIT	18
4.17 TEST NO. 14 - SULPHURIC ACID EXTRACTION FOR PORCELAIN-ENAMELLED STEEL USED FOR LINERS	18
4.18 TEST NO. 15 - CONDENSING SULPHUR DIOXIDE	18

4.19 TEST NO. 16 - VIBRATION (LOOSE FILL INSULATED CHIMNEYS)	19
4.20 TEST NO. 17 - ACCELERATED CORROSION	19
4.21 TEST NO. 18 – ATTIC INSULATION SHIELD VENTILATION OPENING	20
5 INSTALLATION INSTRUCTIONS	20
6 USE AND MAINTENANCE INSTRUCTIONS	23
7 MARKING	23
TABLES	25
FIGURES	27

ULC STANDARDS COMMITTEE ON FACTORY-BUILT FIREPLACES, CHIMNEYS AND VENTS

NAME	AFFILIATION	REGION	CATEGORY
J. Wade (Chair)	ULC Standards	Canada	Non-Voting
M. Brunt	Flexmaster Canada Ltd.	Canada	Producer
M. Byle	Stove Parlour and Gallery Inc.	Ontario	User
Q. Choudry	Office of the Fire Marshal and Emergency Management	Ontario	Regulator
L. Cleroux	Industrial Chimney Company Inc.	Canada	Producer
E. Dufour	Security Chimneys International Ltd.	Canada	Producer
G. Faber	SCM Risk Management Services Inc.	Canada	General Interest
Z. Gadomski	Wood Energy Technicians of British Columbia (WETBC)	British Columbia	User
T. Gottschalk	Hearth, Patio and Barbecue Association of Canada	Canada	Producer
J. Herald	J & D Herald Consulting	Ontario	General Interest
M. Hladysh	Selkirk Canada Corp.	Canada	Producer
N. Khan	Technical Inspection Network	Canada	General Interest
M. Kulik	Technical Standards and Safety Authority (TSSA)	Ontario	Regulator
A. Marcakis	Association des Professionnels du Chauffage (APC)	Quebec	User
L. Gill (Associate Member)	IPEX Management Inc.	Canada	Non-Voting
S. Scott (Associate Member)	Royal Building Products	Canada	Non-Voting
B. Zeigler (Associate Member)	Intertek	USA	Non-Voting
G. Ottley (Project Manager)	ULC Standards	Canada	Non-Voting

This list represents the membership at the time the Committee balloted on the final text of this edition. Since that time, changes in the membership may have occurred.

ULC STANDARDS SUBCOMMITTEE ON CHIMNEYS AND VENTS**MEMBER****REPRESENTING**

M. Brunt	Flexmaster Canada Ltd., Canada
L. Cleroux	Industrial Chimney Company Inc., Canada
E. Dufour	Security Chimneys International, Canada
G. Edgar	VenTech Consulting, U.S.A
Z. Gadowski	Wood Energy Technicians of British Columbia (WETBC); British Columbia
J. Herald	J & D Herald Consulting, Ontario
M. Hladysh	Selkirk Canada Corp., Ontario
M. Kulik	Technical Standards and Safety Authority, Canada
G. Nicholls	Don Park Inc., Ontario
P. Vesik	Ecco Manufacturing, Canada

STANDARD FOR FACTORY-BUILT TYPE A CHIMNEYS

PREFACE

This is the Fourth Edition of the Standard for Factory-Built Type A Chimneys, CAN/ULC-S604.

This Edition of the Standard has been formally approved by the ULC Standards Committee on Factory-Built Fireplaces, Chimneys and Vents.

This Standard has been developed in compliance with the requirements of SCC for accreditation of a Standards Development Organization.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

This Fourth Edition National Standard of Canada is based on, and now supersedes, the Third Edition.

Attention is drawn to the possibility that some of the elements of this Canadian standard may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

Requests for interpretation of this Standard should be sent to ULC Standards. The requests should be worded in such a manner as to permit a “yes” or “no” answer based on the literal text of the requirement concerned.

The review and action to revise or reaffirm this Standard will not exceed 5 years from the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards.

This Standard is intended to be used for conformity assessment.

AVADocuments

1 SCOPE

1.1 These requirements apply to Factory-Built Type A Chimneys, which do not require field fabrication. They are for use with gas and liquid fuel-fired residential appliances and building heating equipment, where the appliance or equipment flue-gas temperatures do not exceed 540 °C. They are intended for use in accordance with the National Building Code of Canada, CSA-B139.2, Installation Code for Oil Burning Equipment for Residential and Small Commercial Buildings, and CSA-B149.1, Natural Gas and Propane Installation Code. They are intended for installation inside or outside of buildings to provide an essentially vertical conduit or passageway for conveying flue gases to the outer air from the above-described class of appliances.

2 REFERENCE PUBLICATIONS

2.1 The documents shown below are referenced in the text of this Standard. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this ULC Standard.

Documents Published by CSA Group
178 Rexdale Boulevard, Toronto, ON Canada M9W 1R3
Telephone: 1-800-463-6727
www.csagroup.org

- CSA B139.2-15, Installation Code for Oil Burning Equipment for Residential and Small Commercial Buildings
- CSA B149.1-15, Natural Gas and Propane Installation Code
- CSA C22.2 No. 0.15-15, Adhesive Labels

Documents Published by the National Research Council of Canada
Institute for Research in Construction, Ottawa, ON K1A 0R6
Telephone: (613) 993-2463 or 1-800-672-7990

- National Building Code of Canada, 2015

Documents Published by Underwriters Laboratories Inc. (UL)
333 Pfingsten Road, Northbrook, IL 60062-2096, U.S.A
Telephone: (888) 853-3503
www.ul.com

- UL 969-95, Marking and Labelling Systems

3 CONSTRUCTION

3.1 MATERIALS

3.1.1 A chimney assembly shall be made of non-combustible corrosion-resistant materials. Materials employed in the construction shall be of such quality and shall possess properties and characteristics, which may be expected to provide the almost unlimited service life expected of a permanent portion of a building. Metals shall not be used in combinations such as to cause detrimental galvanic action, which will adversely affect any part of the assembly.

3.1.2 The thickness of sheet metal employed for a factory-built chimney component or subassembly shall be not less than that indicated in Table 1; except that the sheet metal of lesser thickness may be employed if, upon investigation (consideration being given to the shape, size, and function of the component or subassembly), it is found to have adequate mechanical strength and to be otherwise suitable for the purpose; but in no case shall the thickness of a component or subassembly for any size of chimney be less than that shown in row 1 of Table 1.

3.1.3 Aluminum alloys containing more than 1.0 % magnesium are not to be used if the reflectivity of the material is utilized to reduce fire hazard.

3.1.4 A clean-out tee, liner, and other parts of a chimney assembly in contact with flue gases or subject to condensation shall be of material having durability and resistance to corrosion, fire, and heat equivalent to fire-clay tile, cast iron, or suitable stainless steel.

3.1.5 All portions of a chimney shall be fabricated from materials resistant to the corrosive effects of combustion. An outer casing of a chimney assembly shall be made of material having durability and resistance to physical damage, corrosion and fire such that it is capable of meeting all the requirements of this Standard without noticeable distortion, damage, loss or impairment of protective finishes.

NOTE 1: Type 430 stainless steel ordinarily meets the requirements of the foregoing. Other materials may be considered on the basis of an evaluation to determine equivalency. Galvanized steel, zinc-aluminum coated steel, aluminized steel and aluminum have not been found to be equivalent for mass (solid) insulated chimneys.

NOTE 2: A painted part made of steel not less than 1.40 mm thick, or of cast iron not less than 3 mm thick, and for use only in the interior of buildings is considered as having corrosion resistance equivalent to that required by Clause 3.1.5

3.1.6 All other parts of a chimney shall be made of corrosion resistant materials suitable to this application, and if mild steel, shall be protected by galvanizing or equivalent corrosion protection.

3.1.7 Paint coatings shall not ignite below the maximum temperature obtained on the outer case of the chimney during Test No. 4 – Temperature – 925 °C Flue Gases.

3.1.8 The materials referred to in Clause 3.1.6 shall conform to the requirements contained in Test No. 15 - Condensing Sulphur Dioxide as described in Subsection 4.18.

3.1.9 Except for binder materials, thermal insulation shall be non-combustible.

3.1.10 Thermal insulation shall comply with the following conditions when the chimney is tested in accordance with the requirements of this standard:

- A The products resulting from the combustion or volatilization of any combustible binder shall be discharged to the chimney terminus outside of the building;
- B The insulating material shall retain sufficient physical strength to remain in its intended position;
- C The thermal conductivity of the insulating material shall not be increased; and
- D The thermal insulation shall not show evidence of softening, melting, change in physical structure, or other evidence of failure.

3.1.11 Thermal insulation shall be adequately protected against contact with the products of combustion.

3.1.12 Thermal insulation, which is not adequately self-supporting, shall be securely applied to solid surfaces in a manner to prevent sagging. An adhesive or cement for attaching such material shall retain its adhesive qualities at any temperature the adhesive may attain when tested in accordance with the requirements in this standard and at -18 °C.

3.1.13 A water-absorbing insulating material shall not become wetted by condensation or rain if such wetting will reduce its durability or insulating value.

3.1.14 Nonmetallic structural components of a chimney assembly shall be subject to special investigation with respect to their application and possible deterioration under expected conditions of use.

3.2 ASSEMBLY

3.2.1 A chimney assembly shall consist of all the essential parts necessary for the proper installation of a complete chimney. Each part or assembly shall be designed for ready attachment of one to the other without requiring alteration, cutting, threading, drilling, or similar task by the installer; except that a special assembly or part designed to be cut to length or to fit by the installer may be provided if means, such as bolts or sheet metal screws, are furnished for readily joining any altered part to a companion part or assembly.

3.2.2 Two or more parts or subassemblies, which must bear a definite relationship to each other for proper and safe use, shall be arranged and constructed to permit them to be incorporated into the complete assembly, without need for alteration or alignment, only in the correct relationship with each other; or such parts or subassemblies shall be assembled and shipped from the factory as one element.

3.2.3 Each part (such as a chimney section or length, a cap, firestop-spacer, or support element, etc.) shall be completely assembled by the manufacturer at the factory.

3.2.4 To be in conformance with the requirements of Clause 3.2.3, a chimney section comprised of a liner, formed insulation or other intermediate assembly, and an outer jacket, which are separable, shall be pre-assembled and packaged as one unit. A firestop-spacer assembly may be constructed in two halves, but is to be pre-assembled and packaged as one unit. In such cases, each separable part is to be completely formed, including the joining of all seams.

3.2.5 A chimney assembly, when installed in accordance with the manufacturer's instructions, shall be positioned securely and resistant to wind damage.

3.2.6 A clean-out tee shall be available for each assembly intended for interior installation and shall be so designed as to provide for the clearance to combustible construction of the chimney connector. A clean-out tee shall permit the ready attachment of a standard size chimney connector (See Figure 1).

NOTE: An authority having jurisdiction may impose additional requirements, for example, the requirement in the National Building Code of Canada.

3.2.7 Access shall be provided for inspection of the flue-gas passageway of the chimney assembly.

3.2.8 Chimneys shall not be offset at an angle of greater than 45° to the vertical and shall not include more than two offsets.

3.2.9 The design of a chimney assembly shall not void the firestopping required between spaces of a building when the chimney is installed in accordance with the instructions supplied by the manufacturer.

3.3 JOINTS

3.3.1 Parts of chimneys shall be joined in a manner to prevent disengagement when tested in accordance with the requirements in this standard.

3.3.2 If screws are employed to field-join assemblies, the assemblies to be joined shall readily receive screws without being field-punched or field-drilled. Any such screw shall not extend into a flue-gas passage. If cement is employed for this purpose, the cement shall be of quick-setting type. Cement, screws, and instructions shall be provided.

3.3.3 A joint, when assembled in accordance with the manufacturer's instructions, shall be reasonably gastight.

3.3.4 Chimney section joints shall be designed to permit removal of a single length or section at the end of the chimney assembly including both inner and outer parts, without affecting the security of other joints.

3.3.5 A joint shall not materially reduce the capacity of the chimney.

3.3.6 A joint shall not retain condensation nor permit condensation to flow from the interior to the exterior of the liner.

3.3.7 The joints of chimney assemblies shall be designed to be resistant to the entry of rain.

3.3.8 Where inclined chimneys are used, the method of joining sections shall be sufficiently strong to sustain a load equivalent to four times the vertical component of the mass of angled chimney length between supports applied transversely at the joint between two sections as described in Clause 4.10.4.1.

3.4 FIRESTOP-SPACERS

3.4.1 A chimney intended to pass through a floor or ceiling of a building shall be provided with assemblies designed to provide firestopping at the framed joist opening and to establish and maintain required minimum clearances between chimney sections and combustible construction in this area. Spacers shall have sufficient strength and bearing surface to maintain the required clearance from chimney sections to the inner surface of joists, and ceiling or floor material.

3.4.2 To conform to Clause 3.4.1, the size of a firestop shall be at least 25 mm greater on each side than the nominal joist opening for which the assembly is designed. A spacer shall be provided for substantial continuous interference with the framed joist opening for a height or depth of not less than 25 mm. A joint between factory-made parts, which provide for firestopping shall not have a through-opening greater than 3 mm wide. (See Figure 2.)

3.4.3 A spacer or spacer assembly intended for attic installation shall fully enclose the chimney section for a depth of not less than 250 mm. (See Figure 3.)

3.4.4 The depth of the spacer required by Clause 3.4.3 may be obtained by the use of a separable part intended to be placed above the attic structural framing.

3.5 SUPPORTS

3.5.1 A support assembly (such as a floor or ceiling support) shall be designed to conform to the requirements for firestop-spacers and shall locate at a safe distance the point at which a flue pipe may be connected as determined by testing in accordance with the requirements in this standard.

3.5.2 Chimney assemblies designed for exterior installation shall be provided with both vertical and lateral support assemblies.

3.5.3 A support assembly shall be designed to sustain, without failure, a load equivalent to four times the force imposed upon it by all chimney parts it is intended to support, including the maximum length of inclined chimney.

3.5.4 Inclined chimney sections shall be supported at or immediately above each vertical return elbow at the first floor or roof above the inclined section.

3.5.5 Supports for inclined chimney sections shall be capable of carrying four times the mass of the longest inclined chimney section between adjacent supports.

3.5.6 A support assembly intended to be secured by nails or screws shall be arranged so that such holding means will be loaded in shear.

3.5.7 A lateral support assembly shall be designed so that a supported chimney assembly is able to resist a horizontal force of 1.44 kN/m^2 of projected area applied in any direction, without separation, sagging or other displacement or damage, and without distortion or dislodgment of the supports.

3.5.8 Exterior vertical and lateral support assemblies shall be designed to maintain specified clearances to adjacent combustible constructions.

3.6 RADIATION SHIELDS

3.6.1 A radiation shield, if provided to obtain safe temperatures on floor or ceiling structures, shall be an integral part of a firestop-spacer or support assembly and shall provide a continuous barrier for a vertical distance referenced to the ceiling or floor level of not less than 250 mm for chimney assemblies having an internal diameter of 305 mm or less, and not less than 305 mm for all other sizes. The assembly shall fit into a framed joist area dimensioned not larger than 12 mm greater than the outside diameter of the chimney plus twice the dimension to be specified for clearance between chimney sections and combustible enclosures. A radiation shield intended to penetrate an attic area shall fully enclose the chimney section for a depth of not less than 250 mm (See Figure 3).

3.6.2 Parts of a firestop-spacer or support assembly, which provide incidental shielding from radiation to combustible construction shall not be considered radiation shields.

3.6.3 A radiation shield shall not be provided to obtain safe temperatures on roof structures if employed in a roof or other terminating assembly intended to be altered in the field and if such alteration would require the shifting or relocation of the shield.

3.7 ATTIC INSULATION SHIELDS

3.7.1 An attic insulation shield shall be provided to restrict loose fill or other insulation from contacting the chimney section. The attic insulation shield assembly shall maintain a minimum air space clearance to combustible construction not less than the minimum air space clearance to combustible construction marked on the chimney sections. For the test installation, the vertical height of the shield above attic construction material shall be not less than 250 mm (see Figure 1).

3.7.2 The attic insulation shield shall be separate from the firestop-spacer when the shield is intended to be removed. Also, the removal of the shield, or any part of the shield, shall not affect the firestop-spacer assembly. When the shield is not intended to be removed, the attic insulation shield is integral with the firestop spacer. The spacer assembly includes the attic insulation shield above the attic floor and the firestop-spacer below the attic joist.

3.7.3 An attic insulation shield shall be provided with a permanent marking, visible after installation, as specified in Clause 7.8, when the shield is:

- A Intended for installation in an unoccupied attic space;
- B Specified in the installation instructions in accordance with Clause 5.3 G; and
- C Tested in accordance with Clause 4.2.15.

3.7.4 When openings for ventilation in an attic insulation shield intended for installation in an unoccupied attic space are provided, the opening shall not be located less than 250 mm above the attic construction material and shall be constructed to prevent:

- A Entrance of insulation into the area between the chimney and the shield; and
- B Accumulation of the insulation near the openings, as determined by Test No. 18 – Attic Insulation Shield Ventilation Opening.

3.8 CAPS

3.8.1 A cap shall be provided to prevent the entrance of debris or rain into the liner and into any cooling-air passage terminating exterior to the building if such may cause the chimney assembly to become unsafe for use.

3.8.2 A cap shall be designed so that leaves and debris falling or blown onto it are not likely to be retained so as to obstruct flue-gas or cooling-air passages. A cap shall be designed to avoid accumulation of soot likely to obstruct flue-gas or cooling-air passages.

3.8.3 A cap shall be designed so that the angle of emission of the flue gases is above the horizontal.

3.8.4 A cap shall be removable for chimney inspection and cleaning.

3.9 ROOF ASSEMBLIES

3.9.1 The chimney assembly extending above the roof level shall be capable of resisting, without damage or giving way, a load equivalent to 1.44 kN/m² of exposed area applied to any surface extending above the roof in accordance with the test methods described in Section 4, Performance.

3.9.2 A roof assembly shall be resistant to weather and condensation. A roof assembly when installed as specified by the manufacturer shall prevent the entrance of water and excess debris into the chimney flue and any water into the building where the chimney assembly passes through the roof.

3.9.3 A roof assembly shall be designed so that soot and debris are not likely to accumulate therein when such accumulation may obstruct flue-gas or cooling-air passages or remain in contact with chimney assembly parts having temperatures exceeding the requirements for zero clearance.

3.10 DRAFT

3.10.1 The chimney assembly shall be capable of producing a draft of at least 4.9 Pa, measured at the flue-pipe inlet, per metre of vertical chimney height when tested in accordance with the requirements of this standard. Any flue-gas conveying fitting, such as a coupling, etc., shall not materially reduce the capacity of the chimney with which it is intended to be used.

4 PERFORMANCE

4.1 GENERAL

4.1.1 When a chimney assembly is tested in accordance with the requirements in this standard, safe temperatures on combustible construction shall be maintained.

4.1.2 Resistance to damage by wind, rain, and handling shall be demonstrated.

4.1.3 Criteria for successful completion of Test Nos 1 through 4 include:

- A All seams, welds and mechanical joints shall be intact;
- B Inner liners shall not show any noticeable distortion (loss of roundness up to 5 % shall not constitute noticeable distortion.);
- C The relationship of parts to each other shall remain unaltered;
- D The security of inter-sectional joints shall not have been impaired;
- E The integrity of all corrosion protective coatings shall be retained;
- F The K factor of the insulation shall not have changed by more than 20 %;
- G Materials shall not have softened or melted; and
- H Accessories shall have retained their form and function.

4.1.4 Insulated chimney sections shall be resistant to the corrosive effects of the insulation material(s) when tested in accordance with Test No. 17, Accelerated Corrosion.

4.2 TEST INSTALLATION

4.2.1 A factory-built chimney assembly shall be tested on the following basis:

- A Size and kind;
- B Height; and
- C Minimum clearance to combustible construction.

4.2.2 An insulated chimney assembly shall be preconditioned by subjecting chimney sections filled with the minimum mass of insulation specified by the manufacturer to vibration for 2 h. The chimney sections shall be mounted vertically, in their intended installed position, on a vibration table and subjected to a vertical displacement of 0.50 mm at a frequency of 60 Hz. If chimney sections are received packaged they shall be subjected to this test in the packaged condition.

4.2.3 During the temperature tests, thermocouples shall be located on each chimney section and test enclosure adjacent to any voids in the chimney that result from settling of insulation during the vibration specified in Clause 4.2.2.

4.2.4 The general form of a test structure for a chimney assembly intended for interior installation is illustrated by Figure 4. The height and arrangement of the structure for various designs is illustrated by Figure 5. Test structure details for various arrangements of support, firestop-spacers, and roof assemblies are illustrated by Figures 6 through 11.

4.2.5 When a chimney assembly is intended for both interior and exterior installations, duplicate tests shall be conducted using the installation described by Clauses 4.2.20, 4.10.5.1 and Figure 12.

4.2.6 The chimney assemblies shall be tested as described in Subsections 4.4 through 4.7 and erected as shown in Figure 13 when the chimney run incorporates elbows as recommended by the manufacturer.

4.2.7 Tests are to be conducted as described in Clauses 4.2.8 through 4.2.19 on a chimney assembly of each kind. If the chimney is manufactured in more than one size, tests shall be conducted on as many sizes as may be deemed necessary to determine conformance with the requirements in this standard.

4.2.8 Except as required by Clauses 4.2.5 and 4.2.6, chimney assemblies shall ordinarily be tested using the chimney arrangement illustrated by sketch (c) of Figure 5. If the design indicates that, in one or more tests, higher temperatures would be developed with a chimney of other height, tests shall be conducted with a height producing the most severe temperature condition, but not employing a height greater than that recommended by the manufacturer. (See sketch (b) and (d) of Figure 5.) If the chimney arrangement is to be limited to that illustrated by sketch (a) of Figure 5 or if the maximum height of the chimney is to be limited to be consistent with the arrangement illustrated by sketch (b) of Figure 5, the chimney assembly shall be so tested. Where the testing of chimneys of the greatest height is impractical, acceptance may be based on the extrapolation of results developed on not less than three shorter heights one of which shall be at the 10.6 m level.

4.2.9 The test structure shall be erected within a room which is reasonably free of drafts, and the chimney assembly is to exhaust into the same space or into a space freely communicating with that from which the combustion air is taken. The room shall be such that during any one test the room temperature does not increase more than 11 °C above the room temperature at the beginning of the test.

4.2.10 If a chimney assembly is designed for taking air from an occupied space and exhausting such air to the outside of a building to cool the chimney, all the openings in the parts as assembled, intended to provide such air flow and which would be within an occupied space of the building, shall be closed during the tests.

4.2.11 If a chimney assembly is designed for taking air from the outside of a building to cool the chimney, the test arrangement shall provide means for maintaining the temperature of such air at 27 ± 5 °C.

4.2.12 The test chimney is to consist of an assembly composed of standard chimney sections and other furnished parts erected according to the manufacturer's installation instructions. The top of the test chimney is to be terminated by the roof assembly and cap if always provided as a functional part of the chimney. Other parts, constituting functional parts of the chimney, such as a support, firestop-spacer, etc., shall be used in the test. Test structure details for various arrangements of support, firestop-spacers and roof assemblies are illustrated by Figures 6 through 11.

4.2.13 A gas-fired flue-gas generator as illustrated by Figure 14 is to be used to supply flue gases to the chimney assembly being tested. The generator is to be capable of producing flue gases at the specified test temperatures when fired at the test input specified in Table 2.

4.2.14 The insulated flue-gas generator outlet shall be connected to the inlet of the test chimney assembly by means of an uninsulated stainless steel pipe having a diameter equivalent to that of the chimney inlet. The connection shall be made so as to provide a flue-gas passage length of three chimney diameters measured vertically or horizontally dependent upon design along the pipe centre line, from the generator outlet to the point of entry into the chimney assembly (See Figure 5).

4.2.15 The test chimney assembly is to be totally encased for its full height within all storeys and attic space. Chimney assemblies are to be tested on the basis of clearance to the enclosure of 0 mm, 25 mm or 50 mm, as recommended by the manufacturer, measured between the outer surface of the chimney sections and the interior surfaces of the enclosing material; such clearance is designated by the dimension "X" in Figures 6, 8, 10 and 11. The enclosing casing is to be closed at each ceiling-joist level by the installation of a manufacturer's firestop or firestop-spacer assembly. Additionally, the test chimney is to be totally enclosed for its full height within all stories and the attic space.

Exception: A chimney intended for installation in an unoccupied attic space as described in Clause 3.7.3, is to be tested as shown in Figure 15 (2) and (3), or (2) and (4), as applicable.

4.2.16 Gaps or joints between a chimney section and firestop material, at any penetration of the building envelope, shall be sealed to prevent air and vapour leakage. In all other locations, gaps or joints between chimney sections and firestop material shall not be sealed. Gaps or joints between firestops and combustible construction are to be sealed with tape. Joints between two or more factory-made parts, which in combination provide a firestop, are to be similarly sealed. Joints between one chimney section and another are not to be sealed.

4.2.17 The test enclosure material at each floor-joist level is to be of 38 mm by 235 mm or 184 mm lumber, as the case may be, painted matte black, forming a box placed at zero clearance to the manufacturer's support, or firestop-spacer assembly (see Figure 4). Where the chimney assembly is designed for zero clearance, the box shall be formed at zero clearance to the chimney assembly. The test enclosure material at the roof-joist level shall be of 38 mm by 140 mm lumber forming a box placed at the clearance specified by the manufacturer for enclosures or at the lesser clearance required to provide support means for a roof assembly (See Figures 10 and 11). All ceiling, floor, and roof material is to be cut flush with the inside of all framed joist openings.

4.2.18 Plywood used for the test enclosure is to be 9.5 mm thick.

4.2.19 All joints and openings between spacers or supports and the test enclosure, and all joints and openings in the test enclosure walls are to be sealed with 50 mm wide black cloth adhesive tape.

4.2.20 A chimney assembly intended for both interior and exterior installation shall, in addition to the foregoing, be tested in a configuration representative of a "through-the-wall" installation (See Figure 12). Where a chimney assembly is likely to be enclosed on the outside of a dwelling, the test chimney shall be enclosed at the minimum clearance specified by the manufacturer. The installation shall include all spacers, supports and weather-protection components as described in the manufacturer's installation instructions. All relevant requirements of Clauses 4.2.1 through 4.2.19 shall apply.

4.2.21 The horizontal connector of a tee section suitable for penetration of a combustible wall shall be designed to sustain for 5 min without failure a load applied as described in Clause 4.10.5.1.

4.3 TEMPERATURE MEASUREMENT

4.3.1 The inlet flue-gas temperature is to be determined for Test Nos. 1 through 4 by a thermocouple located within the insulated outlet of the flue-gas generator (see Figure 14). The thermocouples shall be Type K (chromel-alumel) 0.51 mm diameter with untwisted welded bead junctions of minimum size (not over 1.27 mm) enclosed in a suitable sealed tube of inside diameter of 1.5 mm (see Figure 16).

4.3.2 The location of the flue-gas temperature thermocouple with reference to the cross-sectional area of the insulated outlet pipe of the generator is to be determined prior to the beginning of a series of tests. The flue-gas thermocouple shall be inserted initially at the centre of the insulated generator outlet using the entry tube parallel to the long generator axis.

4.3.3 The gas burner is then to be operated as for Test No. 2, and the dilution air shall be regulated so that the temperature indicated by the centre point flue-gas thermocouple is approximately 500 °C above room temperature, using the flue-gas generator input shown in Column 2 of Table 2, for the size of chimney under test. With the input and all other generator adjustments constant, the flue-gas thermocouple shall then to be moved horizontally back and forth along its axis to a position where the maximum flue-gas temperature is indicated, but shall not be closer to the inside surface of the generator outlet than one-sixth of the diameter of this outlet.

4.3.4 Having located the position of maximum flue-gas temperature within the outlet pipe, the thermocouple shall be fixed in this location for all further tests. The dilution air adjustments for Test Nos. 1 through 4 shall be set as necessary to obtain the specified flue-gas temperatures for the individual test as measured by the thermocouple located as described above.

4.3.5 Temperatures on combustible enclosures shall be measured by Type J (iron-constantan) thermocouples not greater than 0.51 mm diameter. For structural elements in contact with chimney parts, junctions of thermocouples shall be placed on the chimney part surfaces, except that where a point or line contact of a spacer, not over 3 mm diameter or width, is made, thermocouples shall be placed on the test structure at points 12 mm from the centre line of such point or line contact. Thermocouples shall be attached to structural elements having a surface adjacent to the chimney parts and onto ceilings or roof areas adjacent to the chimney assembly, so as to have 12 mm of wire exposed and be secured by staples over the insulated portions of the wires. The junctions shall be depressed flush with the surface and held in thermal contact with the surface by 50 mm wide black wide cloth tape or its equivalent.

4.3.6 The temperatures attained by parts of the chimney shall be obtained by means of thermocouples applied to assure good thermal contact with the parts. Thermocouples to be attached to surfaces of metal parts shall have junctions welded, brazed, silver-soldered or taped to the surface, as appropriate for the expected temperatures. Thermocouples to be attached to surfaces of nonmetallic parts shall have the junction and at least 25 mm of the lead wires embedded flush with the surface of the material. Furnace cement shall be smoothed over such indentations to assure thermal contact. Such thermocouples shall be located at points attaining maximum temperatures. Additional thermocouples may be placed at other locations as deemed necessary.

4.3.7 Room or ambient temperatures shall be obtained by shielded thermocouples located centrally within a 150 mm length of aluminum-painted 60.3 mm O.D. steel pipe, open at both ends. Ambient temperatures shall be determined by such shielded thermocouples located with suitable reference to the various parts of the chimney, test structure, and flue-gas generator and by placing the shield in a manner to avoid direct radiation to the thermocouple.

4.3.8 In Zone A (Figure 4), the ambient temperature shall be determined by the average of two such thermocouples located 300 mm down from the ceiling and 600 mm away from the right- and left-hand sides of the chimney enclosure. The flue-gas temperature rise shall be based on the room temperature at the level of the flue-gas generator.

4.3.9 For Zones B, C, etc., above Zone A, the ambient temperature shall be determined by a thermocouple located 600 mm away from the front centre line of the enclosure and 1200 mm above the floor (600 mm in the attic space).