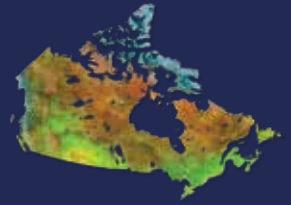




Natural Resources  
Canada

Ressources naturelles  
Canada



# 2012 R-2000 Standard



Canada

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# R-2000 Standard<sup>1, 2</sup> (2012 Edition)

Effective July 1<sup>st</sup>, 2012

## Changes to this version:

Version	Technical Changes
2012	<ul style="list-style-type: none"> <li>• Updated website links.</li> <li>• Updated referenced standards where necessary.</li> <li>• Revision of eligible buildings under “scope” to be more clear. Eligibility remains the same.</li> <li>• Removal of energy rating requirements for windows since the specifications were out of date. Minimum requirement is now only double glazed, low-e coating, etc. The more stringent R-2000 energy target should ensure that higher performing windows are installed.</li> <li>• Revisions to the water conservation requirements since the previous requirements were equal to or lower than code. New requirements are in line with those recommended by the R-2000 Committee for the 2014 R-2000 Standard.</li> <li>• Revisions to the minimum requirements for several Pick List items since some requirements had become obsolete. These items include:               <ul style="list-style-type: none"> <li>○ Air filtration (A2a) - now need MERV 13 air filter instead of 10 percent ASHRAE average dust efficiency since the latter is not a common indicator in residential applications. The MERV 13 rating is in line with that recommended by the R-2000 Committee for the 2014 R-2000 Standard.</li> <li>○ Low-toxicity finishes (A3, A4, A5, A7, B1-4)– re-phrased as third-party certified low-VOC (volatile organic compound) content, with additional choices for the third party</li> <li>○ Removal of measures to avoid window condensation measures (A9a) since these are now covered under window performance requirements (4.4), and</li> <li>○ Cooling Systems (B13) – now need to be ENERGY STAR qualified.</li> </ul> </li> <li>• The existing energy target formula in Appendix B is now multiplied by 0.5 to reflect the increased energy target.</li> </ul>

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<sup>1</sup> This standard is subject to revision. Please refer to the NRCan R-2000 web site, or contact your R-2000 service organization for the current version of this standard.

<sup>2</sup> The purpose of the commentaries provided throughout this Standard is to provide the user with an explanation of the clause and, in some cases, provide references to best practices to meet the requirements.

## 1. PURPOSE

- 1.1 The Technical Requirements** - The R-2000 Standard presents the criteria that a new house must meet to be eligible for R-2000 certification. The technical requirements of the R-2000 Standard include measures for the efficient use of energy, improved indoor air quality and better environmental responsibility in the construction and operation of a house.

**Commentary**

*The goal of the R-2000 Standard is to improve the energy efficiency of new houses without compromising either the interior or exterior environments. These technical requirements include both the performance goals and prescriptive measures that a house must meet to become eligible for R-2000 certification. The requirements are intended to give the builder flexibility in the selection of construction techniques, building products, mechanical equipment, lighting and appliances. The R-2000 Standard is periodically updated to ensure that R-2000 houses represent the leading edge of cost-effective housing technology.*

- 1.2 A Voluntary National Standard** - The R-2000 Standard is a voluntary national standard intended to encourage builder and consumer participation.

**Commentary**

*The technical requirements are applicable to all parts of Canada, although there is provision for the approval of additional, supplemental requirements at the regional level, provided they do not compromise the intent of the technical requirements or the health and safety features of the houses.*

- 1.3 Other Applicable Documents** - The following documents provide additional information on procedures and any revisions to the requirements of the R-2000 Standard since this document was published:

- ◆ *R-2000 Plan Evaluation, Inspection and Airtightness Testing Procedures and Guidelines*
- ◆ *R-2000 Indoor Air Quality and Environmental Features Pick-List –Appendix A*
- ◆ *Energy Target Calculation Procedure – Appendix B*

**Commentary**

*Technical and administrative procedures are combined in the R-2000 Procedures Manual. To ensure that you are working with the most current version of the Standard please refer to Natural Resources Canada's (NRCan's) R-2000 web site at <http://oee.nrcan.gc.ca/residential/builders-renovators-trades/12148> or contact your R-2000 service organization.*

## 2. SCOPE

- 2.1 Types of Buildings to Which These Requirements Apply** – This Standard applies to residential buildings that are within the scope of Part 9 of the National Building Code of Canada and are one of the following types:

- (i) detached houses, including houses with secondary suites,
- (ii) attached houses, which include semi-detached houses, row houses, and attached houses with secondary suites, and,
- (iii) multi-unit residential buildings (MURBs), which include stacked townhouses, duplexes, triplexes and apartment buildings.

**Commentary**

*Please refer to NRCan's R-2000 Web site at <http://oee.nrcan.gc.ca/residential/builders-renovators-trades/12148> or contact your R-2000 service organization for the current compliance procedures.*

- 2.2 R-2000 Technical Requirements are in Addition to Building Code Requirements** - These technical requirements are in addition to provincial building codes and local building requirements or, in the absence of such codes or requirements, to the requirements of the current edition of the *National Building Code of Canada*. Where an overlap exists, the more stringent requirement shall apply.

**Commentary**

*The R-2000 Standard is not a substitute for local or provincial building codes. Rather, it is an additional set of requirements that are intentionally more stringent in areas of energy efficiency, indoor air quality and environmental responsibility.*

### 3. COMPLIANCE

- 3.1 Only Licensed R-2000 Builders Can Construct R-2000 Houses** - To be eligible for R-2000 certification under the R-2000 Standard, the house must be constructed by a trained and licensed R-2000 Builder. R-2000 trained builders are required to register, build and certify an R-2000 Demonstration Home before they can become licensed.

**Commentary**

*See the Glossary at the end of this standard for the definition of “Licensed R-2000 Builder” and other program terms.*

- 3.2 R-2000 Certification** - To be eligible for R-2000 certification, the house shall comply with the rules and procedures established by Natural Resources Canada for plan evaluation, inspection, airtightness testing and issuance of an R-2000 certificate.

**Commentary**

*Each R-2000 service organization is authorized to enforce NRCan’s certification procedures. Service organizations shall adhere to minimum requirements set by Natural Resources Canada that include: (a) R-2000 house application; (b) plan evaluation; (c) inspection; (d) airtightness testing; and (e) issuance of an R-2000 certificate. The R-2000 Procedures Manual provides additional information.*

- 3.3 Equivalency** - Natural Resources Canada, in consultation with the Canadian Home Builders' Association and/or other industry representatives and the R-2000 service organization has the sole authority to accept equivalent materials, products, techniques or qualifications.

**Commentary**

*This clause provides the mechanism by which new products, systems or concepts may be accepted under the R-2000 Standard. It also allows for the resolution of differences of opinion as to whether a given feature meets the intent of the requirements.*

### 4. BUILDING ENVELOPE REQUIREMENTS

- 4.1 Minimum Insulation Levels** - Thermal insulation levels must meet or exceed provincial or local requirements.

**Commentary**

*Because the technical requirements are performance-based standards intended to allow the designer flexibility in how to meet the energy target, minimum insulation requirements are not specified, provided provincial and local requirements are met.*

- 4.2 Basement Wall Insulation** - Insulation shall be applied to a substantial portion of basement walls without any reduction in the RSI value.

**Commentary**

*Although full-height insulation is preferred, the phrase “substantial portion” was added because builders in some areas feel they can avoid moisture problems or the impact of flooding by raising the insulation off the floor slab to a maximum of 300 mm, thus leaving a small gap in the wall insulation. This practice is acceptable, provided the soil gas barrier is maintained and the energy target is met.*

- 4.3 Airtightness Requirements** - The building envelope shall be constructed sufficiently airtight such that either the air change rate at 50 Pascals is no greater than 1.5 air changes per hour, or the Normalized Leakage Area at 10 Pascals does not exceed 0.7 cm<sup>2</sup>/m<sup>2</sup> (1.0 in<sup>2</sup>/100 ft<sup>2</sup>), when measured in accordance with CAN/CGSB-149.10-M86 (*Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method*).

**Commentary**

*Airtightness is critical to building performance, not only to save energy but also to help ensure durability by preventing moist interior air from leaking outward and condensing within the envelope. Every R-2000 house must have the airtightness of its building envelope tested by a trained and R-2000 licensed airtightness tester to confirm that this requirement has been met. A dwelling unit shall be tested individually without fan depressurization of any adjacent heated space. Envelope area will include that of building components separating a dwelling unit from other dwelling units, heated space and/or the outdoors.*

- 4.4 Window Performance Requirements** - Windows shall have the following minimum requirements: double-glazed window with a low-emissivity coating, inert gas fill, and an insulated spacer with a wood, vinyl or fiberglass frame.

**Commentary**

*Decorative windows (side lights, windows in doors, half-circle windows, lead windows, transoms and other specialty glazing products) are allowed provided that the total glazing area of such decorative glazing does not exceed 15% of the total glazing surface area of the house. Canadian ENERGY STAR qualified windows meet or exceed these requirements. A list of these products can be found at: <http://oee.nrcan.gc.ca/residential/business/manufacturers/search/windows-search.cfm>*

## **5. MECHANICAL SYSTEMS**

### **5.1 Space Heating, Space Cooling and Water Heating Systems**

- 5.1.1 Fuel-Fired Space and Water Heating Appliances** - All natural gas-, propane- and oil-fired space and water heating appliances shall have either sealed direct-vent, induced-draft or forced-draft venting systems with electronic ignition and shall be independently vented. Induced-draft and forced-draft vented appliances shall be capable of positive shutdown in the case of venting system blockage.

**Commentary**

*The intent of this requirement is to confirm that all appliances used for space and water heating are not susceptible to combustion spillage since this can pose a serious health and safety risk to the occupants. Naturally aspirated appliances, as well as appliances with standing pilot lights, which are susceptible to spillage, do not meet this requirement. Also, spillage-resistant appliances operate at higher efficiencies, thereby saving energy and reducing operating costs. The prohibition against combined venting systems avoids the problem of one appliance spilling into the other if the house is depressurized. Although the Canadian Gas Association considers B-vents spillage-susceptible, their use is permitted provided the appliance is individually vented. The requirement specifies "venting system blockage" since the available technology, such as pressure switches, is capable of detecting blockage but not other types of failures, such as vent separation.*

- 5.1.2 Natural Gas and Propane Fireplaces** - Natural gas and propane fireplaces must be either direct-vent (sealed) and top- or rear-vented; or power-vented and shall also be capable of positive shutdown in the case of venting system blockage. Natural gas and propane fireplaces with doors that open shall not be installed. If the fireplace uses a standing pilot light, its energy consumption will be included in the energy consumption of the house when calculating whether the design meets the R-2000 space heating energy target.

**Commentary**

*The requirement for fireplaces without doors that open reduces the possibility of the appliance becoming susceptible to combustion spillage. Standing pilot lights are discouraged as they could increase the energy consumption of an R-2000 house from 6 to 23 percent with no useful contribution to the space-heating load.*

**5.1.3 Domestic Water Heaters** - Electric water heaters shall have standby losses not exceeding 65 Watts for a 175 L (40 imp. gal.) tank or 80 Watts for a 270 L (60 imp. gal.) tank, measured in accordance with CSA-C191-M90-04 *Performance of Electric Storage Tank Water Heaters for Household Service*, or an additional builder-installed insulation blanket with a minimum RSI of 1.8 (R-10). Natural gas and propane water heaters shall have an Energy Factor of 0.58 or greater. Oil-fired water heaters shall have an Energy Factor of 0.57 or greater.

**Commentary**

*Another technique for reducing the water-heating load is to use a drain water heat recovery system as these systems can be accounted for in HOT2000.*

## **5.2 Ventilation Systems**

**5.2.1 Design, Installation and Balancing of Ventilation Systems** – Mechanical ventilation systems shall be designed, installed and balanced in accordance with CAN/CSA-F326-M91 (R2010) *Residential Mechanical Ventilation Systems* by an HRAI-certified Residential Mechanical Ventilation Designer or Installer, or an R-2000-recognized equivalent.

**Commentary**

*A properly designed and performing mechanical ventilation system is essential in all houses to maintain good indoor air quality. Compliance with CAN/CSA-F326-M91 (R2010) means that the house automatically meets the ventilation requirements (Section 9.32) of the 2010 National Building Code of Canada.*

**5.2.2 Ventilation Equipment** – All heat recovery ventilators (HRVs), energy recovery ventilators (ERVs), exhaust fans and kitchen range hoods shall be certified by the Home Ventilating Institute (HVI).

**Commentary**

*This requirement was expanded in 2001 to include exhaust fans and kitchen hoods. A copy of the HVI Certified Home Ventilating Products Directory can be obtained from HVI's web site at [www.hvi.org/directory](http://www.hvi.org/directory). New types of integrated mechanical and ventilation equipment are rapidly entering the market. Please contact your R-2000 service organization or refer to NRCAN's R-2000 web site at <http://oee.nrcan.gc.ca/residential/builders-renovators-trades/12148> to determine whether equivalency has been established for any specific new product.*

## **5.3 Wood-Burning Appliances**

**5.3.1 Requirements** - All wood-burning appliances – including fireplaces, wood stoves and pellet stoves – must be certified as meeting either B415.1-10 *Performance Testing of Solid-Fuel-Burning Heating Appliances*, or the U.S. Environmental Protection Agency (EPA) wood-burning appliance standards (1990), 40 CFR Part 60.

**Commentary**

*The purpose of this requirement is to provide a minimum level of energy efficiency for wood-burning appliances. The CSA International and EPA standards are emissions-testing procedures that specify maximum levels of flue-gas emissions. Not surprisingly, appliances that produce low flue-gas emissions also burn more efficiently. Site-built fireplaces, with the exception of masonry heaters (discussed in clause 5.3.2 below), are not permitted in R-2000 houses.*

**5.3.2 Masonry Heaters** - Masonry heaters shall comply with the requirements specified in the *R-2000 Procedures Manual*.

**Commentary**

*Masonry heaters are appliances designed to burn rapidly a load of solid fuel mixed with an adequate amount of air at high temperature, to store the heat in the mass of the appliance, and to then gradually release the stored heat. They should not be confused with conventional fireplaces. Builders should confirm that their local authority having jurisdiction accepts masonry heaters.*

## 5.4 Verification of Heating, Cooling and Ventilation Systems

**5.4.1 Verification of Heating and Cooling Systems** – Heating and cooling system nameplate information shall be verified by a licensed R-2000 inspector in accordance with R-2000-recognized inspection procedures.

**Commentary**

*This requirement is intended to ensure that the specifications of the installed heating and cooling systems have been documented. This information will be reflected in the as-built HOT2000 run. Refer to the R-2000 Plan Evaluation, Inspection and Airtightness Testing Procedures and Guidelines section of the R-2000 Procedures Manual for information on these procedures.*

**5.4.2 Verification of Ventilation Systems** – Ventilation systems shall be inspected by a licensed R-2000 inspector in accordance with R-2000-recognized inspection procedures.

**Commentary**

*This requirement is intended to confirm that the specifications of the installed equipment are documented and the installation complies with clause 5.2 of this Standard. Refer to the R-2000 Plan Evaluation, Inspection and Air Tightness Testing Procedures and Guidelines section of the R-2000 Procedures Manual for information on these procedures. This information will be reflected in the as-built HOT2000 run.*

**5.5 Carbon Monoxide Detectors** - Carbon monoxide detector(s) conforming to CAN/CSA-6.19-01 (2006) *Residential Carbon Monoxide Alarming Devices* shall be installed in houses/each suite of residential occupancy containing either fuel-fired appliances or attached garages.

**Commentary**

*This requirement addresses concerns about potential combustion spillage from fuel-fired appliances and attached garages. The following describes the recommended best practices for complying with this requirement: 1.) The carbon monoxide detector(s) shall be equipped with an integral alarm which satisfies the audibility requirements of CAN/CSA-6.19-01(2006) Residential Carbon Monoxide Alarming Devices; 2.) The carbon monoxide detector(s) shall be permanently connected to an electrical circuit and shall have no disconnect switch between the over current device and the carbon monoxide detector; 3.) The carbon monoxide detector(s) shall be installed either inside each bedroom, or if outside, within 5 m, measured following corridors and doorways, of each bedroom door; 4.) The carbon monoxide detector(s) shall be mechanically fixed at a height recommended by the manufacturer; 5.) Where a fuel-burning appliance is installed in a service room that is not in a suite of residential occupancy, a carbon monoxide detector shall be installed either inside each bedroom, or if outside, within 5 m, measured following corridors and doorways, of each bedroom door in every suite of residential occupancy that shares a wall or floor/ceiling assembly with the service room, and in the service room. (Note: Item 5) applies to Multi-Unit Buildings only)*

**5.6 Ducts Carrying Outdoor Air** - Ducts that carry outdoor air through a conditioned space shall be insulated with a minimum of RSI 0.5 (R-3) and have a sealed vapour barrier.

**Commentary**

*The intention of this requirement is to help control heat loss and condensation problems on any ductwork that carries outdoor air through a conditioned space. The insulation requirements of this clause are consistent with those of CAN/CSA-F326-M91(R2010) Residential Mechanical Ventilation Systems.*

**5.7 Unvented Combustion Appliances** - No unvented combustion appliances shall be installed unless specific provision is made to exhaust the products of combustion to the outdoors.

**Commentary**

*This clause addresses the health, safety and indoor air quality concerns created by the operation of unvented combustion appliances. Unvented gas heaters are not permitted. Interlocking the range hood control to the gas range is suggested, provided it meets the manufacturer's installation requirements. Gas-fired ranges are permitted, provided a provision is made to exhaust the products of combustion to the outdoors.*



## 6. ENERGY PERFORMANCE TARGETS

- 6.1 Space Heating and Domestic Hot Water Energy Target** - The annual household energy consumption target for space heating and domestic hot water heating combined shall be that calculated using the current authorized version of HOT2000 and multiplied by 50%.

**Commentary**

*One of the most important components of the R-2000 Standard is the energy target, based on the combined consumption of energy for space heating and domestic water heating. The energy target is calculated for each house based on its size, location and fuel type. The equations for calculating the energy target are embedded in the HOT2000 program but need to be multiplied by 50% by the R-2000 plan evaluator. The energy target equations are presented in Appendix B – Energy Target Calculation Procedure.*

- 6.2 Determining Compliance with the Energy Target** - Compliance with the energy target shall be determined by a licensed R-2000 plan evaluator by using either the current authorized version of HOT2000 or the Pre-Approved Evaluation Method, as described in the *R-2000 Plan Evaluation, Inspection and Airtightness Testing Procedures and Guidelines* section of the *R-2000 Procedures Manual*.

**Commentary**

*The Pre-Approved Evaluation Method has been developed so that a house, or a group of similar houses, can be designed and pre-approved as meeting the energy target regardless of their orientation or insignificant changes in their design. With either method the detailed procedures set out in the R-2000 Procedures Manual must be followed. Once compliance has been demonstrated with either method, the house is deemed to have met the energy target.*

## 7. INDOOR AIR QUALITY

- 7.1 Indoor Air Quality** - At least three of the indoor air quality features identified in the current version of the *R-2000 Indoor Air Quality and Environmental Features Pick-List* shall be used in the house.

**Commentary**

*Superior indoor air quality is one of the features of an R-2000 house. While adequate ventilation is part of an effective control strategy, the most effective way to improve indoor air quality is to reduce or eliminate sources of pollutants. Proper materials selection is a key area where builders can make a difference in the air quality of the house. The R-2000 Indoor Air Quality and Environmental Features Pick-List is now produced as a separate document so that it can be more easily updated and any regional considerations added. The R-2000 Pick-List is included in Appendix A. Copies of the most recent pick-list are available from R-2000 service organizations and NRCan's R-2000 web site at <http://oee.nrcan.gc.ca/residential/builders-renovators-trades/12148>*

## 8. WATER CONSERVATION AND ENVIRONMENTAL FEATURES

- 8.1 Water Conservation** - Plumbing fixtures shall meet the following criteria:

- Toilets: Water-saver or ultra-low flush units using 4.8 litres/flush (1.3 U.S. gallons/flush) or less.
- Showers: Low-flow showerheads using 7.6 litres/min. (2.0 U.S. gallons/min) or less when tested at 551 kPa (80 psi).
- Faucets: Lavatory faucets using 5.7 litres/min. (1.5 U.S. gallons/min) or less when tested at 413 kPa (60 psi).

**Commentary**

*The R-2000 Standard recognizes the need to improve the environmental performance of housing both during construction and ongoing operation. This clause is intended to reduce the amount of water consumed on a daily basis in the house. The values chosen reflect both desired performance and market availability, and are based on WaterSense<sup>®</sup> specifications (<http://www.epa.gov/watersense/>). .*

**8.2 Environmental Features** - At least two of the environmental features identified in the current version of the *R-2000 Pick-List* shall be used in the house.

**Commentary**

*The R-2000 Indoor Air Quality and Environmental Features Pick-List is now produced as a separate document so that it can be more easily updated and any regional considerations added. The R-2000 Pick-List is included in Appendix A. Copies of the most recent pick-list are available from R-2000 service organizations and NRCan's R-2000 web site at <http://oee.nrcan.gc.ca/residential/builders-renovators-trades/12148>.*

## **GLOSSARY**

**Licensed R-2000 Builder** - A builder, who has successfully completed an R-2000 Builder Workshop, has built a certified R-2000 Demonstration Home, has taken periodic R-2000 technical updates as required, and holds a valid R-2000 Builder Licensing Agreement with Natural Resources Canada.

**R-2000 Trained Builder** - A builder who has been trained but has not yet successfully completed a certified R-2000 Demonstration House to prove that he/she has mastered the knowledge taught in the R-2000 Builder Workshop.

**R-2000 Service Provider** - An individual holding a valid R-2000 license in one or more of the following categories: R-2000 Plan Evaluator, R-2000 Inspector, R-2000 Airtightness Tester.

**R-2000 Demonstration Home** - The first home that an R-2000 trained builder builds to the R-2000 Standard. The house has been evaluated by a licensed R-2000 plan evaluator to determine compliance as designed. It has been registered with an R-2000 service organization and entered into the national R-2000 database. After construction, the house must be inspected and air tested to determine whether it meets the R-2000 Standard as built. If the house meets all R-2000 requirements, it is certified as an R-2000 demonstration home.

**Certified R-2000 Home** - A home constructed by a licensed R-2000 builder that meets the R-2000 Standard as built, and as determined by a successful completion of the R-2000 quality assurance process, consisting of a plan evaluation, inspection (building envelope and mechanical systems), and airtightness test, and that has been issued a certificate by NRCAN or its authorized designate.

**R-2000 Service Organization** – the R-2000 service organizations administer the R-2000 Standard on a regional basis.

## R-2000 Indoor Air Quality and Environmental Features Pick-List

### *The R-2000 Pick-List*

#### A. INDOOR AIR QUALITY FEATURES

The dwelling shall incorporate a minimum of **three** of the following indoor air quality features (from A-1 to A-9) inside the air barrier or air/vapour barrier.

1. **Carpeting** - Except as noted, carpeting used in the house shall meet either of the following criteria:
  - a) The carpet shall be labeled under the Canadian Carpet Institute's Green Label Program; *or*
  - b) A non-Green Label carpet shall cover no more than 50 percent of the interior floor area. In this case, the interior floor area does not include the basement floor area.

The following floor coverings are exempt: wool or cotton area rugs, and carpeting that has latex-free backing. These exempt floor coverings shall not be glued to the floor and cannot have under pads.

2. **Air filtration** - One of the following shall be installed:
  - a) A medium-efficiency air filter with a minimum MERV rating of 13 or 10 percent ASHRAE average dust spot efficiency, installed where air-circulating heating, or cooling systems are used; *or*
  - b) An electronic air cleaner permanently installed in the forced-air system ductwork; *or*
  - c) An air filtration system (e.g., activated carbon, catalytic air cleaners, etc.) in the forced-air system ductwork that is capable of removing gaseous contaminants from the air.
3. **Paints and varnishes** - All liquid coatings used indoors, including wood floors, shall have low-VOC content as determined by a third party certification program<sup>3</sup>. Pre-finished items are allowed.
4. **Flooring adhesives** - All finish flooring adhesives shall be water dispersion, low-VOC<sup>4</sup> formulations or be pre-adhesive types.
5. **Kitchen cabinets and bathroom vanities** - Cabinets and vanities shall be solid wood or, if made from manufactured wood products, shall be made from formaldehyde-free fibre board or particleboard meeting the E-1 European standard or the HUD Standard, 24 CFR Part 3280.308; or have all exposed surfaces sealed with an Environmental Choice-approved sealer or a low-VOC<sup>5</sup> sealer.
6. **Vinyl flooring** - All vinyl flooring shall be either linoleum or synthetic vinyl tile. Sheet vinyl flooring shall not be used.

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<sup>3</sup> VOC stands for volatile organic compounds. Eligible third party certification programs include: Green Seal, EcoLogo or GREENGUARD.

<sup>4</sup> *Ibid.*

<sup>5</sup> *Ibid.*

7. **Particleboard underlayment** - All particleboard-flooring underlayment shall meet the E-1 European standard or the ANSI A208.1-1993 Table B standard; or have all surfaces sealed with an Environmental Choice-approved sealer or a low-VOC<sup>6</sup> sealer; or be pre-finished.
8. **Sub-slab depressurization system** - Install an active sub-slab depressurization system to control the entry of radon and soil gases into the house.
9. **Indoor moisture control** - Choose one of the following options:
  - a) Provide control measures to isolate a crawl space or space underneath a basement floor so as to minimize the transmission of moisture and soil gases into the occupied space; or
  - b) Provide insulation with an RSI of 0.9 (R-5) or greater under the entire floor slab area; or
  - c) Include basement waterproofing, as opposed to dampproofing, or a free-draining layer, as a measure to keep the foundation drier and therefore less prone to mould development.

## B. ENVIRONMENTAL FEATURES

The dwelling shall incorporate a minimum of **two** of the following environmental features (from B-1 to B-14).

**Insulation** - As a minimum, use entirely in the attic, the main walls or the basement walls.

1. **Glass Fibre Insulation** - Meets or exceeds the requirements of the EcoLogo<sup>CM</sup> Program for raw material from recycled glass.
2. **Cellulose Insulation** - Meets or exceeds the requirements of the EcoLogo<sup>CM</sup> Program for raw material from recycled paper.
3. **Mineral Fibre Insulation** - Meets or exceeds the requirements of the EcoLogo<sup>CM</sup> Program for recycled raw material.
4. **Insulation Made from Plastic** - Meets or exceeds the requirements of the EcoLogo<sup>CM</sup> Program for recycled content.

**Sheathing/Drywall** - Product must replace equivalent conventional product throughout the house.

5. **Fibreboard** - Product is made from recycled newsprint and/or wood fibres.
6. **Siding** - Product is manufactured from factory and sawmill waste.
7. **Drywall** - Product contains recycled gypsum and/or newsprint.

**Interior framing and trim** - Product must replace equivalent conventional product for entire floor.

8. **Steel Studs** - A minimum of 23 percent of the raw material is recycled steel.
9. **Studs and trim** - Product is manufactured from sawmill cut-offs and waste, and is urea-formaldehyde free.
10. **Foundation and/or under-slab drainage** - Install a mixture of post-consumer glass and crushed rock or stone around the foundation wall and/or under the slab-on-grade. Product must replace equivalent conventional backfill in its entirety.

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<sup>6</sup> *Ibid.*

11. **Energy-efficient appliances** - Builders who include major electrical household appliances with the sale of the home shall provide appliances that meet the ENERGY STAR<sup>®</sup> technical specifications, where applicable. For appliance categories that are not part of the ENERGY STAR Program, the energy performance of the appliances must be in the upper 33 percent of the EnerGuide rating for that appliance category.

**Reduction in energy use**

12. **Energy target** - The house's predicted energy consumption is at least 15 percent less than its Energy Target (greenhouse gas reduction measure).
13. **Cooling systems** - The cooling system shall be ENERGY STAR qualified.
14. **Energy-Efficient Motors** – The house air distribution system shall be equipped with an energy-efficient motor (known as brushless DC motors, DC variable speed motors and ECM<sup>™</sup> motors). The furnace blower or the air handler can contain the energy-efficient motor.

## Energy Target Calculation Procedure

The annual energy consumption target for complying with the R-2000 Standard is determined from the following equation:

$$\text{Annual Energy Target} = [Q_S + Q_W] * 0.5$$

where:

$Q_S$  = space heating energy consumption target

$Q_W$  = domestic hot water energy consumption target

The annual space heating energy consumption target is calculated using the following equation:

$$Q_S = S * (49 * DD / 6000) * (40 + V / 2.5)$$

where:

$S$  = 4.5 megajoules (MJ) for fuel-fired space heating systems, or

$S$  = 1.0 kilowatt hours (kWh) or 3.6 megajoules (MJ) for electric space heating systems

$DD$  = Celsius heating degree-days for the locality

$V$  = Interior heated volume, including basement, in cubic meters

The annual domestic hot water heating energy consumption target is calculated using the following equation:

$$Q_W = 4745 * W * (55 - T_W) / (55 - 9.5)$$

where:

$T_W$  = local water mains temperature

$W$  = 1.72 kilowatt hours (kWh) or 6.19 megajoules (MJ) for fuel-fired DHW systems

$W$  = 1.075 kilowatt hours (kWh) or 3.87 megajoules (MJ) for electric DHW systems.

### Standard Conditions for Evaluating R-2000 Energy Performance

Main floor heating set point	21.0°C
Basement heated	Yes
Basement cooled	No
Basement set point	19.0°C
Basement separate thermostat	No
Allowable daily temperature rise	3.5°C
Interior loads, lighting	3.0 kWh/day
Interior loads, appliances	14.0 kWh/day
Interior loads, other	3.0 kWh/day
Average exterior use	4.0 kWh/day
Hot water load	225.0 L/day
Hot water temperature	55.0°C
Fraction of internal gains in basement	0.15
Adult occupants	2, at home 50% of time
Child occupants	2, at home 50% of time
Terrain, building site	Suburban, Forest
Local shielding, walls	Very Heavy
Local shielding, flue	Light local shielding
Ventilation sizing, including HRV	as per CSA Standard F326

## Mechanical Ventilation Rates for Evaluating the Energy Target

To comply with the R-2000 Standard, the ventilation energy use calculation assumes that a house is ventilated at a monthly average rate of 0.30 normal air changes per hour, with a minimum of 25 L/s and a maximum of 100 L/s, of combined natural and mechanical ventilation. The ventilation rates are provided mainly for the purpose of modelling and NOT for the purpose of sizing the ventilation equipment or systems. Ventilations systems must be designed and installed in accordance with CAN/CSA-F326-M91(R2010) *Residential Mechanical Ventilation Systems*. The following graph shows the HOT2000 modelling of monthly average ventilation rates:

