Government of Canada
Gouvernement du Canada

Canadian General Standards Board
Office des normes générales du Canada

CAN/CGSB-51.71-2005

Supersedes CAN/CGSB-51.71-95

Depressurization Test

ICS 91.140.20

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NATIONAL STANDARD OF CANADA

CAN/CGSB-51.71-2005

Supersedes CAN/CGSB-51.71-95

DEPRESSURIZATION TEST

Prepared by the

Canadian General Standards Board CGSB

Approved by the

Standards Council of Canada

Published April 2005 by the
Canadian General Standards Board
Gatineau, Canada K1A 1G6

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Acknowledgment is made for the translation of this National Standard of Canada by the Translation Bureau of Public Works and Government Services Canada.

CANADIAN GENERAL STANDARDS BOARD

DEPRESSURIZATION TEST

1. SCOPE

1.1 This standard provides a test method for determining whether the depressurization of a dwelling unit by air-moving devices is sufficient to affect the ability of vented fuel-burning appliances and their venting systems to exhaust some or all of their combustion products to the outdoors.

1.2 This standard applies to dwelling units (detached, semi-detached and row housing[1]) equipped with both fuel-burning appliances whose products of combustion are intended to be vented to the outdoors and air exhaust devices expelling air to the outdoors or air-moving devices moving air within the dwelling unit.

1.3 This standard establishes specific conditions of test and describes the pressure-measuring apparatus and the procedures for measuring the resultant depressurization.

1.4 This standard includes a list of depressurization limits for specified fuel-burning appliances and their venting systems. These limits are used to assess whether the level of depressurization measured is likely to result in the spillage of combustion products within the dwelling unit.

1.5 The testing and evaluation of a dwelling unit against this standard may require the use of materials and/or equipment that could be hazardous. This document does not purport to address all the safety aspects associated with its use. Anyone using this standard has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use.

2. PRINCIPLE AND LIMITATIONS

2.1 Depressurization of a dwelling unit by the ventilation system or exhaust devices can cause spillage of combustion products from certain types of fuel-burning appliances.

2.2 The test method in this standard assesses the likelihood for depressurization-induced spillage of combustion products occurring in dwelling units equipped with fuel-burning appliances and venting systems. Depressurization of the dwelling unit is measured under specific conditions using the pressure-measuring apparatus and procedures described. The test result is compared to the level of depressurization that can be tolerated by the venting systems located within the dwelling unit.

2.3 Test set-up procedures include closing intentional openings in the building envelope (e.g. windows) to make the dwelling unit as airtight as might be experienced during the normal heating season, and simultaneously operating specified exhaust devices.

2.4 Equipment capable of contributing to the depressurization of the dwelling unit is included in the test. This includes equipment designed to operate continuously, in particular, forced-air circulating fans (e.g. forced-air furnace blowers), and combined air supply and exhaust ventilators (e.g. heat recovery ventilators (HRVs)). In addition, intermittent exhaust fans rated at more than 75 L/s are also included in the test.

2.5 This standard does not take into account all possible contributors to depressurization. For test method limitations, see Appendix E.

2.6 In some cases, a pre-test calculation may be performed to decide whether the depressurization test described in this standard should be applied to the dwelling unit. Appendix F describes such a pre-test calculation.

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[1] *The standard applies to row housing that is ground accessible and equipped with self-contained ventilation and venting systems.*

2.7 The depressurization limits in this standard are based on the assumption that the installed fuel-burning appliances with their venting systems are free of design flaws and manufacturing defects, have been installed properly and have been adequately maintained.

2.8 The depressurization limits in this standard are based on the performance of typical fuel-burning appliances and their venting systems during the heating season. These limits are not suitable for predicting non-heating season performance, such as water-heater operation during the summer months.

Note: *Fuel-fired water heaters connected to vertical chimneys pose a special problem when operated during the summer in an airtight dwelling. Even low levels of house depressurization may be unacceptable since flue gas buoyancy is reduced in warmer weather.*

3. REFERENCED PUBLICATIONS

3.1 The following publications are referenced in this standard:

3.1.1 Canadian General Standards Board (CGSB)

CAN/CGSB-149.10 — Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method.

3.2 A dated reference in this standard is to the issue specified. An undated reference in this standard is to the latest issue, unless otherwise specified by the authority applying this standard. The sources are given in the Notes section.

4. TERMINOLOGY

4.1 The following definitions apply in this standard:

Air Exhaust Device (Dispositif d'extraction d'air)
An air-moving device that removes air from a space.

Air-Moving Device (Dispositif à déplacement d'air)
A fan or vent capable of moving air from one part of a dwelling unit to another, from the dwelling unit to the outside, or from the outside into the dwelling unit.

Air Supply Device (Dispositif d'alimentation en air)
An air-moving device delivering air to the conditioned space.

Airtightness (Étanchéité à l'air)
The degree to which unintentional openings in the building envelope have been avoided.

Building Envelope (Enveloppe du bâtiment)
The ensemble of walls, ceilings and floors, that enclose the dwelling unit under test.

Chimney (Vent) (Cheminée (conduit de fumée))
A primarily vertical shaft enclosing at least one flue for conducting flue gases to the outdoors.

Combined Air Supply and Exhaust Ventilator (Ventilateur combiné d'alimentation et d'extraction)
A unit or system that incorporates a means to supply air and to exhaust air continuously to and from the dwelling unit.

Depressurization (Dépressurisation)
A negative air pressure differential induced in the dwelling unit relative to atmospheric pressure.

Depressurization Limit (Limite de dépressurisation)
The level of depressurization beyond which there is a likelihood of negative depressurization-induced spillage occurring for specified fuel-burning appliances and their venting systems.

Direct Vented (Directement ventilé)
(As applied to a fuel-fired space or water-heating appliance) An appliance and its venting system in which all the combustion air is supplied directly from, and the products of combustion are vented directly to, the outdoors by independent totally enclosed passageways connected directly to the appliance.

Dwelling Unit (Unité d'habitation)
A suite operated as a housekeeping unit, used or intended to be used as a domicile by one or more persons and usually containing cooking, eating, living, sleeping and sanitary facilities.

Forced-Air Furnace (Générateur d'air chaud à air pulsé)
A furnace equipped with a fan (furnace blower) that provides the primary means for the circulation of air.

Fuel-Burning Appliance (Appareil à combustion)
A solid-, liquid- or gas-fired heating device designed to vent combustion gases outside of the dwelling unit.

Heat Recovery Ventilator (HRV) (Ventilateur-récupérateur de chaleur (VRC))
A combined air supply and exhaust ventilator with the provision to transfer heat between two isolated air streams.

Intentional Openings (Ouvertures intentionnelles)
An opening in the building envelope deliberately made to fulfill a particular function.

Intermittent Exhaust Fan (Ventilateur d'extraction à fonctionnement intermittent)
A device normally operated in a non-continuous manner, which exhausts air to the outdoors.

Make-Up Air (Air d'appoint)
Outdoor air supplied to replace exhaust air.

Mechanically Vented[2] (Ventilation mécanique)
(As applying to a fuel-fired space or water-heating appliance) An appliance and its venting system in which the products of combustion are exhausted to outdoors entirely by a mechanical device, such as a fan, blower or aspirator, upstream or downstream from the combustion zone of the appliance, via independent totally enclosed passageways connected directly to the appliance.

Power Vented (Ventilation à air pulsé)
See *Mechanically Vented*.

Pressure-Averaging Device (Appareil d'égalisation de la pression)
A unit that dampens or minimizes the effect of wind pressure fluctuations and allows for the suitable connection of the outdoor pressure tube to the pressure-measuring apparatus.

Pressure Tube, Indoor (Tube manométrique intérieur)
A pressure tube, 5 m or longer, fitted to the low-pressure tap of the pressure-measuring apparatus and used as an indoor pressure-sensing tube.

Pressure Tube, Outdoor (Tube manométrique extérieur)
A pressure tube, 5 m or longer, fitted to the high-pressure tap of the pressure-measuring apparatus and used as an outdoor pressure-sensing tube.

Spillage (Émanation)
The flow of some or all of the combustion products out of a fuel-burning appliance or its venting system into the dwelling unit.

Spillage, Depressurization-Induced (Émanation due à la dépressurisation)
Spillage resulting primarily from the depressurization of the dwelling unit.

Vent (Évent)
That portion of a venting system designed to convey flue gases directly to the outdoors from either a vent connector or a fuel-burning appliance when a vent connector is not used.

Venting (Évacuation)
Removal of combustion products from the dwelling unit to the outdoors by means of natural draft chimneys or mechanical exhaust systems.

5. APPARATUS

5.1 **Pressure-Measuring Apparatus** — The pressure-measuring apparatus shall only be operated within its range of calibration. It shall be capable of measuring pressure differences at least within the range of 0 to 50 Pa with a resolution of 1 Pa or less.

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[2] *This definition is intended to be inclusive of all types of appliances and venting systems that rely entirely on fans to exhaust the products of combustion. Systems variously referred to as "forced draft," "power vented" and "induced draft" in standards and industry terminology may be covered by this definition. The key characteristic of such systems is that they are more resistant to depressurization-induced spillage of combustion products into the building in which they are housed because the mechanically vented equipment acts to overcome flow resistance in the venting system caused by wind effects, building depressurization and venting system flow resistance.*

5.1.1 ***Accuracy***

5.1.1.1 The pressure-measuring apparatus shall have an accuracy of ±1 Pa within the range of 5 to 50 Pa.

5.1.1.2 Apparatus accuracy shall be based either on the manufacturer's specifications provided with the apparatus or on the documentation (Appendix A) provided by the testing body responsible for calibrating the apparatus.

5.1.2 ***Calibration***

5.1.2.1 The pressure-measuring apparatus shall be calibrated in accordance with the manufacturer's instructions or in accordance with Appendix A.

5.1.2.2 The pressure-measuring apparatus, other than fluid-filled manometers, shall be accompanied by a sticker or report showing the serial number, date of last calibration, name of testing body and the calibrating technician, and any corrections required to the readings.

5.1.2.3 The date of calibration shall be less than one year before the date of the depressurization test.

5.2 **Pressure-Averaging Device** — When the depressurization test is conducted under conditions where wind fluctuations affect the pressure readings, means shall be employed to average these fluctuations. These include the pressure-averaging device described in CAN/CGSB-149.10, an electronic manometer with reading averaging capability, or capillary tubes within the outdoor reference tubes corresponding to Table 1 below.

TABLE 1

Damping Tube (Capillary) Length vs.
Pressure Tube[a] Length for Four-point Manifold System

Capillary Length, (tube ID 0.5 mm) mm	Tubing Length, (tube ID 3.125 mm) m
0	30
25	20
50	10
75	5
100	2

[a] *Capillary tubing is usually a tiny copper pipe, which can be inserted into the plastic pressure tube to the outside. It helps to reduce pressure variations due to wind. A long plastic tube does not require damping. However, if the plastic tube to the outside is short, a length of capillary tube can provide the necessary damping.*

6. TEST SET-UP

6.1 Dwelling Unit

6.1.1 Prepare the dwelling unit in accordance with Table 2. Start the test with all air-moving devices (blowers) turned off and with no fuel-burning appliances operating.

6.1.1.1 When applying this method to row housing, determine whether separating walls are continuous across all heated areas of the dwelling unit under test, including foundations and crawl spaces. If the walls separating the dwelling unit in the row housing unit are not continuous, this method does not apply.

Note: *Row houses that are built to current code requirements can sometimes have problems due to interference from air-moving devices in adjoining dwelling units.*

TABLE 2

Preparation of the Dwelling Unit

Item	State of Item
Windows	Close
Exterior doors	Close
Basement door	Close
Doors on an enclosed furnace room	Close
Chimney with manual damper	Close
Chimney without manual damper	Leave as is
Make-up air supply with manual damper	Close
Make-up air supply without manual damper	Leave as is
Solid fuel wood-burning appliances	No fire Close doors and air control dampers
Thermostatically controlled fuel-burning appliances, other than water heaters[a]	Turn down thermostat
Switch controlled fuel-burning appliances, other than water heaters[b]	Turn off
Water heaters	Non-operating[c]
Floor drains and other trap plumbing connections	Fill traps with water
Air exhaust and supply devices	Turn off
Ventilating and air-moving devices	Turn off
Air conditioner	Turn off
Clothes dryer(s)	Turn off
Attic hatch	Close
Crawl-space vents	Close
Broken windows and other short-term openings	Tape over
Subslab ventilation fans or subfloor ventilation systems for soil gas control	Turn off

[a] *Gas furnaces and boilers, gas combo units, some gas fireplaces, oil furnaces and boilers.*
[b] *Some gas or oil fireplaces.*
[c] *The water heater must be non-operational for the entire test.*

6.2 **Pressure-Measuring Apparatus**

6.2.1 Follow the manufacturer's instructions regarding the correct use of the pressure-measuring apparatus including levelling, apparatus and ambient temperature, zeroing and other preparations for accurate pressure measurements.

6.2.1.1 When zeroing the pressure-measuring apparatus, pay particular attention to wind effects. Observe the pressure reading for one minute, giving attention to any pressure fluctuation resulting from wind effects around the dwelling unit.

Note: *Pressure fluctuations due to wind effects can increase the difficulty of making accurate readings. Refer to Appendix B for guidance on how to minimize wind effects during the test.*

6.2.2 ***Apparatus, Indoor*** — Place the pressure-measuring apparatus, or the indoor pressure tube, near the fuel-burning appliance under test. Repeat the set-up for each fuel-burning appliance, in the case where more than one exists in the dwelling unit.

6.2.3 ***Apparatus, Outdoor***

6.2.3.1 Extend the outdoor pressure tube outside of the dwelling unit through a suitable location (e.g. a mail slot, a key hole, window or door corner) and end it at least 3 m from the dwelling unit. Use duct tape or other means to seal any cracks or holes created.

6.2.3.2 Inside the dwelling unit connect the other end of the outdoor pressure tube to the positive pressure or reference side of the pressure-measuring apparatus. For a fluid-filled manometer, the positive pressure side is the lower end of the manometer.

7. TEST PROCEDURE

Operate the circulation fans of the fuel-burning appliances, combined air supply and exhaust ventilators, air exhaust and air supply devices designed for continuous operation, and the intermittent exhaust fans in accordance with par. 7.1 to 7.4, in the sequence specified, prior to determining the level of depressurization for the dwelling unit (par. 7.5). For test method limitations, see Appendix E.

7.1 Forced-Air Furnace

7.1.1 Turn on and operate, at maximum speed, the air-circulating fans (furnace blower) of all fuel-burning appliances equipped with a switch or control mechanism that permits occupants to operate the fan for extended periods of time, independent of other ventilation fans.

7.1.2 Read and record the pressure difference in pascals.

7.1.2.1 If the dwelling unit is depressurized, leave the air-circulating fans (furnace blower) operating for the remainder of the depressurization test. If the dwelling unit is not depressurized, turn them off.

7.1.2.2 If the fuel-burning appliance is located in an enclosed room, perform the test with the door to the room open and closed. Where the fuel-burning appliance, regardless of fuel type, is located on a lower level, such as in a basement with a closable door, perform the test with the closable door open and closed as well. Retain the test condition that results in the greatest room depressurization for the remainder of the depressurization test.

7.2 Combined Air Supply and Exhaust Ventilator System or Unit

7.2.1 Turn on and operate, at the maximum speed, any combined air supply and exhaust ventilator system or a unit such as a HRV.

7.2.2 Read and record the pressure difference in pascals.

7.2.2.1 If the combined air supply and exhaust ventilator depressurizes the dwelling unit when operated, leave it on for the remainder of the depressurization test. Otherwise, turn it off.

7.3 Air Exhaust and Air Supply Devices Designed for Continuous Operation

7.3.1 Turn on air exhaust devices in the dwelling unit intended for continuous operation, such as exhaust-only ventilation fans. If the net effect of an air supply fan interlocked to an exhaust fan intended for continuous operation is to pressurize the building, turn it off during testing.

7.3.2 Turn on all foundation air exhaust devices intended for continuous operation, such as soil gas (radon), and foundation wall or crawl space cavity fans.

7.3.3 Read and record the pressure difference in pascals.

7.3.3.1 Leave the air exhaust and air supply devices designed for continuous operation on for the remainder of the test.

7.4 **Intermittent Exhaust Fans**

7.4.1 Operate the clothes dryer and any intermittent exhaust fans rated at more than 75 L/s in accordance with par. 7.4.2 to 7.4.5.

7.4.2 ***Clothes Dryer*** — Turn on all clothes dryers that exhaust air to the outdoors. Where the dryer is not vented to the exterior of the dwelling unit or where no clothes dryer or air exhaust vent exists for the clothes dryer, simulate the air removed by a vented clothes dryer using a portable air exhaust device.

7.4.2.1 To simulate the air removed by a vented clothes dryer, vent a portable air exhaust device to the outdoors through a suitable wall penetration, such as a roughed-in dryer opening. If a wall opening is not available, use a window or other suitable opening in the building envelope using duct tape or other suitable means to seal the remainder of the opening. The portable air exhaust device, including the associated ducting, shall have airflow in the range of 70 to 80 L/s.

7.4.3 ***Kitchen Exhaust Fan*** — Turn on all kitchen exhaust fans that are vented to the outdoors unless they are clearly rated at less than 75 L/s. If the rating is not available, turn the kitchen exhaust fan on. If the grease filter is clean, leave it in place. If grease buildup on the filter is likely to cause blockage, remove it to conduct the test.

7.4.4 ***Intermittent Exhaust Fans Rated at More Than* 75 L/s** — Turn on and operate, at maximum speed, any other intermittent exhaust fan rated by the manufacturer[3] at more than 75 L/s in conjunction with the air exhaust and air supply devices previously identified.

7.4.5 ***Make-up Air Fan*** — Operate normally any make-up air fan that is electrically interlocked with an exhaust device, which is turned on for this test.

7.5 **Level of Depressurization Created Within the Dwelling Unit** — Complete the test procedure by determining the level of depressurization created within the dwelling unit for the specified test conditions.

7.5.1 Read and record the pressure difference in pascals.

8. CLEAN-UP PROCEDURES

8.1 Return the dwelling unit to its normal condition of operation upon completion of the test as follows:

a. Reset thermostats

b. Reset water heater, if necessary

c. Reset forced-air furnace circulating fans, and combined air supply and exhaust ventilators

d. Return air exhaust and air supply devices to normal operation

e. Return intermittent exhaust fans to normal operation

f. Return doors and windows to normal operation

g. Open dampers that were closed

h. Untape any openings that were closed temporarily

i. Replace the filter of the kitchen exhaust fan if removed.

8.2 Remove all depressurization test equipment, including:

a. Pressure-measuring apparatus

b. Pressure-averaging device

c. All manometers

d. All tubing

e. Portable air exhaust device used to simulate a clothes dryer.

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[3] *When the manufacturer's rating cannot be determined, the exhaust duct diameter may be used to estimate the airflow. An exhaust duct diameter of* 125 mm *or less is considered unlikely to exhaust more than* 75 L/s.

9. INTERPRETATION OF RESULTS

9.1 Determine the level of depressurization created within the dwelling unit for the specified test conditions (par. 7.5).

9.2 Compare the above depressurization value observed for the dwelling unit with the depressurization limits established by the manufacturer for the fuel-burning appliance(s) and venting system(s) located within the dwelling unit.

9.2.1 Use the depressurization limits in Table 3 as default values if no limits are available from the manufacturer.

9.2.2 Conclude in the depressurization test report whether depressurization-induced spillage is likely to result from the operation of the fuel-burning appliance(s) and venting system(s) in the dwelling unit during the normal heating season (par. E1.5.4).

TABLE 3

Depressurization Limits[a] for Fuel-Burning Appliances and Venting Systems

Description of Fuel-Burning Appliances and Venting Systems	Depressurization Limit[b], max. (Pa)
Natural Draft including: — all gas, propane and oil-fired fuel-burning appliances connected to flues that rely on natural draft, and draw combustion air from the indoors; — most conventional furnaces and water heaters, including low- and mid-efficiency gas-fired furnaces, and oil furnaces with barometric dampers; — all vertically vented, natural draft gas or oil-fired heating stoves and fireplaces; — all wood-burning fireplaces, stoves, ranges and central-heating appliances.	5
Sidewall Vented Oil – for example: — high-pressure burner oil-fired appliances with sealed sidewall vents, but with no sealed supply of outdoor combustion air.	5
Pellet Stoves – for example — pellet stoves with exhaust fans and sealed vents.	15
Sealed Combustion – for example: — direct-vented appliances in which combustion air is supplied directly from, and the products of combustion are vented directly to, the outdoors by independent sealed passageways connected directly to the appliance's combustion chamber.	20
Power Vented Gas Appliance – for example: — power-vented gas water-heaters.	20

[a] *Use the depressurization limits in Table 3 as default values if depressurization limits are not available from the manufacturer. The limits in Table 3 are valid only during the heating season and for the following types of dwelling units: detached, semi-detached and row housing.*

[b] *For infrequently used wood-burning appliances, such as a decorative fireplace, higher depressurization limits may be allowed if they are equipped with warning labels and alarms appropriate for the fuel being burned.*

10. DEPRESSURIZATION TEST REPORT

10.1 Complete a depressurization test report.

10.1.1 Report at least the following information:

a. Name and address of the company which conducted the test

b. Name of the tester

c. Address of the dwelling unit under test

d. Type of dwelling unit tested (detached, semi-detached, row housing)

e. Date of test and date of report

f. Approximate outdoor temperature (°C)

g. Approximate wind speed and variability (km/h)

h. Vented fuel-burning appliances in the dwelling unit and associated depressurization limits (Table 3)

i. Type of pressure-measuring apparatus, and pressure-averaging device, used for testing

j. Measured depressurization in pascals caused by any forced-air circulating fan (par. 7.1)

k. Measured depressurization in pascals caused by operation of any combined supply and exhaust ventilators (par. 7.2)

l. Pressure difference measured for continuous devices in pascals (par. 7.3)

m. Pressure difference measured for intermittent devices in pascals (par. 7.4)

n. Comparison of the depressurization value observed for the dwelling unit (par. 7.5) and the depressurization limits established for the fuel-burning appliances

o. Deviations from the test method prescribed herein, and

p. Follow-up actions completed and required.

10.1.2 The depressurization test report shall include the following:

a. Completed form similar to that presented in Appendix C; and

b. Completed depressurization checklist, Appendix D, which includes confirmation of the test set-up (D3), of the preparation of the dwelling unit (completed checklist version of Table D1), of the test procedures (D4) and clean-up procedures (D5).

11. NOTES

11.1 **Related Publications** — This standard is relevant to a number of other standards and publications that address the operation of specific fuel-burning appliances. Related publications which should be of interest when performing this test method follow:

11.1.1 National Research Council Canada (NRC)

National Building Code of Canada[4].

11.1.2 Canadian Standards Association (CSA)

CAN/CSA-B139 — Installation Code for Oil Burning Equipment

CAN/CSA-B149.1 — Natural Gas and Propane Installation Code

CAN/CSA-B365 — Installation Code for Solid-Fuel-Burning Appliances and Equipment

CAN/CSA-F326 — Residential Mechanical Ventilation Systems.

11.1.3 Minnesota Department of Administration

Minnesota North Star Main Web Page – Manufacturers' "Letter of Compliance."

11.1.4 Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI)

SAR-R4 Residential Mechanical Ventilation Manual.

[4] *Consult also the relevant provincial building code, which may differ from the National Building Code of Canada.*

11.2 **Sources of Referenced Publications**

11.2.1 The publication referred to in par. 3.1.1 may be obtained from the Canadian General Standards Board, Sales Centre, Gatineau, Canada K1A 1G6. Telephone (819) 956-0425 or 1 (800) 665-2472. Fax (819) 956-5644. E-mail ncr.cgsb-ongc@pwgsc.gc.ca. Web site www.ongc-cgsb.gc.ca.

11.2.2 The publication referred to in par. 11.1.1 may be obtained from the Publication Sales Department, M-20, National Research Council of Canada, Institute For Research in Construction, Ottawa, Canada K1A 0R6. Telephone (613) 993-2463 or 1 (800) 672-7990. Fax (613) 952-7673. E-mail IRC.Client-Services@nrc-cnrc.gc.ca. Web site http://irc.nrc-cnrc.gc.ca/publications/order.html

11.2.3 The publications referred to in par. 11.2.2 may be obtained from the Canadian Standards Association, Standards Sales, 5060 Spectrum Way, Suite 100, Mississauga, Ontario L4W 5N6. E-mail: sales@csa.ca. Web site: www.csa.ca

11.2.4 The Web page for the Minnesota Department of Administration, Office of Technology referred to in par. 11.1.3 can be viewed at http://www.state.mn.us/cgi-bin/portal/mn/jsp/content.do?contentid=536894726&contenttype=EDITORIAL&agency=NorthStar.

11.2.5 The publication referred to in par. 11.1.4 may be obtained from the Heating, Refrigeration and Air Conditioning Institute of Canada, 5045 Orbitor Drive, Building 11, Suite 300, Mississauga, ON L4W 4Y4. Telephone 1 (800) 267-2231 or (905) 602-4700. Fax (905) 602-1197. E-mail skilltech@hrai.ca. Web site: www.hrai.ca/site/skilltech/hraicatalogue/index.html.

APPENDIX A
(This appendix forms a mandatory part of the standard.)

CALIBRATION OF PRESSURE-MEASURING APPARATUS

A1. SCOPE

A1.1 The pressure-measuring apparatus shall be calibrated in accordance with the manufacturer's instructions or in accordance with Appendix A for a digital manometer or a mechanical gauge as described herein.

A2. PRINCIPLE

A2.1 Calibration involves the use of a "Y" tube to join the gauge being calibrated to the reference gauge. The readings from these gauges are then compared for a range of pressures. Any discrepancies between the gauges are recorded, and later used to correct readings taken with the calibrated gauge. The calibration method in this appendix uses the fluid-filled manometer as the reference gauge.

A2.1.1 ***Reference Gauge*** — The fluid-filled manometer used as a reference gauge is typically a solid plastic block containing a coloured oil of a known density. The oil-filled chamber is sloped, so it is easy to observe slight changes in the height of the fluid, caused by air pressure differences on either side. An electronic fluid-filled manometer, which is more accurate, may also be used as a reference gauge.

Note 1: *A fluid-filled manometer is excellent for calibration because the plastic block and fluid cannot be knocked out of calibration. As long as the scale of the manometer is not bent or otherwise distorted, it is a permanent reference gauge that can be used repeatedly for calibrating field instruments.*

Note 2: *If the reference gauge is not a fluid-filled manometer, use the following instructions cautiously. Rapid depressurization of the syringe can damage the reference and test manometers.*

A3. TEST EQUIPMENT

A3.1 The following equipment is required:

a. Fluid-filled manometer

b. Flexible polypropylene tubing, 5 mm outside diameter

c. A 10 cc plastic syringe

d. A Y-joint for connecting tubes to the gauge and the syringe.

A4. EQUIPMENT SET-UP

A4.1 **Fluid-filled Manometer** — Set up the fluid-filled manometer on a flat surface away from direct sunlight or other heat sources. Adjust the manometer as follows:

a. Level the bubble built into the plastic block by carefully adjusting the foot screw.

b. Open the air pressure taps located at the low and high sides of the manometer by unscrewing a half turn. Verify that both taps are open by lightly blowing into one of the taps to move the fluid.

c. Stabilize the temperature by allowing the manometer to reach room temperature.

d. Zero the scale so that the low end of the fluid is at zero. If the scale cannot reach zero, add more oil in accordance with the manufacturer's instructions. To zero the scale, loosen the setscrew and move the scale until the zero lines up with the meniscus of the fluid, that is, until the zero line on the scale is tangent to the arc of the fluid. Tighten the scale in place once it is zeroed.

Note 1: *The meniscus is the lowest point of the curve and is used as the reference point for reading against the scale.*

Note 2: *The scale is reflective aluminum to avoid errors in reading caused by looking at the manometer from an angle. To keep the scale perpendicular to the line of vision, the reflection of the meniscus on the aluminum should line up perfectly with the actual meniscus.*

A4.2 **Pressure-Measuring Apparatus** — Set-up the apparatus as normally used, giving special attention to zeroing the scale and levelling the apparatus. Use three sections of tubing, and a Y-joint to connect the reference gauge, the pressure-measuring apparatus and the plastic syringe.

A5. CALIBRATION PROCEDURE

A5.1 Calibrate the pressure-measuring apparatus as follows:

a. Adjust the syringe to create different pressure readings on the reference gauge in increments of 2 Pa within the range of 0 to 50 Pa.

b. Record any discrepancies between the pressure reading on the reference gauge and the pressure-measuring apparatus being calibrated.

c. If the apparatus being calibrated is a mechanical device that might suffer from stickiness, lightly tap the apparatus continuously during calibration.

d. Prepare a calibration report as shown.

CALIBRATION REPORT

Date of calibration:	
Place of calibration:	
Pressure-measuring apparatus type and model:	
Pressure-measuring apparatus serial no.:	
Reference gauge type and model:	
Reference gauge serial no.:	
Name and company of technician performing calibration:	

Reference Gauge Pressure Pa	Pressure-Measuring Apparatus Pressure Pa	Correction Pa
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
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APPENDIX B

(This appendix does not form a mandatory part of the standard.)

MINIMIZING WIND EFFECTS DURING THE DEPRESSURIZATION TEST

B1. GENERAL

B1.1 Wind pressures can create uneven fluctuation of pressures around the dwelling unit and affect the performance of air exhausting and air-moving devices, leading to inaccurate test results.

B1.1.1 The test should not be performed when strong or variable winds exist and can cause pressure fluctuations that lead to unreliable test results. The test should be carried out in calmer weather, or action should be taken to minimize the affects of wind pressures should the decision be made to undertake the test under windy conditions.

B1.1.2 Generally, if fluctuations from wind pressure exceed 2 Pa, the test is unreliable.

B2. MINIMIZING PROBLEMS RELATED TO WIND PRESSURE

B2.1 The following actions should be taken into consideration to minimize wind effects on the test results:

a. *Choose a Calm Day:* Choose a calm day, especially if the dwelling unit is exposed to winds.

   i. The amount of shelter around a dwelling unit has been found to greatly affect the wind pressures experienced during the test. Trees, small hills, hedges, fences and neighbouring buildings all reduce wind velocity locally.

   ii. Weather stations typically report wind speeds that have been measured at an airport, where no shelter exists at a height of 10 m. As a rule, wind speeds will be much less at the dwelling unit site, although it is hard to predict the differences. An important exception to this rule is a dwelling unit located in a new subdivision, with young trees and larger lots. Avoid testing in new subdivisions, or other exposed sites, when airport wind speeds exceed 15 km/h or when winds are gusty.

b. *Avoid Measuring Pressures Against the Windward Face of the Dwelling Unit:* Typically, the wind pressures are highest and the most turbulent on the side of the dwelling unit facing the wind. Wind pressures are lower on the other faces. To minimize fluctuations, extend the outdoor pressure tube to one of the leeward faces.

c. *Locate the Outdoor Tube in a Sheltered Location:* The outdoor pressure tube should not face directly into air that is moving. Generally, the closer to the ground that the tube is placed, the less air movement. To avoid turbulence, a common technique is to locate the end of the tube in a bush or snowbank. The end of the tube can be protected from moisture or dirt with a piece of open celled foam rubber or a perforated film canister.

d. *Use Pressure-Averaging:* Averaging the pressure is considered the best method used for minimizing problems related to wind pressures. Pressure-averaging may take place in one of several ways as follows:

   i. Spatially: The approach, described in CAN/CGSB-149.10, locates the outdoor pressure tubes on each face of the dwelling unit and requires “Y”ing the tubes together.

   ii. Physically: The approach, described in CAN/CGSB-149.10, requires a capillary tube to dampen the pressure fluctuations caused by wind effects.

   iii. Electronically: Most digital pressure-measuring apparatus have the capability to measure the average pressure by sampling and averaging the pressure differential over a period of seconds. This apparatus is effective in overcoming discrepancies caused by gusty winds.

APPENDIX C
(This appendix forms a mandatory part of the standard.)

DEPRESSURIZATION TEST REPORT FORM

TEST IDENTIFICATION

Test date:	
Date of report:	
Test number:	
Company name:	
Company address:	
Name and signature of tester:	
Type of dwelling unit tested:	
Address of dwelling unit:	
Purpose of test:	

TEST CONDITIONS AND APPARATUS

Approximate outdoor temperature (°C):	
Approximate wind speed and variability:	
Pressure-measuring apparatus type:	
Pressure-measuring apparatus I.D. #:	
Pressure-averaging device type:	None; or:
Deviations from CAN/CGSB-51.71:	None; or:

DEPRESSURIZATION LIMITS FOR FUEL-BURNING APPLIANCES AND VENTING SYSTEMS

Fuel-burning Appliance (see Table 3[a])	**Depressurization[b] Limit, max. Pa**

PRESSURE MEASUREMENTS (may be different for each appliance tested)

Mechanical Devices and Venting Systems in Operation	Depressurization Pa	Special Circumstances (if any)
Forced-air furnace (furnace blower)		
Combined air supply and exhaust ventilator		
Devices designed for continuous operation		
Intermittent exhaust fans		

RECOMMENDATIONS

Interpretation of results (conclude on likelihood of depressurization-induced spillage from the operation of fuel-burning appliance(s) and venting system(s) in the dwelling unit during the normal heating season):
Follow-up action completed:
Follow-up action required (Update report upon completion):

[a] *See Table 3.*

[b] *Use the depressurization limits established by the manufacturer for the fuel-burning appliance and venting system for the heating season. Use the depressurization limits in Table 3 as default values. The limits in Table 3 are valid only during the heating season and for the following type of dwelling units: detached, semi-detached and row housing.*

DEPRESSURIZATION CHECK LIST

Complete a checklist similar to that described below for each element. This checklist is not all-inclusive. In addition to referring to the checklist it is the responsibility of the testing body to ensure that the depressurization test is performed in accordance with CAN/CGSB-51.71.

D1. APPARATUS

a. Pressure-measuring apparatus

b. Pressure-averaging device

c. Clothes dryer simulator (portable air-exhaust device)

D2. DOCUMENTS

a. CAN/CGSB-51.71

b. CAN/CGSB-149.10

c. Depressurization Test Report Form

D3. TEST SET-UP

a. Complete the section ‘Test Identification’ on the Depressurization Test Report Form.

b. Complete the section ‘Test Conditions and Apparatus’ on the Depressurization Test Report Form.

c. Prepare the dwelling unit in accordance with CAN/CGSB-51.71.

d. Record the depressurization limit for each fuel-burning appliance and venting system (CAN/CGSB-51.71 Table 3) if depressurization limits are not available from the manufacturer.

e. Install the clothes dryer simulator if required.

f. Set up the pressure-measuring apparatus in accordance with CAN/CGSB-51.71.

g. Extend the outdoor pressure tubing outside the dwelling unit.

h. Attach the outdoor pressure tubing to the pressure-measuring apparatus.

i. Zero the pressure-measuring apparatus and observe fluctuations resulting from wind effects.

j. Attach the pressure-averaging device in accordance with CAN/CGSB-51.71, taking into account the minimization of wind effects (see Appendix B).

k. Complete a checklist confirming completion of test set-up procedures, similar to that in Table D1, entitled ‘Checklist for the Preparation of the Dwelling Unit.”

TABLE D1

Checklist for the Preparation of the Dwelling Unit

	Item	State of Item
	Windows	Close
	Exterior doors	Close
	Basement door	Close
	Doors on an enclosed furnace room	Close
	Chimney with manual damper	Close
	Chimney without manual damper	Leave as is
	Make-up air supply with manual damper	Close
	Make-up air supply without manual damper	Leave as is
	Solid fuel wood-burning appliances	No fire Close doors and air control dampers
	Thermostatically controlled fuel-burning appliances, other than water heaters[a]	Turn down thermostat
	Switch controlled fuel-burning appliances, other than water heaters[b]	Turn off
	Water heaters	Not operating[c]
	Floor drains and other trap plumbing connections	Fill traps with water
	Air exhaust and supply devices	Turn off
	Ventilating and air-moving devices	Turn off
	Air conditioner	Turn off
	Clothes dryer(s)	Turn off
	Attic hatch	Close
	Crawl space vents	Close
	Broken windows and other short-term openings	Tape over
	Subslab ventilation fans or subfloor ventilation systems for soil gas control	Turn off

[a] *Gas furnaces and boilers, gas combo units, some gas fireplaces, oil furnaces and boilers*
[b] *Some gas or oil fireplaces*
[c] *The water heater must be non-operational for the entire test.*

D4. TEST PROCEDURE

a. Operate the forced-air furnace circulating fan(s). Record the pressure difference in pascals. Prior to proceeding with the next step, see CAN/CGSB-51.71, par. 7.1.2 for appropriate test conditions.

b. Operate the combined supply and exhaust ventilators. Record the pressure difference in pascals. Prior to proceeding with next step, see CAN/CGSB-51.71, par. 7.2.2 for appropriate conditions.

c. Operate the air exhaust and air supply devices designed for continuous operation. Record the pressure difference in pascals. Prior to proceeding with next step, see CAN/CGSB-51.71, par. 7.3.3 for appropriate conditions.

d. Operate the intermittent exhaust fans including:

   i. Clothes dryer(s) or simulator if included in the test (par. 7.4.2);

ii. Kitchen exhaust fan(s) (par. 7.4.3);

iii. All other intermittent exhaust fans rated at more than 75 L/s (par. 7.4.4);

iv. Make-up air fan that is electrically interlocked with an exhaust device (par. 7.4.5).

e. Close the window or door to the outdoors.

f. Record the pressure difference in pascals.

g. Determine the level of depressurization created within the dwelling unit for the specified test conditions, see CAN/CGSB-51.71, par. 7.5. Compare the depressurization value observed for the dwelling unit with limits established for the fuel-burning appliance and venting system located within the dwelling unit (see CAN/CGSB-51.71, section 9).

h. Complete the form "Depressurization Test Report Form."

D5. CLEAN-UP

D5.1 Return the dwelling unit to its normal condition of operation as follows:

a. Reset thermostats

b. Reset water heater to normal operation, if necessary

c. Reset forced-air furnace circulating fan(s)

d. Reset combined air supply and exhaust ventilator(s)

e. Return air exhaust and air supply devices to normal operation

f. Return intermittent exhaust fans to normal operation

g. Return doors and window to normal operation

h. Open dampers that were closed and

i. Untape any openings that were closed temporarily

j. Replace the filter of the kitchen exhaust fan if removed.

D5.2 Remove all depressurization test equipment, including:

a. Pressure-measuring apparatus

b. Pressure-averaging device

c. All manometers

d. All tubing

e. Portable air-exhaust device used to simulate a clothes dryer.

LIMITATIONS OF THE TEST METHOD

The maximum pressure difference created under the specific test conditions of this standard does not necessarily represent the "worst-case," that is, the maximum possible depressurization ever to be experienced by the dwelling unit.

E1. The following limitations have been identified.

E1.1 This standard does not take into account all contributors to depressurization, specifically:

a. Small (<75 L/s) exhaust fans and appliances, such as whole house central vacuum cleaners

b. Powered attic ventilation fans, which may inadvertently draw air from the combustion fuel-burning appliance zone

c. Exhaust caused by a negative pressure in an attached unit of an adjacent dwelling unit, where separation between the units is not complete

d. Exhaust caused by fireplaces or wood stoves

e. Exhaust caused by combustion gas venting from gas- or oil-fired appliances, which draw air from the dwelling unit

f. Exhaust caused by windows being left open in closable rooms

g. Stack effect

h. Wind

i. Operation of central circulating fan at a higher speed during cooling

j. Intermittent exhaust during the HRV defrost cycle in cold weather.

E1.2 Wind can greatly affect the accuracy and repeatability of the test.

E1.3 The possible re-introduction of combustion gases, which left the building, back into the dwelling unit via another pathway such as an air intake or window is not considered.

E1.4 Combustion gases that are not intentionally vented (e.g. from a gas range or oven) are not considered.

E1.5 Although the depressurization limits in Table 3 have been determined based on field research, a fuel-burning appliance may not vent at lower levels, notably in the following situations:

E1.5.1 Chimney draft during warm summer weather can be low, especially in periods of negligible wind. Chimney vented appliances that operate during this period (e.g. hot water heaters) may be operating against a reverse chimney flow, even though the house depressurization is less than the specified limit. There is insufficient data to predict how often this occurs and whether a gas-fired hot water tank, for example, can restart chimney venting under periods of low house depressurization.

E1.5.2 Conversely, in very cold weather, a sustained, off-cycle backdraft can chill the flue and create a stable backdraft condition, which may persist even if house depressurization subsequently decreases. Again, there is presently insufficient evidence on the frequency of this happening and the ability of various appliances to reverse a sustained, cold backdraft.

E1.5.3 Depressurization limits are predicated on the fuel-burning appliance being installed according to appliance standards. Improper installations or non-maintained appliances will not have the same ability to establish venting. If the appliance shows evidence of previous backdrafting (e.g. melted grommets and staining at the dilution air), the homeowner should be advised to have the appliance checked by a qualified technician, even if it passes the depressurization test.

E1.5.4 Note that depressurization test limits should not be viewed strictly as pass/fail criteria. More broadly, in a house with a 5 Pa limit, depressurization under 4 Pa is likely safe; depressurization over 6 Pa is likely to cause problems; and results in the 4-6 Pa range should be further investigated to see if there are means to attain a better margin of safety.

E2. DISCUSSION EXPLAINING THE TEST CONDITIONS ESTABLISHED IN CAN/CGSB-51.71

E2.1 The most simple depressurization test procedure, and the one first used by Canada Mortgage and Housing Corporation (CMHC) in the 1980s, called for the activation of all exhaust appliances when testing for depressurization of the dwelling unit. At the time, CMHC believed that this protocol represented a worst-case condition and that the house and fuel-burning appliances should be able to tolerate this condition.

E2.2 Based on subsequent findings, it is important to bring to the reader's attention and to clarify that CAN/CGSB-51.71 never required the activation of all exhaust appliances. In research, conducted by CMHC[E1] and the U.S. Gas Research Institute[E2] of houses susceptible to excessive house depressurization, the field results showed that the simultaneous activation of all exhaust appliances was very rare.

E2.3 There are two other factors at play in the decision not to activate all exhaust appliances. The first, depressurization of the dwelling unit, is measured with all doors and windows closed. Additional CMHC survey work done in Ontario shows that many homeowners leave windows open on a regular basis, increasing the leakage area of the building envelope.[E3] Secondly, the depressurization levels observed for the dwelling units were established during periods of low or no wind. Wind generally aids chimney draft. Low wind periods are relatively rare.

E2.4 The specific test conditions established for CAN/CGSB-51.71 include the simultaneous activation of several large exhaust appliances, the closure of windows, and a theoretical chimney draft unaided by wind. Since these conditions result in a very conservative test, the Committee has decided not to make the fan activation schedule as severe as it could be (i.e. operation of all exhaust appliances).

E2.4.1 As a further precaution, it is prudent to have at least one carbon monoxide alarm installed in houses with combustion fuel-burning appliances.

E3. RELATED PUBLICATIONS

E3.1 This appendix is relevant to a number of publications that address the operation of specific fuel-burning appliances. Related publications, which should be of interest when performing this test method, follow:

E3.1.1 Canada Mortgage and Housing Corporation

Residential Combustion Spillage Monitoring.

Analysis of Ventilation System Performance in New Ontario Houses, Research Highlight.

E3.1.2 Indoor Air 99

Grimsrud, D.T., Hadlich, D.E., Koontz, M.D., Hemphill, R.J., Leslie, N.P., Li, Z., and Nagda, N.L., Surveys on Depressurization-Induced Backdrafting and Spillage, 334-339, Indoor Air 99, *Official Conference of* The International Society of Indoor Air Quality and Climate (ISIAQ).

E3.2 Sources of Related Publications

E3.2.1 The publication referred to in par. E2.2, E2.3, and E3.1.1 may be obtained from the Canada Mortgage and Housing Corporation, 700 Montreal Road, Ottawa, ON K1A 0P7. Telephone 1 (800) 668-2642. Fax (613) 748-4069. Email chic@cmhc-schl.gc.ca. Web site www.cmhc-schl.gc.ca.

[E1] Canada Mortgage and Housing Corporation. Residential Combustion Spillage Monitoring. See par. E3.1 for the Source of Publication.

[E2] Grimsrud, D.T., Hadlich, D.E., Koontz, M.D., Hemphill, R.J., Leslie, N.P., Li, Z. and Nagda, N.L. Surveys on Depressurization-induced Backdrafting and Spillage, Indoor Air 99. See par. E3.2 for the Source of Publication.

[E3] Canada Mortgage and Housing Corporation Analysis of Ventilation System Performance in New Ontario Houses, Research Highlight. See par. E3.1 for the Source of Publication.

E3.2.2 The publication referred to in par. E2.2 and E3.1.2 may be obtained from the *Official Conference of The International Academy of Indoor Air Science (IAIAS)* Indoor Air 99, Proceedings Volume 1, Edinburgh, Scotland. Construction Research Communications Ltd., 151 Rosebery Avenue, London, EC1R 4GB, UK. Telephone +44 (0) 20 7505 6622. Fax: +44v(0) 20 7505 6606. Email: crc@construct.emap.co.uk, or at the International Society of Indoor Air Quality and Climate, ISIAQ Secretariat, P.O. Box 25, FIN-02131 Espoo, Finland. Fax +358 9 4355 5655. Web site www.isiaq.org.

HRAI PRE-TEST CALCULATION FOR DWELLING UNITS[F1]

The application of a pre-test may first be applied to the dwelling unit to determine whether it would be necessary to carry out the test method described in this standard. In some houses it may be more readily evident that the dwelling unit will not experience combustion spillage problems. A pre-test will help to determine this. Where the result of the pre-test does point to potential combustion spillage problems, CAN/CGSB-51.71 should be applied.

F1. TERMINOLOGY

F1.1 The following definitions apply in this appendix:

Allowable Net Exhaust Flow
The algebraic sum of fan-powered exhaust flows out of the dwelling unit and supply flows into the dwelling unit that is allowable because at this level or below, depressurization-induced spillage of combustion products from fuel-fired heating appliances is unlikely to be a problem.

Conditioned Space
Any space within a dwelling unit, the air temperature of which is controlled to limit variation in response to the exterior ambient air temperature or interior differential temperatures by the provision, either directly or indirectly, by heating or cooling over substantial periods of the year.

Net Rated Exhaust Flow
The algebraic sum of the rated capacities of all fan-powered exhaust devices installed within the dwelling unit and of any fan-powered supply devices wired to operate simultaneously with any of the exhaust devices.

F2. CALCULATION

F2.1 Calculate the floor area of all conditioned space in the dwelling unit in square meters (m^2).

F2.2 Calculate the allowable net exhaust flow for the specific type of dwelling unit in litres per second (L/s) by multiplying the floor area calculated in F2.1 by the appropriate factor from Table F1.

F2.3 Calculate the net rated exhaust flow for the dwelling unit in litres per second (L/s).

F2.4 Where the net rated exhaust flow does not exceed the allowable net exhaust flow, performing the depressurization test described in CAN/CGSB-51.71 may not be warranted; otherwise, the test described in this standard should be performed.

F2.5 Sample Calculation: Most new houses have numerous exhaust appliances and will not pass the pretest. Older houses will often be exempted. Take the example of an older two-storey house of a nominal 140 m^2 size with a basement of 70 m^2 that has a total conditioned floor area of 210 m^2. The sample house has no exhaust fans but a dryer rated at 50 L/s. Applying the factor of 0.28 from Table F1 shows that the allowable net exhaust flow is 59 L/s. Since the net rated exhaust flow of 50 L/s (based on the dryer) is lower than the calculated allowable net exhaust limit of 59 L/s, the house passes the pre-test. If the dryer exhaust flow was not specified, or there was no dryer installed, the default dryer flow rate of 75 L/s would have to be applied, and the house would fail the pre-test.

[F1] *Source: HRAI SAR-R4, Residential Mechanical Ventilation Manual. (HRAI has granted CGSB permission to reproduce this information).*

TABLE F1

Allowable Net Exhaust Factors

House Type	Factor ($L/s \cdot m^2$)
Tight, R2000	0.06
Ordinary, R2000	0.11
New home, British Columbia and Atlantic	0.17
New home, Prairies and Territories	0.11
New home, Ontario and Quebec	0.16
Older home	0.28