Energy Efficiency In Housing and Small Buildings

Building Standards and Licensing Branch

Promoting construction of safe, healthy, habitable buildings

Regina – November 27, 2018
Saskatoon – December 4 , 2018

Presented by: Building Standards and Licensing Branch
Saskatchewan Ministry of Government Relations

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Agenda

- Introduction
- Legal Framework
- Five Principles
- Objective and Functional Statements
- Climatic Data
- Overview of Section 9.36
- Prescriptive Path
  - General
  - Building Envelope
  - Heating Ventilation and Air Conditioning
  - Service Water Heating
- Performance Path
- Summary

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Introduction

Organization

- Government of Saskatchewan
  - Ministry of Government Relations
    - Public Safety Division
      - **Building Standards and Licensing Branch**
        - **Building Standards Unit**
        - Gas and Electrical Licensing
        - Interface to Technical Safety Authority of Saskatchewan
      - Emergency Management and Fire Safety Branch

Legal Framework

Legislative Framework

- *The Uniform Building and Accessibility Standards Act* (the UBAS Act)
- *The Uniform Building and Accessibility Standards Regulations* (the UBAS Regs.)
- Adoption of the National Building Code 2015 (NBC)

Municipal Framework (Local Authority)

- Building Bylaw

Energy Efficiency in Housing and Small Buildings

Legal Framework

Codes Adoption

NBC 2015 Section 9.36 Energy Efficiency
- Adopted January 1, 2018 and in force January 1, 2019

NECB 2015
- Adopted January 1, 2018 and in force January 1, 2019

NECB 2017
- Available from NRC free of charge in digital format
- Proposed for adoption and in force on January 1, 2019

2020 Editions
- Public Review underway from November 7 to January 4

Energy Efficiency in Housing and Small Buildings

Five Principles

Application of the NBC is guided by five principles under provision of the UBAS Act.

1) **Building owners** are responsible to comply.
2) **Local authorities** (municipalities) are responsible to administer and enforce.
3) **The Government of Saskatchewan** is responsible for the legislative, regulatory and policy framework.
4) **Building officials** work for the local authority.
5) **Designers (architects and engineers) and contractors** work for the building owner.

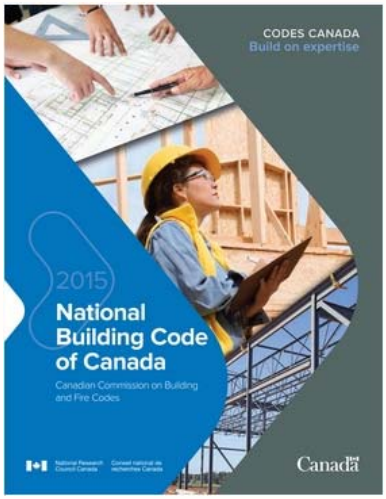
National Building Code (NBC)

Goals

- Protection of Life
- Protection of Property

Objectives

- Safety
- Health
- Accessibility for persons with disabilities
- Fire and structural protection of buildings
- **Environment**



Energy Efficiency

Division A, Part 2, Section 9.36

Objective

- **OE Environment**
  - **An objective of this Code is to limit the probability that, as a result of the design or construction of the *building*, the environment will be affected in an unacceptable manner.**
  - **OE1 Resources**
    - An objective of this Code is to limit the probability that, as a result of the design or construction of the *building*, resources will be used in a manner that will have an unacceptable effect on the environment. The risks of unacceptable effect on the environment due to use of resources addressed in this Code are those caused by –
    - **OE1.1** excessive use of energy

Energy Efficiency

Division A, Part 3, Section 9.36

Functional Statements

F90 - to limit the amount of uncontrolled air leakage through the building envelope.
F91 - to limit the amount of uncontrolled air leakage through the system components.
F92 - to limit the amount of uncontrolled thermal transfer through the building envelope.
F93 - to limit the amount of uncontrolled thermal transfer through the system components.
F94 - to limit the unnecessary energy demand and/or consumption of energy for lighting.

Energy Efficiency

Division A, Part 3, Relating to Section 9.36

Functional Statements

F95 - to limit the unnecessary energy demand and/or consumption of energy for heating and cooling.
F96 - to limit the unnecessary energy demand and/or consumption of energy for service water heating.
F97 - to limit the unnecessary energy demand and/or consumption of electrical equipment an devices.
F98 – to limit the inefficiency of equipment.
F99 - to limit the inefficiency of systems.
F100 - to limit the unnecessary rejection of reusable waste energy.

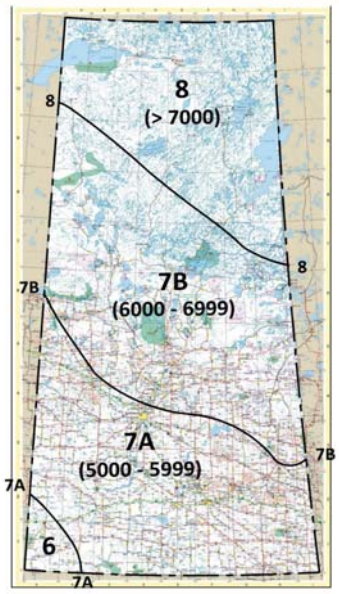
Energy Efficiency

Division C - Climatic Data

- Degrees days based on temperature **below 18°C**
- Data based on **tested** Saskatchewan locations
- Identify a location closest and use data based on heating degree days (HDD)
  - **Zone 6** - HDD 4000 to 4999
  - **Zone 7A** - HDD 5000 to 5999
  - **Zone 7B** - HDD 6000 to 6999
  - **Zone 8** - HDD ≥ 7000
- **www.climate.weather.gc.ca.**

Energy Efficiency

Saskatchewan Climate Zones by Average Annual Heating Degree-days at 18°C			
Zone 6 4000 to 4999	**Zone 7A 5000 to 5999**	**Zone 7B 6000 to 6999**	**Zone 8 ≥7000**
Maple Creek	Assiniboia	Hudson Bay	Island Falls
	Battrum	Humboldt	Uranium City
	Biggar	Kamsack	
	Broadview	Meadow Lake	
	Dafoe	Melfort	
	Dundurn	Nipawin	
	Estevan	Prince Albert	
	Kindersley	Yorkton	
	Lloydminster		
	Melville		
	Moose Jaw		
	North Battleford		
	Qu'Appelle		
	Regina		
	Rosetown		
	Saskatoon		
	Scott		
	Strasbourg		
	Swift Current		
	Weyburn		



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Division B, Section 9.36.

- General – Subsection 9.36.1.
- Building Envelope – Subsection 9.36.2.
- HVAC Requirements – Subsection 9.36.3.
- Service Water Heating Systems – Subsection 9.36.4.
- Energy Performance Compliance – Subsection 9.36.5.

Energy Efficiency

GENERAL
Subsection 9.36.1.

Energy Efficiency

General – Subsection 9.36.1.

- Scope - Article 9.36.1.1.
- Definitions - Article 9.36.1.2.
- Compliance and Application - Article 9.36.1.3.

Energy Efficiency

Scope - Article 9.36.1.1.

Section (9.36) is concerned with the energy used by buildings as a result of

(a) the design and construction of the building envelope, and

(b) the design and construction or specification of systems and equipment for

(i) heating, ventilating or air-conditioning, and

(ii) service water heating

Energy Efficiency

Definitions

- **Advanced framing** means a variety of framing techniques designed to reduce thermal bridging through an assembly resulting in an improved thermal performance

Definitions - Division A, Article 1.4.1.2.

- **Air barrier system** means the assembly installed to provide a continuous barrier to the movement of air

Energy Efficiency

Definitions - Article 9.36.1.2.

- **Common space** means all spaces required to be conditioned spaces in accordance with the requirements of the Code that are not within a suite but does not include crawl spaces and vertical service spaces.
  - Note: walls that enclose a common space are excluded from the calculation of floor area of that common space.

Energy Efficiency

Definitions - Article 9.36.1.2.

- **Effective thermal resistance** or **RSI (metric) value** means the inverse of the overall thermal transmittance of an assembly.
  - opaque material and assemblies are expressed as RSI
  - accounts for framing members, studs and lintels
  - calculations in RSI are required by the NBC.

$$\text{RSI} = \frac{R}{5.678}$$

- **Measured $(M^2 \cdot K)/W$ expressed as meters square-Kelvin per watts**

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Definitions - Article 9.36.1.2.

- **Fenestration** means all building envelope assemblies including their frames that **transfer visible light**, such as windows clerestories, skylights, translucent wall panels, glass block assemblies, transoms, sidelights, sliding, overhead or swinging glass doors and glazed inserts in doors, etc.

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Energy Efficiency

Definitions - Article 9.36.1.2.

- **Overall thermal resistance** or **U-value** means the rate at which heat is transferred through a building assembly that is subject to temperature differences.
  - required by the NECB
  - applied to windows and doors in Section 9.36
  - U-value considered maximum thermal transmittance or Energy Rating (ER) values
  - measured as $W/(m^2 \cdot K)$

$$U = \frac{1}{RSI}$$

Energy Efficiency

Definitions - Article 9.36.1.2.

- **Nominal thermal resistance** or **R (imperial) value** represents the resistance to heat transfer and typically measured in the centre of a batt of insulation.
  - imperial equivalent of RSI
  - measured in $(h \cdot ft.^2 {}^oF)/BTU$
  - conversion to RSI

R = RSI X 5.678

Energy Efficiency

Definitions – Notes to Section 9.36.

- **House(s)** include detached houses, semi-detached houses, duplexes, triplexes, townhouses, row houses and boarding houses.

Definitions - Division A, Article 1.4.1.2.

- ***Conditioned space*** means any space within a *building* the temperature of which is controlled to limit variation in response to the exterior ambient temperature by the provision, either directly or indirectly, of **heating or cooling** over substantial proportions of the year.

Energy Efficiency

Energy Performance Compliance - Definitions – General

- **Thermal barrier (break)** means an element of low conductivity placed between two conductive materials to limit heat flow
- **Thermal bridging** means an area or component of an object which has higher thermal conductivity than the surrounding materials, creating a path of least resistance for heat transfer
- **Thermal mass** means the ability of a material to absorb and store heat energy

Energy Efficiency

Compliance and Application - Sentence 9.36.1.3.(1)

- **Prescriptive**
  - separate requirements for each component/part
  - individual parts/components must comply with their specific targets
  - Includes trade off requirements
    - limited to building envelope
    - trade off higher performance for one part against lower performance of other parts.
- **Performance** requirements
  - based on a building's overall energy consumption; or
- **2015 National Energy Code of Canada for Buildings (NECB)**

Energy Efficiency

Compliance and Application - Sentence 9.36.1.3.(2)

- Prescriptive compliance (9.36.2. to 9.36.4.)
  - Part 9, Group C (residential) buildings
  - Part 9, Group D (office and professional services), Group E (mercantile) and Group F3 (light-hazard industrial) application for D, E and F3 based on ***floor area*** being **less than or equal to 300 m^2**
  - Part 9, combined mixed occupancies of Group C, D, E or F3 where non-residential portion **is less than or equal to 300 m^2**

Energy Efficiency

Compliance and Application - Sentence 9.36.1.3.(3)

Performance compliance (9.36.5.)applies to:

- Houses with or without a *secondary suite*
- *Buildings* containing only dwelling units and common spaces whose total *floor area* does not exceed 20% of the total *floor area* of the *building*.

Energy Efficiency

Compliance and Application – Section 9.36. not applicable to:

- *Building*s containing non-*residential occupancies* whose combined total floor area is **> 300m²**
- Group F2 (*medium-hazard industrial occupancies*)
- Buildings or portions not required to be conditioned space
- Farm buildings
- Seasonally heated buildings (Notes to 9.36)
- Accessory buildings 10m² or less
- Storage and parking garages that serve residential occupancies

Energy Efficiency

Building Types and Sizes	Energy Efficiency Compliance Options		
	NBC 9.36.2. to 9.36.4. (Prescriptive)*	NBC 9.36.5. (Performance)	NECB*
• houses with or without a secondary suite • buildings containing only dwelling units with common spaces ≤ 20% of buildings total floor area	✓	✓	✓
• Group C occupancies • buildings containing Group D, E or F3 occupancies whose combined floor area ≤ 300 m^2 (excluding parking garages that serve residential occupancies) • buildings with a mix of Group C and Group D, E or F3 occupancies where the non-residential portions combined total floor area ≤ 300 m^2 (excluding parking garages that serve residential occupancies)	✓	✘	✓
• buildings containing Group D, E or F3 occupancies whose combined floor area > 300 m^2 • buildings containing Group F2 occupancies of any size	✘	✘	✓
• NOTE: Asterisk denotes that Trade-off Compliance Path may be used in conjunction for meeting either 9.36 of the NBC or the NECB			

Energy Efficiency

BUILDING ENVELOPE
Subsection 9.36.2.

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Building Envelope – Subsection 9.36.2.

- Article 9.36.2.1. Scope and Application
- Article 9.36.2.2. Determination of Thermal Characteristics of Materials, components and Assemblies
- Article 9.36.2.3. Calculation of Ceiling, Wall, Fenestration and Door Area
- Article 9.36.2.4. Calculation of Effective Thermal Resistance of Assemblies
- Article 9.36.2.5. Continuity of Insulation

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Building Envelope – Subsection 9.36.2. (continued)

- Article 9.36.2.6. Thermal Characteristics of Above-ground Opaque Building Assemblies
- Article 9.36.2.7. Thermal Characteristics of Fenestration, Doors and Skylights
- Article 9.36.2.8. Thermal Characteristics of Building Assemblies Below-Grade or in Contact with the Ground
- Article 9.36.2.9. Airtightness
- Article 9.36.2.10. Construction of Air Barrier Details
- Article 9.36.2.11. Trade-off Options for Above-ground Building Envelope Components and Assemblies

Energy Efficiency

Scope and Application -Article 9.36.2.1

Scope

- concerned with energy loss due to heat transfer and air leakage through
  - materials
  - components
  - opaque assemblies

  of the building envelope.

Energy Efficiency

Scope and Application - Article 9.36.2.1

Application

- between conditioned space and unconditioned space, the exterior air or the ground.
- to components of a building envelope assembly that separate a conditioned space from an adjoining storage garage; even if the storage garage is intended to be heated.
- wall and roof assemblies will be defined based on the incline from the horizontal > or < than 60^{o}.
- windows, doors and skylights shall conform to Section 9.7
- thermal insulation, air barrier systems, vapour barrier and related materials shall conform with Section 9.25.

Energy Efficiency

Determination of Thermal Characteristics of Materials, Components and Assemblies - Article 9.36.2.2

Thermal characteristics of **windows, doors and skylights** shall be determined by calculation and testing to:

- CSA A440.2/A440.3, "Fenestration Energy Performance/User Guide to CSA A440.2-14, Fenestration Energy Performance" based on referenced sizes, or
- National Fenestration Rating Council (NFRC) 100, "Determining Fenestration Product U-factors", and NFRC 200, "Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence", based on referenced sizes.

Energy Efficiency

Determination of Thermal Characteristics of Materials, Components and Assemblies - Article 9.36.2.2

Effective thermal resistance of **opaque building assemblies** shall be determined from:

- Calculations conforming with Article 9.36.2.4., or
- Laboratory tests performed in accordance with ASTM C1363, "Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus,"
  - Tests shall use an indoor air temperature of 21 $\pm$ 1°C and an outdoor temperature of **-18 $\pm$ 1°C**
- Log wall RSI values to be determined by calculation to Section 305 of ICC 400, "Design and Construction of Log Structures"

Energy Efficiency

Calculation of Ceiling, Wall, Fenestrations and Door Areas - Article 9.36.2.3.

- **Gross ceiling area** is calculated using the sum of the interior areas of insulated ceiling/roof (including skylight areas)
- Info needed when considering trade off options

Energy Efficiency

Calculation of Ceiling, Wall, Fenestrations and Door Areas - Article 9.36.2.3.

- **Gross wall area** is the sum of the interior surface area of all exterior BE assemblies above finished ground level that are inclined 60^{o} or more from horizontal, including:
  - rim joists
  - fenestration and opaque portions of doors (including frame and sash)
  - insulated walls extending to the inside of the insulated ceiling
  - exposed areas of below ground assemblies where fenestration or doors are located below finished ground

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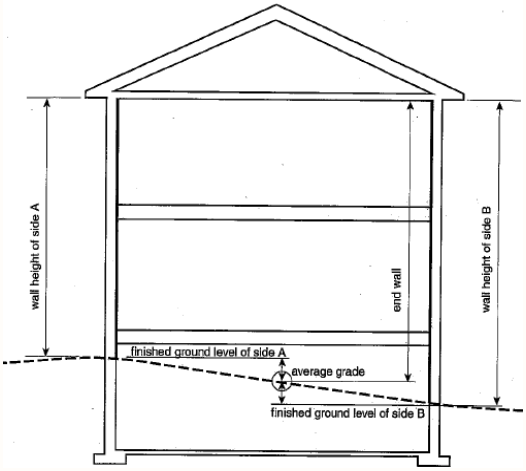
Calculation of Ceiling, Wall, Fenestrations and Door Areas – Notes Sentence 9.36.2.3.(2) and (3)



Courtesy of NRC

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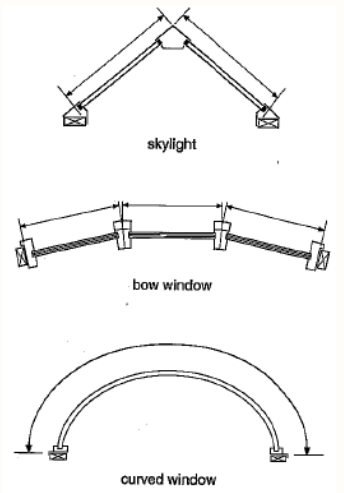
Calculation of Ceiling, Wall, Fenestrations and Door Areas - Article 9.36.2.3.

- Fenestration and door areas shall be the actual sizes of windows, doors and skylights including frames and sash members
- Fenestration areas made of flat planes, not on the same plane or curved planes shall be measured along the glass surface
- **Fenestration and Door area to gross Wall Ratio (FDWR)** introduced

Energy Efficiency

Calculation of Ceiling, Wall, Fenestrations and Door Areas - Article 9.36.2.3.

3 examples of fenestration calculation



Courtesy of NRC

Energy Efficiency

Calculation of Effective Thermal Resistance of Assemblies – Article 9.36.2.4.

- In calculating RSI of assemblies the thermal bridging effect of all members **shall be** included
- Minor penetrations such as pipes, ducts, through wall equipment vents, etc. **need not** be considered
- Major structural penetrations from balcony, canopy slabs, beams, etc. **need not** be included in the calculation provided:
  - the insulation is installed tight against the penetration, and
  - sum of area of all penetrations is $\leq$ 2% of the gross wall area
- Where the building envelope is protected with an enclosed verandah, sun porch or attached garage, the RSI_E of the common wall assembly can be reduced by **0.16 ($m^2 \cdot K$)/W**

Energy Efficiency

Calculation of Effective Thermal Resistance of Assemblies – Article 9.36.2.4.

- Appendix Notes provide examples of calculations and data tables for:
  - framing and cavity percentages for typical wood frame assemblies (Table A-9.36.2.4.(1)-A)
  - factors for steel framing to address higher thermal bridging through steel studs (Table A-9.36.2.4.(1)-B)
  - thermal resistance values for common materials used in assemblies (Table A-9.36.2.4.(1)-D)

Energy Efficiency

Calculating Effective Thermal Resistance of Assemblies – Article 9.36.2.4.

- Calculate the RSI of all layers with continuous materials using the **isothermal-planes (series-parallel) method**
- List the materials in the assembly:
  - exterior air film
  - cladding
  - air spaces
  - sheathing
  - insulation
  - interior finish
  - interior air space, and
  - structural supporting members, framing or foundation

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Energy Efficiency

Calculating Effective Thermal Resistance of Assemblies – Article 9.36.2.4.

- Calculate the RSI of all layers with continuous materials using the **isothermal-planes method**, plus
- Calculate the RSI of opaque assemblies (framing portion), $RSI_{parallel}$ using the following equation:

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Energy Efficiency

Calculating Effective Thermal Resistance of Assemblies – Article 9.36.2.4.

- Calculate the RSI of opaque assemblies (framing portion), $RSI_{parallel}$ using the following equation:

$$\text{RSI parallel} = \frac{100}{\frac{\%\text{ area of framing}}{RSI_F \text{ of framing}} + \frac{\%\text{ area of cavity}}{RSI_C \text{ of insulation in cavity}}}$$

- Table A-9.36.2.4.(1)-A provides the % for framing and cavity

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Energy Efficiency

Framing and Cavity Percentages for Typical Wood-frame Assemblies – Table A-9.36.2.4.(1)-A

Wood-frame Assemblies		Frame Spacing, mm o.c.									
		304		406		488		610		1220	
		% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity
Floors	lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
	I-joists and truss	–	–	9	91	7.5	92.5	6	94	–	–
Roofs/ Ceilings	ceilings with typical trusses	–	–	14	86	12.5	87.5	11	89	–	–
	ceilings with raised heel trusses	–	–	10	90	8.5	91.5	7	93	–	–
	roofs with lumber rafters and ceilings with lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
	roofs with I-joist rafters and ceilings with I-joists	–	–	9	91	7.5	92.5	6	94	–	–
	roofs with structural insulated panels (SIPs)	–	–	–	–	–	–	–	–	9	91
Walls	typical wood-frame	24.5	75.5	23	77	21.5	78.5	20	80	–	–
	advanced wood-frame with double top plate[a]	–	–	19	81	17.5	82.5	16	84	–	–
	SIPs	–	–	–	–	–	–	–	–	14	86
	basement wood-frame inside concrete foundation wall	–	–	16	84	14.5	85.5	13	87	–	–

23% Framing **77% Cavity**

Energy Efficiency

Illustration of Parallel Plane Method

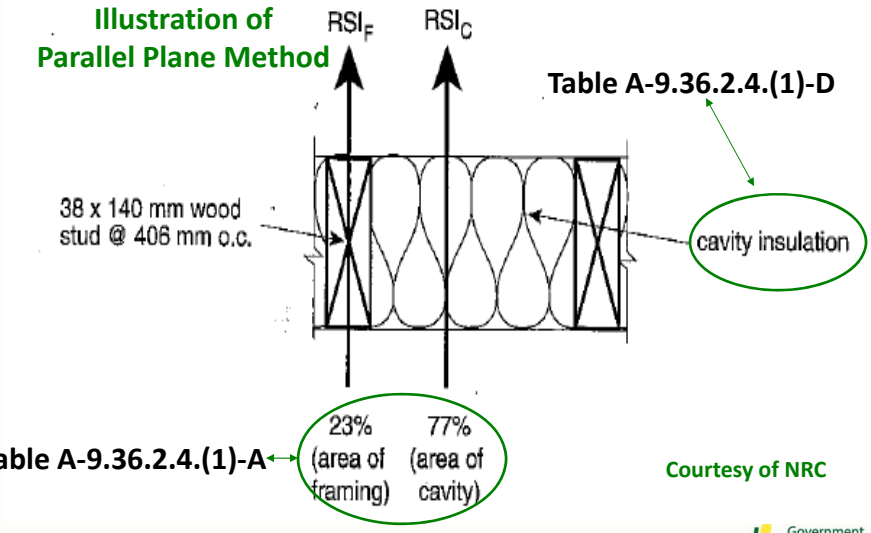

Table A-9.36.2.4.(1)-D

Table A-9.36.2.4.(1)-A

Courtesy of NRC

Energy Efficiency

Thermal Characteristics of Above-ground Opaque Building Assemblies – Article 9.36.2.6.

Opaque assemblies include:

- Above ground assemblies: walls, attics, floors over unheated spaces, etc.
- Below ground assemblies: foundation walls, floor slabs, heated slabs etc.

Two compliance options

- RSI values based on mechanical ventilation (no HRV)
- RSI values based on HRV

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Energy Efficiency

Thermal Characteristics of Above-ground Opaque Building Assemblies – Article 9.36.2.6.

- RSI of rim joists shall be not less than RSI required for above ground wall assemblies
- RSI is permitted to be reduced in the attic area for a length $\leq$ 1200 mm with limitations including maintaining a minimum RSI above the exterior wall of 3.52 $(M^2 \cdot K)/W$
- RSI value for skylight shafts shall be based on wall RSI value

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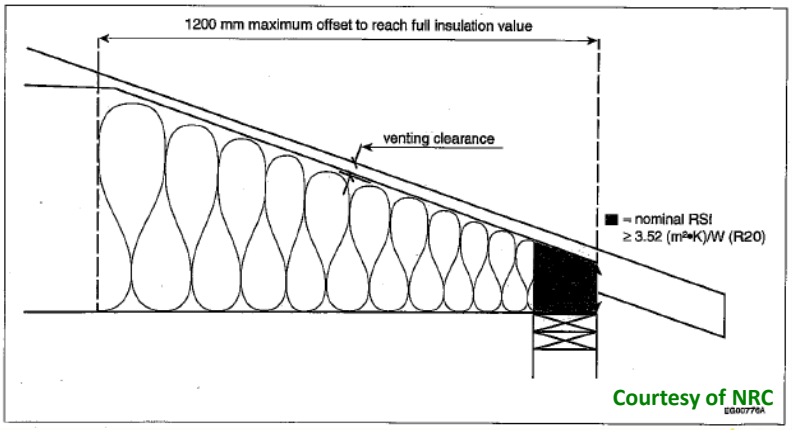
Energy Efficiency

Thermal Characteristics of Above-ground Opaque Building Assemblies – Article 9.36.2.6.



Courtesy of NRC

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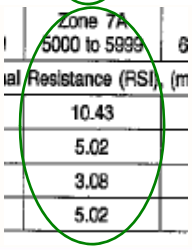
Effective Thermal Resistance of Above-ground Opaque assemblies in Buildings without a Heat-Recovery Ventilator- Table 9.36.2.6.-A

Above-ground Opaque *Building* Assembly	Heating Degree-Days of *Building* Location,(1) in Celsius Degree-Days					
	Zone 4 < 3000	Zone 5 3000 to 3999	Zone 6 4000 to 4999	Zone 7A 5000 to 5999	Zone 7B 6000 to 6999	Zone 8 ≥ 7000
	Minimum Effective Thermal Resistance (RSI), (m²·K)/W					
Ceilings below attics	6.91	8.67	8.67	10.43	10.43	10.43
Cathedral ceilings and flat roofs	4.67	4.67	4.67	5.02	5.02	5.02
Walls(2)	2.78	3.08	3.08	3.08	3.85	3.85
Floors over unheated spaces	4.67	4.67	4.67	5.02	5.02	5.02



Energy Efficiency

Effective Thermal Resistance of Above-ground Opaque assemblies in Buildings with a Heat-Recovery Ventilator- Table 9.36.2.6.-B

Above-ground Opaque *Building* Assembly	Heating Degree-Days of *Building* Location,(1) in Celsius Degree-Days					
	Zone 4 < 3000	Zone 5 3000 to 3999	Zone 6 4000 to 4999	Zone 7A 5000 to 5999	Zone 7B 6000 to 6999	Zone 8 ≥ 7000
	Minimum Effective Thermal Resistance (RSI), (m²·K)/W					
Ceilings below attics	6.91	6.91	8.67	8.67	10.43	10.43
Cathedral ceilings and flat roofs	4.67	4.67	4.67	5.02	5.02	5.02
Walls(2)	2.78	2.97	2.97	2.97	3.08	3.08
Floors over unheated spaces	4.67	4.67	4.67	5.02	5.02	5.02

Zone 7A 5000 to 5999
al Resistance (RSI),
8.67
5.02
2.97
5.02

Energy Efficiency

Sample Design for Opaque Wall Assembly Using Iso-thermal Plane (Series Parallel) Method

- Zone 7A – effective thermal resistance for zone = 2.97 RSI
- Typical wood frame construction
- Typical layers of material to form wall assembly
- Wall framing - 38 X 140 mm @ 400 mm o.c. (2” X 6” @ 16”)
- Wall insulation – RSI 3.87 = R-22
- HRV installed

Energy Efficiency

Framing and Cavity Percentages for Typical Wood-frame Assemblies – Table A-9.36.2.4.(1)-A

Wood-frame Assemblies		Frame Spacing, mm o.c.									
		304		406		488		610		1220	
		% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity
Floors	lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
	I-joists and truss	–	–	9	91	7.5	92.5	6	94	–	–
Roofs/ Ceilings	ceilings with typical trusses	–	–	14	86	12.5	87.5	11	89	–	–
	ceilings with raised heel trusses	–	–	10	90	8.5	91.5	7	93	–	–
	roofs with lumber rafters and ceilings with lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
	roofs with I-joist rafters and ceilings with I-joists	–	–	9	91	7.5	92.5	6	94	–	–
	roofs with structural insulated panels (SIPs)	–	–	–	–	–	–	–	–	9	91
Walls	typical wood-frame	24.5	75.5	23	77	21.5	78.5	20	80	–	–
	advanced wood-frame with double top plate※	–	–	19	81	17.5	82.5	16	84	–	–
	SIPs	–	–	–	–	–	–	–	–	14	86
	basement wood-frame inside concrete foundation wall	–	–	16	84	14.5	85.5	13	87	–	–

23% Framing **77% Cavity**

Energy Efficiency

Step 1 – Calculation RSI Parallel (RSI_P) for Wall Framing and Cavity

Framing % - Table A-9.36.2.4.(1)-(A)		**?%**	**?%**
$RSI_{framing}$ (RSI_F)	**Table A-9.36.2.4.(1)-D**		
Calculated @ (.085 X 140 mm) =	**?**		9-601
RSI_{cavity} (RSI_C)	**Table A-9.36.2.4.(1)-D**		
Calculated @ R-22	**?**		9-599

Energy Efficiency

Step 1 – Calculation RSI Parallel (RSI_P) for Wall Framing and Cavity

Framing % - Table A-9.36.2.4.(1)-(A)		**23%**	**77%**
$RSI_{framing}$ (RSI_F)	**Table A-9.36.2.4.(1)-D**		
Calculated @ (.085 X 140 mm) =	**1.19**		9-601
RSI_{cavity} (RSI_C)	**Table A-9.36.2.4.(1)-D**		
Calculated @ R-22	**3.87**		9-599

Energy Efficiency

Step 2 – Calculation of RSI Parallel (RSI_P) for Total of Wall Framing and Cavity

$RSI_{parallel}$ (RSI_P) Calculation

RSI_P Calculation

$$\frac{100}{\frac{\text{(\% of area of framing)}}{RSI_F} + \frac{\text{(\% of area of cavity)}}{RSI_C}}$$

100

?/? +?/?

= Total $_{parallel}$ RSI_P

Total $_{parallel}$ RSI_P = ?

Energy Efficiency

Step 2 – Calculation of RSI Parallel (RSI_P) for total of Wall Framing and Cavity

$RSI_{parallel}$ (RSI_P) Calculation

RSI_P Calculation $\quad \frac{100}{(\%\text{ of area of framing})/RSI_F + (\%\text{ of area of cavity})/RSI_C}$

$\frac{100}{23/1.19 + 77/3.87}$

= **Total $_{parallel}$ RSI_P**

Total $_{parallel}$ RSI_P = ***2.54944**

Energy Efficiency

Step 3 – Calculation RSI Continuous (RSI_C) for Wall Assembly

Assembly Layers	**A-9.36.2.4.(1)-D**		**Pge No.**
Ext. Air Film		?	9-597
Ext. Cladding – Vinyl		?	9-598
Ext. Sheath. OSB (11 mm) @ (.0098 X 11)		?	9-599
Vapour Barrier		0	9-599
Gypsum (12.7mm) @(.0063 X 12.7)		?	9-599
Inside air film		?	9-597
Total RSIContinuous (RSI_C) =		?	
Total RSIParallel (RSI_P) =		*2.54944	
Total RSIEffective (RSI_E) =	$RSI_P + RSI_C$	?	or ?

Energy Efficiency

Step 3 – Calculation RSI Continuous (RSI_C) for Wall Assembly

Assembly Layers	A-9.36.2.4.(1)-D		Pge No.
Ext. Air Film		0.03	9-597
Ext. Cladding - Vinyl		0.11	9-598
Ext. Sheath. OSB (11 mm) @ (.0098 X 11)		0.108	9-599
Vapour Barrier		0	9-599
Gypsum (12.7mm) @(.0063 X 12.7)		0.08	9-599
Inside air film		0.12	9-597
Total RSIContinuous (RSI_C) =		0.448	
Total RSIParallel (RSI_P) =		*2.54944	
Total RSIEffective (RSI_E) =	$RSI_P + RSI_C$	2.99744	or
		3.00	

Energy Efficiency

Step 4 – Calculation of RSI Effective (RSI_E) for Wall Assembly Including Wall Framing and Wall Cavity

Total $RSI_E = RSI_C + RSI_P$		
RSI_E	2.99744	3.00
Conversion of RSI_E X 5.678 = R	17.019464	17.0

RSI_E for Zone 7A		**2.97**
Conversion of RSI_E X 5.678 = R		16.9
	Compliant Design	

Energy Efficiency

Continuity of Insulation - Article 9.36.2.5.

Insulation shall be continuous across the assembly but not continuous across the face

Permitted exemptions:

- clearances around components required for fire safety
- major structural components that penetrate the envelope
  - provided as per sentence 9.36.2.4.(3):
    - insulation is installed tightly against the penetration
    - sum of areas of major structural penetrations is < 2% of gross wall area

Energy Efficiency

Continuity of Insulation - Sentence 9.36.2.5.(2) to (7)

- Sentences provides relaxations where continuity cannot be maintained and remedies for insulation of various construction details such as:
  - interior walls, foundations, firewalls, party walls or structural elements
  - ornamental or appendage elements
  - behind masonry fireplace
  - behind recessed heaters, ducts, etc.
  - behind pipes, cables, etc.

Energy Efficiency

Continuity of Insulation - Sentence 9.36.2.5.(8)

Joints and junctions (gaps) between walls and other building envelope components shall be insulated to ensure that the RSI is not less than adjoining components

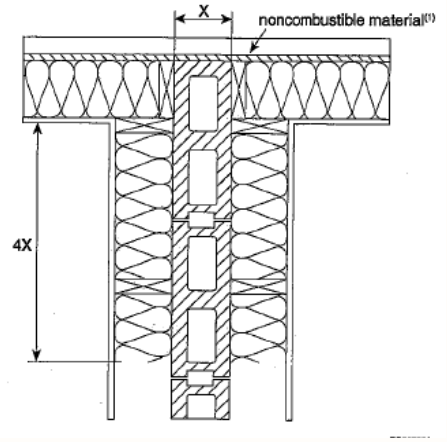
Sentence 9.36.2.5.(9)

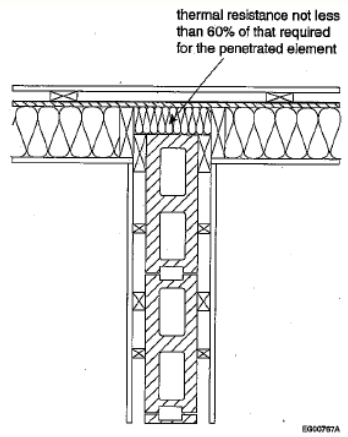
Insulation shall be installed continuous throughout an assembly.

- Except for:
  - joint area between the foundation wall and the floor slab
  - an integral perimeter footing of a slab-on grade
  - at the horizontal portion of a foundation wall that supports masonry veneer and is insulated on the exterior

Energy Efficiency

Continuity of Insulation - Article 9.36.2.5.





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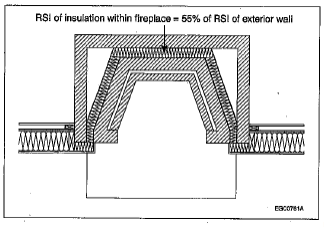
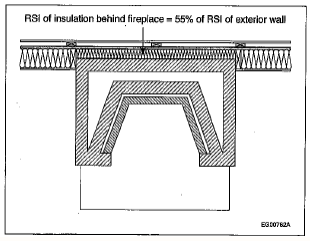
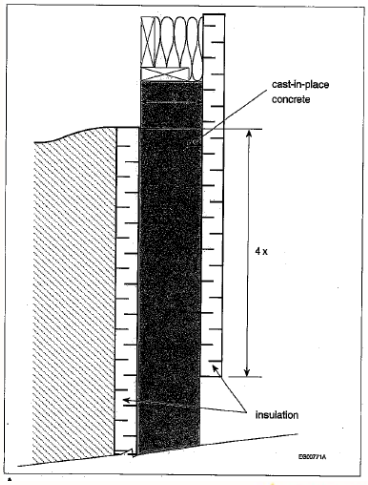
Energy Efficiency

Continuity of Insulation - Article 9.36.2.5.







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Energy Efficiency

Thermal Characteristics of Fenestration, Doors and Skylights - Sentence 9.36.2.7.(1)

- Windows and doors shall have an overall thermal transmittance based on U-value not greater than Table 9.36.2.7.-A, or
- Energy Rating (ER) not less than Table 9.36.2.7.-A

$$U = \frac{1}{RSI}$$

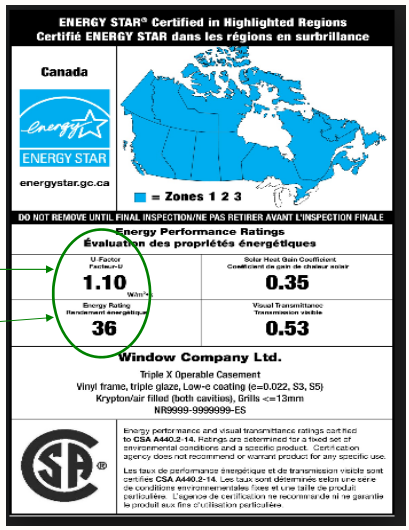
- Not applicable to skylights

Energy Efficiency

Thermal Characteristics of Fenestration, Doors and Skylights – Article 9.36.2.7.

U-Value

Energy Rating (ER)



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Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Thermal Characteristics of Fenestration, Doors and Skylights – Article 9.36.2.7.

General rule of thumb:

- U-value around 1.8 is typically achieved using argon filled glazing units with a low-e coating and energy-efficient spacer materials installed in a frame chosen mostly for aesthetic reasons
- U-value around 1.6 is typically achieved using triple glazing but may be achieved using double glazing with an optimized gas, space and coating configuration installed in an insulated frame
- U-value around 1.4 is typically achieved using triple glazing and multiple low-e coatings

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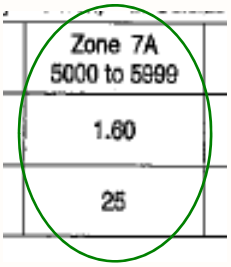
Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Required Thermal Characteristics of Fenestration and Doors - Table 9.36.2.7. –A

Components	Thermal Characteristics[1]	Heating Degree-Days of *Building* Location,[1] in Celsius Degree-Days					
		Zone 4 < 3000	Zone 5 3000 to 3999	Zone 6 4000 to 4999	Zone 7A 5000 to 5999	Zone 7B 6000 to 6999	Zone 8 ≥ 7000
Fenestration[2] and doors	Max. U-value, W/(m²·K)	1.80	1.80	1.60	1.60	1.40	1.40
	Min. Energy Rating	21	21	25	25	29	29



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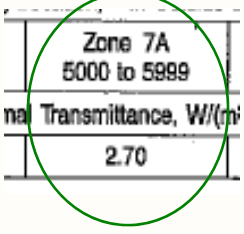
Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Overall Thermal transmittance of Skylights – Table 9.36.2.7.-B

Component	Heating Degree-Days of *Building* Location,[1] in Celsius Degree-Days					
	Zone 4 < 3000	Zone 5 3000 to 3999	Zone 6 4000 to 4999	Zone 7A 5000 to 5999	Zone 7B 6000 to 6999	Zone 8 ≥ 7000
	Maximum Overall Thermal Transmittance, W/(m²·K)					
Skylights	2.90	2.90	2.70	2.70	2.40	2.40



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Energy Efficiency

Compliance Options for Site Built Windows and Glazed Portion of Doors - Table 9.36.2.7.-C

Component	Description of Component	Compliance Options							
		Climate Zones 4 and 5 ≤ 3999 HDD			Climate Zones 6 and 7A 4000 to 5999 HDD			Climate Zones 7B and 8 ≥ 6000 HDD	
		1	2	3	1	2	3	1	2
Frame	non-metallic	✓	✓	–	✓	✓	–	✓	✓
	thermally broken metallic	–	–	✓	–	–	✓	–	–
Glazing	double	–	✓	–	–	–	–	–	–
	triple	✓	–	✓	✓	✓	✓	✓	✓
	argon-filled	–	✓	–	✓	–	✓	–	✓
Low-e coating	none	✓	–	–	–	–	–	–	–
	number of panes with ≤ 0.10	–	≥ 1	–	–	–	–	≥ 2	–
	number of panes with ≤ 0.20	–	–	2	≥ 1	2	≥ 2	–	≥ 2
Spacer	size, mm	12.7	–	12.7	≥ 12.7	12.7	≥ 12.7	≥ 12.7	≥ 12.7
	non-metallic	–	✓	–	–	–	–	–	–

Energy Efficiency

Thermal Characteristics of Fenestration, Doors and Skylights - Article 9.36.2.7.

Exceptions to **overall rating minimums**:

- storm windows and doors – exempt from NBC
- attic or crawl space hatches – RSI minimum of 2.6 $(m^2 \cdot K)/W$
- one main exterior door – U-value maximum of up to 2.6 $W/(m^2 \cdot K)$
- glass block assembly with area < 1.85 m^2 - U-value of 2.9 $W/(m^2 \cdot K)$
- garage doors - RSI minimum of 1.1 $/(m^2 \cdot K)/W$

Energy Efficiency

Thermal Characteristics of Building Assemblies Below-Grade or in Contact with the Ground - Article 9.36.2.8.

Article applies to:

- full height basement wall RSI as per Tables
- where floor assembly falls into two categories – most stringent value to apply
- top section of foundation wall – up to 600 mm above grade to be insulated as a foundation wall
- heated floor slabs must be insulated under entire area and edges as per the Tables
- floating slabs must be insulated under entire slab, excluding integral footing portion
- insulation of slab contingent on depth of frost line

Energy Efficiency

Effective Thermal Resistance of Assemblies Below-Grade or in Contact with the Ground in Buildings without a Heat-Recovery Ventilator – Table 9.36.2.8.-A

Building Assembly Below-*Grade* or in Contact with the Ground[1]	Heating Degree-Days of *Building* Location,[2] in Celsius Degree-Days					
	Zone 4 < 3000	Zone 5 3000 to 3999	Zone 6 4000 to 4999	Zone 7A 5000 to 5999	Zone 7B 6000 to 6999	Zone 8 ≥ 7000
	Minimum Effective Thermal Resistance (RSI), (m²·K)/W					
Foundation walls	1.99	2.98	2.98	3.46	3.46	3.97
Unheated floors[3]						
below frost line[4][5]	uninsulated	uninsulated	uninsulated	uninsulated	uninsulated	uninsulated
above frost line[5]	1.96	1.96	1.96	1.96	1.96	1.96
Heated and unheated floors on permafrost	n/a	n/a	n/a	n/a	4.44	4.44
Heated floors[6]	2.32	2.32	2.32	2.84	2.84	2.84
Slabs-on-grade with an integral footing[6]	1.96	1.96	1.96	3.72	3.72	4.59

Energy Efficiency

Effective Thermal Resistance of Assemblies Below-Grade or in Contact with the Ground in Buildings with a Heat-Recovery Ventilator – Table 9.36.2.8.-B

Building Assembly Below-*Grade* or in Contact with the Ground[1]	Heating Degree-Days of *Building* Location,[2] in Celsius Degree-Days					
	Zone 4 < 3000	Zone 5 3000 to 3999	Zone 6 4000 to 4999	Zone 7A 5000 to 5999	Zone 7B 6000 to 6999	Zone 8 ≥ 7000
	Minimum Effective Thermal Resistance (RSI), (m²·K)/W					
Foundation walls	1.99	2.98	2.98	2.98	2.98	2.98
Unheated floors[3]						
below frost line[4][5]	uninsulated	uninsulated	uninsulated	uninsulated	uninsulated	uninsulated
above frost line[5]	1.96	1.96	1.96	1.96	1.96	1.96
Heated and unheated floors on permafrost	n/a	n/a	n/a	n/a	4.44	4.44
Heated floors[6]	2.32	2.32	2.32	2.84	2.84	2.84
Slabs-on-grade with an integral footing[6]	1.96	1.96	1.96	2.84	2.84	3.72

Energy Efficiency

Airtightness – Article 9.36.2.9.

Two compliance options:

- prescriptive construction details
- using tested assemblies

Energy Efficiency

Airtightness – Article 9.36.2.9.

Prescriptive option for air barriers:

- Shall be continuous:
  - across construction, control and expansion joints
  - across junctions between different building materials and assemblies, and
  - around penetrations through all building assemblies
- Windows, doors and skylights shall comply with minimum air leakage requirements as per:
  - NAFS – North American Fenestration Standards……., and
  - CSA A440S1, Canadian Supplement to NAFS

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Airtightness – Article 9.36.2.9.

Prescriptive option for air barriers:

- Vehicular access doors separating heated space from unconditioned spaces or the exterior shall be weather stripped
- Fireplaces shall be equipped with doors to restrict air movement

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Energy Efficiency

Airtightness – Article 9.36.2.9.

2 tested assemblies options:

- assembly required to conform to CAN/ULC S742, Air Barrier Assemblies – Specification, at a pressure differential of 75 Pa, or
- Assembly tested to ASTM 2357 < 0.20 L/(s·m$^{2)}$ (air barrier material does not need to comply with Can/ULC S741 "Air-barrier Materials"
- Limited reference: material used does not need to comply with CAN/ULC-S741 "Air-barrier Materials"
- Provide junction details (manufacturers' instructions)

Energy Efficiency

Construction of Air Barrier Details - Article 9.36.2.10.

- Article compliments requirements of Article 9.36.2.9. Airtightness requirements
- Air barrier details must meet criteria of NBC Subsection 9.25.3. Air Barrier Systems
- Air sealing materials must be compatible with adjoining material
- Rigid panels must have all joints sealed to maintain continuity of airtightness

Energy Efficiency

Construction of Air Barrier Details - Article 9.36.2.10.

Air barrier systems can be:

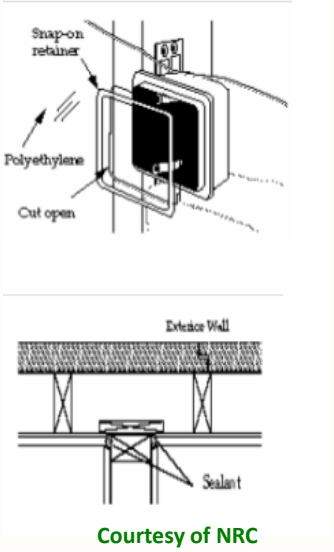
- Rigid panel or materials
  - airtight drywall
  - spray foam insulation
  - rigid panel material (extruded polystyrene)
- Membrane sheets
  - sealed poly
  - exterior building wrap
- Combination of the above

Energy Efficiency

Construction of Air Barrier Details Article 9.36.2.10.

Specific construction details for:

- electrical outlets and switches
- sill plates
- window-wall interface
- overhangs
- party wall details
- chimney and duct penetrations
- ICF (top of the wall to attic ceiling)



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Energy Efficiency

Trade-off Options - Article 9.36.2.11.

3 Trade-off Options:

- Opaque to opaque
- Transparent to transparent
  - limited to trades within same orientation
- Opaque to transparent
  - trade reduced window area for reduced attic insulation
  - intended for factory constructed houses/buildings (max FDWR 15%)

Energy Efficiency

Trade-off Options - Article 9.36.2.11.

- Reference design means a building element that complies with the prescriptive requirements of the NBC
- Proposed design refers to a building element whose RSI value can be traded in accordance with the NBC

Energy Efficiency

Trade-off Limitations – Article 9.36.2.11.

- Can't reduce walls and attic roofs below 55% of required RSI -value
- Can't reduce other opaque assemblies below 60% of required RSI -value
- Can't be applied to heated assemblies
- Can't reduce doors or attic hatches below RSI value
- Can't be applied to components and assemblies already exempted
  - ie: allowance for ceiling insulation reduction at eaves – no credit for raised heel trusses.

Energy Efficiency

Trade-off Equation

$$\sum_{i=1}^{n} \frac{A_{ir}}{R_{ir}} \geq \sum_{i=1}^{n} \frac{A_{ip}}{R_{ip}}$$

Reference Design **Proposed Design**

- R_{ir} = effective thermal resistance of assembly i of the reference case;
- A_{ir} = area of assembly i of the reference case;
- R_{ip} = effective thermal resistance of assembly i of the proposed case;
- A_{ip} = area of assembly i of the proposed case;
- n = total number of above-ground components or assemblies, and
- i = 1, 2, 3, …., n.

Energy Efficiency

Trade-off Options

- An owner wishes to decrease the RSI value of wall insulation as per the prescriptive requirements of Section 9.36. The proposal is a reduction from R-24 to R-20) in the walls
- The reduction of wall insulation will be offset by an increase in attic insulation as an acceptable trade-off

Energy Efficiency

Trade-off Calculation – Step 1

Assemblies Being Traded	Area of Assembly - A	Reference Design Values RSI Values - R Zone 7A	A/R Values	Proposed Design Values RSI Value - R	A/R Value
Wall	40 m^2	3.27 (m^2·K)/W	12.23 W/K	2.93 (m^2·K)/W	13.65 W/K
Attic	200 m^2	8.66 (m^2·K)/W	23.09 W/K	8.66 (m^2·K)/W	23.09 W/K
Total A/R value			35.32 W/K		36.74 W/K
Residual A/R					*1.42 W/K

- Proposed design values W/K must be $\leq$ reference design values for W/K
- Except where proposed W/K is part of trade-off
- Residual W/K of 1.42 = total W/K of proposed minus total W/K of reference (36.74 - 35.32)

Energy Efficiency

Trade-off Calculation – Step 2

Assemblies Being Traded	Area of Assembly - A	Reference Design Values RSI Values - R Zone 7A	A/R Values	Proposed Design Values RSI Value - R	A/R Value
Wall	40 m^2	3.27 (m^2·K)/W	12.23 W/K	2.93 (m^2·K)/W	13.65 W/K
Attic	200 m^2	8.66 (m^2·K)/W	23.09 W/K	9.23 (m^2·K)/W	*21.67 W/K
Total A/R value			35.32 W/K		35.32 W/K

- For Trade-off - residual W/K subtracted from proposed design for attic 23.09 W/K - 1.42 W/K = 21.67 W/K
- RSI of attic has to be minimum (200 /21.67 = 9.23 (m^2·K)/W)
- 9.23 (m^2·K)/W or R-52
- Balance of W/K achieved between reference and proposed

Energy Efficiency

HVAC
Subsection 9.36.3.

Energy Efficiency

HVAC Requirements – Subsection 9.36.3.

- Article 9.36.3.1. Scope and Application
- Article 9.36.3.2. Equipment and Ducts
- Article 9.36.3.3. Air Intake and Outlet Dampers
- Article 9.36.3.4. Piping for Heating and Cooling Systems
- Article 9.36.3.5. Equipment for Heating and Air-Conditioning Systems
- Article 9.36.3.6. Temperature Controls
- Article 9.36.3.7. Humidification
- Article 9.36.3.8. Heat Recovery from Dehumidification in Spaces with an Indoor Pool or Hot Tub
- Article 9.36.3.9. Heat Recovery from Ventilation Systems

Energy Efficiency

HVAC Requirements – Subsection 9.36.3. (continued)

- Article 9.36.3.10. Equipment Efficiency
- Article 9.36.3.11. Solar Thermal Systems

Energy Efficiency

HVAC -Scope and Application – Article 9.36.3.1.

- Subsection to be applied to systems and equipment used for heating, ventilating and air-conditioning (HVAC)
- Heating systems to be designed in accordance with good practice (Sections 9.32 and 9.33)
- HVAC system, equipment or techniques used beyond the scope of subsection 9.36.3., design would have to be to the NECB.

Energy Efficiency

Equipment and Ducts – Article 9.36.3.2.

- Proper sizing of system and ducts to section 9.32 and 9.33
- Outside ducts and piping supplying conditioned air shall be insulated = above-grade wall RSI-value
- Trade-off (rectangular ducts)
  - increase side insulation to compensate for lesser bottom insulation
  - performance expected to be close to equal
  - minimum RSI of insulation 2.11 $(m^2 \cdot K)/W$
- Ducts must be sealed to SMACNA Class A sealing including all joints with sealants or gaskets made from liquids, mastics or heat-applied materials, mastic with embedded fabric, or foil faced butyl tape

Energy Efficiency

Air intake and Outlet Dampers – Article 9.36.3.3.

- Dampers are required for every duct or opening intended to discharge air to the outdoors including
  - motorized dampers
  - gravity or spring loaded dampers
- Except:
  - where other regulations supersede these requirements
  - where the HVAC system operates continuously

Energy Efficiency

Piping for Heating and Cooling Systems – Article 9.36.3.4.

- Piping for heating and cooling shall be designed and installed to subsection 9.33.8.
- Piping for heating or A/C shall be located inside the plane of insulation, or within or outside the plane of insulation, provided the piping is insulated to a RSI not less than required for exterior above ground walls
- Except:
  - high-temperature refrigerator piping

Energy Efficiency

Temperature Controls – Article 9.36.3.6.

- Supply of heating and cooling energy to a dwelling unit shall be controlled by a thermostat
- Thermostatic controls shall activate the appropriate supply when the temperature in a conditioned space fluctuates **± 0.5ºC** to prevent overheating
- Automatic devices or manually operated dampers shall be installed as necessary to permit zone control of the heating
- Heat pumps with supplemental heaters shall include controls to lessen the need for supplemental heat when the pump is able to meet the heating demands

Energy Efficiency

Humidification – Article 9.36.3.7.

- If humidifier is installed with HVAC system, it shall have automatic controls

Energy Efficiency

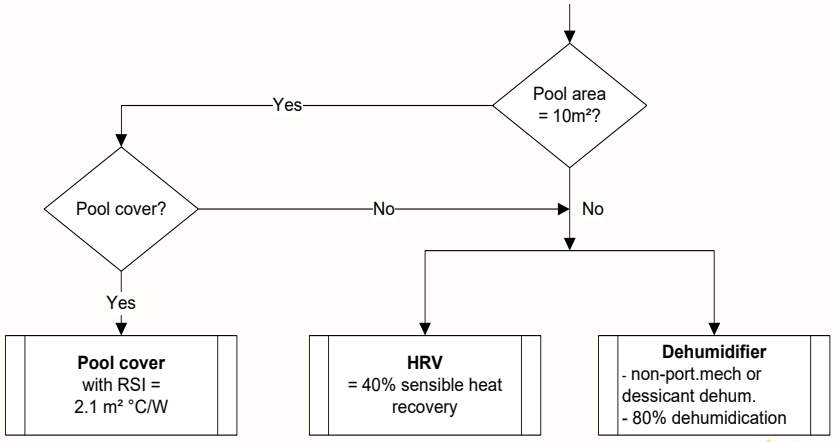
Heat Recovery from Dehumidification in Spaces with an Indoor Pool or Hot Tub – Article 9.36.3.8.

- Heat recovery systems shall be capable of recovering a minimum 40% of the sensible heat from exhausted air when tested to AHRI 1060 (I-P), "Performance Rating of Air-to Air Exchangers for Energy Recovery Ventilation Equipment, or
- Equipped with **sensible-heat-recovery efficiency** complying with Sentence 9.36.3.9.(3) in accordance with CAN/CSA-C439, Rating the Performance of Heat-Energy-Recovery Ventilators.
- Except where there is an alternative dehumidification system providing at least 80% dehumidification

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Heat Recovery from Dehumidification in Spaces with an Indoor Pool or Hot Tub – Article 9.36.3.8.



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Energy Efficiency

Heat Recovery from Dehumidification in Spaces with an Indoor Pool or Hot Tub – Article 9.36.3.8.

- Sensible heat in kW, is the sensible heat content of the total quantity of exhausted air expressed as:
- **Sensible Heat = 0.00123 · Q · (T_e – T_o) where:**
  - T_e = temperature of exhausted air before heat recovery in ^oC
  - T_o – outdoor 2.5 % January design temperature as listed in Appendix C in ^oC
  - Q = rated capacity of exhaust system at normal temperature of exhausted air in L/s

Energy Efficiency

Heat Recovery from Ventilation Systems – Article 9.36.3.9.

- Applies where self-contained mechanical ventilation system is installed which is equipped with a heat-recovery ventilator
- Where integrated mechanical system (IMS) with an HRV provides the principal exhaust ventilation, it must be tested to CSA P.10, “Performance of Integrated Mechanical Systems for Residential Heating and Ventilation”

Energy Efficiency

Equipment Efficiency – HVAC Equipment Performance Requirements - Table 9.36.3.10. (excerpt)
A/C Units

Component or Equipment	Heating or Cooling Capacity, kW	Standard	Minimum Performance[1]
Air-Cooled Unitary Air Conditioners and Heat Pumps – Electrically Operated			
Split system	≤ 19	CSA C656	SEER = 14.5 EER = 11.5 HSPF = 7.1 (region 5 in standard)
Single-package system	≤ 19	CSA C656 (including General Instruction No. 2)	SEER = 14 EER = 11 HSPF = 7.0 (region 5 in standard)
All systems	> 19	CAN/CSA-C746	See Level 2 in standard
Water-Cooled Unitary Air Conditioners and Heat Pumps – Electrically Operated			
Ground-source and water-source			

Energy Efficiency

Equipment Efficiency – HVAC Equipment Performance Requirements - Table 9.36.3.10. (excerpt)

Gas-fired *boilers*[3]	≤ 88 > 88 and ≤ 117.23	CSA P.2 AHRI BTS	AFUE ≥ 90% E_t ≥ 83%
Oil-fired *boilers*	≤ 88	CSA B212 or ANSI/ASHRAE 103	AFUE ≥ 85%
Warm-Air Furnaces, Combination Warm-Air Furnace/Air-conditioning Units, Duct Furnaces and Unit Heaters			
Gas-fired warm-air *furnaces*[3]	≤ 65.9 > 65.9 and ≤ 117.23	CSA P.2 CAN/CSA-P.8	AFUE ≥ 92% E_t ≥ 78.5%
Gas-fired duct *furnaces*[3]	≤ 117.23	ANSI Z83.8/CSA 2.6	E_t ≥ 81%
Gas-fired *unit heaters*[3]	≤ 117.23	CAN/CSA-P.11	E_t ≥ 82%
Oil-fired warm-air *furnaces*	≤ 66	CSA B212	AFUE ≥ 85%
Oil-fired duct *furnaces* and *unit heaters*	—	UL 731	E_c ≥ 80%
Combined space- and water-heating systems (combos)	≤ 87.9 if *boiler*-based ≤ 73.2 if based on *service water heater*	CAN/CSA-P.9[4]	TPF = 0.65
Integrated mechanical systems	—	CSA P.10	OTPF = 0.78
Other			

Energy Efficiency

Equipment Efficiency – Sentence 9.36.3.10.(2)

- Natural gas and propane fireplaces and stoves not referenced in Table 9.36.3.10.
- Current performance levels for such appliances are inconsistent with equipment types currently on the market
- When CSA standard is revised this may change
- Natural gas and propane fireplaces and stoves shall be directed vented, and
- Require pilot on demand, interrupted or intermittent ignition systems without a standing pilot light

Energy Efficiency

Solar Thermal Systems– Article 9.36.3.11. and 9.36.4.3.

- Applies to HVAC and service water heating (SWH)
  - solar space heating technology recognized
  - solar water heating technology recognized
  - shall conform to manufacturer's design and installation procedures, or
  - installation according to NPC

Exception:

- hot water storage tanks shall be installed in conditioned space

Energy Efficiency

SERVICE WATER HEATING SUBSECTION 9.36.4.

Energy Efficiency

Service Water Heating Systems – Scope and Application - Article 9.36.4.1.

- Applies to efficient use of energy by systems used to heat service water for domestic use as well as for indoor pools and hot tubs
- Where compliance cannot be achieved with this Article, NECB shall apply

Energy Efficiency

Service Water Heating Systems – Equipment Efficiency – Article 9.36.4.2.

- Minimum equipment efficiencies identified as per Table 9.36.4.2. for electric, gas or oil
  - service water heaters
  - boilers, pool heaters, and
  - tankless and storage tanks
  - combo systems (water and heating)
- Storage tanks and re-circulating pipes not listed in Table 9.36.4.2. need to be insulated to 1.8 ($m^2 \cdot K$)/W minimum
- SWH equipment must be installed in a *conditioned* space

Energy Efficiency

Service Water Heating Systems – Table 9.36.4.2.

Component	Input[1]	Standard	Performance Requirement[2]
Storage-Type Service Water Heaters			
Electric	≤ 12 kW (50 L to 270 L capacity)	CAN/CSA-C191	SL ≤ 35 + 0.20V (top inlet)
			SL ≤ 40 + 0.20V (bottom inlet)
	≤ 12 kW (> 270 L and ≤ 454 L capacity)		SL ≤ (0.472V) – 38.5 (top inlet)
			SL ≤ (0.472V) – 33.5 (bottom inlet)
	>12 kW (> 75 L capacity)	ANSI Z21.10.3/CSA 4.3 and DOE 10 CFR, Part 431, Subpart G	S ≤ 0.30 + 67V_m
Heat pump water heaters	≤ 24 A and ≤ 250 V	CAN/CSA-C745	EF ≥ 2.0
Gas-fired[6]	< 22 kW	CAN/CSA-P.3	EF ≥ 0.67 – 0.0005V
	≥ 22 kW	ANSI Z21.10.3/CSA 4.3	E_t ≥ 80% and standby loss ≤ rated input[4]/(800 + 16.57·√V)
Oil-fired	≤ 30.5 kW	CAN/CSA-B211	EF ≥ 0.59 – 0.0005V
	> 30.5 kW	ANSI Z21.10.3/CSA 4.3 and DOE 10 CFR, Part 431, Subpart G	E_t ≥ 78% and standby loss ≤ (rated input[4]/800) + 16.57·√V
Tankless Service Water Heaters			
Gas-fired	≤ 73.2 kW	CAN/CSA-P.7	EF ≥ 0.8
	> 73.2 kW	ANSI Z21.10.3/CSA 4.3 and DOE 10 CFR, Part 431, Subpart G	E_t ≥ 80%
Oil-fired	≤ 61.5 kW[5]	DOE 10 CFR, Part 430, Subpart B, Appendix E	EF ≥ 0.59 – 0.0019V_m
	Other	ANSI Z21.10.3/CSA 4.3 and DOE 10 CFR, Part 431, Subpart G	E_t ≥ 80%
Electric	—	—	[illegible]
	≤ 82.9 kW if boiler-based		

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Service Water Heating Systems - Piping – Article 9.36.4.4.

- Insulate first 2 m of outlet and inlet piping from storage or heating vessel minimum 12 mm thick
- Insulate recirculation piping to minimum 12 mm thick (0.8 m² °K/W)
- Insulate piping forming part of the service water heating system located outside the building envelope or in unconditioned space to be not less than the RSI required for exterior above ground walls.

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Service Water Heating – Controls– Article 9.36.4.5.

- Controls for service water heating systems and storage tanks must be equipped with automatic temperature controls capable of adjustment between minimum and maximum temperature settings

Energy Efficiency

Service Water Heating Systems - Indoor Swimming Pool Equipment Controls – Article 9.36.4.6.

- Heaters for indoor swimming pools must be equipped with:
  - thermostat
  - readily accessible and clearly labeled device that allows the heater to be shut off without adjusting the thermostat
- Pumps and heaters shall be equipped with time switches or other types of controls that can be set automatically when pool is not in use

Energy Efficiency

PERFORMANCE SUBSECTION 9.36.5.

Energy Efficiency

Energy Performance Compliance - Article 9.36.5.1.

Application to:

- houses;
- houses with secondary suites; and
- buildings containing dwelling units with common spaces ≤ 20% floor area.

Cannot be applied to non-residential occupancies and buildings

Energy Efficiency

Energy Performance Compliance – Scope – Article 9.36.5.1.

Scope of subsection 9.36.5. concerned with:

- Modeling of energy performance of components, systems and assemblies, including heat gains from internal loads of:
- Prescriptive path includes:
  - building envelope
  - HVAC & SWH
  - no trade-off across building envelope and HVAC
- Excluded internal loads from performance compliance calculation:
  - lighting of unconditioned spaces
  - exterior lighting, and
  - ventilation of unconditioned spaces

Energy Efficiency

Energy Performance Compliance - Definitions - Article 9.36.5.2.

- **Annual energy consumption** means the annual sum of service water heating and space-conditioning energy consumption of the proposed house design, as calculated in accordance with this subsection (9.36.5.)
- **House** is used in this Article and throughout subsection 9.36.5. to include residential buildings in contradiction to the term “building” as otherwise referenced throughout the NECB.

Energy Efficiency

Energy Performance Compliance - Definitions - Article 9.36.5.2.

- **House energy target** shall mean the annual energy consumption of the referenced house, as calculated in accordance with subsection 9.36.5.
- **Principal ventilation rate** means the normal operating exhaust capacity of the principal ventilation fan as required by Article 9.32.3.3.

Energy Efficiency

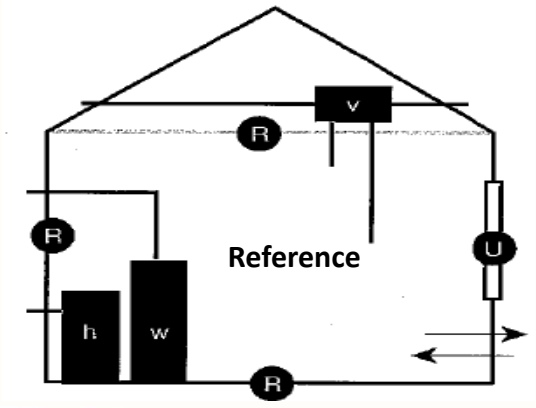
Energy Performance Compliance - Definitions - Article 9.36.5.2.

- **Reference house** means a hypothetical replica of the proposed house design using the same energy sources for the same functions and having the same environmental requirements, occupancy, climatic data and operating schedules.
- Reference house must satisfy the prescriptive requirements of subsections 9.36.2 to 9.36.4

Energy Efficiency

Energy Performance Compliance

- **Reference house** built as proposed house using prescriptive path values (+ assumptions)



= X

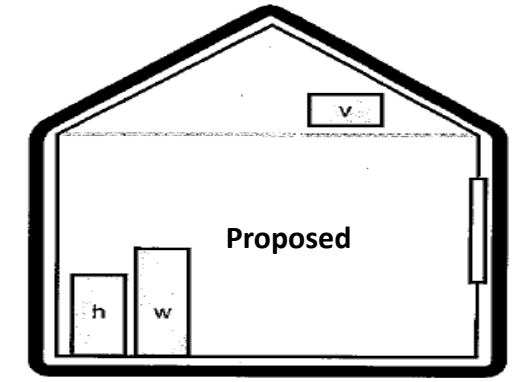
Reference

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Energy Performance Compliance

- **Proposed house** modeled against reference result
- If proposed houses uses ≤ energy = acceptable



≤ X
Reference

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Energy Efficiency in Housing and Small Buildings

Energy Efficiency

Energy Performance Compliance - Article 9.36.5.3.

- Performance compliance calculations (modelling) to determine
  - annual energy consumption of proposed house against house energy target of reference house
- Energy model to show proposed design does not exceed house energy target of reference house
  - house energy target includes building components, systems and assemblies as prescribed in subsections 9.36.2. to 9.36.4.
  - annual energy consumption includes building components, systems and assemblies as prescribed in subsections 9.36.2. to 9.36.4.

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Energy Efficiency

Energy Performance Compliance - Article 9.36.5.3.

Both proposed and reference houses shall be modeled using the same:

- climatic data
- soil conditions
- operating schedules
- temperature set points

Energy Efficiency

Calculation Methods - Article 9.36.5.4.

Shall include annual energy consumption of systems and equipment required for:

- space heating
- ventilation
- SWH
- A/C, if installed
- back up system can be disregarded provided the equipment is not required to provide space conditioning

Energy Efficiency

Calculation Methods - Article 9.36.5.4.

General calculation information:

- user dependent load assumptions and exclusions
- space heating and space cooling temperature set points
- where computer program used it shall be for both reference and proposed houses
- computer programs must satisfy ANSI/ASHRAE 140, "Evaluation of Building Energy Analysis Computer Programs"
- proposed and reference house shall be modeled with same assumptions except as otherwise permitted by 9.36.5.

Energy Efficiency

Climatic Data - Article 9.36.5.5.

- Calculations shall be performed using climatic data measured at a time interval no greater than one hour for one year (8760 h) based on the average of at least 10 years of measured data collected at the weather station nearest to the region in which the proposed house is located.
- In urban regions or where climatic data is not available, energy modelling shall be performed using climatic data that best represent the climate of the building site.

Energy Efficiency

Building Envelope Calculations - Article 9.36.5.6.

Modelling calculations based on each hour of the year:

- Shall account for heat transfer:
  - through wall assemblies, roof-ceiling assemblies, including attics and exposed floor assemblies
- Including building envelope assemblies :
  - above-ground wall and roof-ceiling assemblies
  - floors and walls in contact with the ground
  - doors windows and skylights

Energy Efficiency

Calculation Methods - Article 9.36.5.6.

- Modelling calculations shall account for the presence of thermally active walls, floors and ceilings with embedded conditioning systems forming part of the building envelope
- Where skylights are installed in the roof, the gross roof area shall be determined in accordance with sentence 9.36.2.3.(3)
- Skylights shall be considered to have no shading
- Modelling calculations shall account for exterior permanent and fixed shading based on solar heat gain from fenestration
- Ratio of fenestration area to opaque area of doors shall be the same for proposed and reference houses

Energy Efficiency

HVAC System Calculations - Article 9.36.5.7.

- Modelling shall account for the energy consumption of each heating, ventilating and A/C system for each hour of the year
- Performance requirements prescribed in Table 9.36.3.10. shall be used in the energy model calculations
- Similar time periods shall be used in the modelling simulation of ventilation operation of both the proposed and reference houses
- Where duct and piping losses are included in modelling they shall be applied to both the proposed and reference house

Energy Efficiency in Housing and Small Buildings

Energy Efficiency

HVAC System Calculations - Article 9.36.5.7.

- Modelling shall consider any solar and internal heat gains that cause a temperature rise of 5.5°C above set point
  - excess heat above set points shall be excluded from model calculation, or
  - calculated as heat loss
- Modelling for HRV's shall account for heat recovery efficiency for HRV's using a minimum of 2 test points as prescribed in 9.36.3.9.(3)(a)

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Energy Efficiency

Service Water Heating System - Article 9.36.5.8.

- Performance requirements for SWH as prescribed in Table 9.36.4.2.
- Modelling calculations similar for proposed and reference houses
- Modelling calculations shall use a supply cold water temperature
  - = to -0.002 (HDD) + 20.3, where HDD < 7999
  - = to 4.3, where HDD ≥ 8000, or
  - determined based on the ground and air temperatures in the climatic data file
- Modelling calculations shall use service water temperature of 55°C

Energy Efficiency

General Requirements for Modelling the Proposed House - Article 9.36.5.9.

Except as provided in Article 9.36.5.10. to 9.36.5.12. modelling for **proposed house** shall include:

- fenestration type
- opaque building envelope assembly type
- effective thermal resistance and areas
- HVAC system types and capacities
- SWH system types and capacities

Energy Efficiency

Modelling Building Envelope of Proposed House – Article 9.36.5.10

Modelling for **proposed house building envelope** shall include:

- Area of above-ground portion of foundation walls
- RSI for above-ground walls, ceilings below attics, roof assemblies and rim joists
- Maximum overall RSI for doors
- RSI of below-ground walls and slabs-on-ground, exterior walls, roof-ceiling assembly, doors, walls exposed floors and floors in contact with the ground
- Distribution and orientation of fenestration and doors
- Solar Heat Gain Coefficient (SHGC) and overall RSI of fenestration

Energy Efficiency

Modelling Building Envelope of Proposed House – Article 9.36.5.10 (continued)

Modelling for **proposed house building envelope** shall include:

- Configuration of insulation in assemblies in contact with the ground, and
- RSI of foundation walls
- Additional modelling consideration:
  - shading
  - thermal mass
  - solar absorption
  - orientation of the foundation
  - airtightness

Energy Efficiency

General Requirements for Modelling the Reference House – Article 9.36.5.13.

Modelling calculations for **reference house** shall be consistent with prescriptive requirements of subsections 9.36.2 to 9.36.4. for:

- Fenestration and opaque building envelope assembly types and areas
- HVAC system types and capacities, and
- SWH system types and capacities
- Except, modelling calculations for the reference house shall be the same values with regards to:
  - floor area
  - heated volume, and
  - number and types of rooms

Energy Efficiency

General Requirements for Modelling the Reference House – 9.36.5.14.

Energy model calculations for **reference house** shall include the same values of those used for the proposed house for:

- The gross area of the above-ground portion of foundation walls
- Soil conditions
- Orientation of the foundation, and
- Ratio of fenestration area to opaque area of doors

Energy Efficiency

ENERGY PERFORMANCE MODELLING SUMMARY

	Prescriptive	Reference House	NBC Provisions (Reference)	Proposed House	NBC Provisions (Proposed)
FDWR	Variable	17%-22%	9.36.5.14.(10)	Actual	9.36.5.10.
RSI-values Walls/Floor/ Attic	Variable –Depending on use of HRV	Fixed – No HRV	9.36.5.14.(3)	Actual	9.36.5.10.
U-values Windows	Variable – ER ratings allowed	Fixed Table 9.36.2.7.-A	9.36.5.14.(7)	Actual	9.36.5.10.
Solar Heat Gain Coefficient (SHGC)	Undefined	Fixed (U -value route SHGC of 0.26)	9.36.5.14.(2)	Actual If SHGC not available – use same as reference	9.36.5.10.
Orientation	Undefined	Equal all sides	9.36.5.14.(5)	Actual	9.36.5.10.(8)
Airtightness	Undefined, prescriptive details	Fixed (2.5 Air changes/h (ACH)	9.36.5.14(.2)	3.2 ACH, 2.5 ACH (with details, or as tested)	9.36.5.10.(9)
Ventilation Rate	Fixed (9.32.3.3)	Fixed –Min. rate by bedroom	9.36.5.15.(2)	Actual –Min. rate by bedroom	9.36.5.11.(6)
Ventilation Volume	Undefined	8 h Operated 365 d	9.36.5.15.(4)	8 h Operated 365 d	9.36.5.11.(5)
Heating Efficiency	Fixed	Fixed – Appliance/fuel type	9.36.5.15.(7)	Actual	9.36.5.11.(8)
Service Hot Water	Fixed	Fixed – Appliance/fuel type	9.36.5.16.(1)	Actual	9.36.5.12.(1)

Energy Efficiency

Drawings, Specifications and Calculation for Energy Performance Compliance – Division C – Subsection 2.2.8.

- Reporting requirements apply only to 9.36.5. (performance) for houses with or without a secondary suite and to buildings containing only dwelling units and common spaces whose total floor area **does not exceed 20%** of the total floor area of the building

Energy Efficiency

Drawings, Specifications and Calculation for Energy Performance Compliance – Division C – Subsection 2.2.8.

Requires drawings and specifications for the proposed house including any testing documentation

Requires report for each house design providing:

- project information such as name, description, address, etc.
- summary of building envelope, HVAC and SWH characteristics
- energy performance data summary
- information on software used including, name, version and adaptations where applicable
- statement that the calculations meet requirements in 9.36.5.

Energy Efficiency

Performance Path

Energy Efficiency Programs:

- Energy Star (homes) – qualified
- Built Green - certified
- LEED (homes) – certified
- Net Zero Home - certified
- Passive House – certified
- R-2000 – certified

- Modelling program in compliance with ANSI/ASHRAE 140, “Evaluation of Building Energy Analysis Computer Programs”

Energy Efficiency

Other Resources

Building Standards Guide – Implementation of Energy Codes

Natural Resources Canada (NRCan)

- Modelling programs
- Tables for calculating effective thermal resistance of opaque assemblies

Canadian Wood Council

- Effective R Calculator Tables

Summary

- Introduction
- Legal Framework
- Five Principles
- Objective and Functional Statements
- Climatic Data
- Overview of Section 9.36
- Prescriptive Path
  - General
  - Building Envelope
  - Heating Ventilation and Air Conditioning
  - Service Water Heating
- Performance Path
- Summary

Thank you

Questions and Answers

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