

Section 9.25. Heat Transfer, Air Leakage and Condensation Control

9.25.1. General

9.25.1.1. Scope and Application

- 1) This Section is concerned with heat, air and water vapour transfer and measures to control condensation.
- 2) All walls, ceilings and floors separating *conditioned space* from unconditioned space, the exterior air or the ground shall be
 - a) provided with
 - i) thermal insulation conforming to Subsection 9.25.2. and Section 9.36.,
 - ii) an air barrier conforming to Subsection 9.25.3. and Section 9.36., and
 - iii) a vapour barrier conforming to Subsection 9.25.4., and
 - b) constructed in such a way that the properties and relative position of all materials conform to Subsection 9.25.5.
- 3) Insulation and sealing of heating and ventilating ducts shall conform to Sections 9.32., 9.33. and 9.36.

9.25.2. Thermal Insulation

9.25.2.1. Required Insulation

- 1) All walls, ceilings and floors separating heated space from unheated space, the exterior air or the exterior *soil* shall be provided with sufficient thermal insulation to prevent moisture condensation on their room side during the winter and to ensure comfortable conditions for the occupants. (See Note A-9.1.1.1.(1).)

9.25.2.2. Insulation Materials

- 1) Except as required in Sentence (2), thermal insulation shall conform to the requirements of
 - a) [ASTM C 726, “Mineral Wool Roof Insulation Board,”](#)
 - b) CAN/CGSB-51.25-M, “Thermal Insulation, Phenolic, Faced,”
 - c) CGSB 51-GP-27M, “Thermal Insulation, Polystyrene, Loose Fill,”
 - d) CAN/ULC-S701, “Thermal Insulation, Polystyrene, Boards and Pipe Covering,”
 - e) CAN/ULC-S702, “Mineral Fibre Thermal Insulation for Buildings,”
 - f) CAN/ULC-S703, “Cellulose Fibre Insulation for Buildings,”
 - g) CAN/ULC-S704, “Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced,”
 - h) CAN/ULC-S705.1, “Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material – Specification,” or
 - i) CAN/ULC-S706, “Wood Fibre Insulating Boards for Buildings.”
- 2) The *flame-spread ratings* requirements contained in the standards listed in Sentence (1) shall not apply. (See Note A-9.25.2.2.(2).)
- 3) Insulation in contact with the ground shall be inert to the action of *soil* and water and shall be such that its insulative properties are not significantly reduced by moisture.

9.25.2.3. Installation of Thermal Insulation

- 1) Insulation shall be installed so that there is a reasonably uniform insulating value over the entire face of the insulated area.
- 2) Insulation shall be applied to the full width and length of the space between furring or framing.

3) Except where the insulation provides the principal resistance to air leakage, thermal insulation shall be installed so that at least one face is in full and continuous contact with an element with low air permeance. (See Note A-9.25.2.3.(3).)

4) Insulation on the interior of *foundation* walls enclosing a crawl space shall be applied so that there is not less than 50 mm clearance above the crawl space floor, if the insulation is of a type that may be damaged by water.

5) Insulation around concrete slabs-on-ground shall be located so that heat from the *building* is not restricted from reaching the ground beneath the perimeter, where exterior walls are not supported by footings extending below frost level.

6) Where insulation is exposed to the weather and subject to mechanical damage, it shall be protected with not less than

- a) [reserved](#),
- b) 6 mm preservative-treated plywood, or
- c) 12 mm cement parging on wire lath applied to the exposed face and edge.

7) Insulation located in areas where it may be subject to mechanical damage shall be protected by a covering such as gypsum board, plywood, particleboard, OSB, waferboard or hardboard.

8) Insulation in factory-built *buildings* shall be installed so that it will not become dislodged during transportation.

9.25.2.4. Installation of Loose-Fill Insulation

1) Except as provided in Sentences (2) to (6), loose-fill insulation shall be used on horizontal surfaces only.

2) Where loose-fill insulation is installed in an unconfined sloped space, such as an attic space over a sloped ceiling, the supporting slope shall not be more than

- a) 4.5 in 12 for mineral fibre or cellulose fibre insulation, and
- b) 2.5 in 12 for other types of insulation.

3) Loose-fill insulation is permitted to be used in wood-frame walls of existing *buildings*. (See Note A-9.25.2.4.(3).)

4) Where blown-in insulation is installed in above-ground or below-ground wood-frame walls of new *buildings*,

- a) the density of the installed insulation shall be sufficient to preclude settlement,
- b) the insulation shall be installed behind a membrane that will permit visual inspection prior to the installation of the interior finish,
- c) the insulation shall be installed in a manner that will not interfere with the installation of the interior finish, and
- d) no water shall be added to the insulation, unless it can be shown that the added water will not adversely affect other materials in the assembly.

5) Water repellent loose-fill insulation is permitted to be used between the outer and inner wythes of masonry *cavity walls*. (See Note A-9.25.2.4.(5).)

6) Where soffit venting is used, measures shall be taken

- a) to prevent loose-fill insulation from blocking the soffit vents and to maintain an open path for circulation of air from the vents into the *attic or roof space*, and
- b) to minimize airflow into the insulation near the soffit vents to maintain the thermal performance of the material. (See Article 9.19.1.3.)

9.25.2.5. Installation of Spray-Applied Polyurethane

1) Spray-applied polyurethane insulation shall be installed in accordance with CAN/ULC-S705.2, “Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Application.”

9.25.3. Air Barrier Systems

9.25.3.1. Required Barrier to Air Leakage

1) Wall, ceiling and floor assemblies separating *conditioned space* from unconditioned space or from the ground shall be constructed so as to include an *air barrier system* that will provide a continuous barrier to air leakage

- a) from the interior of the *building* into wall, floor, *attic or roof spaces*, sufficient to prevent excessive moisture condensation in such spaces during the winter, and
- b) from the exterior or the ground inward sufficient to
 - i) prevent moisture condensation on the room side during winter,
 - ii) ensure comfortable conditions for the occupants, and
 - iii) minimize the ingress of *soil* gas.

(See Note A-9.25.3.1.(1).)

9.25.3.2. Air Barrier System Properties

(See Note A-9.25.5.1.(1).)

1) *Air barrier systems* shall possess the characteristics necessary to provide an effective barrier to air infiltration and exfiltration under differential air pressure due to stack effect, mechanical systems or wind.

2) Where polyethylene sheet is used to provide airtightness in the *air barrier system*, it shall conform to CAN/CGSB-51.34-M, "Vapour Barrier, Polyethylene Sheet for Use in Building Construction."

9.25.3.3. Continuity of the Air Barrier System

1) Where the *air barrier system* consists of an air-impermeable panel-type material, all joints shall be sealed to prevent air leakage.

2) Except as provided in Sentence 9.25.3.6.(3), where the *air barrier system* consists of flexible sheet material, all joints shall be

- a) sealed, or
- b) lapped not less than 100 mm and clamped, such as between framing members, furring or blocking, and rigid panels.

3) Where an interior wall meets an exterior wall, ceiling, floor or roof required to be provided with air barrier protection, the *air barrier system* shall extend across the intersection.

4) Where an interior wall projects through a ceiling or extends to become an exterior wall, spaces in the wall shall be blocked to provide continuity across those spaces with the *air barrier system* in the abutting walls or ceiling.

5) Where an interior floor projects through an exterior wall or extends to become an exterior floor, continuity of the *air barrier system* shall be maintained from the abutting walls across the floor assembly.

6) Penetrations of the *air barrier system*, such as those created by the installation of doors, windows, electrical wiring, electrical boxes, piping or ductwork, shall be sealed to maintain the integrity of the *air barrier system* over the entire surface.

7) Where access hatches and sump pit covers are installed through assemblies constructed with an *air barrier system*, they shall be weatherstripped around their perimeters to prevent air leakage.

8) Clearances between *chimneys* or *gas vents* and the surrounding construction that would permit air leakage from within the *building* into a wall or *attic or roof space* shall be sealed by *noncombustible* material to prevent such leakage.

9.25.3.4. Air Leakage Control in Masonry Walls

(See Note A-9.25.3.4. and 9.25.3.6.)

1) Masonry walls required to provide a barrier to the ingress of air from the ground shall

- a) include a course of masonry units without voids, or
- b) be sealed with flashing material extending across the full width of the masonry.

- 2) The masonry course or flashing described in Sentence (1) shall
 - a) be located at the level of the adjoining floor and be sealed to it in accordance with Article 9.25.3.6., or
 - b) in the absence of a floor, be located at the level of the ground cover required by Article 9.18.6.1. and be sealed to it.

9.25.3.5. Air Leakage Control in Underground Roofs

- 1) Waterproofing systems for roofs of underground structures shall be sealed to the air barrier in the walls.

9.25.3.6. Air Barrier Systems in Floors-on-ground

(See Note A-9.25.3.4. and 9.25.3.6.)

1) Materials used to provide a barrier to the ingress of air through floors-on-ground shall conform to CAN/CGSB-51.34-M, “Vapour Barrier, Polyethylene Sheet for Use in Building Construction.”

2) Where the floor-on-ground is a concrete slab, the air barrier shall be

- a) installed below the slab, or
- b) applied to the top of the slab, provided a separate floor is installed over the slab.

(See Note A-9.25.3.6.(2) and (3).)

3) Where the air barrier installed below a floor-on-ground is flexible sheet material, joints in the barrier shall be lapped not less than 300 mm. (See Note A-9.25.3.6.(2) and (3).)

4) Where installed in conjunction with a framed floor-on-ground or above a floor-on-ground, the air barrier shall be installed in accordance with Article 9.25.3.3.

5) A floor-on-ground shall be sealed around its perimeter to the inner surfaces of adjacent walls using flexible sealant.

6) All penetrations of a floor-on-ground that are required to drain water from the floor surface shall be sealed in a manner that prevents the upward flow of air without preventing the downward flow of liquid water.

9.25.4. Vapour Barriers

9.25.4.1. Required Barrier to Vapour Diffusion

1) Thermally insulated wall, ceiling and floor assemblies shall be constructed with a *vapour barrier* so as to provide a barrier to diffusion of water vapour from the interior into wall spaces, floor spaces or *attic or roof spaces*.

9.25.4.2. Vapour Barrier Materials

1) *Vapour barriers* shall have a permeance not greater than 60 ng/(Pa·s·m²) measured in accordance with ASTM E 96/E 96M, “Water Vapor Transmission of Materials,” using the desiccant method (dry cup).

2) Where the intended use of the interior space will result in high moisture generation, the assembly shall be designed according to Part 5. (See Note A-9.25.4.2.(2).)

3) Where polyethylene is installed to serve only as the *vapour barrier*, it shall comply with Clause 4.4, Thermal Stability, and Clause 5.7, Oxidative Induction Time, of CAN/CGSB-51.34-M, “Vapour Barrier, Polyethylene Sheet for Use in Building Construction.”

4) Membrane-type *vapour barriers* other than polyethylene shall conform to the requirements of CAN/CGSB-51.33-M, “Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction.”

5) Where a coating is applied to gypsum board to function as the *vapour barrier*, the permeance of the coating shall be determined in accordance with CAN/CGSB-1.501-M, “Method for Permeance of Coated Wallboard.”

6) Where foamed plastic insulation functions as the *vapour barrier*, it shall be sufficiently thick so as to meet the requirement of Sentence (1).

9.25.4.3. Installation of Vapour Barriers

1) Products installed to function as the *vapour barrier* shall protect the warm side of wall, ceiling and floor assemblies.

2) Where different products are used for the *vapour barrier* and the insulation, the *vapour barrier* shall be installed sufficiently close to the warm side of the insulation to prevent condensation at design conditions. (See Note A-9.25.4.3.(2) and Note A-9.25.5.1.(1).)

3) Where the same product is used for the *vapour barrier* and the insulation, the product shall be installed sufficiently close to the warm side of the assembly to prevent condensation at design conditions. (See Notes A-9.25.4.3.(2), A-9.25.5.1.(1) and A-9.25.5.2.)

9.25.5. Properties and Position of Materials in the Building Envelope

9.25.5.1. General

(See Note A-9.25.5.1.)

1) Except as provided in Sentences (2) to (4), sheet and panel-type materials incorporated into assemblies described in Article 9.25.1.1. shall conform to Article 9.25.5.2., where

- a) the material has
 - i) an air leakage characteristic less than $0.1 \text{ L}/(\text{s}\cdot\text{m}^2)$ at 75 Pa, and
 - ii) a water vapour permeance less than $60 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ when measured in accordance with ASTM E 96/E 96M, "Water Vapor Transmission of Materials," using the desiccant method (dry cup) (see Note A-9.25.5.1.(1)(a)(ii)), and
- b) the intended use of the interior space where the materials are installed will not result in high moisture generation.

(See Note A-9.25.5.1.(1).)

2) Where the intended use of the interior space will result in high moisture generation, the assembly shall be designed according to Part 5.

3) Wood-based sheathing materials not more than 12.5 mm thick and complying with Article 9.23.17.2. need not comply with Sentence (1). (See Note A-9.25.5.1.(3).)

4) Where a material has a water vapour permeance not less than $30 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ and a thermal resistance not less than $0.7 \text{ (m}^2\cdot\text{K)}/\text{W}$ and the heating degree-days of the *building* location are less than 6 000, the assembly need not comply with Sentence (1).

9.25.5.2. Position of Low Permeance Materials

(See Note A-9.25.5.2.)

- 1)** Sheet and panel-type materials described in Article 9.25.5.1. shall be installed
 - a) on the warm face of the assembly (see also Article 9.25.4.2.),
 - b) at a location where the ratio between the total thermal resistance of all materials outboard of its innermost impermeable surface and the total thermal resistance of all materials inboard of that surface is not less than that required by Table 9.25.5.2., or
 - c) outboard of an air space that is vented to the outdoors.
- 2)** For walls, the air space described in Clause (1)(c) shall comply with Clause 9.27.2.2.(1)(a).

Table 9.25.5.2.
Ratio of Outboard to Inboard Thermal Resistance
Forming Part of Sentence 9.25.5.2.(1)

Heating Degree-Days of <i>Building</i> Location ⁽¹⁾ , Celsius degree-days	Minimum Ratio of Total Thermal Resistance Outboard of Material's Inner Surface to Total Thermal Resistance Inboard of Material's Inner Surface
up to 4 999	0.20
5 000 to 5 999	0.30
6 000 to 6 999	0.35
7 000 to 7 999	0.40
8 000 to 8 999	0.50

Table 9.25.5.2. (continued)
Ratio of Outboard to Inboard Thermal Resistance
Forming Part of Sentence 9.25.5.2.(1)

Heating Degree-Days of <i>Building Location</i> ⁽¹⁾ , Celsius degree-days	Minimum Ratio of Total Thermal Resistance Outboard of Material's Inner Surface to Total Thermal Resistance Inboard of Material's Inner Surface
9 000 to 9 999	0.55
10 000 to 10 999	0.60
11 000 to 11 999	0.65
12 000 or higher	0.75

Notes to Table 9.25.5.2.:

(1) See Sentence 1.1.3.1.(1).