Quebec Construction Code, Chapter I.1 – Energy Efficiency of Buildings, and National Energy Code of Canada for Buildings 2015 (amended)

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FOREWORD

The Régie du bâtiment du Québec and the National Research Council of Canada present the *Quebec Construction Code, Chapter I.1 – Energy Efficiency of Buildings, and National Energy Code for Buildings 2015 (amended),* which has been prepared to facilitate the application throughout the province of Quebec of the Construction Code adopted under the Building Act (O.C. 486-2020, 2020 G.O. 2, 1425).

Coming into effect
The amendments to Chapter I.1, Energy Efficiency of Buildings, of the Construction Code became effective on June 27, 2020 (O.C. 486-2020, 2020 G.O. 2, 1425).

Divisions
The document has two divisions:

Division I contains Chapter I.1, Energy Efficiency of Buildings, without the amendments to the National Energy Code for Buildings 2015 (NECB) as adopted by the province of Quebec and mentioned in section 1.1.6. of Division II, Chapter I.1, Energy Efficiency of Buildings.

Division II contains the 2015 NECB including the amendments adopted by the province of Quebec. The reader should note that these amendments are indicated with bold-type vertical lines in the margin. Reproduction of Chapter I.1, Energy Efficiency of Buildings, including the Quebec amendments, has been authorized by Les Publications du Québec.

Questions or comments
The public are invited to submit their questions and comments regarding the amendments to the NECB 2015 as adopted by the province of Quebec, by writing to the following address:

La directrice générale, Direction générale de la réglementation et de l'expertise-conseil
Régie du bâtiment du Québec
255 East Crémazie Boulevard
1st floor
Montréal, Quebec
H2M 2L5

DIVISION I

Regulation to amend the Construction Code

Building Act

(chapter B-1.1, ss. 173, 176, 176.1, 178, 179, 185, pars. 0.1, 37 and 38, and s. 192)

1. The Construction Code (chapter B-1.1, r. 2) is amended by inserting the following after Chapter I:

CHAPTER I.1
ENERGY EFFICIENCY OF BUILDINGS

DIVISION I
INTERPRETATION

1.1.1. In this Chapter, unless the context indicates otherwise, "Code" means the "National Energy Code of Canada for Buildings 2015" (NRCC 56191), first printing, published by the Canadian Commission on Building and Fire Codes, National Research Council of Canada, excluding any later amendments, including errata, that may be published by that organization.

The Code is incorporated into this Chapter by reference, subject to the amendments specified in section 1.1.6.

For the purposes of this Division, the definitions set out in the Code apply, unless otherwise provided.

1.1.2. Subject to section 1.1.4., this Chapter applies to all construction work that is performed on a new building to which the Building Act (chapter B-1.1) applies and to the vicinity of that building.

It also applies to all construction work for new swimming pools designated as facilities intended for use by the public under section 10.03.

1.1.3. Subject to section 1.1.4., this Chapter applies to the addition work of existing buildings where, after that work, the building including its addition

(1) has a building area of more than 600 m² within the meaning of the National Building Code as adopted by Chapter I of the Construction Code;

(2) has a building height of more than 3 storeys within the meaning of the National Building Code as adopted by Chapter I of the Construction Code; or

(3) does not house only dwelling units.

1.1.4. This Chapter does not apply to the construction of

(1) a building referred to in the second paragraph of section 1.04;

(2) a greenhouse;

(3) a building with a building area under 10 m² within the meaning of the National Building Code as adopted by Chapter I of the Construction Code.

DIVISION II
AMENDMENTS TO THE CODE

1.1.5. A reference in this Chapter to a standard, including a code, is, as the case may be, a reference to that standard as adopted by a Chapter of the Construction Code (chapter B-1.1, r. 2), the Safety Code (chapter B-1.1, r. 3) or other regulation adopted under the Building Act (chapter B-1.1) referring to it.

1.1.6. (Publisher's note: Amendments made by Quebec to the National Energy Code of Canada for Buildings 2015 are incorporated in the Code reproduced in Division II.)

DIVISION III
OFFENCE

1.1.7. Any contravention of one of the provisions of this Chapter constitutes an offence.

2. The Regulation respecting energy conservation in new buildings (chapter E-1.1, r. 1) is revoked. Despite the foregoing, the provisions of the Regulation respecting energy conservation in new buildings may apply to construction work referred to in sections 1.1.2 and 1.1.3 of the Construction Code (chapter B-1.1, r. 2), as enacted by section 1 of this Regulation, provided that the work begins before 27 December 2021.

3. This Regulation comes into force on June 27 2020.

DIVISION II

National Energy Code of Canada for Buildings 2015

(incorporating Quebec amendments)

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Preface

The National Energy Code of Canada for Buildings 2015, together with the National Building Code of Canada 2015, the National Plumbing Code of Canada 2015 and the National Fire Code of Canada 2015, is an objective-based National Model Code that can be adopted by provincial and territorial governments. Codes Canada[(1)] are developed by the Canadian Commission on Building and Fire Codes (CCBFC).

In Canada, provincial and territorial governments have the authority to enact legislation that regulates building design and construction within their jurisdictions. This legislation may include the adoption of the National Energy Code for Buildings (NECB) without change or with modifications to suit local needs, and the enactment of other laws and regulations regarding building design and construction, including the requirements for professional involvement.

The NECB is a model code in the sense that it helps promote consistency among provincial and territorial building codes. Persons involved in the design or construction of a building should consult the provincial or territorial government concerned to find out which construction requirements are applicable.

This edition of the NECB succeeds the 2011 edition.

The development of the NECB 2015 has been a collaborative effort involving the National Research Council of Canada (NRC), Natural Resources Canada (NRCan) and other stakeholders. NRCan's financial and technical contributions will improve the energy efficiency of new buildings and reduce greenhouse gas emissions. The NECB 2015 will contribute to long-term benefits for both Canada's economy and the environment.

Code Development

Development of Codes Canada

The Canadian Commission on Building and Fire Codes (CCBFC) is responsible for the content of the National Model Codes. The CCBFC is an independent body made up of volunteers from across the country and from all facets of the code-user community. Members of the CCBFC and its standing committees include builders, engineers, skilled trade workers, architects, building owners, building operators, fire and building officials, manufacturers and representatives of general interests.

The CCBFC is advised on scope, policy and technical issues pertaining to the Codes by the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC), which is a committee of senior representatives from provincial/territorial ministries responsible for the regulation of buildings, fire safety and plumbing in their jurisdictions. The PTPACC was created by the provinces and territories, with provision of guidance to the CCBFC as one of its main functions. Through the PTPACC and its subcommittees on building, fire and plumbing regulation, the provinces and territories are engaged in every phase of the model Code development process.

(1) The National Model Codes are now collectively referred to as "Codes Canada."

The Canadian Codes Centre of the National Research Council (NRC) provides technical and administrative support to the CCBFC and its standing committees. NRC publishes Codes Canada and periodic revisions to the Codes to address pressing issues.

The broader code-user community also makes a significant contribution to the model Code development process by submitting requests for changes or additions to the Codes and by commenting on the proposed changes during the public reviews that precede each new edition.

The CCBFC takes into consideration the advice received from the provinces and territories as well as code users' comments at each stage of Code development. The scope and content of Codes Canada are determined on a consensus basis, which involves the review of technical, policy and practical concerns and debate on the implications of these concerns.

More information on the Code development process is available on NRC's Web site. Printed copies of this information may also be requested from the Secretary of the CCBFC, whose address is provided at the end of this Preface.

Policy Context for the Development of a National Energy Code

The development of the NECB was initiated by the CCBFC in response to a request from numerous stakeholders regarding the addition of a new objective on energy efficiency to Codes Canada. The establishment of new objectives must follow the Protocol for Addressing New Objectives in Model National Codes, which was developed in 2009 by the CCBFC in conjunction with the PTPACC. This Protocol outlines the steps required for considering and establishing a new objective to ensure that the result is responsive to provincial/territorial needs and transparent to all stakeholders.

The CCBFC used the Protocol to analyze the request for an energy efficiency objective and to develop policy goals through discussions with PTPACC, including work by a Joint CCBFC-PTPACC Task Group, consultants' reports, various federal/provincial/territorial policy documents, and discussions with key stakeholders in open meetings. The CCBFC then evaluated the effectiveness of various means available to provincial/territorial governments to encourage energy efficiency —regulations, product standards, voluntary programs, incentives/disincentives, market demand and education—and conducted an impact analysis for each option; a status quo option was also considered.

As a result of the analysis, the CCBFC determined that regulations were an effective tool to support the policy direction of increased energy efficiency for buildings. It also determined that a national model code on energy efficiency was justifiable to effectively address an overall objective related to the environment, with a sub-objective focused on resource conservation and future potential sub-objectives on reduced greenhouse gas emissions, infrastructure capacity and energy security, as well as to address the policy goal of harmonization of construction codes across Canada. It concluded that other tools, such as education, incentives and labeling programs, also contribute to the successful achievement of an overall energy efficiency policy.

The CCBFC thus submitted the proposed new principal objective, Environment, which comprises a second-level objective, Resources, and a sub-objective, Excessive Use of Energy, to public review. Pursuant to favourable comments, the new objective, sub-objectives and related functional statements were approved.

The broad definitions of the NECB objectives and their hierarchical structure provide the flexible framework that is necessary for the provinces and territories to adapt the NECB to meet their specific needs. The NECB 2015 only addresses the efficient use of energy by the building, but some provinces and territories may want to address other goals such as reduction of greenhouse gas emissions or promulgation of alternative energy sources. These additional priorities can easily be accommodated within the context of NECB's Environment objective by adding one or more applicable second-level objectives or sub-objectives. The flexible framework of the model NECB thus increases the potential for the harmonization of national, provincial and territorial codes.

National Energy Code of Canada for Buildings 2015

The National Energy Code for Buildings (NECB) sets out technical provisions to address energy efficiency in the design and construction of new buildings and additions to existing buildings. In the context of the NECB, the use of the term "energy efficiency" shall be understood to mean "energy use efficiency."

Code provisions do not necessarily address all the characteristics of buildings that might be considered to have a bearing on the Code's objective. Through the extensive consensus process used to develop and maintain Codes Canada (see the section entitled Development of Codes Canada), the code-user community has decided which characteristics should be regulated through the NECB.

Because the NECB is a model code, its requirements can be considered as the minimum acceptable measures required to adequately achieve the above-listed objective, as recommended by the Canadian Commission on Building and Fire Codes. They become minimum acceptable requirements once they are adopted and passed into law or regulation by an authority having jurisdiction: i.e. the requirements represent the minimum level of performance required to achieve the objective that is acceptable to the adopting authority.

Code users are also involved in the development of the NECB and they help determine the content. The Code development process is described in the section entitled Development of Codes Canada.

The NECB is a model code which, when adopted or adapted by a province or territory, becomes a regulation. It is not a textbook on the design or construction of energy-efficient buildings. The design of a technically sound building depends upon many factors beyond simple compliance with building regulations. Such factors include the availability of knowledgeable practitioners who have received appropriate education, training and experience and who have some degree of familiarity with the principles of good building practice and experience using textbooks, reference manuals and technical guides.

The NECB does not list acceptable proprietary building products. It establishes the criteria that building materials, products and assemblies must meet. Some of these criteria are explicitly stated in the NECB while others are incorporated by reference to material or product standards published by standards development organizations. Only those portions of the standards related to the objective of this Code are mandatory parts of the NECB.

Relationship between the National Energy Code and the National Building Code

In 2012, energy efficiency provisions were introduced in Section 9.36. of the National Building Code (NBC) 2010 as an interim change along with the Environment objective. These provisions, which apply to housing and small buildings, have a similar scope to that of the NECB, except that they do not address lighting and electrical power systems. The NECB is referenced in NBC Section 9.36. as an acceptable solution.

Code Requirements

The NECB establishes requirements that address one principal objective (OE), Environment, which comprises a second-level objective (OE1), Resources, and a sub-objective (OE1.1), Excessive Use of Energy. Every NECB requirement addresses sub-objective OE1.1.

In dealing with proposed changes or additions to any of Codes Canada, the CCBFC considers many issues such as the following:

- Does the proposed requirement provide the minimum level of performance—and no more than the minimum—needed to achieve the Code's objectives?
- Will persons responsible for Code compliance be able to act on or implement the requirement using commonly accepted practices?
- Will enforcement agencies be able to enforce the requirement?
- Are the costs of implementing the requirement justifiable?

- Have the potential policy implications of the requirement been identified and addressed?
- Is there broad consensus on this requirement among Code users representing all facets of the design and construction industries as well as among provincial and territorial governments?

Guidelines for requesting changes to the NECB are available on NRC's Web site. Printed copies of the guidelines may also be requested from the Secretary of the CCBFC, whose address is provided at the end of this Preface.

Objective-Based Code Format

The National Energy Code for Buildings (NECB) was published in an objective-based code format for the first time in 2011. The principle to develop objective-based codes arose out of the strategic plan adopted by the Canadian Commission on Building and Fire Codes (CCBFC) in 1995.

The NECB comprises three Divisions:
- Division A, which defines the scope of the Code and contains the objectives, the functional statements and the conditions necessary to achieve compliance;
- Division B, which contains acceptable solutions (commonly referred to as “technical requirements”) deemed to satisfy the objective and functional statements listed in Division A; and
- Division C, which contains administrative provisions.

A more complete description of this division-based structure is included in the section entitled Structure of Objective-Based Codes.

Each requirement in Division B is linked to three types of information:
- sub-objective OE1.1, Excessive Use of Energy,
- functional statements (statements on the functions of the building that a particular requirement helps to achieve), and
- an intent statement (detailed statement on the specific intent of the provision).

Objectives

The NECB's objectives are fully defined in Section 2.2. of Division A.

The objectives describe, in very broad terms, the overall goals that the NECB's requirements are intended to achieve. They serve to define the boundaries of the subject areas the Code addresses. However, the Code does not deal with all the issues that might be considered to fall within those boundaries.

The objectives describe undesirable situations and their consequences, which the Code aims to avoid occurring in buildings. The wording of the definitions of the objectives includes two key phrases: “limit the probability” and “unacceptable effect.” The phrase “limit the probability” is used to acknowledge that the NECB cannot entirely prevent the undesirable outcome from happening. The phrase “unacceptable effect” acknowledges that the NECB cannot eliminate all undesirable effects: the “acceptable effect” is the outcome remaining once compliance with the Code has been achieved.

The objectives are entirely qualitative and are not intended to be used on their own in the design and approval processes.

The objective/functional statement sets attributed to the requirements or portions of requirements in Division B are listed in a table at the end of each Part.

Functional Statements

The NECB's functional statements are listed in Section 3.2. of Division A.

The functional statements are more detailed than the objectives: they describe conditions in the building that help satisfy the objectives. The functional statements and the objectives are interconnected: there may be several functional statements related to any one objective.

Like objectives, functional statements are entirely qualitative and are not intended to be used on their own in the design and approval processes.

The functional statements attributed to the requirements or portions of requirements in Division B are listed in a table at the end of each Part.

Intent Statements

Intent statements explain, in plain language, the basic thinking behind each Code provision contained in Division B. Intent statements, each of which is unique to the provision with which it is associated, explain how requirements help to achieve their attributed sub-objective and functional statements. Like the objectives, the intent statements are expressed in terms of risk avoidance and expected performance. They offer insight into the views of the responsible standing committee on what the Code provisions are intended to achieve.

The intent statements serve explanatory purposes only and do not form an integral part of the Code provisions: as such, they are similar in function to the explanatory notes at the end of each Part. Due to the sheer volume of intent statements, they are only available as part of an online Code subscription and as a separate electronic document entitled "Supplement to the NECB 2015: Intent Statements," which is posted on NRC's Web site.

All this additional information—objectives and functional and intent statements—is intended to facilitate the implementation of the Code in two ways:

- Clarity of intent: The objectives, functional statements and intent statements linked to a Code requirement clarify the reasoning behind that requirement and facilitate understanding of what must be done to satisfy that requirement. This added information may also help avoid disputes between practitioners and officials over these types of issues.
- Flexibility: The additional information allows for flexibility in Code compliance. A person seeking to propose a new method or material not described or covered in the Code will be able to use the added information to understand the expected level of performance that their alternative solution must achieve to satisfy the Code.

Structure of Objective-Based Codes

The National Energy Code for Buildings (NECB) is organized into three Divisions.

Division A: Compliance, Objectives and Functional Statements

Division A defines the scope of the NECB and presents the objective that the Code addresses and the functions the building must perform to help to satisfy that objective.

Division A cannot be used on its own as a basis for designing and constructing a building, or for evaluating a building's compliance with the Code.

Division B: Acceptable Solutions

The term "acceptable solutions" refers to the technical provisions contained in the Code. It reflects the principle that codes establish an acceptable level of risk or performance and underlines the fact that a code cannot describe all possible valid design and construction options. The term provokes the question "To whom are these solutions considered acceptable?" Acceptable solutions represent the minimum level of performance that will satisfy the NECB's objective and that is acceptable to an authority that adopts the NECB into law or regulation.

The requirements in Division B—the acceptable solutions—are linked to the sub-objective, OE1.1, and to one or more functional statements found in Division A. These linkages play an important role in allowing objective-based codes to accommodate innovation.

It is expected that the majority of Code users will primarily follow the acceptable solutions presented in Division B and that they will consult Division A only when seeking clarification on the application of Division B's requirements to a particular situation, when considering an alternative solution, or to read the definition of selected terms in the context of the NECB.

Division C: Administrative Provisions

Division C contains administrative provisions relating to the application of the Code. Many provinces and territories establish their own administrative provisions upon adopting or adapting the NECB; having all the administrative provisions in one Division facilitates their customization to suit jurisdictional needs.

Relationship between Division A and Division B

Sentence 1.2.1.1.(1) of Division A is a very important sentence: it is a precise statement of the relationship between Divisions A and B and is central to the concept of objective-based codes.

1) Compliance with this Code shall be achieved by
a) complying with the applicable acceptable solutions in Division B (see Note A-1.2.1.1.(1)(a)), or
b) using alternative solutions that will achieve at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the applicable acceptable solutions (see Note A-1.2.1.1.(1)(b)).

Clause (a) makes it clear that the acceptable solutions in Division B are automatically deemed to satisfy the linked sub-objective and functional statements of Division A.

Clause (b) makes it clear that alternative solutions can be used in lieu of compliance with the acceptable solutions. However, to do something different from the acceptable solutions described in Division B, a builder, designer or building owner must show that their proposed alternative solution will perform at least as well as the acceptable solution(s) it is replacing. The sub-objective and functional statements attributed to the acceptable solution(s) identify the areas of performance where this equivalence must be demonstrated.

Additional Information

New Structure

This edition of the NECB has been restructured to align with the restructuring of the National Building Code 2015.

Numbering System

A consistent numbering system has been used throughout Codes Canada. The first number indicates the Part of the Code; the second, the Section in the Part; the third, the Subsection; and the fourth, the Article in the Subsection. The detailed provisions are found at the Sentence level (indicated by numbers in brackets), and Sentences may be broken down into Clauses and Subclauses. This structure is illustrated as follows:

3	Part
3.5.	Section
3.5.2.	Subsection
3.5.2.1.	Article
3.5.2.1.(2)	Sentence
3.5.2.1.(2)(a)	Clause
3.5.2.1.(2)(a)(i)	Subclause

Change Indication

Where a technical change or addition has been made relative to the 2011 edition, a vertical line has been added in the margin next to the affected provision to indicate the approximate location of new or modified content. No change indication is provided for renumbered or deleted content.

Meaning of the words "and" and "or" between the Clauses and Subclauses of a Sentence

Multiple Clauses and Subclauses are connected by the word "and" or "or" at the end of the second last Clause or Subclause in the series. Although this connecting word appears only once, it is meant to apply to all the preceding Clauses or Subclauses within that series.

For example, in a series of five Clauses—a) to e)—in a Code Sentence, the appearance of the word "and" at the end of Clause d) means that all Clauses in the Sentence are connected to each other with the word "and." Similarly, in a series of five Clauses—a) to e)—in a Code Sentence, the appearance of the word "or" at the end of Clause d) means that all Clauses in the Sentence are connected to each other with the word "or."

In all cases, it is important to note that a Clause (and its Subclauses, if any) must always be read in conjunction with its introductory text appearing at the beginning of the Sentence.

Administration

A separate CCBFC document entitled Administrative Requirements for Use with the National Building Code of Canada 1985 is also published by the National Research Council. It is automatically adopted as per Article 2.2.1.1. of Division C if the adopting authority does not provide other administrative requirements.

Parts in Division B and Professional Disciplines

Division B is organized into Parts that are largely related to disciplines. However, this does not mean that persons of a certain discipline who are executing the design or construction of a particular building component can necessarily deal with only one Part of the Code in isolation since provisions related to that building component may be found in more than one Part. For this reason, the part-based structure of Division B is not well suited for use as the basis for allocating responsibilities to different professions or as the basis for contractual arrangements.

Complementary Publications

The following NRC Construction publications are referenced in the NECB 2015 or facilitate the application of its requirements:
- (a) National Building Code of Canada 2015
- (b) National Fire Code of Canada 2015
- (c) National Plumbing Code of Canada 2015
- (d) Supplement to the NECB 2015: Intent Statements
- (e) User's Guide – National Energy Code of Canada for Buildings 2011

Commercial Rights to Reproduce the National Energy Code for Buildings

Production and Marketing Manager
Building Regulations
NRC Construction
National Research Council of Canada
Ottawa, Ontario K1A 0R6
E-mail: Codes@nrc-cnrc.gc.ca

Contact Information

The CCBFC welcomes comments and suggestions for improvements to the National Energy Code for Buildings. Persons interested in requesting a change to an NECB provision should refer to the guidelines available on NRC's Web site.

To submit comments or suggestions or to request printed copies of Internet material referred to in this Preface, contact:

The Secretary
Canadian Commission on Building and Fire Codes
NRC Construction
National Research Council of Canada
Ottawa, Ontario K1A 0R6
Telephone: 613-993-9960
Fax: 613-952-4040
E-mail: Codes@nrc-cnrc.gc.ca

Relationship of the NECB to Standards Development and Conformity Assessment

The development of many provisions in the National Energy Code of Canada for Buildings (NEBC) and the assessment of conformity to those provisions are supported by several of the member organizations of Canada's National Standards System (NSS).

The NSS is a federation of accredited organizations concerned with standards development, certification, testing, inspection, personnel and management systems registration that is established under the auspices of the Standards Council of Canada Act. Activities of the NSS are coordinated by the Standards Council of Canada (SCC), which has accredited 8 standards development organizations, 36 certification organizations, 21 registration organizations, and 344 calibration and testing laboratories.

The SCC is a federal non-profit Crown corporation responsible for the coordination of voluntary standardization in Canada. It also has responsibilities for Canada's activities in voluntary international standardization.

Canadian Standards

The NECB contains many references to standards published by accredited standards development organizations in Canada. As part of the accreditation requirements, these organizations adhere to the principles of consensus. This generally means substantial majority agreement of a committee comprising a balance of producer, user and general interest members, and the consideration of all negative comments. The organizations also have formal procedures for the second-level review of the technical preparation and balloting of standards prepared under their auspices. (The Canadian Commission on Building and Fire Codes (CCBFC) follows these same principles of consensus in the operation of its Code development process.)

The following organizations are accredited as standards development organizations in Canada:

- American Society for Testing and Materials International (ASTM)
- Bureau de normalisation du Québec (BNQ)
- Canadian General Standards Board (CGSB)
- Canadian Standards Association (CSA)
- Underwriters' Laboratories (UL)
- ULC Standards (ULC)

Table 1.3.1.2. of Division B lists the standards referenced in the NECB. Standards proposed to be referenced in the NECB are reviewed to ensure their content is compatible with the Code. Thereafter, referenced standards are reviewed as needed during each Code cycle. Standards development organizations are asked to provide information on any changes in the status of their standards referenced in the NECB—withdrawals, amendments, new editions, etc. This information is passed on to the CCBFC, its standing committees, the provinces and territories, and interested stakeholders on particular issues, all of whom are given the opportunity to identify any problems associated with the changes. These bodies do not necessarily review in detail the revised standards; rather, the approach relies on the consensus process involved in the maintenance of the standards and on the extensive knowledge and backgrounds of committee members, provincial or territorial staff, NRC staff, and consulted stakeholders to identify changes in the standards that might create problems in the Code.

Non-Canadian Standards

A number of subject areas for which the Canadian standards development organizations have not developed standards are covered in the NECB. In these cases, the Code often references standards developed by organizations in other countries, such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the National Fire Protection Association (NFPA). These standards are developed using processes that may differ from those used by the Canadian standards development organizations; nevertheless, these standards have been reviewed by the relevant standing committees and found to be acceptable.

Conformity Assessment

The NECB establishes minimum measures, either within its own text or that of referenced standards. However, the NECB does not deal with the question of who is responsible for assessing conformity to the measures or how those with this responsibility might carry it out. This responsibility is usually established by the governing legislation of the adopting provinces or territories. Provincial or territorial authorities should be consulted to determine who is responsible for conformity assessment within their jurisdiction.

Those persons responsible for ensuring that a material, appliance, system or equipment meets the requirements of this Code have several means available to assist them. These means vary from on-site inspection to the use of certification services provided by accredited third-party organizations. Test reports or mill certificates provided by manufacturers or suppliers can also assist in the acceptance of products. Engineering reports may be required for more complex products.

Testing

The accreditation programs of the SCC include many organizations accredited for testing and calibration that are capable of reliably testing building products to specified standards. The test results produced by these organizations can be used in the evaluation, qualification and certification of building products to Code provisions. The SCC's Web site (www.scc.ca) lists accredited certification bodies and allows users to search the scope of accreditation for each of these organizations.

Certification

Certification is the confirmation by an independent organization that a product or service meets a requirement. Certification of a product, process, or system entails physical examination, testing as specified in the appropriate standards, plant examination, and follow-up unannounced plant inspections. This procedure leads to the issuing of a formal assurance or declaration, by means of a certification mark or certificate, that the product, process or system is in full conformity with specified provisions.

In some cases, a product for which no standard exists can be certified using procedures and criteria developed by the accredited certifying organization and specifically designed to measure the performance of that product. Certification bodies publish lists of certified products and companies.

Registration

Quality Registration Organizations assess a company's conformance to quality assurance standards like the International Organization for Standardization ISO 9000.

Evaluation

An evaluation is a written opinion by an independent professional organization that a product will perform its intended function in a building. An evaluation is very often done to determine the ability of an innovative product, for which no standards exist, to satisfy the intent of a Code requirement. Follow-up plant inspections are not normally part of the evaluation process. Several organizations, including the Canadian Construction Materials Centre (CCMC), offer such evaluation services.

Qualification

The qualification of building products also evaluates the ability of a product to perform its intended function by verifying that it meets the requirements of a standard. Qualification normally includes some follow-up plant inspection. Some organizations publish lists of qualified products that meet the specified requirements. Some organizations qualify manufacturing and/or testing facilities for building products for compliance with the Code and relevant standards.

Canadian Commission on Building and Fire Codes and Standing Committees

Canadian Commission on Building and Fire Codes

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Codes Canada staff who provided assistance to the Commission

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A. Gribbon
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Standing Committee on Energy Efficiency in Buildings

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Division A

Compliance, Objectives and Functional Statements

Part 1
Compliance

Part 1
Compliance

Section 1.1. General

1.1.1. Application of this Code

1.1.1.1. Application of this Code

1) Except as provided in Sentence (2) and as provided in section 1.1.2 and 1.1.3 of the Construction Code (chapter B-1.1, r.2) made under the Building Act (chapter B-1.1), this Code applies
- a) to the design and construction of
  - i) all new *buildings*, and
  - ii) all new swimming pools designated as facilities intended for use by the public under section 10.03 of the Construction Code, and
- b) to *additions*.

(See Note A-1.1.1.1.(1).)

2) This Code does not apply to *farm buildings*.

1.1.1.2. Building Parameters Covered by this Code

(See Note A-1.1.1.2.)

1) This Code contains requirements for
- a) the design and construction of the *building envelope*,
- b) the design and construction or specification of systems and equipment for
  - i) heating, ventilating or air-conditioning,
  - ii) *service water* heating, and
  - iii) lighting, and
- c) the provision of electrical power systems and motors, excluding process loads.

1.1.1.3. Deleted

Section 1.2. Compliance

1.2.1. Compliance with this Code

1.2.1.1. Compliance with this Code

1) Compliance with this Code shall be achieved by
- a) complying with the applicable acceptable solutions in Division B (see Note A-1.2.1.1.(1)(a)), or
- b) using alternative solutions that will achieve at least the minimum level of performance required by Division B in the areas defined by the objective and functional statements attributed to the applicable acceptable solutions and approved by the Régie du bâtiment du Québec or, in the case of *buildings* or equipment on which the Board has no jurisdiction, by the *authority having jurisdiction* (see Note A-1.2.1.1.(1)(b)).

2) For the purposes of compliance with this Code as required in Clause (1)(b), the objective and functional statements attributed to the acceptable solutions in Division

B shall be the objective and functional statements referred to in Subsection 1.1.2. of Division B.

1.2.2. Materials, Appliances, Systems and Equipment

1.2.2.1. Characteristics of Materials, Appliances, Systems and Equipment

1) All materials, appliances, systems and equipment installed to meet the requirements of this Code shall possess the necessary characteristics to perform their intended functions when installed in a *building*.

1.2.2.2. Storage on the Building Site

1) All *building* materials, appliances and equipment on the *building* site shall be stored in such a way as to prevent the deterioration or impairment of their essential properties.

1.2.2.3. Used Materials, Appliances and Equipment

1) Unless otherwise specified, used materials, appliances and equipment are permitted to be reused when they meet the requirements of this Code for new materials and are satisfactory for the intended use.

Section 1.3. Divisions A, B and C of this Code

1.3.1. General

1.3.1.1. Scope of Division A

1) Division B contains the compliance and application provisions, objectives and functional statements of this Code.

1.3.1.2. Scope of Division B

1) Division B contains the acceptable solutions of this Code.

1.3.1.3. Scope of Division C

1) Division C contains the administrative provisions of this Code.

1.3.1.4. Internal Cross-references

1) Where the Division of a referenced provision is not specified in this Code, it shall mean that the referenced provision is in the same Division as the referencing provision.

1.3.2. Application of Division A

1.3.2.1. Application of Parts 1, 2 and 3

1) Parts 1, 2 and 3 of Division A apply to all *buildings* covered in this Code. (See Article 1.1.1.1.)

1.3.3. Application of Division B

1.3.3.1. Application of Parts 1 to 8

1) Parts 1 to 8 of Division B apply to all *buildings* covered in this Code. (See Article 1.1.1.1.)

1.3.4. Application of Division C

1.3.4.1. Application of Parts 1 and 2

1) Parts 1 and 2 of Division C apply to all *buildings* covered in this Code. (See Article 1.1.1.1.)

Section 1.4. Terms and Abbreviations

1.4.1. Definitions of Words and Phrases

1.4.1.1. Non-defined Terms

1) Words and phrases used in this Code that are not included in the list of definitions in Article 1.4.1.2. shall have the meanings that are commonly assigned to them in the context in which they are used, taking into account the specialized use of terms by the various trades and professions to which the terminology applies.

2) Where objectives and functional statements are referred to in this Code, they shall be the objectives and functional statements described in Parts 2 and 3.

3) Where acceptable solutions are referred to in this Code, they shall be the provisions stated in Parts 3 to 8 of Division B.

4) Where alternative solutions are referred to in this Code, they shall be the alternative solutions mentioned in Clause 1.2.1.1.(1)(b).

1.4.1.2. Defined Terms

1) The words and terms in italics in this Code shall have the following meanings:

Addition means any *conditioned space* that is added to an existing *building* and that increases the *building*'s *floor surface area* by more than 10 m² .

Air barrier assembly means the combination of air barrier materials and air barrier accessories within the environmental separator that are designed to act as a continuous barrier to the movement of air through the environmental separator.

Airflow control area means a portion of a *building* to which the flow of air from the *HVAC systems* can be reduced or stopped without reducing or stopping the flow of air to other portions of the *building*.

Annual energy consumption means the annual evaluation of the energy consumption of the proposed *building*, as calculated in accordance with the requirements of Part 8 of Division B. (See Note A-1.4.1.2.(1).)

*Authority having jurisdiction** means the Régie du bâtiment du Québec, a regional county municipality or a local municipality.

*Boiler** means an *appliance*† other than a *service water* heater† equipped with a direct energy source, to heat a liquid or convert it into steam.

*Building** means any structure used or intended for supporting or sheltering any use or occupancy.

Building energy target means the *annual energy consumption* of a hypothetical replica of the proposed *building*, using the same energy sources for the same functions and having the same environmental requirements, occupancy, climatic data and operation schedules as the proposed *building*, but made to comply with all applicable prescriptive requirements of this Code.

Building envelope means the collection of components that separate *conditioned space* from unconditioned space, the exterior air or the ground, or that separate *conditioned spaces* intended to be conditioned to temperatures differing by more than 10°C at design conditions. (See Note A-1.4.1.2.(1).)

* The definition of this term is reproduced from the National Building Code of Canada 2015.

† The definition of this term can be found in the National Building Code of Canada 2015.

Ceiling height (CH) means the average height of the ceiling where there is a ceiling and the average height of the base of the installed luminaires where there is no ceiling.

Coefficient of performance (COP) means, for a heat pump in the heating mode, the ratio of the rate of net heat output to the total energy input expressed in consistent units and under designated rating conditions, as described in the standards referenced in this Code; for refrigerating equipment or a heat pump in the cooling mode, COP means the ratio of the rate of heat removal to the rate of energy input in consistent units and under designated rating conditions, as described in the standards referenced in this Code.

Combustion efficiency (E_c) means a measure of the efficiency of fuel-burning equipment in converting fuel to heat, as obtained through the procedures described in the standards referenced in this Code.

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 portions of the year.

*Dwelling unit** means a *suite* used or intended to be used as a domicile by one or more persons and usually containing cooking, eating, living, sleeping and sanitary facilities.

Effective thermal resistance (RSI_E value) means the inverse of the *overall thermal transmittance*. The RSI_E value shall be calculated

(a) for *opaque building assemblies*, according to Sentence 3.1.1.5.(5) and Article 3.1.1.7., and
(b) for opaque sections of curtain walls, according to Sentence 3.1.1.5.(6).

Energy-efficiency ratio (EER) means, for refrigerating equipment or a heat pump in the cooling mode, the ratio of net cooling capacity in Btu/h to the total rate of electric input in watts, under designated operating conditions, as described in the standards referenced in this Code.

Exhaust duct means a duct through which air is conveyed from an interior space to the outdoors or to unconditioned space.

*Exit** means that part of a *means of egress*†, including doorways, that leads from the *floor area*† it serves, to a separate *building*, an open public thoroughfare, or an exterior open space protected from fire exposure from the *building* and having access to an open public thoroughfare.

Exterior lighting means lighting other than *interior lighting*. (See Note A-1.4.1.2.(1).)

Facade lighting means lighting installed to highlight features of the principal front of a *building* or a face of a *building* that overlooks a street or open space and includes lighting installed on the facade and on constructed or natural surfaces in close proximity to the facade. *Facade lighting* does not include signage or other lighting installed on the facade that is intended to light exterior spaces or surfaces other than the facade.

*Farm building** means a *building* or part thereof that does not contain a *residential occupancy*† and that is associated with and located on land devoted to the practice of farming, and used essentially for the housing of equipment or livestock, or the production, storage or processing of agricultural and horticultural produce or feeds.

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

*Firewall** means a type of *fire separation*† of *noncombustible construction*† that subdivides a *building* or separates adjoining *buildings* to resist the spread of fire, has a *fire-resistance rating*† as prescribed in the NBC or NFC, and has structural stability to remain intact under fire conditions for the required fire-rated time.

Floor surface area means the area of a space or group of spaces measured from the exterior surface of the perimeter walls, by the axis of party walls and *partitions* and the virtual separation between interconnected spaces, at or near floor level, including the area occupied by columns, interior walls and openings in the floor.

*Foundation** means a system or arrangement of *foundation units*† through which the loads from a *building* are transferred to the supporting *soil*† or *rock*†.

Frame in a door, window or other glazed area means the associated head, jambs, sill and, where applicable, mullions which, when assembled, house the door, *sash* or fixed glazing.

*Furnace** means a *space-heating appliance*† using warm air as the heating medium and usually having provision for the attachment of ducts.

General lighting means lighting that provides primary illumination throughout an interior area. *General lighting* shall not include decorative lighting or lighting that provides a dissimilar level of illumination within that area to serve a specialized application or feature.

Heat trap means an energy-conserving arrangement of the water piping entering or leaving a *service water* heater constructed to counteract the convective forces of the hot water (thermosyphoning) during standby periods.

HVAC system means a heating, ventilating or air-conditioning system comprising all the equipment and ducts serving a *building* or part of a *building*.

Installed interior lighting power means the power used by all the lighting systems that are part of the complete *interior lighting* design.

Integrated coefficient of performance (ICOP) means a single-number figure of merit expressing cooling part-load COP efficiency for commercial unitary air-conditioning and heat pump equipment that is based on weighted operation at various load capacities of the equipment (analogous to IEER).

Integrated energy-efficiency ratio (IEER) means a single-number figure of merit expressing cooling part-load energy efficiency for air-conditioning and heat pump equipment that is based on weighted operation at various load capacities of the equipment, as described in the standards referenced in this Code.

Integrated part-load value (IPLV) means a single-number figure of merit based on part-load *energy-efficiency ratio* or *coefficient of performance* expressing part-load efficiency for air-conditioning and heat pump equipment that is based on weighted operation at various load capacities of the equipment, as described in the standards referenced in this Code.

Interior lighting means lighting installed in *conditioned spaces* or in spaces other than *conditioned spaces* that are sheltered from the outdoor environment and intended to light only those spaces, except for lighting at exterior entrances and exterior exits. (See Note A-1.4.1.2.(1).)

Interior lighting power allowance means lighting power allocated to illuminate the interior of a space or group of spaces.

Landscape lighting means lighting installed to highlight landscape elements, such as trees, shrubs, rocks and pools. *Landscape lighting* does not include lighting of exterior spaces or walkways.

Linear thermal transmittance (Ψ) means the rate, in W/(m·K), at which heat is transferred per unit of length through a *building* assembly resulting from a steady-state temperature difference. (See Note A-1.4.1.2.(1).)

Opaque building assembly means a *building* assembly that is part of the *building envelope*, other than doors, and does not admit light.

Overall thermal transmittance (U-value) means the rate, in W/(m^2·K), at which heat is transferred through a *building* assembly that is subject to a temperature difference. It represents the amount of heat transferred through a unit area in a unit of time induced under steady-state conditions by a unit temperature difference between the environments on its two faces. The U-value reflects the capacity of all elements to transfer heat through the thickness of the assembly, as well as, for instance, through air films on both faces of above-ground components. Where heat is not transferred homogeneously across the area being considered, the *overall thermal transmittance* shall be determined. (See Note A-1.4.1.2.(1).)

Partition means an interior wall one *storey* or part-*storey* in height.

*Plenum** means a chamber forming part of an air duct system.

Point thermal transmittance (χ) means the rate, in W/K, of heat transfer by point penetration through a *building* assembly that is subject to a steady-state temperature difference. (See Note A-1.4.1.2.(1).)

*Return duct** means a duct for conveying air from a space being heated, ventilated or air-conditioned back to the heating, ventilating or air-conditioning *appliance*†.

Sash means an assembly of secondary framing members that fits within the primary *frame* of a window and whose main purpose is to hold and support the glass in operable windows; however, a *sash* is often included in fixed windows to maintain a uniform appearance with operable windows.

Seasonal energy-efficiency ratio (SEER) means the total cooling, in Btu, provided by a central air conditioner or heat pump during its normal annual usage period for cooling, divided by its total electric power usage, in watt-hours, during that same period.

Service water means the drinking water for plumbing systems covered by the NPC.

Service water heater means a device for heating water for plumbing services. [from NBC 2015]

Sidelighting means the illumination of *building* interiors with daylight admitted through *fenestration* located on an exterior wall, such as windows.

Skylight means a form of *fenestration* that is inclined less than 60° from the horizontal.

Standby losses (SL) are the heat losses incurred by a *storage-type service water heater* under a stable condition when no water is withdrawn from the tank and the water temperature is held constant by the thermostats.

*Storage garage** means a *building* or part thereof intended for the storage or parking of motor vehicles and containing no provision for the repair or servicing of such vehicles. (See Note A-1.4.1.2.(1).)

*Storage-type service water heater** means a *service water heater*† with an integral hot water storage tank.

*Storey** means that portion of a *building* that is situated between the top of any floor and the top of the floor next above it, and if there is no floor above it, that portion between the top of such floor and the ceiling above it.

*Suite** means a single room or series of rooms of complementary use, operated under a single tenancy, and includes *dwelling units*, individual guest rooms in motels, hotels, boarding houses, rooming houses and dormitories, as well as individual stores and individual or complementary rooms for *business and personal services occupancies*†. (See Note A-1.4.1.2.(1).)

Supply air handler means that part of an *HVAC system* that conditions return air and/or outdoor air and delivers it to the *supply ducts*.

*Supply duct** means a duct for conveying air from a heating, ventilating or air-conditioning *appliance*† to a space to be heated, ventilated or air-conditioned.

Temperature-control zone means a space that is controlled by an individual temperature-control device.

*Theatre** means a place of public assembly intended for the production and viewing of the performing arts or the screening and viewing of motion pictures, and consisting of an auditorium with permanently fixed seats intended solely for a viewing audience.

Thermal block means a space or group of spaces that is considered as one homogeneous space for energy modeling purposes. A *thermal block* shall be:
(a) one *temperature-control zone*,
(b) a group of *temperature-control zones*

(i) that are served by the same *HVAC system* or by *HVAC systems* considered to be identical,
(ii) that are operated according to the same schedule and controlled on the same temperature and moisture setpoint,
(iii) whose function and envelope characteristics are sufficiently similar that the heating and cooling energy consumption obtained by modeling the group of zones as a *thermal block* is not significantly different from what would be obtained by summing the results for the individual zones modeled separately, and
(iv) whose azimut of the glazed exterior facades of the group of *temperature-control zones* varies by no more than 45°, or

(c) a zone consisting entirely of *conditioned spaces* that are indirectly heated, cooled or ventilated.

(See Note A-1.4.1.2.(1).)

Thermal efficiency (E_t) means a measure of the efficiency of fuel-burning equipment in converting fuel to heat, as obtained through the procedures described in the standards referenced in this Code.

*Unit heater** means a suspended *space heater*† with an integral air-circulating fan.

1.4.2. Symbols and Other Abbreviations

1.4.2.1. Symbols and Other Abbreviations

1) The symbols and other abbreviations in this Code shall have the meanings assigned to them in this Article and Article 1.3.2.1. of Division B.

A	ampere(s)
a	annum (year)
Btu	British thermal unit(s)
CH	*ceiling height*
COP	*coefficient of performance*
°	degree(s) (of an angle)
°C	degree(s) Celsius
°F	degree(s) Farenheit
db	dry bulb (temperature)
E_c	*combustion efficiency*
E_t	*thermal efficiency*
EER	*energy-efficiency ratio*
>	greater than
≥	greater than or equal to
h	hour(s)
HDD	degree-days of heating under 18°C
HVAC	heating, ventilating or air-conditioning
ICOP	*integrated coefficient of performance*
IEER	*integrated energy-efficiency ratio*
IILE	installed *interior lighting* energy
ILEA	*interior lighting* energy allowance
IPLV	*integrated part-load value*
K	Kelvin
kg	kilogram(s)
kVA	kilovolt ampere(s)
kW	kilowatt(s)

< .... less than
≤ .... less than or equal to
L .... litre(s)
LPD .... lighting power density
lx .... lux
m .... metre(s)
max. .... maximum
MBH .... mega Btu/h
min. .... minimum
min .... minute(s)
mm .... millimetre(s)
No. .... number
o.c. .... on centre
Pa .... pascal(s)
% .... per cent
R .... thermal resistance value (imperial unit)
RSI .... thermal resistance value (metric unit)
s .... second(s)
SCOP .... seasonal *coefficient of performance*
SEER .... *seasonal energy-efficiency ratio*
SL .... *standby losses*
Δt .... temperature difference
U-value .... *overall thermal transmittance*
V .... volt(s)
V_t .... storage volume
W .... watt(s)
wb .... wet bulb (temperature)

Section 1.5. Referenced Documents and Organizations

1.5.1. Referenced Documents

1.5.1.1. Application of Referenced Documents

1) Except as provided in Sentence (2), the provisions of documents referenced in this Code, and of any documents referenced within those documents, apply only to the extent that they relate to
a) *buildings*,
b) *building* systems, and
c) the objective and functional statements attributed to the applicable acceptable solutions in Division B where the documents are referenced.
(See Note A-1.5.1.1.(1).)

2) Where a provision of this Code references another National Model Code, the applicable objectives and functional statements shall include those found in that referenced National Model Code.

1.5.1.2. Conflicting Requirements

1) In the case of conflict between the provisions of this Code and those of a referenced document, the provisions of this Code shall govern.

1.5.1.3. Applicable Editions

1) Where documents are referenced in this Code, they shall be the editions designated in Subsection 1.3.1. of Division B.

1.5.2. Organizations

1.5.2.1. Abbreviations of Proper Names

1) The abbreviations of proper names in this Code shall have the meanings assigned to them in Article 1.3.2.1. of Division B.

Notes to Part 1
Compliance

A-1.1.1.1.(1) Application of this Code. This Code applies to buildings and their systems, components and assemblies at the time of their construction.

This Code constitutes the energy component of the Construction Code (chapter B-1.1, r. 2). It does not cover the operation of the building. Buildings that are part of the application of Part 11 of Division B of the NBC, as defined in Sentence 1.3.3.1.(3) of Division A of the NBC, are not covered by this Code.

For the purpose of understanding the scope of this Code, an addition can be thought of as a new building that happens to be built contiguous to an existing building or as a new portion of an existing building.

A-1.1.1.2 Building Parameters. The construction and design parameters used to establish compliance with this Code must represent the anticipated operating conditions of the building. The rentable areas that were not defined when preparing the plans and specifications and constructing the building are not exempted from the requirements of this Code.

A-1.2.1.1.(1)(a) Code Compliance via Acceptable Solutions. If a building design (e.g. material, component, assembly or system) can be shown to meet all provisions of the applicable acceptable solutions in Division B (e.g. it complies with the applicable provisions of a referenced standard), it is deemed to have satisfied the objective and functional statements linked to those provisions and thus to have complied with that part of the Code. In fact, if it can be determined that a design meets all the applicable acceptable solutions in Division B, there is no need to consult the objectives and functional statements in Division A to determine its compliance.

A-1.2.1.1.(1)(b) Code Compliance via Alternative Solutions. Where a design differs from the acceptable solutions in Division B, then it should be treated as an “alternative solution” and be approved by the Régie du bâtiment du Québec according to the conditions it determines in accordance with section 127 of the Building Act (chapter B-1.1) or, in the case of buildings or equipment on which the Board has no jurisdiction, by the authority having jurisdiction. A proponent of an alternative solution must demonstrate that the alternative solution addresses the same issues as the applicable acceptable solutions in Division B and their attributed objective and functional statements. However, because the objective and functional statements are entirely qualitative, demonstrating compliance with them in isolation is not possible. Therefore, Clause 1.2.1.1.(1)(b) identifies the principle that Division B establishes the quantitative performance targets that alternative solutions must meet. In many cases, these targets are not defined very precisely by the acceptable solutions—certainly far less precisely than would be the case with a true performance code, which would have quantitative performance targets and prescribed methods of performance measurement for all aspects of building performance. Nevertheless, Clause 1.2.1.1.(1)(b) makes it clear that an effort must be made to demonstrate that an alternative solution will perform as well as a design that would satisfy the applicable acceptable solutions in Division B—not “well enough” but “as well as.”

In this sense, it is Division B that defines the boundaries between acceptable situations and the “unacceptable” situations referred to in the statements of the Code's objectives.

Level of Performance

Where Division B offers a choice between several possible designs, it is likely that these designs may not all provide exactly the same level of performance. Among a number of possible designs satisfying acceptable solutions in Division B, the design providing the lowest level of performance should generally

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

be considered to establish the minimum acceptable level of performance to be used in evaluating alternative solutions for compliance with the Code.

Sometimes a single design will be used as an alternative solution to several sets of acceptable solutions in Division B. In this case, the level of performance required of the alternative solution should be at least equivalent to the overall level of performance established by all the applicable sets of acceptable solutions taken as a whole.

Each provision in Division B has been analyzed to determine to what it applies and what it is intended to achieve. The resultant intent statements clarify what undesirable results each provision seeks to preclude. These statements are not a legal component of the Code, but are advisory in nature, and can help Code users establish performance targets for alternative solutions. They are published as part of the online Code subscriptions and as a separate electronic document entitled “Supplement to the NECB 2015: Intent Statements,” which is available on NRC's Web site.

Areas of Performance

A subset of the acceptable solutions in Division B may establish criteria for particular types of designs (e.g. certain types of materials, components, assemblies, or systems). The acceptable solutions in Division B establish acceptable levels of performance for compliance with the Code only in those areas defined by the objective and functional statements attributed to the acceptable solutions.

Applicable Acceptable Solutions

In demonstrating that an alternative solution will perform as well as a design that would satisfy the applicable acceptable solutions in Division B, its evaluation should not be limited to comparison with the acceptable solutions to which an alternative is proposed. It is possible that acceptable solutions elsewhere in the Code also apply. The proposed alternative solution may be shown to perform as well as the most apparent acceptable solution which it is replacing but may not perform as well as other relevant acceptable solutions. For example, an innovative window assembly may perform adequately as an air barrier system but may not have adequate thermal properties. All applicable acceptable solutions should be taken into consideration in demonstrating the compliance of an alternative solution.

A-1.4.1.2.(1) Defined Terms.

Annual Energy Consumption

Fuel consumption is generally calculated by the programs in terms of volume. In such a case, the consumption must be converted in terms of energy.

Building Envelope Application

Several types of spaces can be unconditioned and thus need to be treated differently, e.g., mechanical rooms, crawl spaces, garages, loading docks.

There is also a need to consider components that separate spaces that are conditioned to substantially different temperatures (e.g., swimming pools, skating rinks).

Exterior Lighting

Exterior lighting includes in particular lighting of exterior advertising signage and exterior parking areas.

Interior Lighting

Completely glazed market stalls and vestibules are examples of interior spaces that are sheltered from the exterior environment and not necessarily heated or conditioned where the interior lighting is intended only to illuminate that space.

The illumination of the covered portion of a parking area may be considered interior lighting. The illumination of the non-covered portion of a parking area, such as the open air last storey of a multi-storey parking garage, may be considered exterior lighting.

The illumination of a covered exterior walkway may be considered exterior lighting.

Linear Thermal Transmittance

The coefficient makes it possible to express the influence of a linear thermal bridging over the total heat losses of part of the envelope of a building.

Overall Thermal Transmittance (U-value)

The overall thermal transmittance, U-value in W/(m^2·K), is the inverse of the effective RSI in m^2·K/W. To convert RSI to an imperial R-value, use 1 m^2·K/W = 5.678263 h·ft^2·°F/Btu.

Point Thermal Transmittance

The coefficient makes it possible to express the influence of a point thermal bridging over the total heat losses of part of the envelope of a building.

Storage Garage

Entrances at which vehicles stop for a short time beneath an unenclosed canopy to pick up and drop off passengers are not considered as storage garages.

Suite

Tenancy in the context of the term “suite” applies to both rental and ownership tenure. In a condominium arrangement, for example, dwelling units are considered separate suites even though they are individually owned. In order to be of complementary use, a series of rooms that constitute a suite must be in reasonably close proximity to each other and have access to each other either directly by means of a common doorway or indirectly by a corridor, vestibule or other similar arrangement.

The term “suite” does not apply to rooms such as service rooms, common laundry rooms and common recreational rooms that are not leased or under a separate tenure in the context of the Code. Similarly, the term “suite” is not normally applied in the context of buildings such as schools and hospitals, since the entire building is under a single tenure. However, a room that is individually rented is considered a suite. A warehousing unit in a mini-warehouse is a suite. A rented room in a nursing home could be considered as a suite if the room were under a separate tenure. A hospital bedroom, on the other hand, is not considered to be under a separate tenure, since the patient has little control of that space, even though he or she pays the hospital a per diem rate for the privilege of using the hospital facilities, which include the sleeping areas.

Thermal Block

Where multiple control zones have windows on more than one facade of the building, they may be considered a thermal block only under certain conditions. Grouping zones that have fenestration in a single thermal block is permitted only where the fenestration has a similar azimuth, that is, where the elements of fenestration have an azimuth that differs less than 45°. It is also possible that multiple azimuths of a same zone have an exterior fenestration, such as an office in the northeastern corner of an office tower. In that case, only one thermal block could be formed with all the offices of the intermediate storeys of the northeastern corner.

A-1.5.1.1.(1) Application of Referenced Documents. Documents referenced in the NECB may contain provisions covering a wide range of issues, including issues that are unrelated to the objectives and functional statements stated in Parts 2 and 3 of Division A respectively. Sentence 1.5.1.1.(1) is intended to make it clear that, whereas referencing these documents in the NECB generally has the effect of making the provisions of those documents part of the Code, provisions that are unrelated to buildings or to the objective and functional statements attributed to the provisions in Division B where the document is referenced are excluded.

Furthermore, many documents referenced in the NECB contain references to other documents, which may also, in turn, refer to other documents. These secondary and tertiary referenced documents may contain provisions that are unrelated to buildings or to the objectives and functional statements of the NECB: such provisions—no matter how far down the chain of references they occur—are not included in the intent of Sentence 1.5.1.1.(1).

Part 2
Objectives

Part 2
Objectives

Section 2.1. Application

2.1.1. Application

2.1.1.1. Application

1) This Part applies to all *buildings* covered in this Code. (See Article 1.1.1.1.)

2.1.1.2. Application of Objectives

1) The objectives described in this Part apply
a) to all *buildings* covered in this Code (see Article 1.1.1.1.), and
b) only to the extent that they relate to compliance with this Code as required in Article 1.2.1.1.

Section 2.2. Objectives

2.2.1. Objectives

2.2.1.1. Objectives

1) The objectives of this Code are as follows (see Note A-2.2.1.1.(1)):

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

Notes to Part 2
Objectives

A-2.2.1.1.(1) Objectives. Where the term “the building” is used in the wording of the objectives, it refers to the building for which compliance with the NECB is being assessed.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

Part 3
Functional Statements

Part 3
Functional Statements

Section 3.1. Application

3.1.1. Application

3.1.1.1. Application

1) This Part applies to all *buildings* covered in this Code. (See Article 1.1.1.1.)

3.1.1.2. Application of Functional Statements

1) The functional statements described in this Part apply
a) to all *buildings* covered in this Code (see Article 1.1.1.1.), and
b) only to the extent that they relate to compliance with this Code as required in Article 1.2.1.1.

Section 3.2. Functional Statements

3.2.1. Functional Statements

3.2.1.1. Functional Statements

1) The objectives of this Code are achieved by measures, such as those described in the acceptable solutions in Division B, that are intended to allow the *building* or its elements to perform the following functions (see Note A-3.2.1.1.(1)):

F90 To limit the amount of uncontrolled air leakage through the *building envelope*.

F91 To limit the amount of uncontrolled air leakage through 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 system components.

F94 To limit the unnecessary demand and/or consumption of energy for lighting.

F95 To limit the unnecessary demand and/or consumption of energy for heating and cooling.

F96 To limit the unnecessary demand and/or consumption of energy for *service water* heating.

F97 To limit the unnecessary demand and/or consumption of energy for electrical equipment and 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.

Notes to Part 3
Functional Statements

A-3.2.1.1.(1) Listing of Functional Statements. There is a master list of functional statements covering the National Model Codes—the National Building Code, the National Fire Code, the National Plumbing Code and the National Energy Code for Buildings—but not all functional statements are pertinent to all Codes. The numbered functional statements are grouped according to functions that deal with closely related subjects.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

Division B

Acceptable Solutions

Part 1
General

Part 1
General

Section 1.1. General

1.1.1. Application

1.1.1.1. Application

1) This Part applies to all *buildings* covered in this Code. (See Article 1.1.1.1. of Division A.)

1.1.2. Compliance

1.1.2.1. Prescriptive, Trade-off or Performance Compliance

(See Note A-1.1.2.1.)

1) *Buildings* shall comply with
a) the prescriptive or trade-off requirements stated in Parts 3 to 7, or
b) the performance requirements stated in Part 8.

1.1.3. Objective and Functional Statements

1.1.3.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in Division B shall be the objective and functional statements identified in Sections 3.5., 4.5., 5.5., 6.5., 7.5. and 8.5. (See Note A-1.1.3.1.(1).)

1.1.4. Basic Data and Calculation Methods

1.1.4.1. Climatic Values

1) The climatic values required for the design of *buildings* under this Code shall be in conformance with the values established by the *authority having jurisdiction* or, in the absence of such data, with the climatic values in Table C-1 for the location nearest to the *building* site. (See Note A-1.1.4.1.(1).)

1.1.4.2. Calculation Procedures

1) Calculations carried out to ensure compliance with this Code and not described in the balance of this Subsection or in other Parts of the Code shall be carried out using procedures recognized for the particular purposes, such as those described in, but not limited to:
a) ASHRAE Handbooks, Standards and Guidelines,
b) “HRAI Digest,” and
c) Hydronics Institute Manuals.

Section 1.2. Terms and Abbreviations

1.2.1. Definitions of Words and Phrases

1.2.1.1. Non-defined Terms

1) Words and phrases used in Division B that are not included in the list of definitions in Article 1.4.1.2. of Division A shall have the meanings that are commonly assigned to them in the context in which they are used, taking into account the specialized use of terms by the various trades and professions to which the terminology applies.

2) Where objectives and functional statements are referred to in Division B, they shall be the objectives and functional statements described in Parts 2 and 3 of Division A.

3) Where acceptable solutions are referred to in Division B, they shall be the provisions stated in Parts 3 to 8.

1.2.1.2. Defined Terms

1) The words and terms in italics in Division B shall have the meanings assigned to them in Article 1.4.1.2. of Division A.

2) Deleted.

1.2.2. Symbols and Other Abbreviations

1.2.2.1. Symbols and Other Abbreviations

1) The symbols and other abbreviations in Division B shall have the meanings assigned to them in Article 1.4.2.1. of Division A and Article 1.3.2.1.

Section 1.3. Referenced Documents and Organizations

1.3.1. Referenced Documents

1.3.1.1. Effective Date

1) Unless otherwise specified herein, the documents referenced in this Code shall include all amendments, revisions, reaffirmations, reapprovals, addenda and supplements effective to 30 June 2014.

1.3.1.2. Applicable Editions

1) Where documents are referenced in this Code, they shall be the editions designated in Table 1.3.1.2. (See also Note A-1.5.1.1.(1) of Division A.)

Table 1.3.1.2.
Documents Referenced in the National Energy Code of Canada for Buildings 2015
Forming Part of Sentence 1.3.1.2.(1)

Issuing Agency	Document Number(1)	Title of Document(2)	Code Reference
AAMA	501.5-07	Thermal Cycling of Exterior Walls	3.1.1.8.(3)
AHRI	1061 (SI)-2013	Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment	5.2.10.1.(5) 5.2.10.4.(2)
AMCA	ANSI/AMCA 500-D-12	Testing Dampers for Rating	5.2.4.2.(2)
AMCA	ANSI/AMCA 500-L-12	Testing Louvers for Rating	5.2.4.2.(2)

Table 1.3.1.2. (Continued)

Issuing Agency	Document Number[(1)]	Title of Document[(2)]	Code Reference
ASHRAE	2013	ASHRAE Handbook – Fundamentals	3.1.1.5.(4) A-3.1.1.5.(5)(b) A-3.1.1.5.(5)(c), (6)(c) and (7)(a) A-3.3.1.3.(2) A-8.4.3.3.(7)
ASHRAE	ASHRAE/IES 90.1-2013	User's Manual	A-6.2.3.1.(1) and (5) and 6.2.3.2.(1) A-8.4.4.6.(4)
ASHRAE	ANSI/ASHRAE 111-2008	Measurement, Testing, Adjusting and Balancing of Building HVAC Systems	A-5.2.5.2.(1)
ASHRAE	ANSI/ASHRAE 140-2011	Evaluation of Building Energy Analysis Computer Programs	8.4.2.2.(1) A-8.4.2.2.(1)
ASTM	C 177-13	Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus	3.1.1.5.(1)
ASTM	C 335/C 335M-10e1	Steady-State Heat Transfer Properties of Pipe Insulation	5.2.5.3.(6) 6.2.3.1.(4)
ASTM	C 518-10	Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	3.1.1.5.(1)
ASTM	C 1363-11	Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	3.1.1.5.(4) 3.1.1.5.(5) 3.1.1.5.(7)
ASTM	E 283-04	Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	3.1.1.8.(3) 3.1.1.8.(4)
ASTM	E 2357-11	Determining Air Leakage of Air Barrier Assemblies	3.1.1.8.(1) A-3.1.1.8.(1)
CCBFC	NRCC 56190	National Building Code of Canada 2015	1.4.1.2.(1)[(3)] 3.1.1.5.(1) 5.2.1.1.(1) 5.2.2.1.(1) 5.2.2.8.(2) 5.2.5.1.(1) 5.2.8.8.(4) 5.2.8.8.(5) 5.2.10.2.(2) 8.4.3.6.(1) 8.4.4.15.(2) 8.4.4.17.(4) 8.4.4.17.(5) A-1.1.1.1.(1)[(3)] A-3.1.1.5.(5)(b) A-3.2.1.1.(1)[(3)] A-3.2.3.1.(3) A-5.2.2.8.(2) A-5.2.8.3.(1)
CCBFC	NRCC 56192	National Fire Code of Canada 2015	1.4.1.2.(1)[(3)] A-3.2.1.1.(1)[(3)]
CCBFC	NRCC 56193	National Plumbing Code of Canada 2015	1.4.1.2.(1)[(3)] A-3.2.1.1.(1)[(3)]
CSA	AAMA/WDMA/CSA 101/I.S.2/A440-11	NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights	3.1.1.5.(3) 3.1.1.8.(2) 3.1.1.8.(4)

Table 1.3.1.2. (Continued)

Issuing Agency	Document Number[1]	Title of Document[2]	Code Reference
CSA	A440S1-09	Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440, NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights	3.1.1.8.(2) 3.1.1.8.(4)
CSA	CAN/CSA-A440.2-14/A440.3-14	Fenestration Energy Performance/User Guide to CSA A440.2-14, Fenestration Energy Performance	3.1.1.5.(3) 3.1.1.5.(6) A-3.1.1.6.(3)
CSA	CAN/CSA-C439-09	Rating the Performance of Heat/Energy-Recovery Ventilators	5.2.10.1.(5) 5.2.10.4.(2) A-5.2.10.4.(2)(a)
HRAI	SAR-G1	HRAI Digest 2005	1.1.4.2.(1) A-5.2.1.1.(1)
HVI	HVI Publication 911	Certified Home Ventilating Products Directory	A-5.2.10.4.(2)(a)
IES	ANSI/IES RP-28-07	Lighting and the Visual Environment for Senior Living	Table 4.2.1.6. Table 8.4.3.4.-A Table A-8.4.3.8.(1)-B
ISO	ISO 6946:2007	Building components and building elements – Thermal resistance and thermal transmittance – Calculation method	3.1.1.5.(5) A-3.1.1.5.(5)(b)
NFRC	100-2010	Determining Fenestration Product U-factors	3.1.1.5.(3) 3.1.1.5.(6)
SMACNA	ANSI/SMACNA 006-2006	HVAC Duct Construction Standards – Metal and Flexible	5.2.2.3.(1) A-5.2.2.1.(1) A-5.2.2.3.(1)
SMACNA	ANSI/SMACNA 016-2012	HVAC Air Duct Leakage Test Manual	5.2.2.4.(1) A-5.2.2.1.(1)
SMACNA	2003	Fibrous Glass Duct Construction Standards	A-5.2.2.1.(1)
SMACNA	2006	HVAC Systems – Duct Design	A-5.2.2.1.(1)
UL	UL 181A-2013	Closure Systems for Use with Rigid Air Ducts	5.2.2.3.(5)
UL	UL 181B-2013	Closure Systems for Use with Flexible Air Ducts and Air Connectors	5.2.2.3.(5)
ULC	CAN/ULC-S742-11	Air Barrier Assemblies – Specification	3.1.1.8.(1) A-3.1.1.8.(1)

Notes to Table 1.3.1.2.:

(1) Some documents may have been reaffirmed or reapproved. Check with the applicable issuing agency for up-to-date information.

(2) Some titles have been abridged to omit superfluous wording.

(3) Code reference is in Division A.

1.3.2. Organizations

1.3.2.1. Abbreviations of Proper Names

1) The abbreviations of proper names in this Code shall have the meanings assigned to them in this Article.

AAMA .... American Architectural Manufacturers Association (www.aamanet.org)

AHRI .... Air-Conditioning, Heating and Refrigeration Institute (www.ahrinet.org)

AMCA .... Air Movement and Control Association (www.amca.org)

ANSI .... American National Standards Institute (www.ansi.org)

ASHRAE .... American Society of Heating, Refrigerating and Air-Conditioning Engineers (www.ashrae.org)

ASME .... American Society of Mechanical Engineers (www.asme.org)

ASTM	American Society for Testing and Materials International (www.astm.org)
BRE	Building Research Establishment (www.bregroup.com))
CAN	National Standard of Canada designation
CCBFC	Canadian Commission on Building and Fire Codes (see NRC)
CSA	CSA Group (www.csagroup.ca)
CTI	Cooling Technology Institute (www.cti.org)
DOE	U.S. Department of Energy (www.energy.gov)
HRAI	Heating, Refrigeration and Air Conditioning Institute of Canada (www.hrai.ca)
HVI	Home Ventilating Institute (www.hvi.org)
IES	Illuminating Engineering Society (www.ies.org)
ISO	International Organization for Standardization (www.iso.org)
NBC	National Building Code
NECB	National Energy Code of Canada for Buildings 2015
NFC	National Fire Code of Canada 2015
NFRC	National Fenestration Rating Council (www.nfrc.org)
NPC	National Plumbing Code of Canada 2015
NRC	National Research Council of Canada (Ottawa, Ontario K1A 0R6; www.nrc-cnrc.gc.ca)
NRCan	Natural Resources Canada (www.nrcan.gc.ca)
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association (www.smacna.org)
TIAC	Thermal Insulation Association of Canada (www.tiac.ca)
WDMA	Window & Door Manufacturers Association (www.wdma.com)
UL	Underwriters Laboratory (www.ul.com)
ULC	ULC Standards (canada.ul.com/ulcstandards)

Notes to Part 1
General

A-1.1.2.1. NECB Compliance Options. Figure A-1.1.2.1. shows the three compliance options available in Division B.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

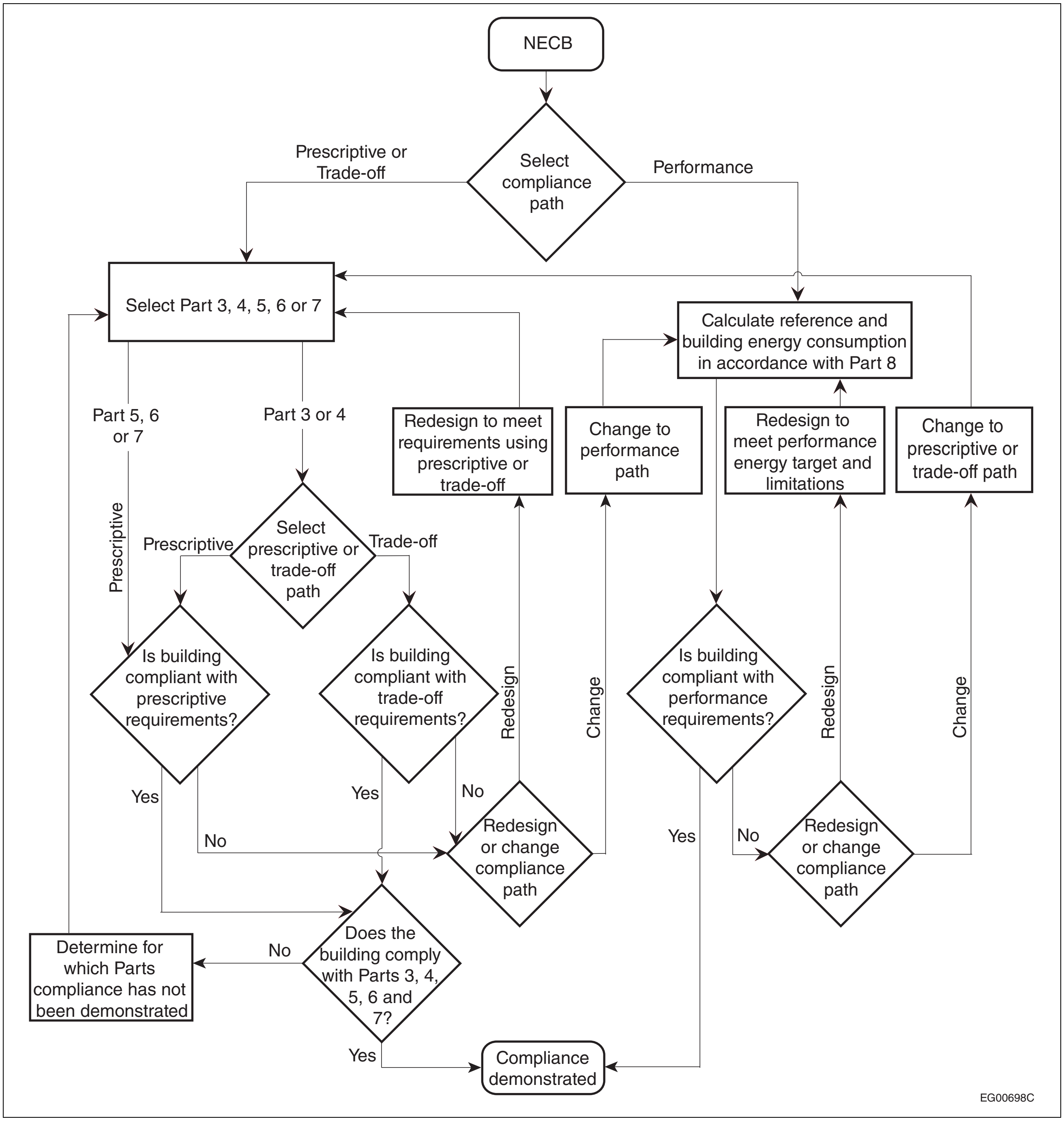

Figure A-1.1.2.1.
Decision flow chart for Code compliance

Prescriptive Path

The first compliance option is to apply the prescriptive requirements of the Code, which generally dictate minimum thermal characteristics for envelope elements and energy efficiency measures that can be stated as specific instructions.

Trade-off Path

The second option affords some degree of flexibility in the application of the prescriptive requirements. For example, the trade-off paths for Part 3 allow Code users to vary the thermal characteristics of one or more components of the building envelope from that permitted in Section 3.2., provided it can be demonstrated that the resultant building envelope will not transfer more energy than it would if all its components complied with that Section. The trade-off options present an easy way to make small adjustments to the characteristics of the building without having to follow the whole-building performance route.

The building energy performance compliance path used to achieve compliance of buildings is an approach that applies to the whole building. Therefore, if that path is chosen to achieve compliance, it must be the only path used for all the parameters of the building. It should be noted that certain building parameters may not be amended in that path in respect of prescriptive requirements. Those restrictions are specified in Sections 3.4., 4.4., 5.4., 6.4. and 7.4., and in Part 8.

Performance Path

The third option is a performance path: if some aspects of the prescriptive and trade-off routes are considered too limiting, the building could, for example, be designed with any thermal characteristics desired (subject to certain limitations), provided that it would not have a calculated energy consumption under standardized conditions that is greater than it would have been had the building been designed in strict conformity with the prescriptive requirements, all other aspects of the building (those that are not the object of a requirement in this Code) remaining the same in both cases. The proof of compliance when using the performance path option is achieved through two energy analyses: one on the building as if it met the prescriptive requirements, which gives the “target” performance, and the other on the actual design for which a building permit is requested.

A-1.1.3.1.(1) Objective and Functional Statements Attributed to Acceptable Solutions. The objective and functional statements attributed to each Code provision are shown in Tables at the end of each Part in Division B.

Many provisions in Division B serve as modifiers of or pointers to other provisions, or serve other clarification or explanatory purposes. In most cases, no objective and functional statements have been attributed to such provisions, which therefore do not appear in the above-mentioned tables.

For provisions that serve as modifiers of or pointers to other referenced provisions and that do not have an objective and functional statements attributed to them, the objective and functional statements that should be used are those attributed to the provisions they reference.

A-1.1.4.1.(1) Climatic Values. Climatic values for municipalities not listed in Table C-1 may be obtained by contacting the Meteorological Service of Canada, Environment Canada, 4905 Dufferin Street, Downsview, Ontario M3H 5T4; www.climate.weather.gc.ca.

Hourly climatic values are available from multiple sources such as Environment Canada, Natural Resources Canada, the Regional Conservation Authority and other such public agencies that record this type of information. Hourly weather data are also available from public and private agencies that format this information for use with annual energy consumption simulation software; in some cases, these data have been incorporated into the software.

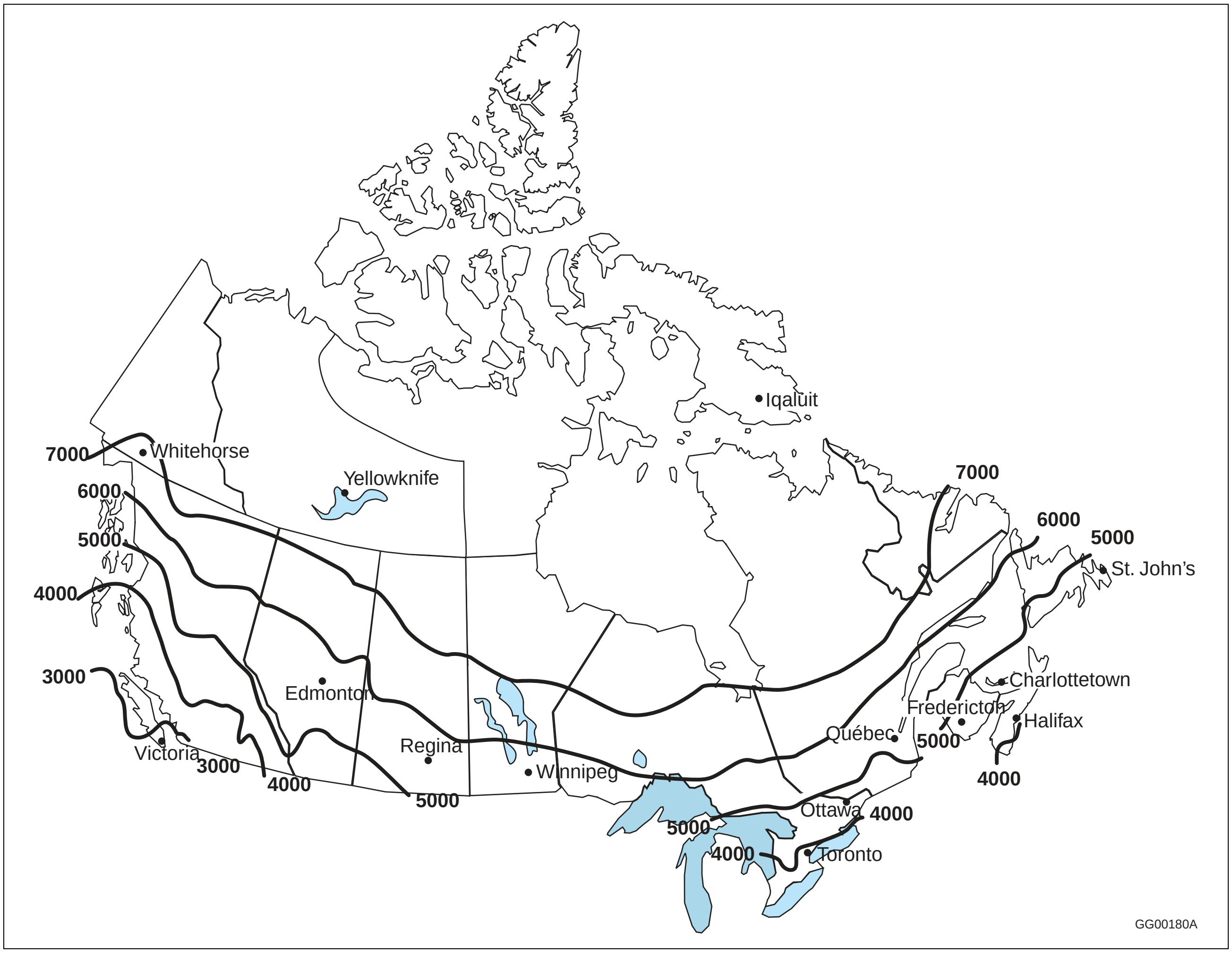

Figure A-1.1.4.1.(1)
Contour map showing approximate average annual heating degree-days taken at 18°C

Part 2
Reserved

Part 3
Building Envelope

Part 3
Building Envelope

Section 3.1. General

3.1.1. General

3.1.1.1. Scope

1) This Part is concerned with the transfer of heat and air through
a) *building* materials, components and assemblies forming part of the *building envelope*, and
b) interfaces between *building* materials, components and assemblies forming part of the *building envelope*.

3.1.1.2. Application

1) This Part applies to the *building envelope* in *buildings* and parts of a *building*
a) that are equipped with *HVAC systems* or have provisions for the future installation of such systems, and
b) whose heating and/or cooling system output capacity is at least 10 W/m² of *floor surface area*. (See Note A-3.1.1.2.(1)(b).)

3.1.1.3. Compliance

1) Compliance with this Part shall be achieved by following
a) the prescriptive path described in Section 3.2.,
b) the trade-off path described in Section 3.3., or
c) the performance path described in Section 3.4. (see Note A-3.1.1.3.(1)(c)).
(See Note A-3.1.1.3.(1).)

3.1.1.4. Definitions

1) Words that appear in italics are defined in Article 1.4.1.2. of Division A.

3.1.1.5. Thermal Characteristics of Building Assemblies

1) The thermal characteristics of *building envelope* materials shall be determined in accordance with the applicable product standards listed in the NBC or, in the absence of such standards or where such standards do not address the determination of thermal characteristics, in accordance with
a) ASTM C 177, "Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus," or
b) ASTM C 518, "Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus."

2) Calculations and tests performed in accordance with Sentence (1) shall be carried out at an average temperature of 24±2°C and under a temperature difference of 22±2°C.

3) Except as provided in Sentence (4), the *overall thermal transmittance* of *fenestration* and doors shall be determined for the reference sizes listed in accordance with
a) CAN/CSA-A440.2/A440.3, "Fenestration Energy Performance/User Guide to CSA A440.2-14, Fenestration Energy Performance,"

b) NFRC 100, "Determining Fenestration Product U-factors", or
c) AAMA/WDMA/CSA 101/I.S.2/A440, "NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights."

4) The *overall thermal transmittance* of *fenestration* and doors that are not within the scope of the standards listed in Sentence (3) shall be determined from
a) calculations carried out using the procedures described in the "ASHRAE Handbook – Fundamentals," or
b) laboratory tests performed in accordance with ASTM C 1363, "Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus," using an indoor air temperature of 21±1°C and an outdoor air temperature of –18±1°C measured at the mid-height of the *fenestration* or door.

5) The *effective thermal resistance* of *building* assemblies other than *fenestration*, doors and opaque sections of curtain walls shall be determined in accordance with
a) the calculation method described in ISO 6946, "Building components and building elements – Thermal resistance and thermal transmittance – Calculation method,"
b) a method calculating the *effective thermal resistance* of *building* assemblies
  i) with a discontinuity at the expanses of insulation, and
  ii) whose thermal conductivity difference between the materials contributing to the discontinuity is moderate, so that the heat transferred from the structural members is parallel to that of the insulation (see Note A-3.1.1.5.(5)(b)),
c) the heat transfer digital simulations (see Note A-3.1.1.5.(5)(c), (6)(c) and (7)(a)), or
d) laboratory tests performed in accordance with ASTM C 1363, "Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus," using an indoor air temperature of 21±1°C and an outdoor air temperature of –18±1°C.

6) Except as provided in Sentences 3.3.1.3.(4) and 8.4.3.3.(8), the *effective thermal resistance* of the opaque sections of curtain walls shall be determined in accordance with
a) CAN/CSA-A440.2/A440.3, "Fenestration Energy Performance/User Guide to CSA A440.2-14, Fenestration Energy Performance,"
b) NFRC 100, "Determining Fenestration Product U-factors," or
c) the heat transfer digital simulations (see Note A-3.1.1.5.(5)(c), (6)(c) and (7)(a)).

7) Except as provided in Sentence 3.3.1.3.(3), the *linear thermal transmittance* and the *point thermal transmittance* shall be determined from
a) the heat transfer digital simulations (see Note A-3.1.1.5.(5)(c), (6)(c) and (7)(a)), or
b) laboratory tests performed in accordance with ASTM C 1363, "Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus," using an indoor air temperature of 21±1°C and an outdoor air temperature of -18±1°C.

3.1.1.6. Characteristics and Calculation of Surface Areas

1) *Opaque building assemblies* areas shall be calculated along the plane of the insulation using dimensions measured to the exterior walls of adjacent *building* assemblies, and include the area of the intersection surfaces of the interior *building* assemblies. (See Note A-3.1.1.6.(1).)

2) Wall assemblies inclined less than 60° from the horizontal shall be considered as roof assemblies, and roof assemblies inclined 60° or more from the horizontal shall be considered as wall assemblies.

3) *Fenestration* and door areas shall be calculated to the rough opening in the *opaque building assemblies*. (See Note A-3.1.1.6.(3).)

4) *Fenestration* and door areas integrated to curtain walls shall be calculated from the axis of any mullion separating the *fenestration* or doors from the opaque sections of curtain walls.

5) The *fenestration* area made of flat panes that are not all in the same plane or curved panes shall be measured along the surface of the glass. (See Note A-3.1.1.6.(5).)

6) In the calculation of allowable door and *fenestration* area, excluding *skylight* areas, the gross wall area shall be calculated as the sum of the areas of all above-ground wall assemblies including *fenestration* and doors, but not including parapets, projected fins, ornamentation and appendages.

7) In the calculation of allowable *skylight* area, the gross roof area shall be calculated as the sum of the areas of insulated roof including *skylights*.

8) In the calculation of allowable door and *fenestration* area in *additions*, *additions* shall be considered as new *buildings*.

3.1.1.7. Calculation of Effective Thermal Resistance

1) The calculation of the *effective thermal resistance* of *opaque building assemblies* shall account for the specific thermal resistance of

a) continuous members,
b) repetitive structural members, such as studs and joists, jambs and resilient bars, and
c) ancillary structural members, such as lintels, sills and plates.

(See Note A-3.1.1.7.(1).)

2) In calculating the *effective thermal resistance* of *opaque building assemblies*, the thermal bridging effect of major structural members, such as columns and spandrel beams, that are parallel to the plane of the *building envelope* and partly penetrate that *building envelope* assembly need not be taken into account, provided they do not reduce the *effective thermal resistance* at the projected area at less than half the value required by Section 3.2. (See Note A-3.1.1.7.(2).)

3) In calculating the *effective thermal resistance* of *opaque building assemblies*, the following elements need not be taken into account when they must partially or completely penetrate the *building envelope* to perform their intended function and comply with the requirements of Article 3.2.1.2.:

a) pipes,
b) ducts,
c) equipment with through-the-wall venting,
d) equipment of an *HVAC system*,
e) minor ties and anchors, and any other similar member, necessary to the structure of the envelope,
f) linear anchoring devices, such as shelf angles for masonry, and
g) major structural penetrations, such as balcony slabs, beams, girders, columns, ornamentation and appendages.

(See Note A-3.1.1.7.(3).)

4) Where a component of the *building envelope* is protected by an enclosed space other than a *conditioned space*, such as a sun porch, enclosed veranda or vestibule, the enclosure may be considered to have an *effective thermal resistance* of 0.16 $m^2 \cdot K/W$. (See Note A-3.1.1.7.(4).)

5) In calculating the *effective thermal resistance* of an *opaque building assembly*, the effect of overlapping expanses of insulation, on either side of a *building* assembly, does not have to be taken into account where they comply with the requirements of Article 3.2.1.2.

6) In calculating the *effective thermal resistance* of an *opaque building assembly*, the effect of the transitions between the constructive systems of the *building envelope*, such as joints between walls and *fenestration*, does not have to be taken into account where they comply with the requirements of Article 3.2.1.2.

3.1.1.8. Air Leakage in Building Assemblies

1) *Air barrier assemblies* in *opaque building assemblies* excluding the opaque sections of curtain walls shall be assessed in accordance with
a) CAN/ULC-S742, "Air Barrier Assemblies – Specification," or
b) ASTM E 2357, "Determining Air Leakage of Air Barrier Assemblies," provided that
   i) the *building* is erected in an area where it will not be submitted to extended wind pressures having a probability of 1 out of 50 to be exceeded during one year by more than 0.65 kPa, and
   ii) the *air barrier assembly* is installed inboard of the *building envelope* of the thermal insulation of the *opaque building assembly*.

(See Note A-3.1.1.8.(1).)

2) Except as provided in Sentence (3), the air leakage rates of the *fenestration* excluding the glazed sections of curtain walls shall be assessed in accordance with
a) AAMA/WDMA/CSA 101/I.S.2/A440, "NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights," and
b) CSA A440S1, "Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440, NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights,"

3) Air leakage rates of curtain walls forming part of the *building envelope* shall be assessed in accordance with ASTM E 283, "Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen," when the specimen is prepared in accordance with Clause 6 of AAMA 501.5, "Thermal Cycling of Exterior Walls."

4) Air leakage rates of doors forming part of the *building envelope* shall be assessed in accordance with
a) ASTM E 283, "Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen," or
b) the following standards:
   i) AAMA/WDMA/CSA 101/I.S.2/A440, "NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights," and
   ii) CSA A440S1, "Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440, NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights,"

Section 3.2. Prescriptive Path

3.2.1. General

3.2.1.1. Protection of Insulation Materials

1) Except as provided in Sentence (2), the *building envelope* shall be designed to avoid reducing the thermal resistance of the insulation material due to
a) air leakage or convection,
b) wetting, or
c) moisture bypassing the plane of thermal resistance.

(See Note A-3.2.1.1.(1).)

2) Where any of the conditions described in Clauses (1)(a) to (c) occur as a result of the designed *building envelope* system, their effect on the thermal resistance of the insulation material shall be calculated in accordance with Article 3.1.1.5.

3.2.1.2. Continuity of Insulation

1) Except as provided in Sentences (2) to (7) and (9), interior *building* assemblies, including *partitions* and major structural members that are embedded along exterior walls that partly penetrate the *building envelope*

a) shall not break the continuity of the insulation, and
b) shall have an *effective thermal resistance* at their projected area equal to at least the resistance required for the *building envelope*.

(See Note A-3.2.1.2.(1).)

2) The following members need not be taken into account to comply with Sentence (1):

a) repetitive structural members, such as studs and joists, jambs and resilient bars,
b) ancillary structural members, such as lintels, sills and plates, and
c) minor penetrations of the envelope, such as ties.

(See Note A-3.2.1.2.(2).)

3) Except as provided in Sentences (4), (9) and (10), where an interior wall, *foundation* wall, *firewall*, party wall, structural member, ornamentation or appendage penetrates the *building envelope* and breaks the continuity of its insulation, it shall

a) be insulated
   i) on its faces exposed to air inward or outward from the *building envelope* for a distance equal to 4 times its uninsulated thickness, and
   ii) so that the *effective thermal resistance* of the penetrating member is not, for the distance prescribed by Subclause (a)(i), less than that required for the penetrated component, or
b) be insulated in continuity with the insulation of the penetrated component so that the *effective thermal resistance* at that location is equal to at least half the resistance required for the penetrated component.

(See Note A-3.2.1.2.(3).)

4) Where a structural slab penetrates the *building envelope* and breaks the continuity of the insulation, the slab shall be insulated

a) in accordance with the requirements of Sentence (3), or
b) with materials having a thermal resistance of at least
   i) 1.76 $m^2 \cdot K/W$ installed on the axis of the expanse of insulation of the penetrated wall for a distance of at least 2/3 of the penetration area, and
   ii) 0.09 $m^2 \cdot K/W$ installed above and under the slab inward for a distance equal to at least 4 times the thickness of the slab.

(See Note A-3.2.1.2.(4).)

5) Linear anchoring devices, shelf angles for masonry and other similar devices that penetrate the insulation of a component of the *building envelope* shall include intermittent transverse supports so that only the latter penetrate the insulation. (See Note A-3.2.1.2.(5).)

6) Joints between *building* assemblies of the *building envelope*, such as expansion or construction joints and joints between walls and doors or *fenestration*, shall be insulated

a) in a manner that provides continuity across such joints, and
b) in a manner that the *effective thermal resistance* at the location of those joints is equal to at least half of the lowest of the values required for the contiguous *building* assemblies.

(See Note A-3.2.1.2.(6).)

7) Except as provided in Clause (9)(e), where 2 expanses of insulation are separated by a member of the *building envelope* and do not intersect, those expanses of insulation shall overlap for a distance equal to at least 4 times the thickness of the assembly separating them. (See Note A-3.2.1.2.(7).)

8) To comply with Sentence (7), hollow-core masonry walls shall be filled with grout, mortar or insulation at the location coinciding with the limits of the overlapped expanses of insulation. (See Note A-3.2.1.2.(8).)

9) The continuity of the insulation may be broken

a) between a *foundation* wall and a floor slab in contact with the ground where the *foundation* wall is insulated from the exterior,

b) the horizontal part of a *foundation* wall supporting an exterior screen-wall where it is insulated from the exterior,

c) at minor transitions between the constructive systems of the *building envelope* that must break the continuity of the insulation to perform their intended function, such as backing necessary for fastening flashing at the intersection of parapets and roofs (see Note A-3.2.1.2.(9)(c)),

d) where ducts or devices penetrate expanses of insulation of the *building envelope*, provided that the insulation is installed to follow closely the perimeter of those elements, or

e) where the 2 expanses of insulation may not be extended for the distance required by Sentence (7), provided that the *effective thermal resistance* of the member of the *building envelope* that makes contact between the two insulation layers is equal to at least half the minimum value required.

10) A thermal bridging breaker part of a point penetration of the *building envelope* need not be insulated in accordance with the requirements of Sentence (3) where all the components of the point penetration have a *point thermal transmittance* of not more than 0.5 W/°C.

3.2.1.3. Spaces Heated or Cooled to Different Temperatures

1) The *effective thermal resistance*, RSI_{E1}, in m²·K/W, of *building* assemblies separating *conditioned spaces* that are intended to be heated or cooled to temperatures that differ by more than 10°C shall be equal to at least the value obtained with the following equation:

$$RSI_{E1} = [(t_2 - t_1) \cdot RSI_E] / 43$$

where

t_1 = indoor design temperature of the colder *conditioned space*, in °C,
t_2 = indoor design temperature of the warmer *conditioned space*, in °C, and
RSI_E = *effective thermal resistance* of 3.60 m²·K/W for a wall and 5.46 m²·K/W for a floor.

(See Note A-3.2.1.3.(1).)

2) The *building* assemblies covered in Articles 3.2.2.2., 3.2.2.3., 3.2.2.4. and 3.2.3.1. insulating a heated but not cooled space, whose heating setpoint is less than 18°C, shall have an *effective thermal resistance*, RSI_{E1}, in m²·K/W, equal to at least the value obtained with the following equation:

$$RSI_{E1} = [(t_1 - t_0) \cdot RSI_E] / (18 - t_0)$$

where

t_1 = heating setpoint in winter months, in °C,
t_0 = outdoor 2.5% January heating design temperature according to the location of the *building* determined in accordance with Sentence 1.1.4.1.(1), in °C, and
RSI_E = *effective thermal resistance* required in Tables 3.2.2.2., 3.2.2.3., 3.2.2.4. and 3.2.3.1., in m²·K/W.

(See Note A-3.2.1.3.(2).)

3.2.1.4. Allowable Fenestration and Door Area

1) The total area of doors and *fenestration*, excluding the *skylight* area, shall be equal to or less than 40% of the gross wall area determined in accordance with Article 3.1.1.6.

2) The total *skylight* area shall be less than 3% of the gross roof area as determined in Article 3.1.1.6.

3) The *overall thermal transmittance* of the *fenestration* and doors of an *addition* whose *floor surface area* does not exceed 200 m² and whose *fenestration* or door area exceeds the requirements of Sentence (1) or (2) shall comply with the requirements of Sentences 3.2.2.3.(3) and 3.2.2.4.(2).

3.2.2. Above-ground Components of the Building Envelope

3.2.2.1. Vestibules

1) Except as provided in Sentence (3), a door that separates *conditioned space* from the exterior shall be protected with an enclosed vestibule whose doors opening into and out of the vestibule are equipped with self-closing devices.

2) Except for doors equipped with power operators in barrier-free entrances, vestibules required in Sentence (1) shall be designed so that users passing through the vestibule are not required to open the interior and exterior doors at the same time.

3) A vestibule is not required for an exterior door that
a) is a revolving door,
b) is used primarily to facilitate vehicular movement or material handling,
c) is intended to be used as a service, emergency *exit*, or stairwell *exit* door only,
d) is intended to be used as a seasonal use door, such as a door leading to a patio,
e) opens directly from a *dwelling unit*, or
f) opens directly from a retail space less than 200 m² in *floor surface area* or from a space less than 150 m² in *floor surface area* for other uses.

3.2.2.2. Thermal Characteristics of Above-ground Opaque Building Assemblies

1) Except as provided in Sentences (2), (4), (5) and (6) and Article 3.2.1.3., the *effective thermal resistance* of above-ground *opaque building assemblies* shall be equal to at least that shown in Table 3.2.2.2. for the *building* or part thereof enclosed by the *opaque building assembly*, for the applicable heating-degree-day category taken at 18°C. (See Note A-3.2.2.2.(1).)

Table 3.2.2.2.
Effective Thermal Resistance of Above-ground Opaque Building Assemblies
Forming Part of Sentences 3.2.2.2.(1) and (2)

Above-ground *Opaque Building Assembly*	Heating Degree-Days under 18 °C 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_E, in m²·K/W					
Walls	3.60	3.60	3.60	3.60	4.05	4.05
Roofs	5.46	5.46	5.46	5.46	6.17	6.17
Floors	5.46	5.46	5.46	5.46	6.17	6.17

Notes to Table 3.2.2.2.:
(1) See Sentence 1.1.4.1.(1).

2) The *effective thermal resistance* of portions of a *foundation* wall that are above ground of which less than 50% of the area is exposed to exterior air shall be equal to at least that shown in Table 3.2.3.1. for walls in contact with the ground. (See Note A-3.2.2.2.(2) and (3).)

3) The percentage of *foundation* walls that are above ground described in Sentence (2) shall be assessed independently for
a) each of the walls,

b) each of the *storeys*, and
c) each constructive system.
(See Note A-3.2.2.2.(2) and (3).)

4) Where radiant heating cables or heating or cooling pipes or membranes are integrated to above-ground *opaque building assemblies*, the minimum *effective thermal resistance* provided for in Sentence (1) shall be increased by 25%. (See Note A-3.2.2.2.(4).)

5) The *effective thermal resistance* required for a flat roof may be reduced by not more than 20% at its lowest point when drainage slopes are created by the insulation materials, provided that the value of the average *effective thermal resistance* for the roof is at least equal to the value in Table 3.2.2.2. required for a roof. (See Note A-3.2.2.2.(5).)

6) The *effective thermal resistance* required for a roof may be reduced for a distance of not more than 1200 mm measured from the outside face of the wall when the slope of the roof and the necessary clearance for the ventilation so require, provided that it is equal to at least the value in Table 3.2.2.2. required for an above-ground wall. (See Note A-3.2.2.2.(6).)

3.2.2.3. Thermal Characteristics of Fenestration

1) For the purposes of this Article, use of the term "*fenestration*" does not include doors, which are covered in Article 3.2.2.4.

2) Except as provided in Article 3.2.1.3., the *overall thermal transmittance* of *fenestration* shall be not more than that shown in Table 3.2.2.3. for the applicable heating-degree-day category taken at 18°C, as determined in accordance with Article 3.1.1.5.

3) The *overall thermal transmittance* of *fenestration* shown in Table 3.2.2.3. shall be reduced by at least 10% in the case of an *addition*
a) whose *floor surface area* is not more than 200 m², and
b) whose opening percentage exceeds the values prescribed in Sentence 3.2.1.4.(1).

4) Deleted.

Table 3.2.2.3.
Overall Thermal Transmittance of Fenestration
Forming Part of Sentences 3.2.2.3.(2) and (3)

Component	Heating Degree-Days under 18°C 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*, in W/(m²·K)					
Fenestration except *skylights*	2.0	2.0	2.0	2.0	1.6	1.6
Skylights	2.85	2.85	2.85	2.85	2.7	2.7

Notes to Table 3.2.2.3.:
(1) See Sentence 1.1.4.1.(1).

3.2.2.4. Thermal Characteristics of Doors and Access Hatches

1) Except as provided in Sentences (2) and (4) and Article 3.2.1.3., the *overall thermal transmittance* of doors shall be not more than that shown in Table 3.2.2.4. for the applicable heating-degree-day category taken at 18°C, as determined in accordance with Article 3.1.1.5.

2) Except as provided in Sentences (3) and (5), the *overall thermal transmittance* of doors shown in Table 3.2.2.4. shall be reduced by at least 10% in the case of an *addition*
a) whose *floor surface area* is not more than 200 m², and
b) whose opening percentage exceeds the values prescribed in Sentence 3.2.1.4.(1).

3) The following doors need not comply with Sentence (1) or (2) where their total area is not more than 2% of the gross wall area calculated in accordance with Article 3.1.1.6.:
a) automatic sliding glass doors,
b) revolving doors,
c) fire shutters, and
d) other types of doors having an *overall thermal transmittance* of not more than 4.4 W/(m²·K).

4) Access hatches that are part of a *building envelope* shall be insulated to a nominal thermal transmittance of not more than 1.3 W/(m²·K), exclusive of stiffeners or edge construction.

5) Storm doors need not comply with Sentence (1) or (2).

Table 3.2.2.4.
Overall Thermal Transmittance of Doors
Forming Part of Sentences 3.2.2.4.(1) and (2)

Component	Heating Degree-Days under 18°C 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*, in W/(m²·K)					
Glazed doors	2.0	2.0	2.0	2.0	1.6	1.6
Doors without glazing	0.9	0.9	0.9	0.9	0.8	0.8

Notes to Table 3.2.2.4.:
(1) See Sentence 1.1.4.1.(1).

3.2.3. Building Assemblies in Contact with the Ground

3.2.3.1. Thermal Characteristics of Walls in Contact with the Ground

1) Except as provided in Sentences (2) and 3.2.1.3.(2), the *effective thermal resistance* of walls or portions thereof that are below the exterior ground level and are part of the *building envelope* shall not be less than that shown in Table 3.2.3.1. for the applicable heating-degree-day category taken at 18°C.

2) Where radiant heating cables or heating or cooling pipes or membranes are located in a wall or portion thereof that is below the ground level and that separates *conditioned space* from the outdoor ground, the minimum *effective thermal resistance* provided for in Sentence (1) shall be increased by at least 25%. (See Note A-3.2.3.1.(2).)

Table 3.2.3.1.
Effective Thermal Resistance of Building Assemblies in Contact with the Ground
Forming Part of Sentences 3.2.3.1.(1) and (4), and 3.2.3.2.(1)

Assembly in Contact with the Ground	Heating Degree-Days under 18°C 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_E, in m²·K/W					
Walls	2.64	2.64	2.64	2.64	2.64	2.64
Roofs	2.64	2.64	2.64	2.64	2.64	2.64

Table 3.2.3.1. (Continued)

Notes to Table 3.2.3.1.:

(1) See Sentence 1.1.4.1.(1).

3) Insulation on walls or portions thereof that are in contact with the ground shall extend at least 2.4 m down from contiguous ground level or to the bottom of the wall. (See Note A-3.2.3.1.(3).)

4) The *effective thermal resistance* of the vertical portion of a slab-on-ground shall be the same as that required for walls in contact with the ground over the full height of the slab. (See Note A-3.2.3.1.(4).)

3.2.3.2. Thermal Characteristics of Roofs in Contact with the Ground

1) The *effective thermal resistance* of below-ground roofs that are part of the *building envelope* and are less than 2.4 m below the exterior ground level shall be equal to at least the values shown in Table 3.2.3.1. for the heating-degree-day category taken at 18°C. (See Note A-3.2.3.2.(1).)

3.2.3.3. Thermal Characteristics of Floors in Contact with the Ground

(See Note A-3.2.3.3.)

1) For the purposes of this Article, "floor" also means the unfinished surface of a crawl space, where it is *conditioned space*.

2) Floors separating *conditioned space* from the ground shall be insulated with material having a thermal resistance of at least the value shown in Table 3.2.3.3.-A or 3.2.3.3.-B, as the case may be.

Table 3.2.3.3.-A
Insulation of Floors in Contact with the Ground for any Occupancy except Dwelling Units
Forming Part of Sentences 3.2.3.3.(2) and (3)

Floors	Insulation Material	Intersection of the *Foundation* Wall with the Floor-on-ground
	Minimum Thermal Resistance, RSI, in m²·K/W	
Floors of a slab-on-ground that does not have integrated heating ducts or cables or heating or cooling pipes	1.76 installed at the perimeter of the floor over a width of 1.2 m	n/a
Floors less than 0.6 m under contiguous ground level that does not have integrated heating ducts or cables or heating or cooling pipes	0.88 installed over the full area or 1.32 installed at the perimeter of the floor-on-ground over a width of at least 1.2 m	0.88
Floors-on-ground that have integrated heating ducts or cables or heating or cooling pipes	1.76 installed over the full area	1.32
Floors of a slab-on-ground that have integrated heating ducts or cables or heating or cooling pipes	1.76 installed over the full area	n/a

Table 3.2.3.3.-B
Insulation of Floors in Contact with the Ground for Dwelling Units
Forming Part of Sentences 3.2.3.3.(2) and (3)

Floors	Insulation Material	Intersection of the *Foundation* Wall with the Floor-on-ground
	Minimum Thermal Resistance, RSI, in m²·K/W	
Floors of a slab-on-ground that does not have integrated heating ducts or cables or heating or cooling pipes	1.32 installed over the full area	n/a
Floors at less than 0.6 m under contiguous ground level that do not have integrated heating ducts or cables or heating or cooling pipes		1.32
Floors at more than 0.6 m under contiguous ground level that do not have integrated heating ducts or cables or heating or cooling pipes	0.88 installed over the full area, or 1.32 installed at the perimeter of the floor-on-ground over a width of at least 1.2 m	0.7
Floors of a slab-on-ground that have integrated heating ducts or cables or heating or cooling pipes	1.76 installed over the full area	n/a
Floors-on-ground that have integrated heating ducts or cables or heating or cooling pipes		1.32

3) The thermal resistance of the insulation material between the *foundation* wall and the floor-on-ground shall be equal to at least the values shown in Table 3.2.3.3.-A or 3.2.3.3.-B, except
a) where the insulation is installed on the exterior of the *foundation* wall and extends 2.4 m down from ground level or to the lower portion of the wall, or
b) where the *foundation* wall and the floor slab are insulated from the inside and the insulation between the wall and the slab is continuous.

3.2.4. Air Leakage

3.2.4.1. General

1) The *building envelope* shall be designed and constructed with a continuous air barrier system comprised of *air barrier assemblies* to control air leakage into and out of the *conditioned space*.

3.2.4.2. Opaque Building Assemblies

1) All *opaque building assemblies* that act as environmental separators, excluding opaque sections of curtain walls, shall include an *air barrier assembly* conforming to Sentence (2).

2) *Air barrier assemblies* shall have an air leakage rate not more than 0.2 L/(s·m²) at a pressure differential of 75 Pa determined in accordance with Article 3.1.1.8.

3.2.4.3. Fenestration and Curtain Walls

1) For the purposes of this Article, use of the term "*fenestration*" does not include doors, which are covered in Article 3.2.4.4.

2) Curtain walls that act as environmental separators shall have an air leakage rate not greater than 0.20·L/(s·m²) at a pressure differential of 75 Pa determined in accordance with Article 3.1.1.8.

3) Fixed windows and *skylights* that act as environmental separators shall have an air leakage rate not greater than 0.20 L/(s·m²) determined in accordance with Article 3.1.1.8.

4) Operable windows and *skylights* that act as environmental separators shall have an air leakage rate not greater than 0.5 L/(s·m²) determined in accordance with Article 3.1.1.8.

3.2.4.4. Doors

1) Except as provided in Sentences (2) and (3), doors that act as environmental separators shall have an air leakage rate not greater than 0.50 L/(s·m^2) at a pressure differential of 75 Pa determined in accordance with Article 3.1.1.8.

2) Revolving doors and automatic commercial sliding doors, including their respective fixed sections, as well as overhead doors that act as environmental separators shall have an air leakage rate not greater than 5.0 L/(s·m^2) at a pressure differential of 75 Pa determined in accordance with Article 3.1.1.8.

3) Main entry exterior doors that act as environmental separators are permitted to have an air leakage rate not greater than 5.0 L/(s·m^2) when tested as a complete assembly at a pressure differential of 75 Pa, provided that the total area of such doors does not exceed 2% of the gross wall area calculated in accordance with Article 3.1.1.6. and determined in accordance with Article 3.1.1.8. (See Note A-3.2.4.4.(3).)

4) Loading docks that interface with truck boxes shall have weather seals that seal the truck box to the *building*.

3.2.4.5. Fireplace Doors

1) Fireplaces shall be equipped with doors or enclosures to restrict air movement through the chimney when the fireplace is not in use.

Section 3.3. Trade-off Path

(See Note A-1.1.2.1.)

3.3.1. General

3.3.1.1. Application

1) Subject to the limitations stated in Article 3.3.1.2., where the *building envelope* does not comply with the requirements of Section 3.2. or 3.4., it shall comply with this Section.

2) This Section does not apply to *building* assemblies of the *building envelope* separating *conditioned spaces* intended to be conditioned to temperatures differing by more than 10°C at design conditions.

3) For the purposes of this Section, "reference *building*" refers to a *building* whose envelope complies with the requirements of Section 3.2.

3.3.1.2. Limitations

(See Note A-3.3.1.2.)

1) The method of trade-off paths described in this Section may only take into consideration the energy performance of above-ground *building* assemblies of the *building envelope* covered in Sentences 3.2.1.2.(3) to (7) and (10), 3.2.2.2.(1), 3.2.2.3.(2) and Article 3.2.2.4.

2) The *building envelope* shall comply with the requirements of Section 3.2., except the provisions listed in Sentence (1).

3) Except as provided in Sentence 3.3.1.3.(2), performances that can be characterized in accordance with Articles 3.1.1.5. and 3.1.1.6. shall be taken into consideration in the trade-off path for

a) the minimum energy performance of above-ground *building* assemblies of the reference *building envelope* covered in Sentence (1), and
b) the lower or higher performance of *building* assemblies of the proposed *building* covered in Sentence (1).

4) The trade-off path shall apply individually to *building* assemblies of spaces whose heating setpoint is less than 18°C and to those whose heating setpoint is 18°C or more.

3.3.1.3. Compliance

1) Except as provided in Sentence (2), compliance with this Section shall be determined using the equation that follows to demonstrate that the sum of the areas of all above-ground *building* assemblies of the proposed *building* divided by their *effective thermal resistance* is not more than it would be if all above-ground assemblies complied with Section 3.2.:

$$\sum_{i=1}^{n} \frac{A_i}{RSI_{Eip}} \leq \sum_{i=1}^{n} \frac{A_i}{RSI_{Eir}}$$

where
n = total number of above-ground assemblies,
A_i = area of above-ground assembly i of the *building* calculated in accordance with the requirements of Article 3.1.1.6., in m²,
RSI_{Eip} = *effective thermal resistance* of above-ground assembly i of the proposed *building*, in (m²·K)/W, and
RSI_{Eir} = *effective thermal resistance* of above-ground assembly i of the reference *building*, in (m²·K)/W.
(See Note A-3.3.1.3.(1).)

2) Except as provided in Sentence (3), where the requirements of Sentences 3.2.1.2.(1) to (7) and (10) are not complied with, the *effective thermal resistance* of above-ground *opaque building assemblies* of the *building envelope* shall be derated using the equation that follows to take into account the thermal bridging covered in Sentence 3.3.1.2.(1):

$$RSI_{EDi} = \frac{1}{\frac{\sum_{j=1}^{m}(\Psi_j \cdot L_j) + \sum_{k=1}^{n}(X_k \cdot N_k)}{A_i} + \frac{1}{RSI_{Ei}}}$$

where
RSI_{EDi} = derated *effective thermal resistance* of *opaque building assembly* i of the proposed or reference *building*, in (m²·K)/W,
Ψ_j = *linear thermal transmittance* of the type j intersection calculated in accordance with Sentence 3.1.1.5.(7), in W/(m·K),
L_j = length of the type j intersection, in m,
m = total number of types of intersections,
X_k = *point thermal transmittance* of the type k penetration calculated in accordance with Sentence 3.1.1.5.(7), in W/K,
N_k = number of type k point penetrations,
n = total number of types of penetrations,
A_i = area of *opaque building assembly* i, calculated in accordance with Article 3.1.1.6., in m², and
RSI_{Ei} = *effective thermal resistance* of the non-derated *opaque building assembly*, calculated in accordance with any of Sentences 3.1.1.5.(5) and (6), in (m²·K)/W.
(See Note A-3.3.1.3.(2).)

3) A *point thermal transmittance* of 0.5 W/K and the values of *linear thermal transmittance* in Table 3.3.1.3.
a) may be used for the applicable penetrations or intersections of the proposed *building* that comply with Sentences 3.2.1.2.(1) to (7) and (10), and
b) shall be used for the applicable penetrations and intersections of the reference *building*.
(See Note A-3.3.1.3.(3).)

Table 3.3.1.3.
Default Linear Thermal Transmittance of Certain Intersections Complying with the Prescriptive Requirements of Article 3.2.1.2.
Forming Part of Sentence 3.3.1.3.(3)

Intersection	Maximum *Linear Thermal Transmittance*, Ψ, in W/(m·K)
Wall/roof	0.325
Wall/intermediate floor	0.300
Wall/projection	0.500
Wall/*foundation*	0.450

4) Where the *effective thermal resistance* of the opaque section of curtain walls has not been determined in accordance with Sentence 3.1.1.5.(6), the values that follow shall be used in the proposed *building*:
a) 0.35 $(m^2 \cdot K)/W$, where the opaque section of curtain walls does not have an insulation material, or
b) 0.88 $(m^2 \cdot K)/W$, where the opaque section of curtain walls has an insulation material.

Section 3.4. Performance Path

(See Note A-1.1.2.1.)

3.4.1. General

3.4.1.1. Scope

1) Subject to the limitations stated in Article 3.4.1.2., where the *building envelope* does not comply with the requirements of Section 3.2. or 3.3., it shall comply with Part 8.

3.4.1.2. Limitations

(See Note A-3.4.1.2.)

1) The performance path described in this Section may only take into consideration the energy performance of the *building* assemblies of the *building envelope* covered
a) in Articles 3.2.1.2. to 3.2.1.4. and 3.2.2.2. to 3.2.2.4., and
b) except as provided in Sentence 8.4.3.3.(7), in Subsection 3.2.3.

2) The *building* assemblies of the *building envelope* that are not covered in Sentence (1) shall comply with the requirements of Section 3.2.

Section 3.5. Objective and Functional Statements

3.5.1. Objective and Functional Statements

3.5.1.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in this Part shall be the objective and functional statements listed in Table 3.5.1.1. (See Note A-1.1.3.1.(1).)

Table 3.5.1.1.
Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 3
Forming Part of Sentence 3.5.1.1.(1)

Functional Statements and Objectives(1)	
3.1.1.5. Thermal Characteristics of Building Assemblies	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
(3)	[F92-OE1.1]
(4)	[F92-OE1.1]
(5)	[F92-OE1.1]
(6)	[F92-OE1.1]
(7)	[F92-OE1.1]
3.1.1.7. Calculation of Effective Thermal Resistance	
(1)	[F92-OE1.1]
3.1.1.8. Air Leakage in Building Assemblies	
(1)	[F90-OE1.1]
(2)	[F90-OE1.1]
(3)	[F90-OE1.1]
(4)	[F90-OE1.1]
3.2.1.1. Protection of Insulation Materials	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
3.2.1.2. Continuity of Insulation	
(1)	[F92-OE1.1]
(3)	[F92-OE1.1]
(4)	[F92-OE1.1]
(5)	[F92-OE1.1]
(6)	[F92-OE1.1]
(7)	[F92-OE1.1]
(8)	[F92-OE1.1]
3.2.1.3. Spaces Heated or Cooled to Different Temperatures	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
3.2.1.4. Allowable Fenestration and Door Area	
(1)	[F92,F99-OE1.1]
(2)	[F92,F99-OE1.1]
3.2.2.1. Vestibules	
(1)	[F90-OE1.1]
(2)	[F90-OE1.1]
3.2.2.2. Thermal Characteristics of Above-ground Opaque Building Assemblies	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
(3)	[F92-OE1.1]
(4)	[F92,F95-OE1.1]

Table 3.5.1.1. (Continued)

Functional Statements and Objectives(1)	
3.2.2.3. Thermal Characteristics of Fenestration	
(2)	[F92-OE1.1]
(3)	[F92-OE1.1]
3.2.2.4. Thermal Characteristics of Doors and Access Hatches	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
(4)	[F92-OE1.1]
3.2.3.1. Thermal Characteristics of Walls in Contact with the Ground	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
(3)	[F92,F95-OE1.1]
(4)	[F92-OE1.1]
3.2.3.2. Thermal Characteristics of Roofs in Contact with the Ground	
(1)	[F92-OE1.1]
3.2.3.3. Thermal Characteristics of Floors in Contact with the Ground	
(2)	[F92-OE1.1]
(3)	[F92-OE1.1]
3.2.4.1. General	
(1)	[F90-OE1.1]
3.2.4.2. Opaque Building Assemblies	
(1)	[F90-OE1.1]
(2)	[F90-OE1.1]
3.2.4.3. Fenestration and Curtain Walls	
(2)	[F90-OE1.1]
(3)	[F90-OE1.1]
(4)	[F90-OE1.1]
3.2.4.4. Doors	
(1)	[F90-OE1.1]
(4)	[F90-OE1.1]
3.2.4.5. Fireplace Doors	
(1)	[F90-OE1.1]
3.3.1.1. Application	
(2)	[F92-OE1.1]
3.3.1.2. Limitations	
(1)	[F90,F92-OE1.1]
(2)	[F90,F92-OE1.1]
(3)	[F90,F92-OE1.1]
3.3.1.3. Compliance	
(1)	[F92-OE1.1]
(2)	[F92-OE1.1]
(3)	[F92-OE1.1]

Table 3.5.1.1. (Continued)

Functional Statements and Objectives[1]	
3.4.1.2. Limitations	
(1)	[F90,F92-OE1.1]
(2)	[F90,F92-OE1.1]

Notes to Table 3.5.1.1.:

(1) See Parts 2 and 3 of Division A.

Notes to Part 3
Building Envelope

A-3.1.1.2.(1)(b) Building with Low Heat Requirement. The exemption provided for in Clause 3.1.1.2.(1)(b) could apply, for example, to buildings in which permanent processes produce at all times sufficient heat so that no other heating source of a capacity of more than 10 W/m² is necessary to ensure comfort for the occupants during the whole year.

A-3.1.1.3.(1) Compliance. The flow chart in Figure A-3.1.1.3.(1) illustrates the process for all three paths of compliance applicable to Part 3.

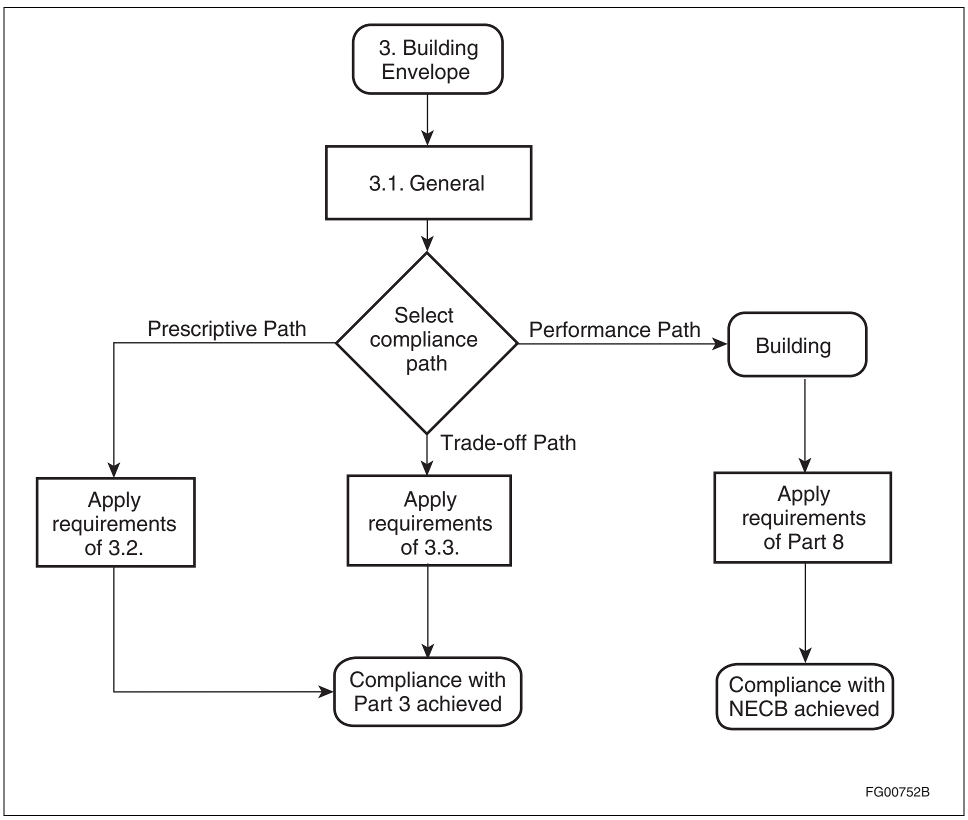

Figure A-3.1.1.3.(1)
Code compliance paths for the building envelope

A-3.1.1.3.(1)(c) Performance Path. The building energy performance compliance path is a whole-building approach; therefore if this path is chosen to achieve compliance, it must be the only path applied to all building parameters.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

A-3.1.1.5.(5)(b) Methods of Calculation of the Effective Thermal Resistance. Where the main frame of the assembly is composed of metal posts, it is possible to use the calculation method described in ISO 6946, "Building components and building elements – Thermal resistance and thermal transmittance – Calculation method," to which weighing coefficients are applied based on the configuration of the main frame as described in "BRE Digest 465."

The method for calculating isothermal planes described in the ASHRAE Handbook – Fundamentals may be used for calculating the effective thermal resistance of assemblies that have a discontinuity in insulation layers. To implement that calculation method, the material creating the discontinuity in the insulating layer must have a thermal conductivity slightly different from that of the insulating layer, as is the case for assemblies with wood frames. That method could not apply to a metal frame assembly because the difference in thermal conductivity between the frame and the insulation is too high.

Where the main frame is composed of metal posts, it is also possible to use the method of calculation of the effective thermal resistance of steel-frame assemblies described in Note A-9.36.2.4.(1) of the NBC without the amendments provided for in Chapter I, Building, of the Construction Code (chapter B-1.1, r. 2), despite its section 1.1.5.

A-3.1.1.5.(5)(c), (6)(c) and (7)(a) Digital Simulation of Heat Transfer. The ASHRAE Handbook – Fundamentals refers to the approach developed as part of research project ASHRAE RP-1365, "Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings" (Morrison Hershfield), for calculating thermal characteristics of building assemblies.

The thermal characteristics of building assemblies determined according to such an approach involve the implementation of digital simulation tools that allow to obtain, for example, using a finite element analysis, the distribution of heat under steady state in a building assembly. The thermal characteristics such as linear and point thermal transmittance of building details or the effective thermal resistance of a building assembly may be determined with that type of simulation.

A-3.1.1.6.(1) Calculation of the Area of Opaque Building Assemblies. Parapets, projected fins, ornamentation, appendages, and fenestration and doors, are excluded from the area of opaque building assemblies. The area of an opaque building assembly in contact with the ground shall be calculated from the exterior ground level to the bottom surface of the slab-on-ground.

Figure A-3.1.1.6.(1) illustrates the calculation of the area of opaque building assemblies according to the requirements of Sentence 3.1.1.6.(1).

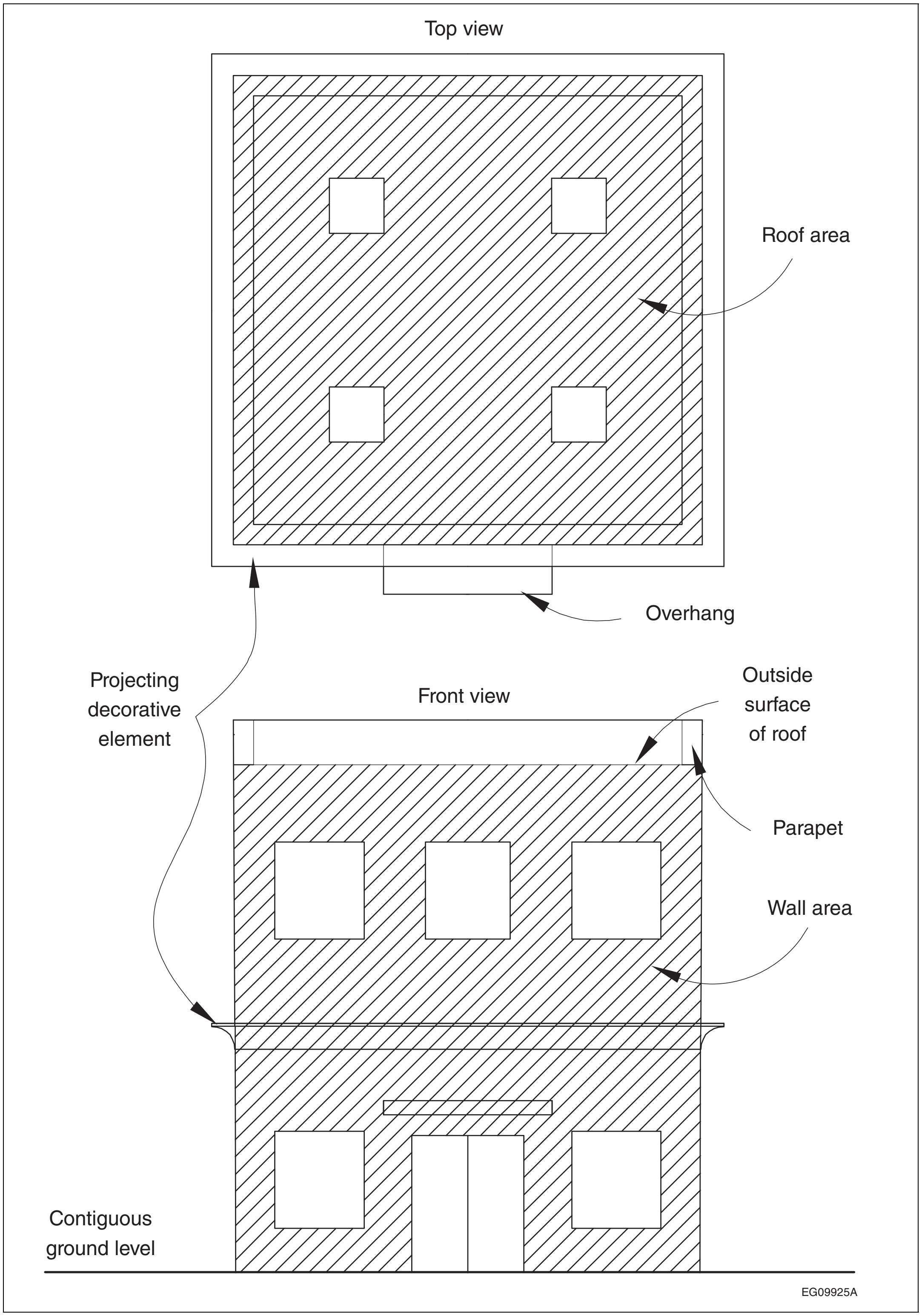

Figure A-3.1.1.6.(1)
Calculation of the area of opaque building assemblies

A-3.1.1.6.(3) Fenestration and Door Areas. The method of calculation of fenestration and door areas is slightly different in Sentence 3.1.1.6.(3) from the one used in CAN/CSA-A440.2/A440.3, "Fenestration Energy Performance/User Guide to CSA A440.2-14, Fenestration Energy Performance," for windows and doors. For calculating the door and fenestration area of a building, the Code uses the dimensions of rough openings including frames and sashes to facilitate determination of compliance.

Garage doors are included in the calculation of the door and fenestration area of a building.

The opaque sections (spandrel panels) of curtain walls are part of the opaque building assembly. That component of curtain walls shall be taken into account in the calculation of the area of opaque building assemblies and not in the calculation of the fenestration and door area.

Figure A-3.1.1.6.(3) illustrates the requirements of Sentence 3.1.1.6.(3).

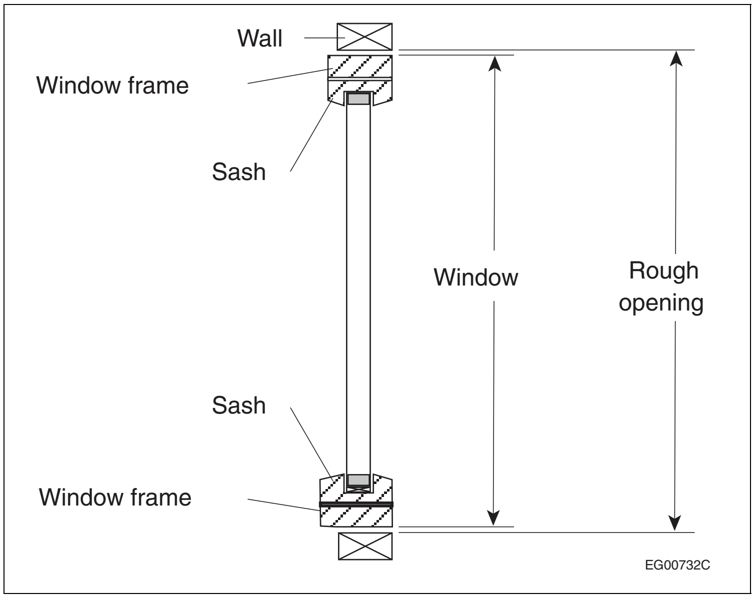

Figure A-3.1.1.6.(3)
Measuring fenestration and door areas

A-3.1.1.6.(5) Areas of Other Fenestration. Figure A-3.1.1.6.(5) illustrates how to measure the area of glass panes as described in Sentence 3.1.1.6.(5).

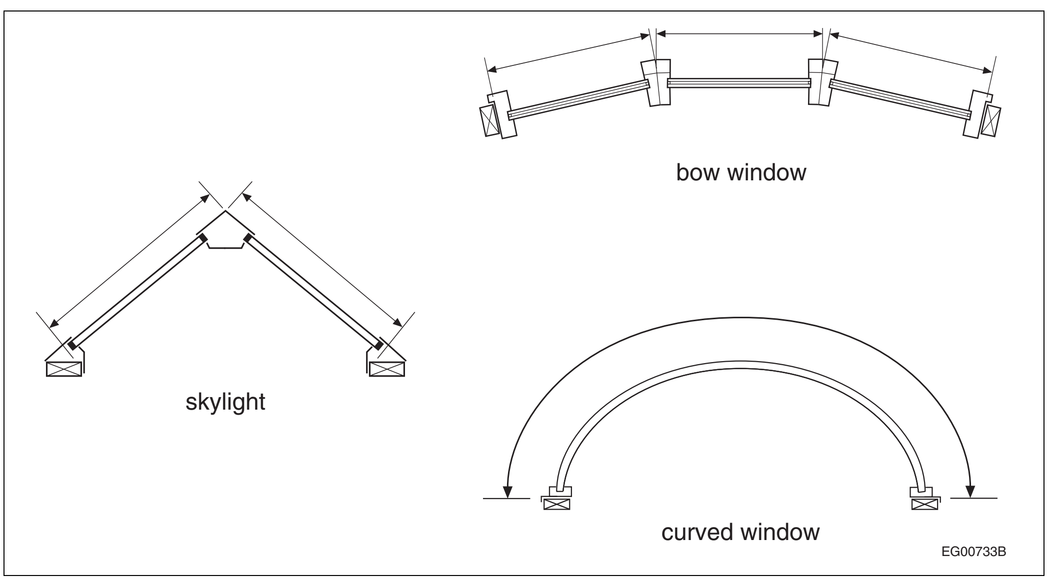

Figure A-3.1.1.6.(5)
Measuring areas of glazing that is not in the same plane

A-3.1.1.7.(1) Calculations of the Effective Thermal Resistance of Opaque Building Assemblies of the Building Envelope. For calculating the effective thermal resistance, Part 3 requires that the contribution of all continuous components of the envelope such as the insulation, siding and sheathing, of all repetitive structural members, such as columns, studs and resilient bars, and all secondary structural members such as lintels, sills and plates, be taken into account. Members that break the building envelope, such as beams, studs, joists and balconies, also have an effect on overall effective thermal resistance, but are excluded from the calculations of the effective thermal resistance, except as provided in Article 3.1.1.7. and Section 3.3. Those elements are the subject of prescriptive requirements detailed in Article 3.2.1.2.

A-3.1.1.7.(2) Continuity of Insulation at Beams and Columns. The effective thermal resistance at spandrel beams may be reduced compared to what is required for walls penetrated by beams without any penalty, provided that the resulting effective thermal resistance across the building envelope at the spandrel beam is not less than half the required effective thermal resistance for the wall (see Figure A-3.1.1.7.(2)). A similar approach may be used for columns in exterior walls.

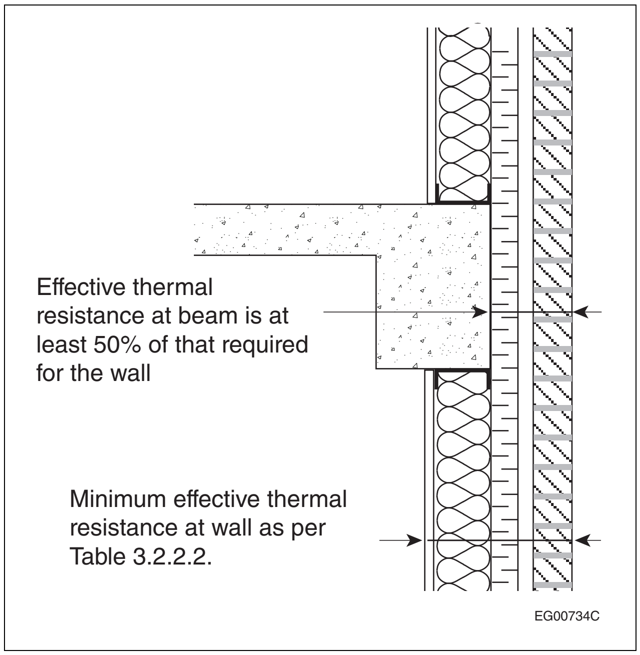

Figure A-3.1.1.7.(2)
Continuity of insulation at beams

A-3.1.1.7.(3) Penetrations of the Building Envelope. The minor ties and anchors necessary for the assembly of the envelope, such as screws, bolts and masonry anchors, may be excluded from the calculation of the effective thermal resistance for demonstrating compliance. Other partial or complete discontinuities of insulation listed in Sentence 3.1.1.7.(3) need not be part of the calculation of the effective thermal resistance of the opaque building assembly affected where the penetrations comply with the requirements of Article 3.2.1.2.

Permafrost

Penetrations caused by metal pilings supporting the buildings constructed in permafrost regions need not be part of the calculation of the effective thermal resistance of the opaque building assembly where the penetrations comply with the requirements of Article 3.2.1.2.

A-3.1.1.7.(4) Effect of a Closed Space other than a Conditioned Space. The effective thermal resistance required in Sentence 3.1.1.7.(4), which is equivalent to that of a layer of glass, is intended to provide an easy credit under the prescriptive path for any closed space other than a conditioned space that may be protecting a component of the building envelope.

The value given does not take into account the construction of the enclosure surrounding the space; the construction of this enclosure being uncontrolled by this Code, too many variables, such as its size or airtightness, may negate any higher credit that could be allowed. There may be simulation tools under the performance path that can provide a better assessment of the effect of an unheated space, which may be used to advantage when an unheated space is designed to provide significantly better protection than the assumed worst-case scenario. Vented spaces, such as attic and roof spaces or uninsulated crawl spaces, are considered to be part of the exterior space; therefore, Sentence 3.1.1.7.(4) does not apply when calculating the effective thermal resistance of opaque building assemblies.

A-3.1.1.8.(1) Air Barrier Assembly Testing. Air barrier assemblies of the envelope of a building are subject to structural loading induced by mechanical systems, wind pressure and stack effect. Those assemblies may also be affected by physical degradation resulting from thermal or structural movement throughout time.

The limits of the tests to be conducted in accordance with CAN/ULC-S742, "Air Barrier Assemblies – Specification," and ASTM E 2357, "Determining Air Leakage of Air Barrier Assemblies," are indicated in the test procedures to which they refer.

A-3.2.1.1.(1) Protection of Insulation Materials. Sentence 3.2.1.1.(1) is not intended to preclude the use of building envelope systems such as protected membrane roofing systems, vegetative roofing systems, EIFS in rainscreen applications, and exterior insulation on below-grade walls.

A-3.2.1.2.(1) Continuity of Insulation. Sentence 3.2.1.2.(1) applies to building components such as partitions, chimneys, fireplaces, and columns and beams that are embedded along exterior walls, but not to stud framing and ends of joists. Studs and joists in frame construction are not considered to break the continuity of the insulation. The Sentence also applies to components of mechanical and electrical systems in walls, roofs or floors.

A-3.2.1.2.(2) Structural Members and Minor Penetrations. Sentence 3.2.1.2.(2) takes into account the fact that repetitive structural members are already included in the method for calculating effective thermal resistance of building assemblies as described in Article 3.1.1.7.

A-3.2.1.2.(3) Break in the Continuity of Insulation. Where they penetrate the envelope, interior walls, foundation walls, firewalls, party walls, structural members such as slabs, ornementations and other appendages are an important source of heat losses and have a significant impact on the overall thermal performance of the building envelope.

Figures A-3.2.1.2.(3)-A, A-3.2.1.2.(3)-B, A-3.2.1.2.(3)-C and A-3.2.1.2.(3)-D illustrate ways to comply with the requirements of Sentence 3.2.1.2.(3).

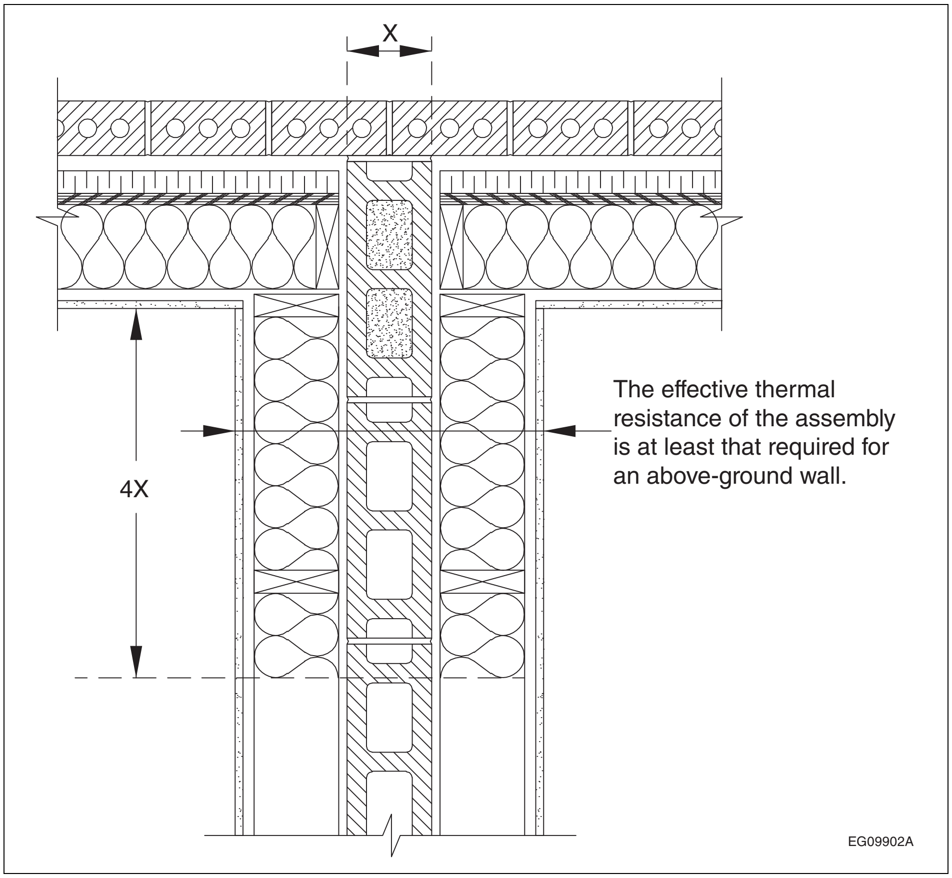

Figure A-3.2.1.2.(3)-A
Example of a firewall part of a penetration insulated on both of its sides in accordance with Clause 3.2.1.2.(3)(a)

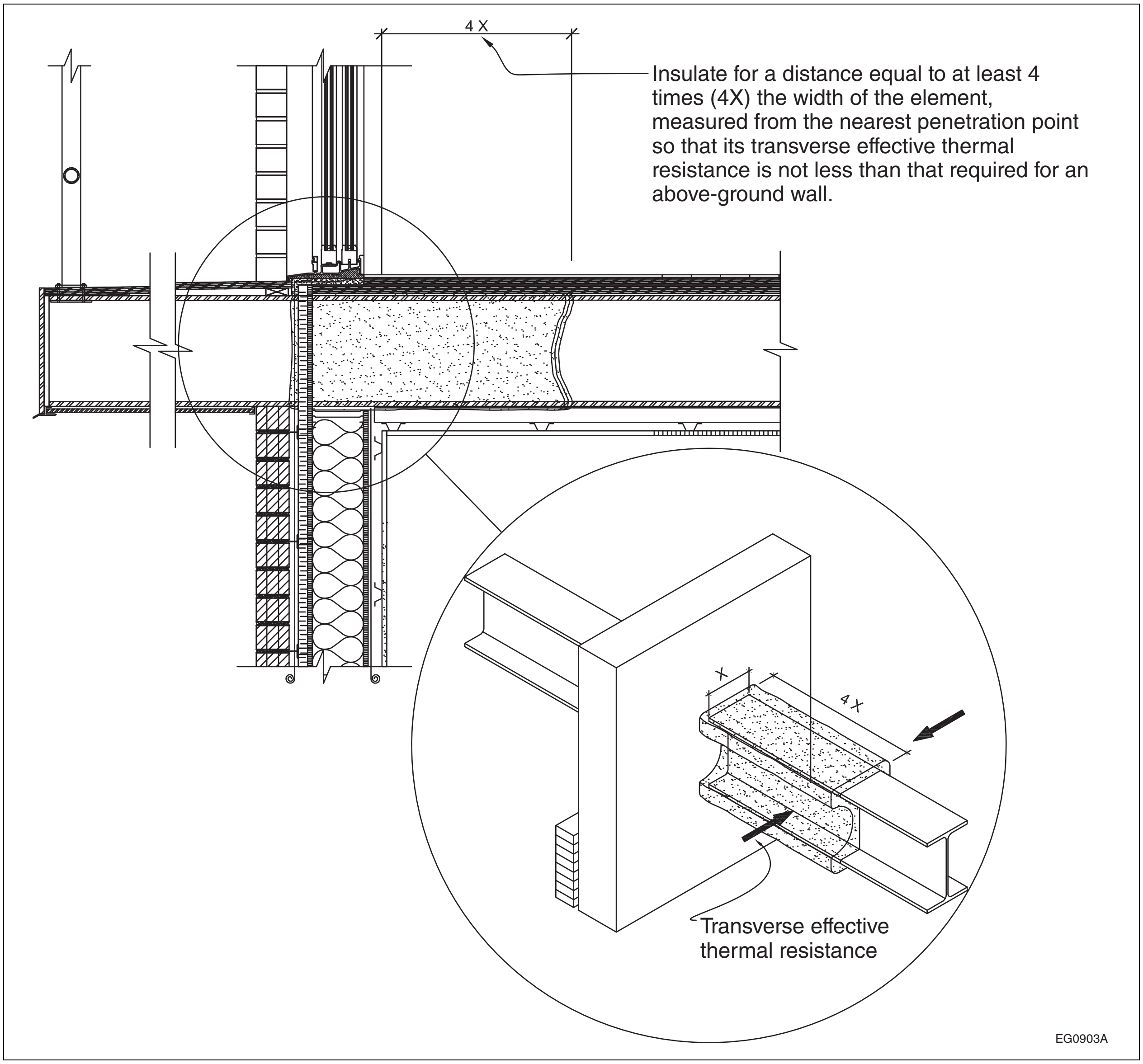

Figure A-3.2.1.2.(3)-B
Example of a structural beam part of a penetration insulated on all its surfaces in accordance with Clause 3.2.1.2.(3)(a)

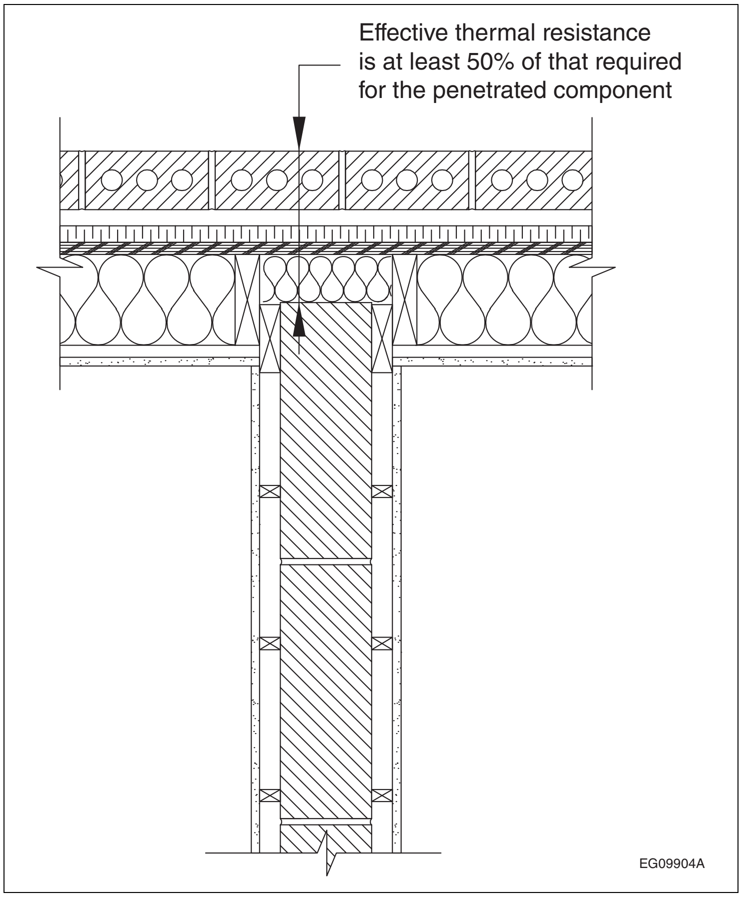

Figure A-3.2.1.2.(3)-C
Example of a party wall part of a penetration insulated along the plane of the insulation of the exterior wall in accordance with Clause 3.2.1.2.(3)(b)

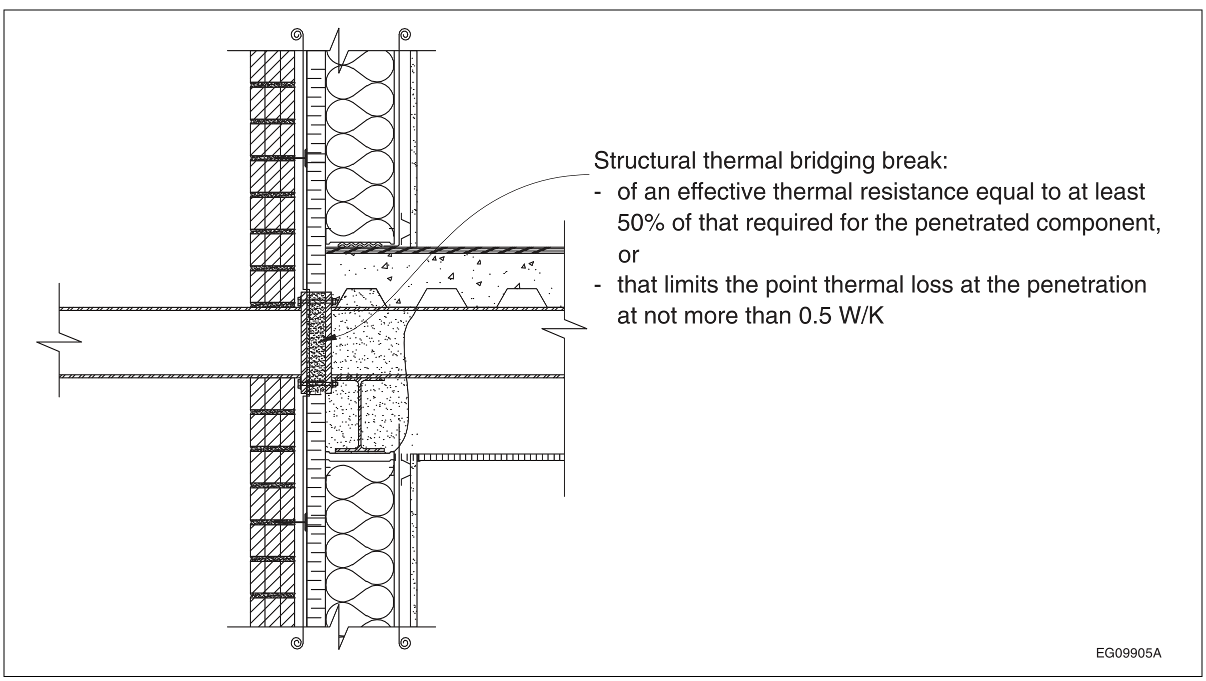

Figure A-3.2.1.2.(3)-D
Example of a structural beam part of a penetration insulated along the plane of the insulation of the exterior wall in accordance with Clause 3.2.1.2.(3)(b) and Sentence 3.2.1.2.(10)

A-3.2.1.2.(4) Insulation of a Concrete Slab. Sentence 3.2.1.2.(4) is intended to limit heat loss at the level of concrete structural slabs that are often extended outward to become balconies. That heat loss results in an excessive energy consumption and may also be the source of discomfort for occupants. Figures A-3.2.1.2.(4)-A, A-3.2.1.2.(4)-B and A-3.2.1.2.(4)-C show ways to comply with the requirements of Sentence 3.2.1.2.(4).

The effective thermal resistance of the structural thermal bridging breaker excludes metal reinforcing members.

Where the assembly complies with the requirements of Clause 3.2.1.2.(4)(b), the insulation material under and above the slab should be mould resistant.

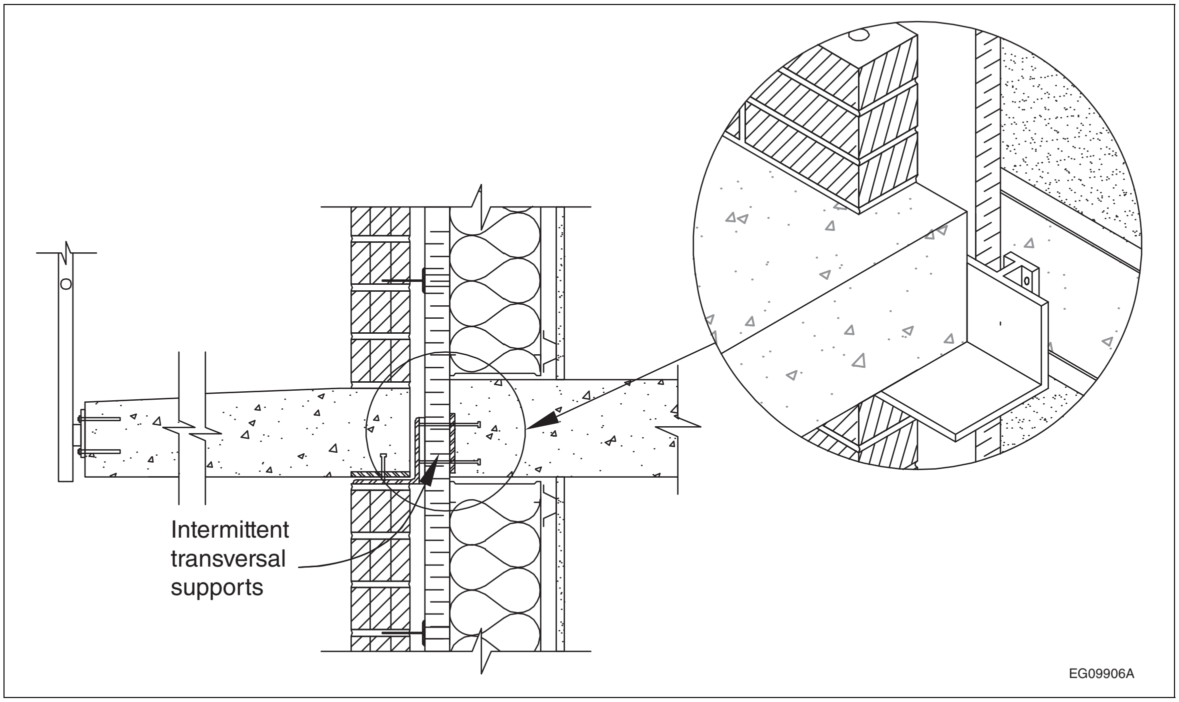

Figure A-3.2.1.2.(4)-A
Insulation in continuity with the insulation of the component penetrated by the use of angles for intermittent transversal supports, in accordance with Clause 3.2.1.2.(4)(a)

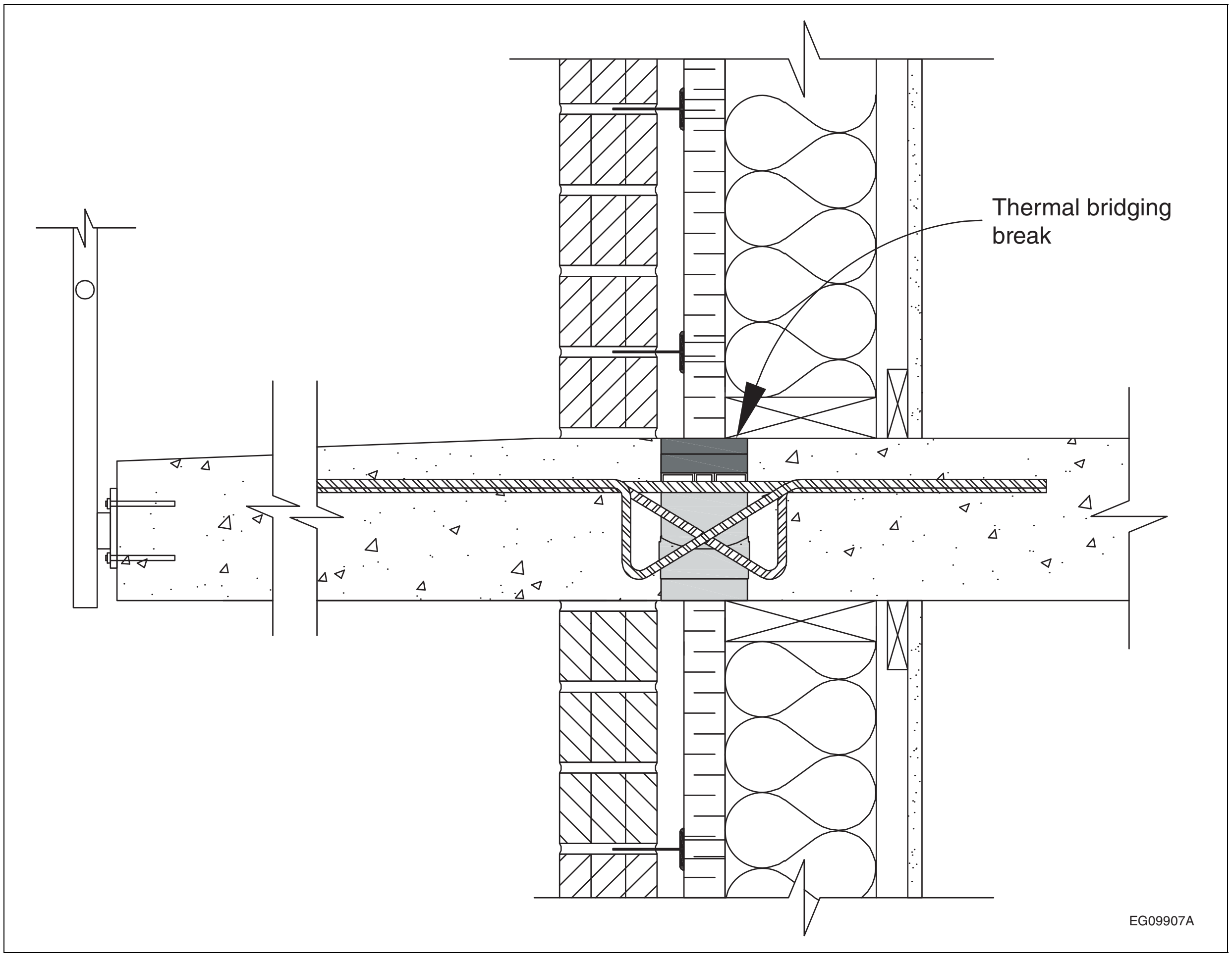

Figure A-3.2.1.2.(4)-B
Insulation in continuity with the insulation of the component penetrated by the use of thermal bridging breaks, in accordance with Clause 3.2.1.2.(4)(a)

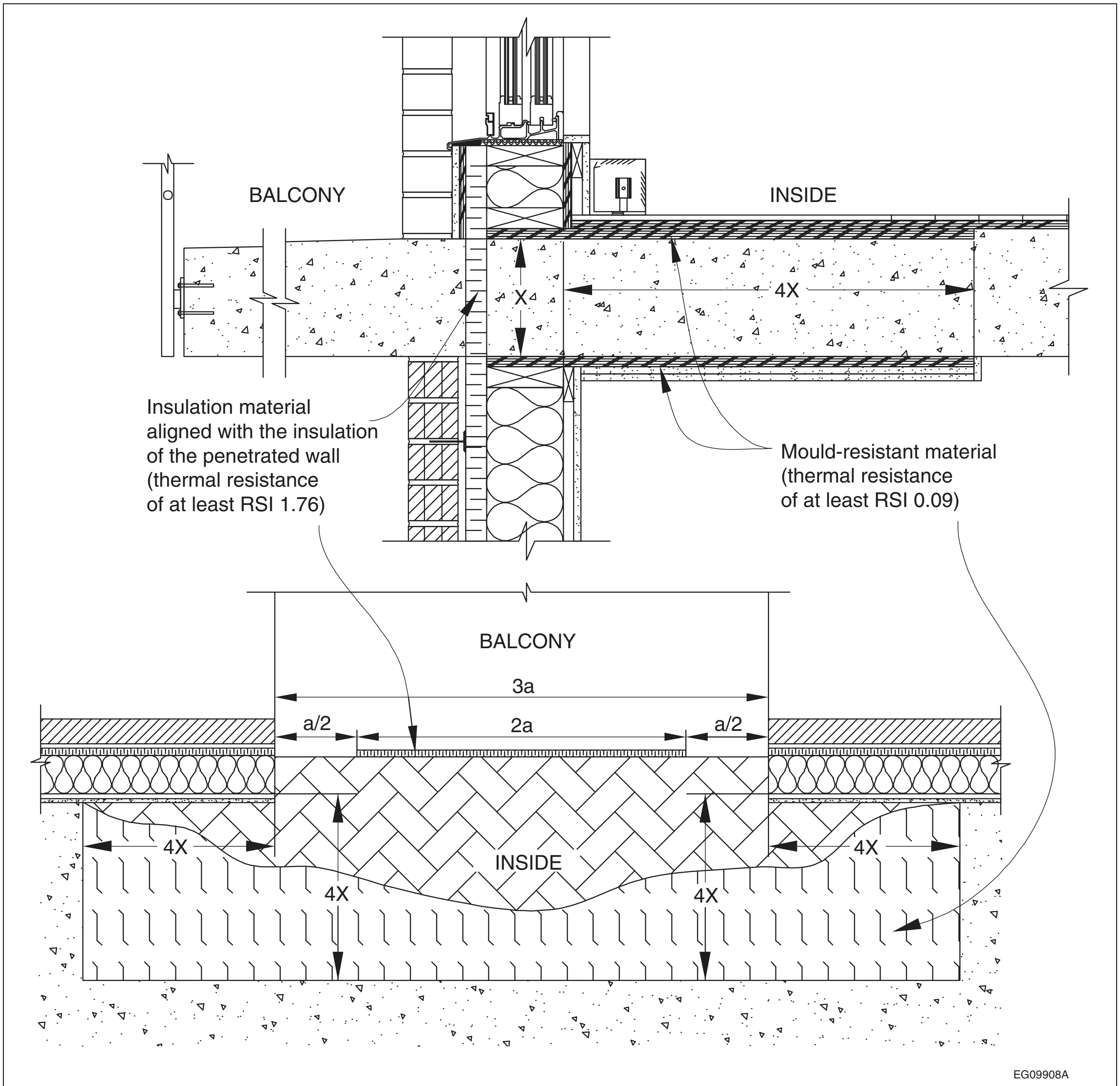

Figure A-3.2.1.2.(4)-C
Insulation of a balcony slab over two thirds of its surface, in accordance with Clause 3.2.1.2.(4)(b)

A-3.2.1.2.(5) Intermittent Transversal Supports. Sentence 3.2.1.2.(5) is intended to reduce the contact surface between anchoring devices and structural members to limit heat loss at the level of those elements. Figure A-3.2.1.2.(5) shows how to comply with the requirements of Sentence 3.2.1.2.(5). It should be noted that Sentence 3.2.1.2.(3) provides for requirements concerning the insulation of the slab.

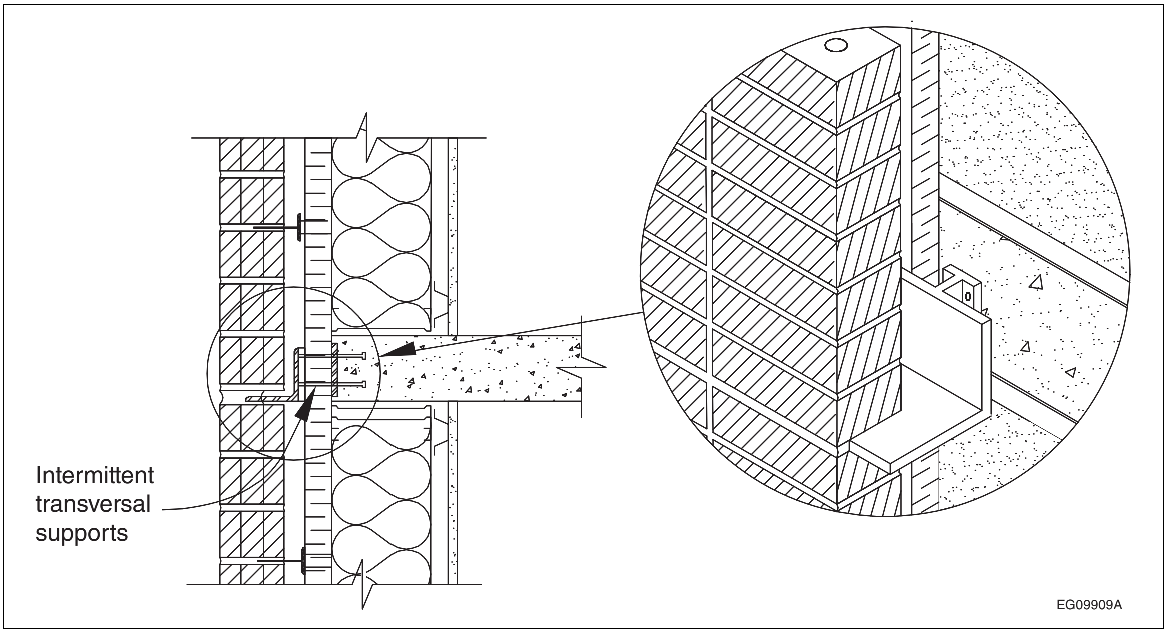

Figure A-3.2.1.2.(5)
Shelf angle attached to intermittent transversal supports

A-3.2.1.2.(6) Continuity of Insulation Where Components Meet. Sentence 3.2.1.2.(6) calls for continuity of the insulation at the intersection of two components of the building envelope, such as a wall with another wall or a roof, or a wall with a window. This means that there should be no gap in the insulation between the two components. An obvious application is insulating the space between a window or door frame and the rough framing members. However, structural members, such as studs and top plates, do not have to be taken into account, as provided in Sentences 3.1.1.7.(1) and 3.2.1.2.(2).

A-3.2.1.2.(7) Insulation Overlap. Where the break in insulation is due to the perpendicular interposition of a member of the envelope relative to another, Sentence 3.2.1.2.(7) requires that the overlap be carried out to extend the path of least thermal resistance from the inside out or toward an unheated adjacent space, as illustrated in Figure A-3.2.1.2.(7).

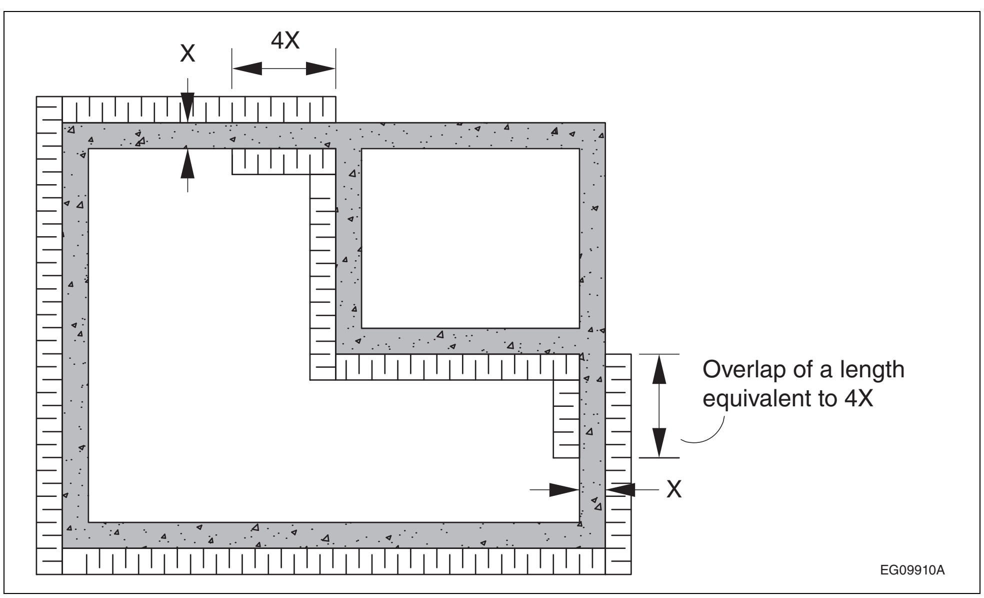

Figure A-3.2.1.2.(7)
Overlap of insulation planes in accordance with Sentence 3.2.1.2.(7)

A-3.2.1.2.(8) Overlap of Insulation for Hollow-core Masonry Walls. Where 2 insulation planes are separated by a hollow-core masonry wall and they cannot physically join, Sentence 3.2.1.2.(8) provides that they must overlap and the cores of the masonry wall coinciding with the upper and lower edges of each respective insulation plane must be filled with grout, mortar or insulation to carry the air barrier across the wall and limit the effect of convection in the cores, as shown in Figure A-3.2.1.2.(8).

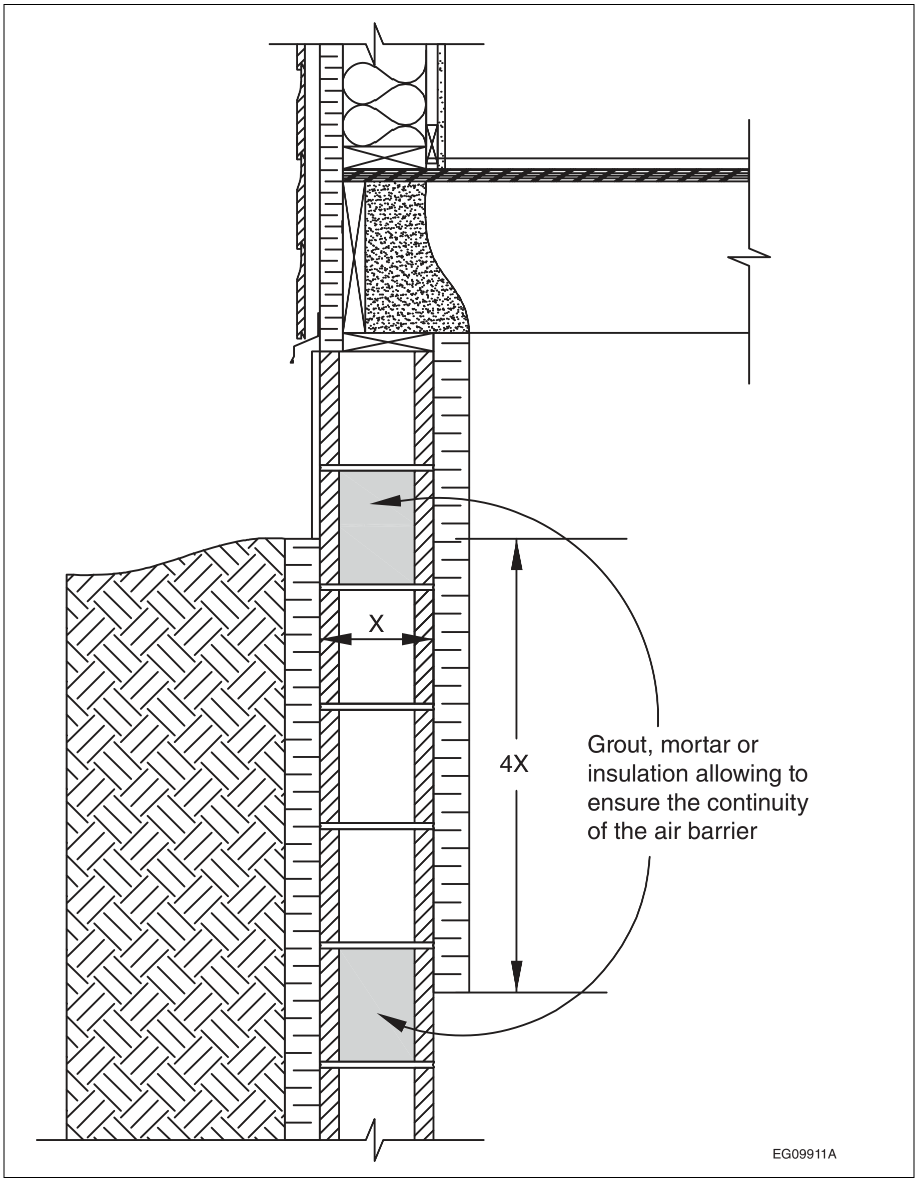

Figure A-3.2.1.2.(8)
Overlap of insulation planes for hollow-core masonry walls

A-3.2.1.2.(9)(c) Continuity of Insulation at the Level of Parapets. The continuity of insulation may be broken at minor transitions between constructive systems, such as backing necessary to attach the membrane, tie rods and flashings. Figure A-3.2.1.2.(9)(c) shows an example where insulation is broken by backing.

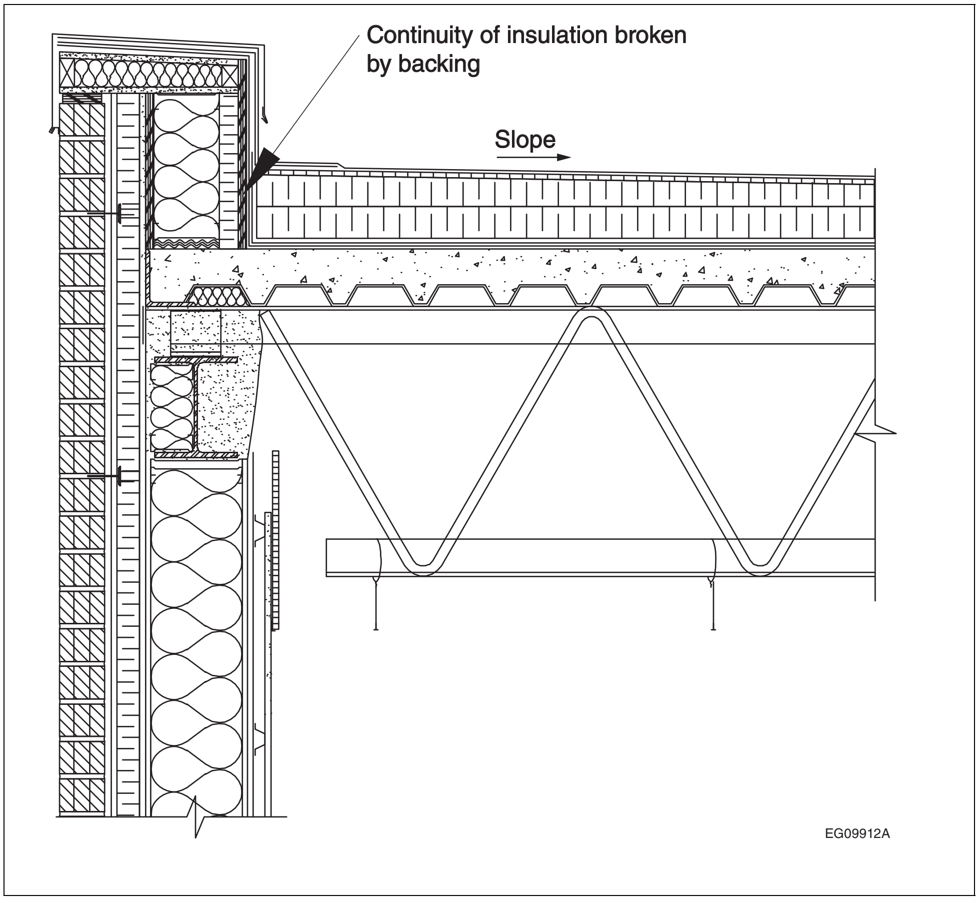

Figure A-3.2.1.2.(9)(c)
Example of continuity of insulation at the level of the parapet broken by backing

A-3.2.1.3.(1) Spaces Heated or Cooled to Different Temperatures. The requirement of Sentence 3.2.1.3.(1) applies, for example, to walls or floors that separate a space heated to a normal comfort temperature of 22°C from another space maintained at a temperature of 5°C. This would be the case, for example, of a wall between an office block and an attached warehouse.

The value of the effective thermal resistance of building assemblies separating 2 spaces at different temperatures varies on the basis of the temperature difference between the spaces and does not depend on the location of the building. That effective thermal resistance is calculated from a reference value corresponding to the effective thermal resistance of building assemblies for less than 6000 degree-days of heating at 18°C.

A-3.2.1.3.(2) Semi-heated Spaces. The Sentence applies to building assemblies of the envelope separating spaces heated to keep them above freezing. Given that setpoint, heat losses are reduced in winter. The heating setpoint is the temperature determined for the design of the heating system, and the outdoor heating design temperature is the 2.5% January design temperature according to the location of the building. The Sentence does not apply to spaces that must be conditioned to an indoor temperature of less than 18°C, such as a refrigerated warehouse.

A-3.2.2.2.(1) Thermal Characteristics of Opaque Above-ground Building Assemblies. The effective thermal resistance required for above-ground walls also applies to opaque sections of curtain walls and to the above-ground portion of foundation walls, except as provided in Sentence 3.2.2.2.(2).

If no RSI value may be obtained for a material or assembly according to the requirements of Article 3.1.1.5., then no RSI value may be allocated to the material or assembly concerned. No growing media and vegetation from a green roof may be allocated an RSI value. Similarly, a high sun reflectance index of a roof covering does not allow the reduction of the effective thermal resistance required for the roof.

A-3.2.2.2.(2) and (3) Insulation of an Exterior Wall. The percentage of the exposed surface of the foundation walls must be established by considering each wall located in a same plane and for each storey. Where the foundation walls comprise various constructive systems, the percentage of the exposed surface is considered separately for each system. The entire above-ground surface of a foundation wall exposed to air over more than 50% of its surface will be insulated as an above-ground wall and the portion below ground level will be insulated as a wall in contact with the ground. Figure A-3.2.2.2.(2) and (3) shows an example of the application of Sentence (2).

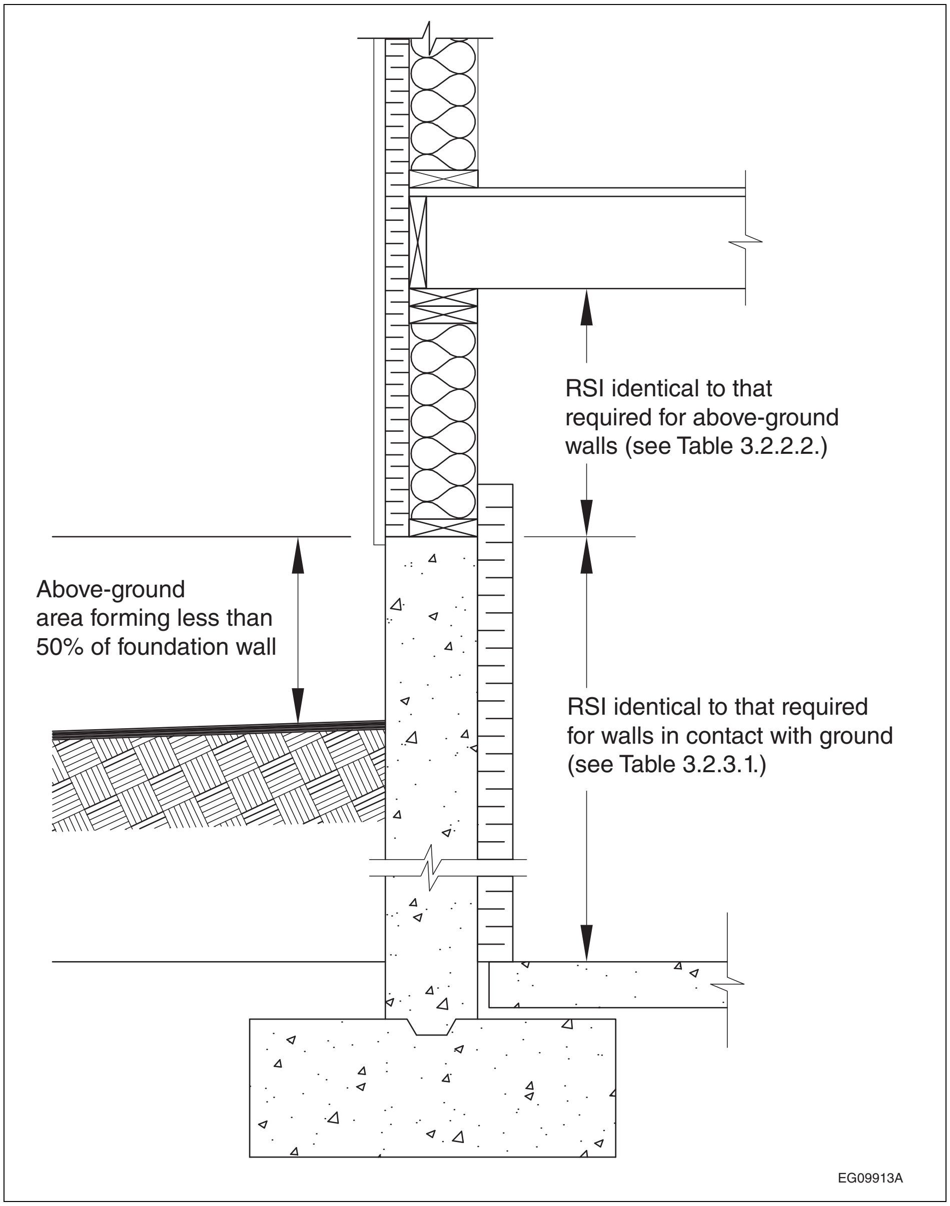

Figure A-3.2.2.2.(2) and (3)
Insulation of a foundation wall having less than 50% of the surface exposed to outdoor air

A-3.2.2.2.(4) Thermal Characteristics of Above-ground Opaque Building Assemblies with Embedded Radiant Heating or Cooling. Sentence 3.2.2.2.(4) applies in particular to overhanging floors and to insulated walls and top-storey ceilings under a roof or unheated attic space. The requirement also applies to floors above a crawl space, where it is kept at a temperature that differs by more than 10°C. The minimum thermal resistance of a floor, wall or ceiling containing radiant heating cables or heating or cooling pipes or membranes is increased to minimize heat losses due to the increased temperature difference between the interior and exterior surfaces.

A-3.2.2.2.(5) Effective Thermal Resistance of a Flat Roof. Sentence 3.2.2.2.(5) allows the reduction of the effective thermal resistance around the drain of a roof provided that the dimension of the roof and the slope are sufficient to offset heat losses incurred in the portion that does not comply with the requirements of Article 3.2.2.2. Figure A-3.2.2.2.(5) illustrates the application.

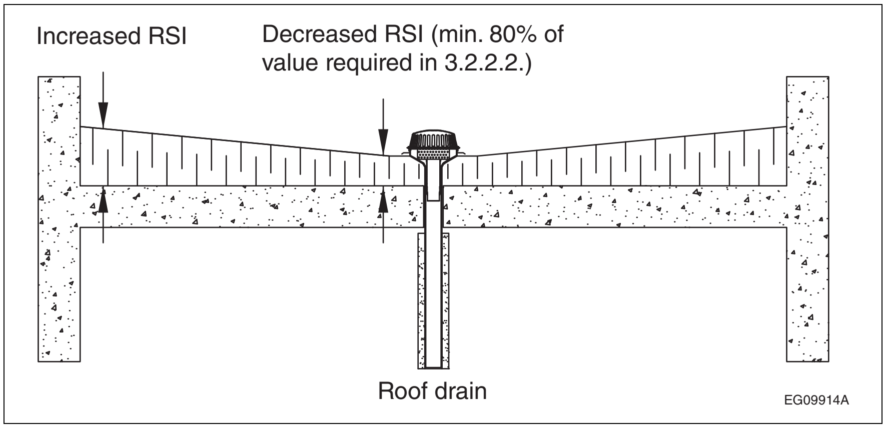

Figure A-3.2.2.2.(5)
Reduction of the sloped insulation on a flat roof in accordance with Sentence 3.2.2.2.(5)

A-3.2.2.2.(6) Effective Thermal Resistance Near the Eaves. The values of the effective thermal resistance required for roofs with attic spaces are greater than those required for walls. The reduction allowed in Sentence 3.2.2.2.(6) assumes that the thickness of the insulation will be increased on the basis of the increase of the slope of the roof with an attic space until the space is sufficient to contain the full thickness of the insulation. Figure A-3.2.2.2.(6) illustrates the reduction allowed in that Article.

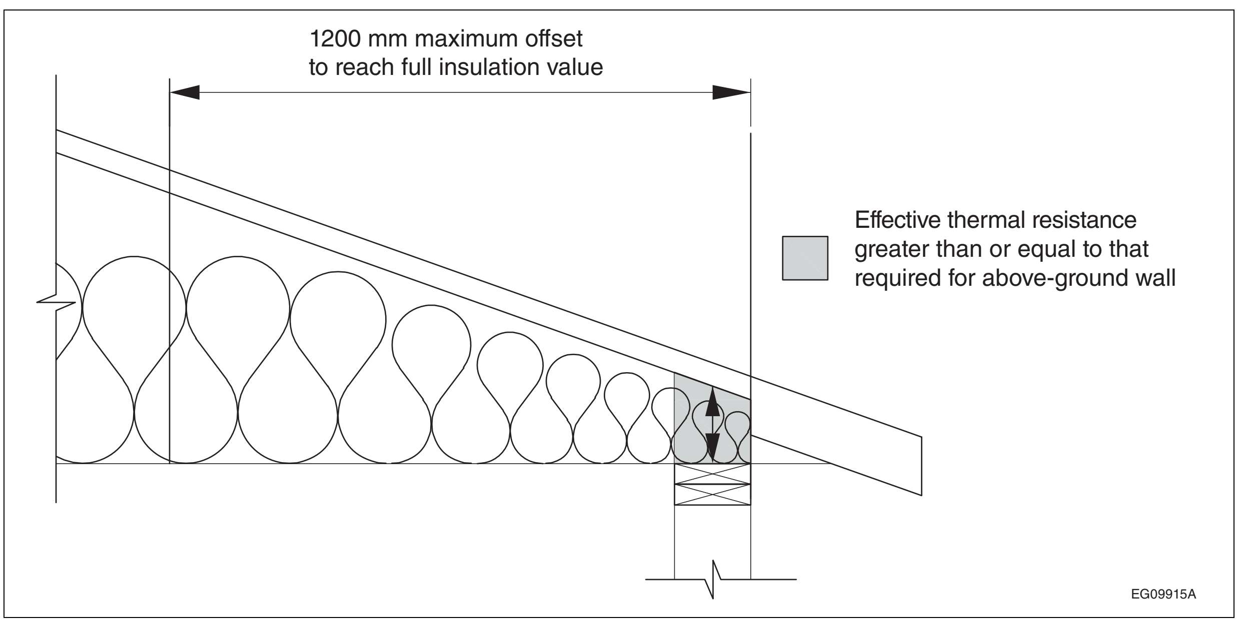

Figure A-3.2.2.2.(6)
Insulation reduction allowed for sloped roofs in accordance with Sentence 3.2.2.2.(6)

A-3.2.3.1.(2) Thermal Characteristics of Building Assemblies in Contact with the Ground with Embedded Radiant Heating or Cooling. The minimum effective thermal resistance of a wall that has radiant heating cables or heating or cooling pipes or membranes is increased to counteract the increased heat loss that occurs due to the increased temperature difference between the interior and exterior surfaces.

A-3.2.3.1.(3) Walls in Contact with the Ground. The term "ground level" as used in Sentence 3.2.3.1.(3) has a different meaning than "grade," which is defined in the NBC. The wording of Sentence 3.2.3.1.(3) requires that the bottom of the insulation follow the contours of the exterior ground level at the required depth, as shown in Figure A-3.2.3.1.(3).

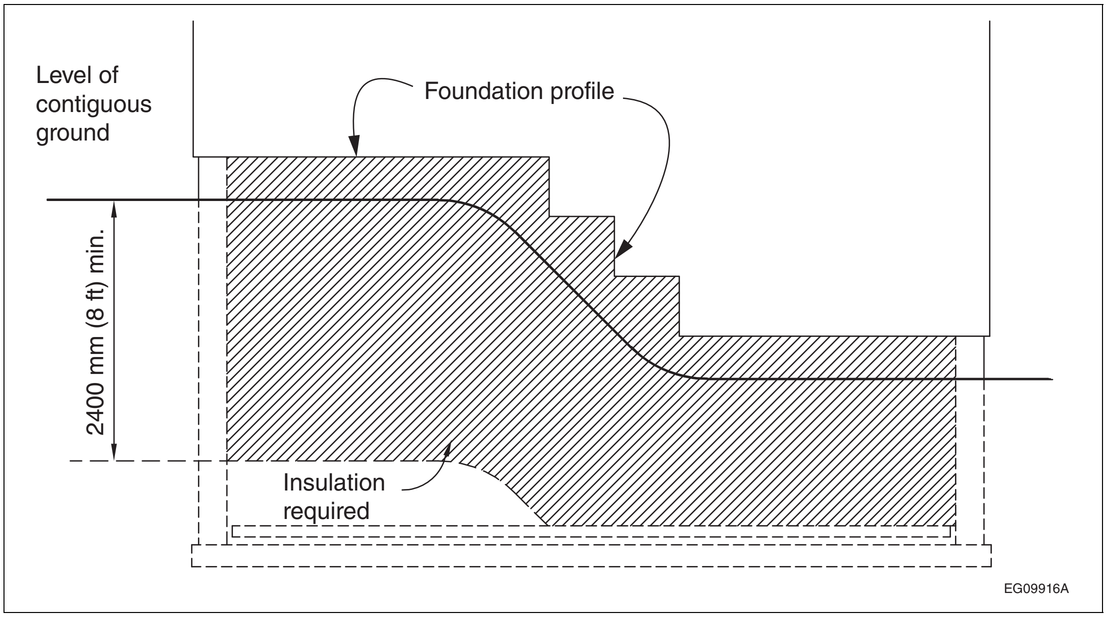

Figure A-3.2.3.1.(3)
Insulation of walls in contact with the ground

A-3.2.3.1.(4) Slabs-on-Ground. Sentence 3.2.3.1.(4) requires that the vertical section of a slab-on-ground be insulated over its entire height just like a wall in contact with the ground in accordance with the requirements of Sentence 3.2.3.1.(1), as shown in Figure A-3.2.3.1.(4).

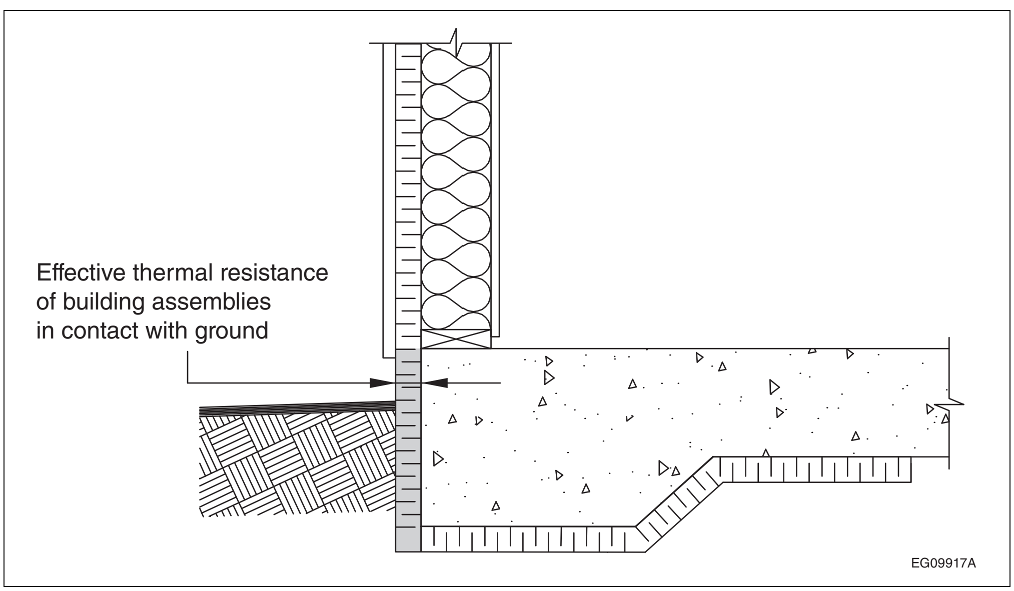

Figure A-3.2.3.1.(4)
Vertical insulation of a slab-on-ground in accordance with Sentence 3.2.3.1.(4)

A-3.2.3.2.(1) Roofs in Contact with the Ground. Sentence 3.2.3.2.(1) refers to structures that are normally below ground level such as walkways or storage garages. It does not refer to structures with vegetative roofs as might be built at elevations above ground level.

A-3.2.3.3. Floors in Contact with the Ground. Article 3.2.3.3. is also intended to include "floors" of heated or cooled crawl spaces even when there is no actual constructed "floor."

The value of the most astringent thermal resistance determines that of the insulation material to be installed over the entire floor surface where the ground level adjacent to a floor-on-ground is variable according to the faces of an immovable. In the case of a building whose floor-on-ground is constructed in tiers, it is possible to apply the requirements of Article 3.2.3.3. to each tier. Consideration should be given to insulating the entire floor at sites where the soil has a high thermal transmittance or where there is a permanently high water table. Figures A-3.2.3.3.-A, A-3.2.3.3.-B, A-3.2.3.3.-C and A-3.2.3.3.-D illustrate the requirements in insulation for various types of floors-on-ground, where these are less than 0.6 m below grade.

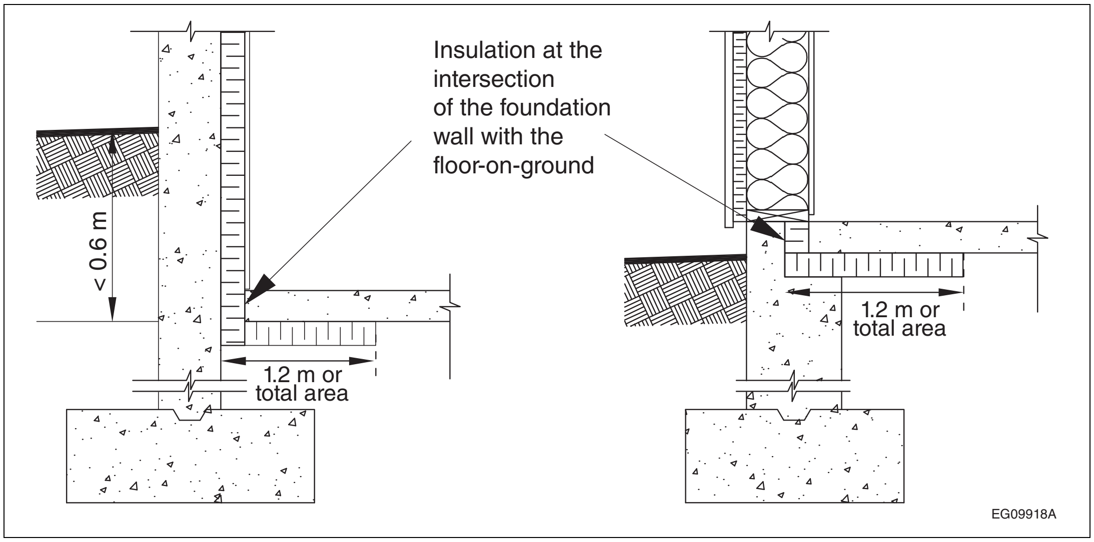

Figure A-3.2.3.3.-A
Insulation of floors in contact with the ground – example of insulation under the slab and at the intersection of the foundation wall with the floor-on-ground in accordance with Sentence 3.2.3.3.(1)

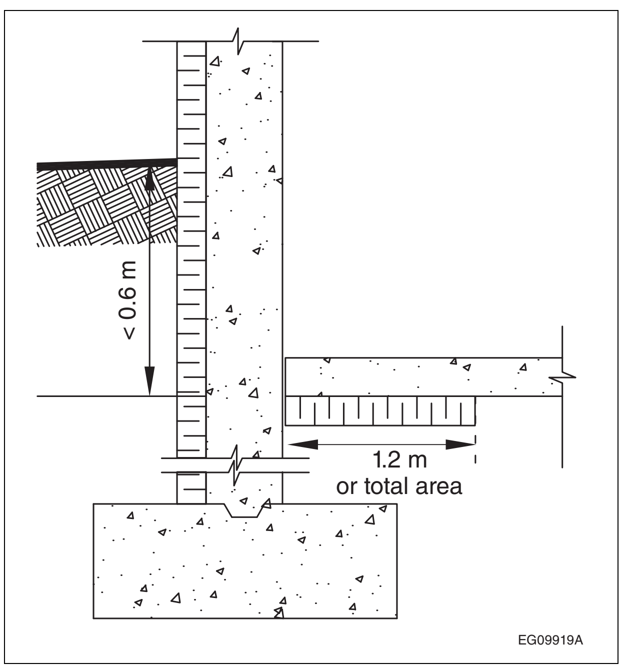

Figure A-3.2.3.3.-B
Insulation of floors in contact with the ground where the foundations are insulated from the exterior in accordance with Clause 3.2.3.3.(2)(a)

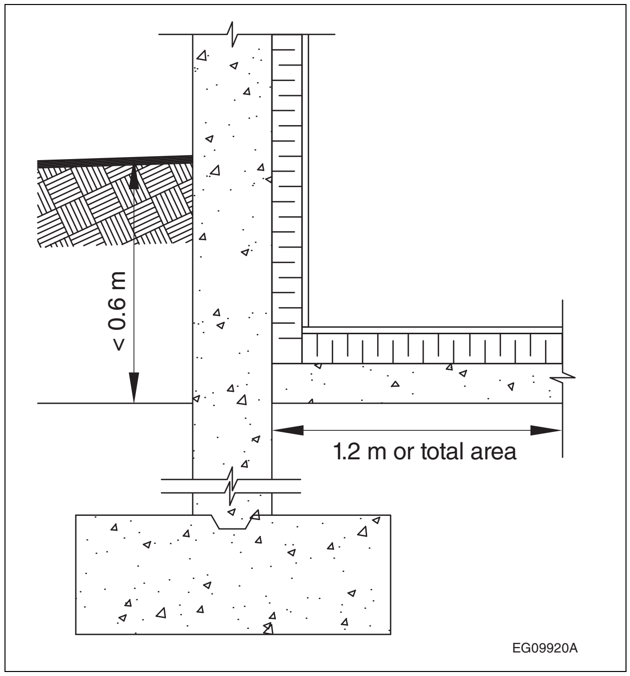

Figure A-3.2.3.3.-C
Insulation of floors in contact with the ground where the slab and the foundation wall are insulated from the interior in accordance with Clause 3.2.3.3.(2)(b)

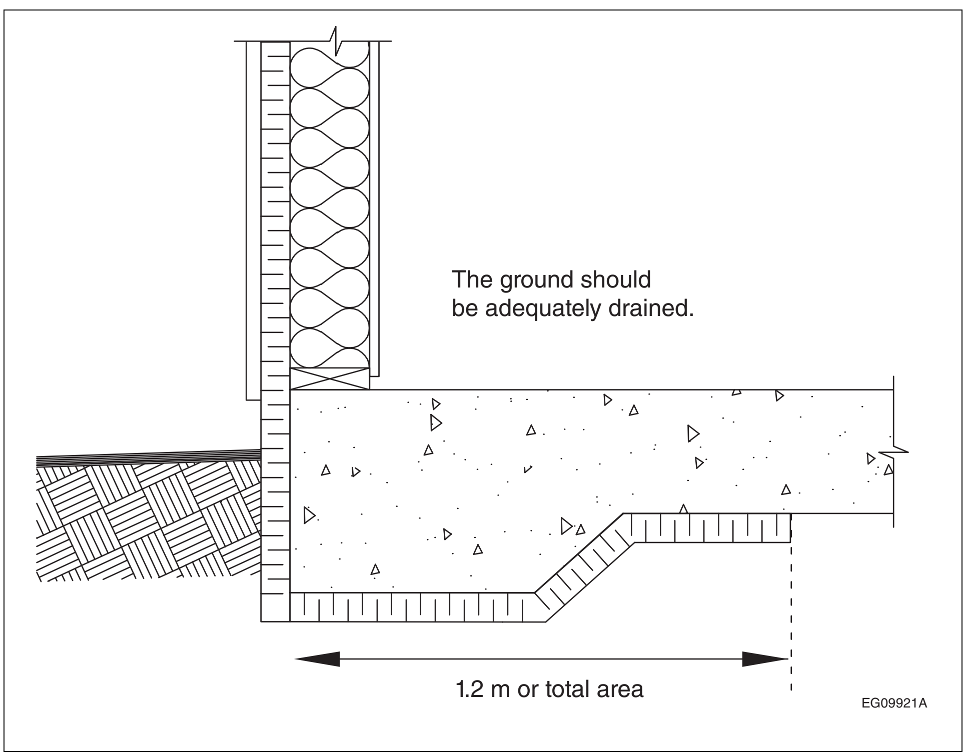

Figure A-3.2.3.3.-D
Insulation of floors in contact with the ground for a slab-on-ground with integrated footings in accordance with Sentence 3.2.3.3.(3)

A-3.2.4.4.(3) Vestibule Doors. Main entry doors that are part of a complete air barrier system, such as interior and exterior doors of a vestibule, may be tested as an entire assembly.

A-3.3.1.2. Limitations. The trade-off path described in Section 3.3. allows the designer to offset the non-compliance with the prescriptive requirements of certain above-ground building assemblies of the building envelope by considering the enhanced performance, i.e. higher than the prescriptive requirements, of other above-ground building assemblies of the envelope. For example, on the basis of the demonstration required in Section 3.3., it would be possible for a designer to offset the lower energy performance of a structural glazing by enhancing the energy performance of other windows of the building above the prescriptive requirements of Section 3.2. Simpler than the building energy performance compliance path detailed in Part 8, the trade-off path is limited to certain components of the building envelope.

A-3.3.1.3.(1) Trade-off. The trade-off path is based on the comparison of the steady-state energy performance of above-ground building assemblies of the proposed building envelope, i.e. the building as in the plans and specifications, with that of a reference building: an identical building except its envelope, completely in conformity with the prescriptive requirements of Section 3.2. The area of each above-ground assembly (A_i), including doors and fenestration, must be identical for the reference building and the proposed building. For opaque building assemblies of buildings that do not comply with the prescriptive requirements respecting the continuity of the insulation specified in Sentences 3.2.1.2.(1) to (7) and (10), the effective thermal resistance must be derated in accordance with Sentence (2).

A-3.3.1.3.(2) Derating of the Effective Thermal Resistance. The "derated" effective thermal resistance of opaque building assemblies of the envelope is generated from their effective thermal resistance calculated in accordance with Article 3.1.1.5. It must be derated to account for additional energy losses at the site of intersections and point penetrations of the envelope, if applicable, including those intended in Sentence 3.2.1.2.(1). The intersections most often encountered in buildings are those of opaque building assemblies with parapets, foundations, intermediate floors and projections (such as cantilevered balconies).

Whereas the prescriptive requirements of those intersections or penetrations are descriptive in nature (see Sentences 3.2.1.2.(3) to (7) and (10)), the trade-off requires to quantify heat losses in relation to those intersections and penetrations (those of the required prescriptive details and those of the proposed details) where the prescriptive requirements are not complied with, in order to derate the effective thermal resistance of the opaque building assemblies concerned. The operation for the derating of the effective thermal resistance of opaque building assemblies to consider the effect of thermal bridging of intersections and penetrations may be carried out using the equation in Sentence 3.3.1.3.(2).

The derating of the effective thermal resistance of opaque building assemblies may be considered only if it is possible to characterize the parameters of the equation, whose values may be lower or higher than the prescriptive requirements, from recognized paths, in particular those in Articles 3.1.1.5. and 3.1.1.6.

The linear thermal transmittance of an intersection and the point thermal transmittance of a penetration may be obtained, for example, from laboratory tests or generated using digital heat transfer simulations (see those of the research project of ASHRAE RP-1365, "Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings" provided as a reference in the ASHRAE Handbook – Fundamentals or the "Building Envelope Thermal Bridging Guide" by Morrison Hershfield). Point penetrations of the envelope and the wall/roof, wall/foundation, wall/projection and wall/intermediate floor intersections of the reference building must be characterized by the default values in Sentence 3.3.1.3.(3).

A-3.3.1.3.(3) Linear Thermal Transmittance and Point Thermal Transmittance by Default of Certain Intersections and Penetrations of the Reference Building. Where the derating of the effective thermal resistance of opaque building assemblies is required, in accordance with the requirement in Sentence 3.3.1.3.(2), the trade-off path allows the application of the linear thermal transmittance provided for in Table 3.3.1.3. and the point thermal transmittance of 0.5 W/K.

A-3.4.1.2. Limitations. The performance path allows to offset the non-compliance with the prescriptive requirements of the building assemblies of the envelope considered in Sentence 3.4.1.2.(1) by improving the performance of the lighting systems, the HVAC systems, the service water heating systems and the building assemblies of the envelope considered in Sentence 3.4.1.2.(1). As with the trade-off path and as provided in Sentence 8.4.2.8.(4), the performance exchanges with the building assemblies of the envelope may only be considered if it is possible to characterize the thermal performance of those assemblies in accordance with Articles 3.1.1.5. and 3.1.1.6.

The performance path offers the designer more flexibility than the trade-off path since it allows performance exchanges between the various systems of the building. Quantification of exchanges, to be carried out to demonstrate compliance of the building by the performance path, is performed using a building energy model that is described and standardized in Part 8. Contrary to the trade-off path, the performance path allows consideration of a fenestration area greater than 40%, and heat exchanges of building assemblies in contact with the ground, except as provided in Sentence 8.4.3.3.(7). (See Note A-8.4.3.3.(7).)

Certain prescriptive requirements, such as those concerning the air barrier of the building envelope, are not specified in Sentence 3.4.1.2.(1). In that case, the proposed building must comply with the prescriptive requirements of Section 3.2.

Part 4
Lighting

Part 4
Lighting

Section 4.1. General

4.1.1. General

4.1.1.1. Scope

1) This Part is concerned with lighting components and systems for the applications listed in Article 4.1.1.2.

4.1.1.2. Application

1) Except as provided in Sentence (2), this Part applies to lighting components and systems that are connected to the *building*'s electrical service. (See Note A-4.1.1.3.(1).)

2) This Part does not apply to the following lighting systems:
a) emergency lighting that is automatically off during normal hours of *building* operation, and
b) lighting within *dwelling units* (see Note A-4.1.1.2.(2)(b)).

4.1.1.3. Compliance

1) Compliance with this Part shall be achieved by following
a) the prescriptive path described in Section 4.2.,
b) the trade-off path described in Section 4.3., or
c) the performance path described in Section 4.4. (see Note A-3.1.1.3.(1)(c)).
(See Note A-4.1.1.3.(1).)

4.1.1.4. Definitions

1) Words that appear in italics are defined in Article 1.4.1.2. of Division A.

Section 4.2. Prescriptive Path

4.2.1. Interior Lighting Power

4.2.1.1. Deleted

4.2.1.2. Deleted

4.2.1.3. Limits to Installed Interior Lighting Power

(See Note A-4.2.1.3.)

1) Each space of the *building* shall appear in a space assembly considered in Sentence (3), except where the *building* has only one space, in which case the space is deemed to comply with Clauses (2)(a) and (b).

2) The space assembly considered in Sentence (3) shall
a) be composed of more than one space,
b) be composed of adjacent or superposed spaces, and
c) except as provided in Sentence (4), correspond to a function in Table 4.2.1.5.

3) Except as provided in Sentence (6), the total *installed interior lighting power* calculated in Article 4.2.1.4. for a space assembly shall not exceed the total *interior lighting power allowance* for that assembly, calculated in accordance with one of the following methods:
a) the *building* area method described in Article 4.2.1.5., or
b) the space-by-space method described in Article 4.2.1.6.

4) The total *interior lighting power allowance* of the *building* shall be calculated using the space-by-space method described in Article 4.2.1.6. in the following cases:
a) where the space assembly considered in Sentence (1) corresponds to a function different than those in Table 4.2.1.5., or
b) where a space cannot be included in a space assembly in conformity with Sentence (2).

5) The *installed interior lighting power* of a space may exceed the *interior lighting power allowance* of that space, the transfer of power between spaces of the same assembly being permitted. (See Note A-4.2.1.3.(5).)

6) Where a *building* has several space assemblies, the total *installed interior lighting power* of a space assembly may exceed the total *interior lighting power allowance* of that space assembly, the transfer of power between space assemblies being permitted on the following conditions:
a) only one of the methods described in Sentence (3) is used for all the spaces considered,
b) one of the following conditions is met:
i) electrical inputs for all the spaces considered are connected to the same electric meter, or
ii) all the spaces considered are intended to be occupied by the same occupant, and
c) except as provided in Sentence 4.2.1.6.(8), the total *interior lighting power allowance* for all the spaces considered is not exceeded.
(See Note A-4.2.1.3.(6).)

4.2.1.4. Determination of the Installed Interior Lighting Power

(See Note A-4.2.1.4.)

1) Except as provided in Sentence (4), the *installed interior lighting power* shall include all power used by the luminaires, including lamps, ballasts, transformers, and control devices.

2) The determination of the *installed interior lighting power* shall include
a) connected lighting power for both permanently installed *interior lighting* and supplemental *interior lighting* provided by movable or plug-in luminaires, and
b) in cases where two or more independently operating lighting systems in a space are controlled to prevent simultaneous operation, the lighting system with the highest wattage.
(See Note A-4.2.1.4.(2).)

3) Luminaire wattage to be included in *installed interior lighting power* shall be determined in accordance with the following criteria:
a) except as provided in Clause (b), the wattage of luminaires shall be the design operating input wattage of the lamp/auxiliary combination based on values provided by a recognized testing laboratory or, in the absence of such information, the maximum labeled wattage of the luminaire shall be used (see Note A-4.2.1.4.(3)(a)),
b) the wattage of luminaires with ballasts designed for multiple wattages shall be the maximum labeled wattage of the luminaire,
c) for line-voltage lighting track and plug-in busway designed to allow the addition and/or relocation of luminaires without altering the wiring of the system, the wattage shall be
i) the highest value between 98 W for each m of length of the line-voltage lighting track or the plug-in busway and the specified wattage of the luminaires included in the system,

ii) the wattage limit of the system's circuit breaker, or
iii) the wattage limit of other permanent current-limiting device(s) on the system,

d) the wattage of a low-voltage lighting system shall be the specified wattage of the transformer supplying the system (see Note A-4.2.1.4.(3)(d)), and
e) the wattage of all other miscellaneous lighting equipment shall be the specified wattage of the lighting equipment.

4) Lighting for the following functions, spaces or equipment need not be included in the calculation of *installed interior lighting power*:

a) display or accent lighting that is an essential element for the function it performs in galleries, museums, and monuments,
b) lighting that is integral to equipment or instrumentation and is installed by its manufacturer,
c) lighting specifically designed for use only during medical or dental procedures,
d) lighting integral to both open and glass-enclosed refrigerator and freezer cases,
e) lighting integral to food warming and food preparation equipment,
f) lighting for plant growth or maintenance,
g) lighting in retail display windows, provided the display area is enclosed by ceiling-height *partitions*,
h) deleted,
i) lighting that is an integral part of advertising or directional signage,
j) *exit* signs,
k) lighting of devices that are for sale or for educational demonstration systems (see Note A-4.2.1.4.(4)(k)),
l) lighting for theatrical purposes, including performance, stage, and film and video production,
m) lighting for television broadcasting in sporting activity areas,
n) casino gaming areas,
o) mirror lighting in dressing rooms,
p) accent lighting in religious pulpit and choir areas,
q) lighting for covered vehicle entrances and exits from *storage garages*, and
r) lighting of work areas integrated to the furniture.

4.2.1.5. Calculation of Interior Lighting Power Allowance Using the Building Area Method

1) Calculation of the total *interior lighting power allowance* for the space assembly described in Sentence 4.2.1.3.(2) using the *building* area method shall be carried out as follows:

a) the *floor surface area* shall be determined for that space assembly,
b) the lighting power density (LPD) allowed for the *floor surface area* determined in accordance with Clause (a) shall be determined from Table 4.2.1.5. for the specific function, and
c) the total *interior lighting power allowance* of the space assembly shall be calculated by multiplying the *floor surface area* determined in Clause (a) by the allowed LPD determined in Clause (b).

Table 4.2.1.5.
Lighting Power Density (LPD) Allowed According to the Function for Use with the Building Area Method
Forming Part of Sentences 4.2.1.3.(2) and (4) and 4.2.1.5.(1)

Function	Lighting Power Density, W/m²
Automotive facility	8.6
Convention centre	10.9
Courthouse	10.9
Dining:	
bar lounge/leisure	10.9
cafeteria/fast food	9.7
family	10.2
Dormitory	6.1
Exercise centre	9.0
Fire station	7.2
Gymnasium	10.1
Health care clinic	9.7
Hospital	11.3
Hotel/Motel	9.4
Library	12.8
Manufacturing facility	12.6
Motion picture *theatre*	8.2
Multi-unit residential *building*(1)	5.5
Museum	11.0
Office	8.8
Penitentiary	8.7
Performing arts *theatre*	14.9
Police station	9.4
Post office	9.4
Religious *building*	10.8
Retail area	13.5
School/university	9.4
Sports arena	9.8
Storage garage	2.3
Town hall	9.6
Transportation facility	7.5
Warehouse	7.1
Workshop	12.8

Notes to Table 4.2.1.5.:
(1) See Note A-4.1.1.2.(2)(b).

4.2.1.6. Calculation of Interior Lighting Power Allowance Using the Space-by-Space Method

1) The total *interior lighting power allowance* for the space assembly described in Sentence 4.2.1.3.(2) using the space-by-space method shall be determined as follows:
a) the *floor surface area* of each space of the assembly shall be determined,
b) the allowed lighting power density (LPD) for each space shall be determined using Table 4.2.1.6. for the exact space type or a space type that most

closely represents the proposed use of each space, except as provided in Sentence (2),

c) the *interior lighting power allowance* for each space shall be calculated by multiplying the *floor surface area* determined in Clause (a) by the allowed LPD determined in Clause (b), and

d) the total *interior lighting power allowance* of the space assembly shall be calculated by summing the *interior lighting power allowance* determined in Clause (c) for each space.

2) Where the use of a space corresponds to more than one type provided for in Table 4.2.1.6., not dividing the space is permitted provided that the type described in Table 4.2.1.6. represents a *floor surface area* of

a) less than 20% of the space, for a space having a *floor surface area* of 1500 m^2 or less, or

b) less than 300 m^2, for a space having a *floor surface area* of more than 1500 m^2.

3) Increasing by 20% the *interior lighting power allowance* of a space other than an atrium, calculated in accordance with Clause (1)(c), is permitted where the space adjustment factor, AF, calculated using the following equation, is greater than the value referred to in Table 4.2.1.6.:

$$AF = 2.5 \cdot (H_1 - H_2) \cdot L/S$$

where

H_1 = height of luminaires in relation to the floor, in m,

H_2 = height of work surface in relation to the floor, in m,

L = perimeter of the *floor surface area* of the space, in m, and

S = *floor surface area* of the space, in m^2.

(See Note A-4.2.1.6.(3).)

4) Increasing by 20% the *interior lighting power allowance* of a corridor or transition area is permitted where the width of the space is less than 2.4 m. (See Note A-4.2.1.6.(4).)

5) Where lighting of a portion of a space is controlled by the type of control listed in Table 4.2.1.6. separately from the *general lighting* of the space, increasing the *interior lighting power allowance* of that portion of space by additional power, $P_{additional}$, in W, calculated using the following equation, is permitted:

$$P_{additional} = IILP_{portions} \cdot PI_{LPD}$$

where

$IILP_{portion}$ = *installed interior lighting power* of the portion of the space concerned, in W, and

PI_{LPD} = percentage of increase of allowed LPD indicated in Table 4.2.1.6.

(See Note A-4.2.1.6.(5).)

6) Where decorative lighting or lighting for displaying works of art or artefacts is controlled separately from the *general lighting* of the space, increasing the *interior lighting power allowance* of that portion of space by 10.8 W/m^2 is permitted. (See Note A-4.2.1.6.(6).)

7) Where lighting for displaying items for sale is controlled separately from the *general lighting* of the space, increasing the *interior lighting power allowance* of that portion of space by additional power, $P_{additional}$, in W, calculated using the following equation, is permitted:

$$P_{additional} = 1000\ W + \left(A_1 \cdot 27\ W/m^2\right) + \left(A_2 \cdot 15\ W/m^2\right) + \left(A_3 \cdot 6.5\ W/m^2\right)$$

where

A_1 = areas reserved for displaying jewelry or crockery, including a traffic area having a width of not more than 900 mm, in m^2,

A_2 = areas reserved for displaying furniture, clothing, cosmetics or works of art for sale, including a traffic area having a width of not more than 900 mm, in m^2, and

A_3 = areas reserved for displaying any other item for sale, including a traffic area having a width of not more than 900 mm, in m^2.

(See Note A-4.2.1.6.(7).)

8) Except for the additional power listed in Sentences (6) and (7), the transfer of unused additional power listed in this Article to increase the *interior lighting power allowance* of another space in accordance with Sentence 4.2.1.3.(6) is permitted.

Table 4.2.1.6.
Allowed Lighting Power Density (LPD) for Use with the Space-by-Space Method, Adjustment Factor (AF) and Allowed Additional Lighting Power Density
Forming Part of Sentences 4.2.1.6.(1), (3), (4) and (5), 4.2.2.1.(2), (3), (6), (8), (9), (10), (12) and (14), 4.3.3.1.(1) and (2), and 8.4.3.4.(2)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})(1)	Type of Lighting Control(2)						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON(3) [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF(4) [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Common Space Types(5)										
Atrium										
< 6 m in height	1.06 per m (height)	n/a	10% where C2	X	A	A	–	–	B	B
≥ 6 m and ≤ 12 m in height	1.06 per m (height)	n/a	10% where C2	X	A	A	X	–	B	B
> 12 m in height	4.3 + 0.71 per m (height)	n/a	10% where C2	X	A	A	X	–	B	B
Audience seating area – permanent										
for auditorium	6.8	6	n/a	X	A	A	X	–	B	B
for convention centre	8.9	4	n/a	X	A	A	X	–	B	B
for gymnasium	7.0	6	n/a	X	A	A	X	–	B	B
for motion picture *theatre*	12.3	4	n/a	X	A	A	X	–	B	B
for penitentiary	3.0	4	n/a	X	A	A	–	–	B	B
for performing arts *theatre*	26.2	8	n/a	X	A	A	X	–	B	B
for religious *building*	16.5	4	n/a	X	A	A	X	–	B	B
for sports arena	4.6	4	n/a	X	A	A	–	–	B	B
other	4.6	4	n/a	X	A	A	–	–	B	B
Banking activity area	10.9	6	n/a	X	A	A	X	–	B	B
Classroom, lecture hall and training room										
for penitentiary	14.5	4	10% where C1 or C2	X	A	A	X	–	X	–
other	13.4	4	10% where C1 or C2	X	A	A	X	–	X	–

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})(1)	Type of Lighting Control(2)						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON(3) [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF(4) [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Conference, meeting and multi-purpose room	13.3	6	10% where C1 or C2	X	A	A	X	–	X	–
Confinement cell	8.8	6	n\a	X	A	A	X	–	B	B
Copy and print room	7.8	6	n\a	X	A	A	X	–	X	–
Corridor and transition area										
for hospital	10.7	Width < 2.4 m (see 4.2.1.6.(4))	10% where C2	X	–	–	–	B	B	B
for manufacturing facility	4.4	Width < 2.4 m (see 4.2.1.6.(4))	10% where C2	X	–	–	–	–	B	B
for space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living,” and used primarily by residents	9.9	Width < 2.4 m (see 4.2.1.6.(4))	10% where C2	X	–	–	–	X	B	B
other	7.1	Width < 2.4 m (see 4.2.1.6.(4))	10% where C2	X	–	–	–	X	B	B
Courtroom	18.6	6	10% where C1 or C2	X	A	A	X	–	B	B

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})(1)	Type of Lighting Control(2)						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON(3) [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF(4) [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Dining area										
for bar lounge and leisure dining	11.6	4	10 % where C2	X	A	A	X	–	B	B
for cafeteria and fast food dining	7.0	4	10% where C2	X	A	A	X	–	B	B
for family dining	9.6	4	10% where C2	X	A	A	X	–	B	B
for penitentiary	10.3	6	10% where C2	X	A	A	X	–	B	B
for space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living,” and used primarily by residents	28.5	4	10% where C2	X	A	A	X	–	B	B
other	7.0	4	10% where C2	X	A	A	X	–	B	B
Dressing room for performing arts – *theatre*	6.6	6	n/a	X	A	A	X	–	X	–
Electrical or mechanical room	4.6	6	124%(6)	X	–	–	–	–	–	–
Emergency vehicle garage	6.1	4	10% where C2	X	A	A	–	–	B	B
Food preparation area	13.1	6	n/a	X	A	A	X	–	B	B
Guest room	5.1	6	n/a	See Sentence 4.2.2.6.(2)						
Laboratory										
for classroom	15.5	6	n/a	X	A	A	X	X	B	B
other	19.5	6	n/a	X	A	A	X	–	B	B
Laundry/Washing area	6.5	4	n/a	X	A	A	X	–	B	B
Loading dock – interior	5.1	6	n/a	X	A	A	–	–	B	B

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})(1)	Type of Lighting Control(2)						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON(3) [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF(4) [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Lobby										
for elevator	7.0	6	10% where C2	X	–	–	–	–	B	B
for hotel	11.5	4	10% where C2	X	–	–	–	–	B	B
for motion picture *theatre*	6.4	4	10% where C2	X	–	–	–	–	B	B
for performing arts *theatre*	21.6	6	10% where C2	X	–	–	–	X	B	B
for space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living," and used primarily by residents	19.4	4	10% where C2	X	–	–	–	X	B	B
other	9.7	4	10% where C2	X	–	–	–	X	B	B
Locker room	8.1	6	n/a	X	A	A	X	–	X	–
Lounge or break room										
for health care facility	10.0	6	n/a	X	A	A	X	–	X	–
other	7.9	4	n/a	X	A	A	X	–	X	–
Office										
enclosed, ≤ 25 m²	12.0	8	5% where C1 or C2	X	A	A	X	–	X	–
enclosed, > 25 m²	12.0	8	5% where C1 or C2	X	A	A	X	–	B	B
open plan	10.6	4	5% where C1 or C2 25% where C3 30% where C4	X	A	A	X	–	B	B
Pharmacy area	18.1	6	n/a	X	A	A	X	–	B	B
Sales area	15.5	6	n/a	X	A	A	X	–	B	B
Seating area	5.9	4	n/a	X	A	A	–	–	B	B
Server room	18.4	4	n/a	X	A	A	X	–	B	B
Stairway, except stairwell	The control and lighting power density requirements shall be the same as those for the space containing the stairway.									

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})[1]	Type of Lighting Control[2]						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON[3] [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF[4] [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Stairwell	7.4	10	10% where C2	X	–	–	X	X	B	B
Storage garage – interior	2.1	4	10% where C2	See Article 4.2.2.2.						
Storage room										
< 5 m²	13.3	6	n/a	X	–	–	–	–	B	B
≥ 5 m² and ≤ 100 m²	6.8	6	n/a	X	A	A	–	–	X	–
> 100 m²	6.8	6	n/a	X	A	A	–	X	B	B
Vehicle maintenance area	7.3	4	n/a	X	A	A	X	–	B	B
Washroom										
for space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living," and used primarily by residents	13.1	8	n/a	X	–	–	–	–	X	–
other	10.5	8	n/a	X	–	–	–	–	X	–
Workshop	17.2	6	n/a	X	A	A	X	–	B	B
Building-Specific Space Types[5]										
Convention centre – exhibit space	15.7	4	n/a	X	A	A	X	–	B	B
Dormitory – living quarters	4.2	8	n/a	X	–	–	–	–	–	–
Fire station – sleeping quarters	2.4	6	n/a	X	–	–	–	–	–	–
Gymnasium and fitness centre										
exercise area	7.8	4	10% where C2	X	A	A	X	–	B	B
playing area	13.0	4	10% where C2	X	A	A	X	–	B	B

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})(1)	Type of Lighting Control(2)						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON(3) [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF(4) [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Health care facility										
exam or treatment room	18.0	8	n/a	X	–	–	X	–	B	B
imaging room	16.3	6	n/a	X	–	–	X	–	B	B
medical supply room	8.0	6	n/a	See Storage Room under Common Space Types for applicable control requirements.						
nursery	9.5	6	n/a	X	–	–	X	–	B	B
nurses' station	7.6	6	n/a	X	–	–	X	–	B	B
operating room	26.8	6	n/a	X	–	–	X	–	B	B
patient room	6.7	6	n/a	X	–	–	X	–	B	B
physical therapy room	9.9	6	n/a	X	–	–	X	–	B	B
recovery room	12.4	6	n/a	X	–	–	X	–	B	B
Library										
reading area	11.5	4	n/a	X	A	A	X	–	B	B
stacks	18.4	4	n/a	X	A	A	X	X	B	B
Manufacturing facility										
detailed manufacturing area	13.9	4	n/a	X	A	A	X	–	B	B
equipment room	8.0	6	n/a	X	A	A	X	–	B	B
extra high bay area (> 15 m floor-to-ceiling height)	11.3	4	n/a	X	A	A	X	–	B	B
high bay area (7.5 m to 15 m floor-to-ceiling height)	13.3	4	n/a	X	A	A	X	–	B	B
low bay area (< 7.5 m floor-to-ceiling height)	12.9	4	n/a	X	A	A	X	–	B	B
Museum										
general exhibition area	11.4	6	n/a	X	A	A	X	–	B	B
restoration room	11.0	6	n/a	X	A	A	X	–	B	B
Post office – sorting area	10.2	4	n/a	X	A	A	X	X	B	B

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})(1)	Type of Lighting Control(2)						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON(3) [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF(4) [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Religious *building*										
fellowship hall	6.9	4	n/a	X	A	A	X	–	B	B
worship, pulpit and choir area	16.5	4	n/a	X	A	A	X	–	B	B
Retail facility										
dressing/fitting room	7.7	8	n/a	X	A	A	X	–	X	–
mall concourse	11.9	4	10% where C2	X	A	A	X	–	B	B
Space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living”										
chapel used primarily by residents	23.8	4	n/a	X	A	A	X	–	B	B
recreation room used primarily by residents	25.9	6	n/a	X	A	A	X	–	B	B
Sports arena – playing area										
playing area with facilities for more than 5000 spectators	39.7	4	n/a	X	A	A	X	–	B	B
playing area with facilities for more than 2000 spectators and not more than 5000 spectators	25.9	4	n/a	X	A	A	X	–	B	B
playing area with facilities for more than 200 spectators and not more than 2000 spectators	19.4	4	n/a	X	A	A	X	–	B	B
playing area with facilities for less than 200 spectators or without facilities for spectators	13.0	4	n/a	X	A	A	X	–	B	B

Table 4.2.1.6. (Continued)

Space Type	Lighting Power Density (LPD), W/m²	Adjustment Factor (AF)	Percentage of Increase of Allowed LPD (PI_{LPD})[1]	Type of Lighting Control[2]						
				Manual [see 4.2.2.1.(3)]	Restricted to Manual ON [see 4.2.2.1.(6)]	Restricted to Partial Automatic ON[3] [see 4.2.2.1.(8)]	Bi-Level [see 4.2.2.1.(9)]	Automatic Partial OFF [see 4.2.2.1.(10)]	Automatic Full OFF[4] [see 4.2.2.1.(12)]	Scheduled Shut-off [see 4.2.2.1.(14)]
Transportation facility										
airport concourse	3.9	4	n/a	X	A	A	–	–	B	B
baggage/carousel area	5.7	4	n/a	X	A	A	–	–	B	B
terminal ticket counter	8.7	4	n/a	X	A	A	X	–	B	B
Warehouse – storage area										
medium to bulky palletized items	6.2	4	n/a	X	A	A	X	X	B	B
small items	10.2	6	n/a	X	A	A	X	X	B	B

Notes to Table 4.2.1.6.:

(1) Controls C1 to C4 designate the following controls:
C1: controls lighting using a manual dimmer;
C2: controls lighting using an hourly program for multiple lighting levels;
C3: controls lighting using occupant sensors, where the lighting meets the following criteria:
(a) the lighting is dedicated exclusively to work stations,
(b) the lighting of each work station is independently controlled,
(c) the portion of the lighting directed towards the work surface is controlled independently from the portion directed toward the ceiling,
(d) the portion of the lighting directed towards the work surface is turned off automatically by continuous dimming devices in the first 30 min of vacancy; dimming for turning off lighting shall last a minimum of 2 min,
(e) at the arrival of the occupant, the portion of lighting directed towards the work surface turns on automatically to a first minimum lighting level, then by continuous dimming for at least 30 s before reaching a preset higher level, and
(f) the portion of lighting directed towards the ceiling meets the requirements of Sentence 4.2.2.1.(12);
C4: controls lighting using a C3 control, while permitting manual adjustment of the lighting level by continuous dimming of the lighting directed towards the work station.

(2) n/a: not applicable;
A: at least one of the lighting controls marked with an “A” must be implemented in this space type;
B: at least one of the lighting controls marked with a “B” must be implemented in this space type;
X: all lighting controls marked with an “X” must be implemented in this space type; and
– (dash): this lighting control is not required to be implemented in this space type.

(3) Controls meeting the requirements for “Partial Automatic ON” in Sentence 4.2.2.1.(8) also comply with the requirements for “Bi-Level” lighting control in Sentence 4.2.2.1.(9).

(4) Controls meeting the requirements for “Automatic Full OFF” in Sentence 4.2.2.1.(12) also comply with the requirements for “Automatic Partial OFF” lighting control in Sentence 4.2.2.1.(10).

(5) In cases where a space type is listed both as a common space type and a *building*-specific space type, the requirements for the *building*-specific space type apply. See Note A-Table 4.2.1.6.

(6) An additional LPD of 5.7 W/m² is permitted, provided that the additional lighting is separately controlled from the lighting whose allowed LPD is 4.6 W/m².

4.2.2. Interior Lighting Controls

4.2.2.1. Interior Lighting Controls

(See Note A-4.2.2.1.)

1) Except as provided in Sentence (2), *interior lighting* controls shall be installed in accordance with this Article for each space type in the *building*.

2) Where the LPD requirements are determined in accordance with the space-by-space method described in Article 4.2.1.6., the same space types shall be used to determine the applicable lighting control requirements from Table 4.2.1.6.

3) At least one manual lighting control device shall be installed in conformance with Sentence (4) in each space type listed in Table 4.2.1.6. to control all the lighting

a) in each area less than or equal to 250 m², where the area of the space is less than or equal to 1 000 m², and
b) in each area less than or equal to 1 000 m², where the area of the space is greater than 1 000 m².

4) Except as provided in Sentence (5), manual lighting control devices referred to in Sentence (3) shall be installed in a readily accessible location from which occupants can see the controlled lighting.

5) Manual lighting control devices are permitted to be located remotely for reasons of safety or security, provided each control device

a) has an indicator pilot light that is integral or adjacent to the control device, and
b) bears a label identifying which lighting it controls.

6) Except as provided in Sentence (7), none of the lighting in spaces requiring controls that are restricted to "Manual ON" in accordance with Table 4.2.1.6. shall turn on automatically.

7) Sentence (6) need not apply where "Manual ON" operation of the *general lighting* would endanger the safety or security of the *building* occupants.

8) Up to 50% of the lighting power for the *general lighting*, and for no other lighting, in spaces requiring controls that are restricted to "Partial Automatic ON" in accordance with Table 4.2.1.6. is permitted to turn on automatically.

9) The *general lighting* in spaces requiring "Bi-Level" lighting control in accordance with Table 4.2.1.6. shall have controls that allow at least one intermediate level of lighting, in addition to "full on" and "full off," that is between 30% and 70% full lighting power, or continuous dimming.

10) Except as provided in Sentence (11), the *general lighting* in spaces requiring controls that are "Automatic Partial Turn OFF" in accordance with Table 4.2.1.6. shall automatically be reduced by 50% or more within 20 min of the space being unoccupied.

11) *General lighting* need not be controlled in accordance with Sentence (10) where

a) the LPD for the space is not greater than 8.6 W/m²,
b) the space is lit by high-intensity discharge (HID) lamps, and
c) the power for the *general lighting* in the space is automatically reduced by 30% or more within 20 min of the space being unoccupied.

12) Except as provided in Sentence (13), the lighting in spaces requiring controls that are "Automatic Full OFF" in accordance with Table 4.2.1.6. shall be controlled by automatic control devices that shut off the lighting within 20 min of the space being unoccupied, where each automatic control device controls an area not greater than 500 m².

13) The following lighting applications need not comply with Sentence (12):

a) *general lighting* and task lighting in shop and laboratory classrooms,
b) *general lighting* and task lighting in spaces where automatic shut-off would endanger the safety or security of the *building* occupants, and
c) lighting required to operate continuously due to operational requirements.

14) Except as provided in Sentence (17), the lighting in spaces requiring controls that are “Scheduled Shut-off” in accordance with Table 4.2.1.6. shall shut off automatically during periods when the spaces are scheduled to be unoccupied by means of control devices complying with Sentence (15) that are
a) time-of-day operated to automatically turn the lighting off at programmed times, or
b) signals from other automatic control devices or alarm/security systems.

15) A control device installed to meet the requirements of Sentence (14) shall
a) control the lighting for an area of not more than 2 500 m² on not more than one *storey*, and
b) consider independently the operation during weekdays, weekends and holidays.

16) Any manual control device installed to override the “Scheduled Shut-off” control device required in Sentence (14) shall
a) turn the lighting on for 2 h or less per activation during scheduled “off” periods, and
b) control an area of 500 m² or less.

17) The control in Sentence (14) is not required where it is
a) required to operate continuously due to operational requirements,
b) located in spaces where patient care is rendered, or
c) located in spaces where automatic shut-off would endanger the safety or security of the *building* occupants.

4.2.2.2. Lighting Controls in Storage Garages

1) Lighting in a *storage garage* shall be divided into zones no larger than 360 m².

2) Except as provided in Sentence (4), the lighting power in a zone referred to in Sentence (1) shall be controlled by a device that automatically reduces the power of each lighting device of the zone by at least 30% when no activity is detected for 20 min. (See Note A-4.2.2.2.(2).)

3) Lighting for covered vehicle entrances and exits from *storage garages* shall be separately controlled by a device that automatically reduces the lighting by at least 50% from sunset to sunrise. (See Note A-4.2.2.2.(3).)

4) Daylight transition zones and ramps without parking need not comply with the provisions of Sentences (1) and (2).

4.2.2.3. Deleted

4.2.2.4. Deleted

4.2.2.5. Deleted

4.2.2.6. Special Applications

1) The following lighting applications shall be controlled separately from the *general lighting* in all spaces:
a) display or accent lighting,
b) lighting in display and merchandising cases,
c) lighting for non-visual applications, such as plant growth and food warming, and
d) lighting equipment that is for sale or for demonstrations in lighting education.

2) Except as provided in Sentence (4), in a hotel or motel *suite*, all the lighting and switched receptables used for lighting shall
a) be automatically controlled so that their power supply turns off within the first 20 min of the space being unoccupied using occupant sensors installed in each space, or
b) be controlled by a captive key system.
(See Note A-4.2.2.6.(2) and (4).)

3) Deleted.

4) In a hotel or motel *suite*, bathrooms shall be equipped with a separate control device installed to automatically turn off the lighting in the bathroom within the first 20 min of the space being unoccupied, except night lighting that does not exceed 5 W. (See Note A-4.2.2.6.(2) and (4).)

5) All supplemental task lighting, including permanently installed undershelf or undercabinet lighting, shall be controlled by a device that is

a) integral to the luminaires, or

b) wall-mounted in a readily accessible location from which the occupant can see the controlled lighting.

4.2.3. Exterior Lighting Power

4.2.3.1. Exterior Lighting

1) *Exterior lighting* allowances shall be based on the lighting zone in which the *building* is located, as determined from Table 4.2.3.1.-A.

Table 4.2.3.1.-A
Lighting Zones Used to Determine Exterior Lighting Allowances
Forming Part of Sentence 4.2.3.1.(1)

Lighting Zone	Description
0	Undeveloped areas within national, provincial or territorial parks, forest land, and rural areas, and other undeveloped areas
1	Developed areas within national, provincial or territorial parks, and rural areas
2	Areas predominantly consisting of residential zoning, neighbourhood business districts, light industrial areas with limited nighttime use, and residential mixed-use areas
3	All other areas
4	High-activity commercial districts

2) Deleted.

3) Except as provided in Sentence (6), the installed *exterior lighting* power for each specific *building* exterior application listed in Table 4.2.3.1.-C that is to be illuminated shall not be greater than the allowance for the application concerned according to the applicable lighting zone plus any unused power from the basic site allowance listed in Table 4.2.3.1.-B. (See Note A-4.2.3.1.(3).)

Table 4.2.3.1.-B
Basic Site Allowances for Exterior Lighting
Forming Part of Sentence 4.2.3.1.(3)

Basic Site Allowance According to Lighting Zone				
Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
0 W	500 W	600 W	750 W	1300 W

4) Except as provided in Sentence (6), the installed *exterior lighting* power for all general *building* exterior applications that are to be illuminated shall not be greater than the sum of the allowances for the applications provided in Table 4.2.3.1.-D according to the applicable lighting zone plus any unused power from the basic site allowance listed in Table 4.2.3.1.-B, the transfer of power between the applications being permitted. (See Note A-4.2.3.1.(4).)

Table 4.2.3.1.-C
Lighting Power Allowances for Specific Building Exterior Applications
Forming Part of Sentences 4.2.3.1.(3) and (4)

<table>
<tr><th rowspan="2">Exterior Application</th><th colspan="5">Lighting Power Allowances According to Lighting Zone</th></tr>
<tr><th>Zone 0</th><th>Zone 1</th><th>Zone 2</th><th>Zone 3</th><th>Zone 4</th></tr>
<tr><td>Building facades (facade lighting)</td><td rowspan="6">A single luminaire of 60 W or less may be installed for each roadway or parking entry, trail head, and toilet facility, or other locations approved by the authority having jurisdiction</td><td>No allowance</td><td>1.1 W/m^2 for each illuminated wall or surface, or 8.2 W/m for each illuminated wall or surface length</td><td>1.6 W/m^2 for each illuminated wall or surface, or 12.3 W/m for each illuminated wall or surface length</td><td>2.2 W/m^2 for each illuminated wall or surface, or 16.4 W/m for each illuminated wall or surface length</td></tr>
<tr><td>Automated teller machines (ATM) and night depositories</td><td colspan="4">270 W per location plus 90 W per additional ATM per location</td></tr>
<tr><td>Entrances and gatehouse inspection stations at guarded facilities</td><td colspan="4">8.1 W/m^2 of covered and uncovered area</td></tr>
<tr><td>Loading areas for law enforcement, fire, ambulance and other emergency service vehicles</td><td colspan="4">5.4 W/m^2 of covered and uncovered area</td></tr>
<tr><td>Drive-up windows and doors</td><td colspan="4">400 W per drive-through</td></tr>
<tr><td>Parking near 24-hour retail establishment entrances</td><td colspan="4">800 W per main entry</td></tr>
</table>

5) Except as provided in Sentence (6), the installed *exterior lighting* power shall be determined in the same manner as the *installed interior lighting power* in accordance with Sentences 4.2.1.4.(1) to (3).

6) The power of the following *exterior lighting* applications may not be considered in calculating the power of the installed *exterior lighting* where the lighting is equipped with an independent control device:
a) lighting integral to signal equipment installed by its manufacturer,
b) lighting for athletic activity areas,
c) lighting for industrial production, material handling, transportation sites, and associated storage areas for industrial sites,
d) lighting for theme or amusement elements,
e) lighting used to highlight art objects or monuments,
f) lighting of water fountains,
g) lighting for directional and signage devices,
h) lighting integral to equipment or instrumentation where it is installed by its manufacturer,
i) lighting for theatrical purposes, including performance, stage, film and video production,
j) lighting integral to swimming pools
k) temporary lighting, and
l) lighting for searchlight.

Table 4.2.3.1.-D
Lighting Power Allowances for General Building Exterior Applications
Forming Part of Sentence 4.2.3.1.(4)

Exterior Application	Lighting Power Allowances According to Lighting Zone				
	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
Uncovered Parking Areas					
Parking areas and drives	No allowances	0.4 W/m^2	0.7 W/m^2	1.1 W/m^2	1.4 W/m^2
Building Grounds	No allowances				
Walkways less than 3 m wide		2.3 W/m	2.3 W/m	2.6 W/m	3.3 W/m
Walkways 3 m wide or greater, plaza areas, special feature areas		1.5 W/m^2	1.5 W/m^2	1.7 W/m^2	2.2 W/m^2
Stairways		8.1 W/m^2	11.0 W/m^2	11.0 W/m^2	11.0 W/m^2
Pedestrian tunnels		1.6 W/m^2	1.6 W/m^2	2.2 W/m^2	3.2 W/m^2
Landscape lighting		0.4 W/m^2	0.5 W/m^2	0.5 W/m^2	0.5 W/m^2
Exterior Entrances and Exterior Exits	No allowances				
Main entries		66 W/m of door width	66 W/m of door width	98 W/m of door width	98 W/m of door width
Other doors		66 W/m of door width	66 W/m of door width	66 W/m of door width	66 W/m of door width
Entry canopies		2.7 W/m^2	2.7 W/m^2	4.3 W/m^2	4.3 W/m^2
Sales Canopies					
Free-standing and attached	No allowances	6.5 W/m^2	6.5 W/m^2	8.6 W/m^2	11.0 W/m^2
Outdoor Sales	No allowances				
Open areas (including vehicle sales lots)		2.7 W/m^2	2.7 W/m^2	5.4 W/m^2	7.5 W/m^2
Street frontage for vehicle sales lots in addition to “open area” allowance		No allowance	33 W/m	33 W/m	98 W/m

4.2.4. Exterior Lighting Controls

4.2.4.1. Exterior Lighting Controls

1) *Exterior lighting* shall be equipped with automatic shut-off controls based on daylight. (See Note A-4.2.4.1.(1).)

2) *Facade lighting* and *landscape lighting* shall be equipped with shut-off controls that shut it off automatically for the period
a) beginning not later than midnight or when the *building* closes, and
b) ending no sooner than 6 a.m. or when the *building* opens.

3) *Exterior lighting*, excluding *facade lighting* and *landscape lighting*, shall be controlled by a device that automatically reduces the installed lighting power by at least 30% according to one of the following conditions:
a) for the period
  i) beginning not later than midnight or 60 min after the *building* closes, and
  ii) ending no sooner than 6 a.m. or when the *building* opens, or
b) during a 15-min period of inactivity.

4) Lighting schedule controllers shall be equipped with backup provisions to retain programming and the time setting for at least 10 h during a power outage.

5) The following *exterior lighting* applications need not comply with the requirements of Sentences (1) to (4):
a) *exterior lighting* for covered vehicle entrances and exits from *storage garages*, and
b) *exterior lighting* provided for in Clauses 4.2.3.1.(6)(g) to (l).

Section 4.3. Trade-off Path

(See Note A-1.1.2.1.)

4.3.1. General

4.3.1.1. Application

1) Subject to the limitations stated in Article 4.3.1.2., this Section applies to *interior lighting* and photocontrols.

4.3.1.2. Limitation

1) *Exterior lighting* and *exterior lighting* controls shall comply with Subsections 4.2.3. and 4.2.4.

2) *Interior lighting* controls shall comply with Subsection 4.2.2.

4.3.1.3. Compliance

1) *Interior lighting* shall be deemed to comply with this Section where the installed *interior lighting* energy, IILE, in kW·h/a, of the proposed *building*, calculated in accordance with Subsection 4.3.2., does not exceed the *interior lighting* energy allowance, ILEA, in kW·h/a, calculated in accordance with Subsection 4.3.3.

4.3.2. Installed Interior Lighting Energy

4.3.2.1. Determination of Installed Interior Lighting Energy

1) The installed *interior lighting* energy, IILE, in kW·h/a, which is the total *annual energy consumption* of *interior lighting* in all spaces of the proposed *building*, shall be calculated using the following equation:

$$\mathrm{IILE} = \sum_{i=1}^{N} E_{i,\mathrm{proposed}}$$

where

N = total number of spaces in the proposed *building*, and

$E_{i,proposed}$ = *annual energy consumption* of *interior lighting* in space i, in kW·h/a, calculated in accordance with Sentence (2).

2) The *annual energy consumption* of *interior lighting* in a space, $E_{i,proposed}$, in kW·h/a, shall be calculated using the following equation:

$$E_{i,\mathrm{proposed}} = \mathrm{LPD}_{i,\mathrm{proposed}} \cdot S_i \cdot t_i / 1000$$

where

$LPD_{i,proposed}$ = proposed LPD of the lighting in space i, in W/m², determined in accordance with Article 4.3.2.2.,

S_i = *floor surface area* of space i, in m², and

t_i = annual operational time of space i, in h/a, determined in accordance with Article 4.3.2.3.

4.3.2.2. Determination of Lighting Power Density

1) The lighting power density for a space, $LPD_{i,proposed}$, in W/m², shall be calculated using the following equation:

$$\mathrm{LPD}_{i,\mathrm{proposed}} = \frac{P_i}{S_i}$$

where

P_i = lighting power in space i, in W, and

S_i = *floor surface area* of space i, in m².

4.3.2.3. Determination of Operational Times

1) The annual operational time of each space, t_i, in h/a, shall be determined from the anticipated operating schedules, by taking into consideration holidays and scheduled shut-off or shut-off attributable to occupant sensors.

2) Where part of a daylighted space is equipped with at least one photocontrol, the reduction of the annual operational time provided for in Sentence (1) is permitted in that part of the space

a) from the detailed hourly calculations of daylight and the dynamic response of photocontrols resulting from a digital simulation conducted using specialized tools, or

b) by applying the following reduction factors:

  i) 10% for photocontrols with two control levels,

  ii) 20% for multi-level photocontrols, or

  iii) 30% for continuous dimming photocontrols.

(See Note A-4.3.2.3.(2).)

4.3.2.4. Deleted

4.3.2.5. Deleted

4.3.2.6. Deleted

4.3.2.7. Deleted

4.3.2.8. Deleted

4.3.2.9. Deleted

4.3.2.10. Deleted

4.3.3. Interior Lighting Energy Allowance

4.3.3.1. Determination of Interior Lighting Energy Allowance

1) The *interior lighting* energy allowance, ILEA, in kW·h/a, which is the maximum allowed *annual energy consumption* of all *interior lighting* complying with the prescriptive LPD determined using the space-by-space method in Article 4.2.1.6. and with the prescriptive lighting controls in Subsection 4.2.2., shall be calculated using the following equation:

$$\mathrm{ILEA} = \sum_{i=1}^{N} E_{i,\mathrm{reference}}$$

where

N = total number of spaces in the proposed *building*, and

$E_{i,reference}$ = *annual energy consumption* for lighting in space i, in kW·h/a, calculated in accordance with Sentence (2).

2) The *annual energy consumption* for lighting in a space, $E_{i,reference}$, in kW·h/a, shall be calculated using the following equation:

$$E_{i,\mathrm{reference}} = \mathrm{LPD}_{i,\mathrm{reference}} \cdot S_i \cdot t_i / 1000$$

where

$LPD_{i,reference}$ = reference LPD of space i, in W/m², determined in accordance with Article 4.2.1.6.,

S_i = *floor surface area* of space i, in m², and

t_i = annual operational time in space i, in h/a, determined in accordance with Article 4.3.2.3.

4.3.3.2. Deleted

4.3.3.3. Deleted

4.3.3.4. Deleted

4.3.3.5. Deleted

4.3.3.6. Deleted

4.3.3.7. Deleted

4.3.3.8. Reserved

4.3.3.9. Reserved

4.3.3.10. Deleted

Section 4.4. Performance Path

(See Note A-1.1.2.1.)

4.4.1. General

4.4.1.1. Scope

1) Where the lighting system does not comply with the requirements of Section 4.2. or 4.3., it shall comply with Part 8.

4.4.1.2. Limitations

1) The *exterior lighting* and the *exterior lighting* controls shall comply with Subsections 4.2.3. and 4.2.4.

2) The *interior lighting* controls shall comply with Subsection 4.2.2.

Section 4.5. Objective and Functional Statements

4.5.1. Objective and Functional Statements

4.5.1.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in this Part shall be the objective and functional statements listed in Table 4.5.1.1. (See Note A-1.1.3.1.(1).)

Table 4.5.1.1.
Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 4
Forming Part of Sentence 4.5.1.1.(1)

Functional Statements and Objectives[1]	
4.2.1.3. Limits to Installed Interior Lighting Power	
(1)	[F94-OE1.1]
4.2.1.4. Determination of the Installed Interior Lighting Power	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
(3)	[F94-OE1.1]
4.2.1.5. Calculation of Interior Lighting Power Allowance Using the Building Area Method	
(1)	[F94-OE1.1]
4.2.1.6. Calculation of Interior Lighting Power Allowance Using the Space-by-Space Method	
(1)	[F94-OE1.1]
4.2.2.1. Interior Lighting Controls	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
(3)	[F94-OE1.1]
(4)	[F94-OE1.1]
(6)	[F94-OE1.1]
(8)	[F94-OE1.1]
(9)	[F94-OE1.1]
(10)	[F94-OE1.1]
(12)	[F94-OE1.1]
(14)	[F94-OE1.1]
(16)	[F94-OE1.1]
4.2.2.2. Lighting Controls in Storage Garages	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
(3)	[F94-OE1.1]
4.2.2.6. Special Applications	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
(4)	[F94-OE1.1]
(5)	[F94-OE1.1]
4.2.3.1. Exterior Lighting	
(1)	[F94-OE1.1]
(3)	[F94-OE1.1]
(4)	[F94-OE1.1]
4.2.4.1. Exterior Lighting Controls	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
(4)	[F94-OE1.1]

Table 4.5.1.1. (Continued)

Functional Statements and Objectives[1]	
4.3.1.3. Compliance	
(1)	[F94-OE1.1]
4.3.2.1. Determination of Installed Interior Lighting Energy	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
4.3.2.2. Determination of Lighting Power Density	
(1)	[F94-OE1.1]
4.3.2.3. Determination of Operational Times	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]
4.3.3.1. Determination of Interior Lighting Energy Allowance	
(1)	[F94-OE1.1]
(2)	[F94-OE1.1]

Notes to Table 4.5.1.1.:

(1) See Parts 2 and 3 of Division A.

Notes to Part 4
Lighting

A-4.1.1.2.(1) Application. Part 4 is intended to apply to all lighting components and systems in or on the building or building site that are connected to the building's electrical service.

A-4.1.1.2.(2)(b) Application to Dwelling Units. The interior lighting of dwelling units need not comply with the requirements of Part 4. The interior lighting of common parts of a building with dwelling units is not covered by the exclusion of that Clause and shall comply with the requirements of Part 4.

A-4.1.1.3.(1) Compliance. The flow chart in Figure A-4.1.1.3.(1) illustrates the process for all three paths of compliance applicable to Part 4. The prescriptive path options for interior lighting requirements (using the building area method or the space-by-space method) are also shown in Figure A-4.1.1.3.(1). Certain requirements apply regardless of the path of compliance chosen, for example, the requirements for exterior lighting and the calculation of the lighting power.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

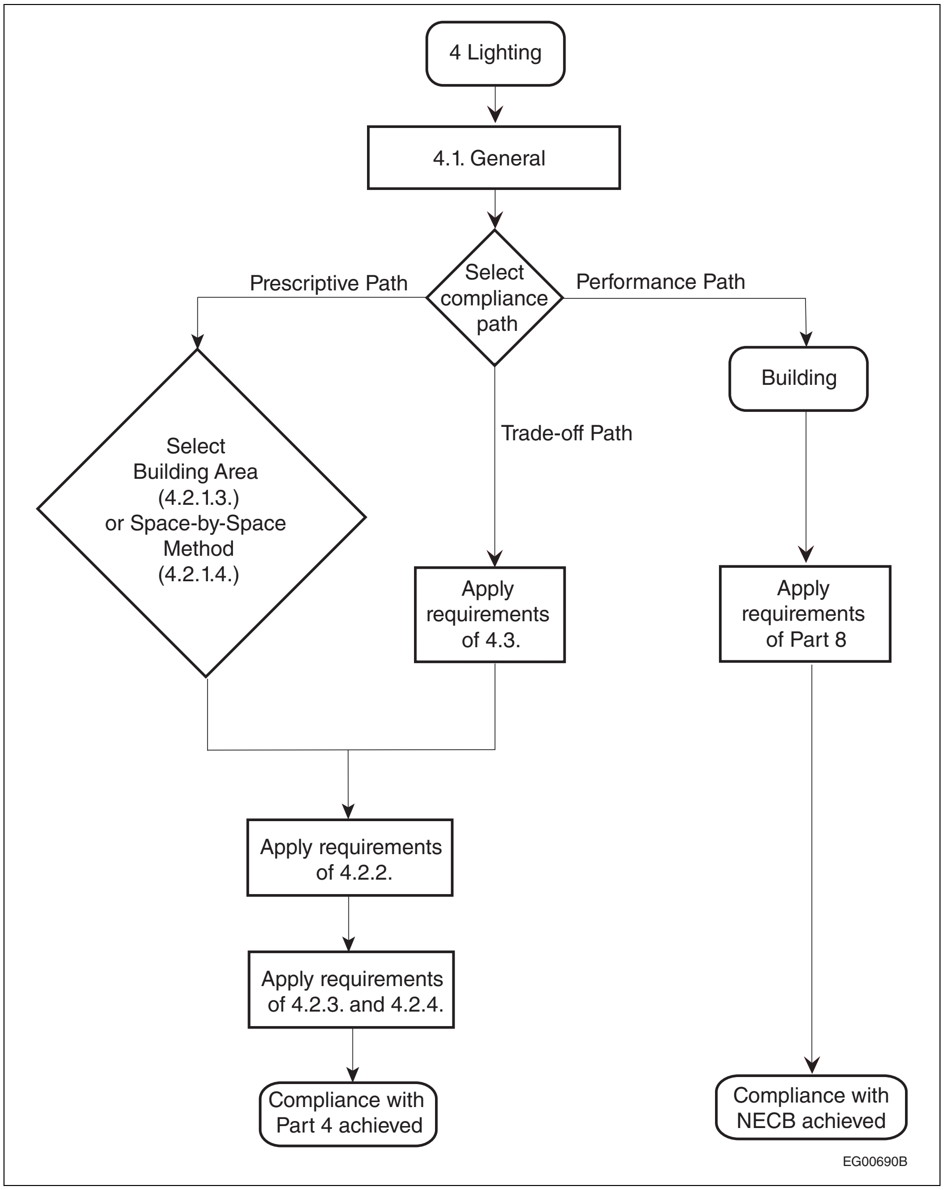

Figure A-4.1.1.3.(1)
Code compliance paths for lighting

A-4.2.1.3. Prescriptive Compliance with Interior Lighting Power Requirements. The prescriptive criteria in Subsection 4.2.1. compare the installed interior lighting power to a permitted interior lighting power allowance. For calculating the permitted interior lighting power allowance, two methods are proposed, i.e. the building area method and the space-by-space method.

The building area method is based on the functions in the building and has limited flexibility. The criteria are not sensitive to type of space and room configurations, which is permitted by the space-by-space method. The building area method permits faster calculations for buildings with common functions. That method is appropriate for projects whose function is not specifically determined in the plans and specifications.

The space-by-space method provides greater flexibility but requires a more detailed calculation procedure. It provides for each space a more appropriate interior lighting power allowance better adapted to complex buildings or buildings with multiple spaces for multiple activities.

The building area and space-by-space methods are not to be used, in the building design, to determine room illuminance levels. The designer is required to design a lighting system that will create an environment sufficiently lighted without exceeding the interior lighting power allowance.

For a building with a single function, such as an elementary school, the designer may use the building area method by ensuring that the total installed interior lighting power complies with the interior lighting power allowance. The latter would be 9.4 W/m² multiplied by the floor surface area of the school. The designer may also decide to use the space-by-space method by dividing the building area: classrooms, corridors, washrooms, gymnasium, cafeteria, etc. The designer will then ensure that the total installed interior lighting power complies with the total interior lighting power allowance calculated using the space-by-space method.

For a building with several suites, for example, retail stores in a mall, the designer may use either methods for each suite or only one method by grouping the suites into the same space assembly in accordance with Sentence 4.2.1.3.(6). (See Note A-4.2.1.3.(6).)

Note that, for flexibility in design, the trade-off path detailed in Section 4.3. or the performance path described in Part 8 may be followed in lieu of the prescriptive requirements stated in Section 4.2.

A-4.2.1.3.(5) Power Transfer of Interior Lighting Allowance not Used Between Several Spaces in the Same Space Assemblies. For a building with a single function, such as a library, the total interior lighting power allowance is determined using the building area method from an LPD of 12.8 W/m² as provided in Table 4.2.1.5. In that case, the washrooms could have an installed LPD greater than 12.8 W/m², provided that the total installed interior lighting power of the library is less than 12.8 W/m².

Similarly, if the interior lighting power allowance of the library were determined using the space-by-space method described in Article 4.2.1.6., the washrooms could have an LPD greater than the 10.5 W/m² provided in Table 4.2.1.6., provided that the total interior lighting power allowance of the library is not exceeded.

A-4.2.1.3.(6) Power Transfer of Interior Lighting Allowance not Used Between Several Space Assemblies. In a building with several space assemblies, the unused portion of the interior lighting power allowance may be transferred from one assembly to the other.

For example, in a commercial building with several suites having different functions, transfer of the unused portion of the interior lighting power allowance is permitted. The transfer may only take place in the conditions described in Sentence 4.2.1.3.(6).

A-4.2.1.4. Spaces to Consider to Determine Installed Interior Lighting Power. The spaces to be considered to determine the installed interior lighting power are defined in the definition for interior lighting. (See Article 1.4.1.2. and Note A-1.4.1.2.(1) of Division A.)

A-4.2.1.4.(2) Installed Interior Lighting Power. For a particular space, the installed interior lighting power must also include the power of moveable plug-in units provided in the design, as indicated in Clause 4.2.1.4.(2)(a), while considering the exclusions provided in Sentence 4.2.1.4.(4). Recognizing that moveable plug-in units are moved, plugged in, unplugged and easily replaced over time, the lighting power of those units is not intended to reflect the actual connected lighting power of those units over the life of the space. Rather, it is to indicate a power level that will support a lighting level appropriate for the intended use of the space. Thus, where the design calls for moveable or plug-in luminaires, the designer must select a sufficient quantity of luminaires to provide the necessary lighting level. The installed interior lighting power must include the lighting load for the installation of those typical units.

Where several lighting systems are controlled to ensure independently several levels of lighting, the system with the highest lighting power must be included in the calculation of the installed interior lighting power.

For example, in a meeting room with a first system for subdued lighting for the use of a projector and a second lighting system for tables, where the controls of the two lighting systems do not allow their simultaneous illumination, Clause 4.2.1.4.(2)(b) allows to consider only the highest power between the two systems to calculate the installed lighting power.

A-4.2.1.4.(3)(a) Auxiliary. The term “auxiliary” includes luminaire components that affect the energy consumption or efficiency of the lighting system other than the lamp such as ballasts, drivers, starters, transformers, active heat sinks, power supplies and sensors.

A-4.2.1.4.(3)(d) Low-Voltage Lighting Systems. Low-voltage lighting systems include low-voltage lighting tracks that allow the addition and/or relocation of luminaires without altering the wiring of the system. Lighting tracks called “low-voltage” are generally supplied with 12 or 24-V direct current and differ from “line-voltage” lighting tracks described in Clause 4.2.1.4.(3)(c), that are generally supplied with 120 or 347-V alternating current.

A-4.2.1.4.(4)(k) Commercial Demonstration Lighting. That lighting designates the lighting devices and accessories that are intended to be sold to the public (e.g. in a luminaire store) and does not include accent lighting for a commercial shop window, which is covered in Clause 4.2.1.4.(4)(g).

A-Table 4.2.1.6. Building Space Types.

Common and Building-Specific

In some cases, a space can be described as both a common space type and a building-specific space type. For example, the medical supply room in a health care facility could also be a storage room. In such case, the building-specific space type "medical supply room" should be used.

Warehouse

In a warehouse storage area, the space used to store small hand-carried items is sometimes referred to as a "picking area."

A-4.2.1.6.(3) Adjustment Factor of Luminaires Positioned High. The height of the luminaires, H_1, used in calculating the adjustment factor, AF, must correspond to the height of the light source. Where luminaires are not built in the ceiling, the designer must assess their heights in relation with the floor. The exchange of the unused portion of the increased interior lighting power allowance for those of the other spaces in accordance with Sentence 4.2.1.6.(8) is permitted.

A-4.2.1.6.(4) Additional Power of Luminaires Positioned in Corridors or Transition Areas. The LPD in Table 4.2.1.6. concerning corridors are determined for corridors 2.4 m wide or more. For widths less than 2.4 m, the reflectance of the light on the walls increases and requires that the designer increase the lighting power to maintain a sufficient lighting level.

The exchange of the unused portion of the increased power allowances for those of the other spaces in accordance with Sentence 4.2.1.6.(8) is permitted.

A-4.2.1.6.(5) Additional Power Due to Controls. In certain conditions, increasing the interior lighting power allowance based on the addition of the controls referred to in Table 4.2.1.6. is permitted. Those controls are in addition to those required in Subsection 4.2.2. The exchange of the unused portion of the increased power allowances for those of the other spaces in accordance with Sentence 4.2.1.6.(8) is permitted.

A-4.2.1.6.(6) Additional Power Due to Decorative Lighting or Display Lighting for Art Work. Although under Clause 4.2.1.4.(4)(a), lighting in museums or art galeries for the display of art work or artefacts is excluded from the calculation of installed power, the additional power due to display lighting applies to all functions that are not museums or art galeries. For example, lighting of a floor surface area occupied by the statue of an athlete at the entrance of an arena will not be excluded from the calculation of the power by Clause 4.2.1.4.(4)(a), and could be increased by 10.8 W for each m² of floor surface area occupied by the statue.

The additional power due to decorative lighting or display lighting for art work is not permitted where the lighting concerned only contributes to the general lighting of the space. For example, where the only source of lighting in a 100 m² corridor are wall luminaires, the luminaires are not eligible for additional lighting due to decorative lighting because the wall luminaires do not have a decorative function but are only intended for the general lighting of the corridor. According to Table 4.2.1.6., the LPD allowance for that 100 m² corridor must not exceed 7.1 W/m² and the interior lighting power allowance for wall luminaires of the corridor will therefore be 710 W.

As provided in Sentence 4.2.1.6.(8), the exchange of the unused portion of those powers against those of other spaces is not permitted.

A-4.2.1.6.(7) Additional Power Due to Display Lighting of Items for Sale. Areas due to display lighting of items for sale only rarely correspond to the full floor surface area of the space considered; they are only constituted of areas occupied by the display cases concerned and an immediate traffic area around the cases.

Where the lighting only contributes to the general lighting of the space, Sentence 4.2.1.6.(7) does not allow the increase of the interior lighting power allowance.

As provided in Sentence 4.2.1.6.(8), the exchange of the unused portion of those powers for those of the other spaces is not permitted.

A-4.2.2.1. Automatic Control Devices. Automatic control devices designed to align the lighting of a space with the presence of occupants can include occupant sensors such as motion sensors, presence sensors, vacancy sensors, and other similar devices (occupant sensors are devices that detect the presence of people within an area and cause lighting, equipment or appliances to be regulated accordingly).

Products that allow for on-site calibration of their sensitivity are recommended as they allow situations of false tripping to be managed.

Using controllable circuit breakers as a means of automatic control is only permitted when they are connected to sensors.

A-4.2.2.2.(2) Reduction of the Power During Unoccupied Periods in a Storage Garage. To ensure user safety, uniform lighting is necessary in the garage. For that reason, the power must be reduced on each lighting unit rather than by turning off one unit out of three, for example.

A-4.2.2.2.(3) Covered Vehicle Entrances and Exits from Storage Garages. A mid-luminance zone is needed for transitioning from a high-luminance zone (garage) to a low-luminance zone (street)—or vice versa—at night. This mid-luminance zone has a lower electrical lighting intensity than the high-luminance zone, resulting in energy savings.

A-4.2.2.6.(2) and (4) Captive Key. A captive key system turns on the lighting and receptacles when the key of the suite is inserted in the reader. When the key is removed from the reader, the lighting and receptacles turn off.

A-4.2.3.1.(3) Lighting Power Allowances for Specific Building Exterior Applications. The lighting power allowance for each specific exterior application listed in Table 4.2.3.1.-C is non-transferable: no trading of allowances with other lighting applications is permitted (in other words, "use it or lose it"). Some or all of the basic site allowance may be applied to the specific lighting applications.

A-4.2.3.1.(4) Transferable Power Allowances for General Exterior Applications. It is possible to transfer the power allowance of the lighting among each of the applications listed in Table 4.2.3.1.-D. The difference between the power allowance and the installed power of an application may permit the increase of the power allowance of another lighting application. It is also possible to increase the power allowance of the applications with all or part of the basic site allowance of the exterior lighting.

A-4.2.4.1.(1) Shut-off Controls of Exterior Lighting During the Day. It is possible to comply with the requirement, for example, by using photocontrolled breakers or an annual detailed program ensuring the automatic turning off of exterior lighting in the presence of daylight.

A-4.3.2.3.(2) Specialized Daylight Simulation Tools. A specialized daylight simulation tool allows the modeling of

- radiosity,
- ray tracing,
- hourly distribution of diffused light sources, such as the sky,
- direct light sources, such as the sun, and
- photocontrol operation parameters.

Where applicable, the specialized daylight simulation tool must also model the operation of concealment devices, such as sun breakers, designed to prevent glare for occupants.

The reduction of the operational time provided in Sentence 4.3.2.3.(2) applies to lighting controlled by photocontrols and not to all the lighting of a space.

Part 5
Heating, Ventilating and Air-conditioning Systems

Part 5
Heating, Ventilating and Air-conditioning Systems

Section 5.1. General

5.1.1. General

5.1.1.1. Scope

1) This Part is concerned with the *HVAC systems* of *buildings* covered by this Code.

5.1.1.2. Application

1) Except as permitted in Sentences (2) and (3), and except for systems and equipment used exclusively for the control of smoke in the event of a fire, this Part applies to *HVAC systems*.

2) Unless otherwise provided in this Part and subject to Sentence (4), this Part does not apply to *HVAC systems*

a) serving rooms in which the processes or activities call for temperatures, airflow rates or humidity levels outside the normal range required for comfort, or

b) dedicated entirely to a process or activity calling for temperatures, airflow rates or humidity levels outside the normal range required for comfort.

(See Note A-5.1.1.2.(2) and (4).)

3) This Part does not apply to the existing components of *HVAC systems* that are extended to serve *additions*.

4) An *HVAC system* serving both rooms referred to in Sentence (2) and rooms calling for conditions within the normal range required for comfort must comply with this Part. (See Note A-5.1.1.2.(2) and (4).)

5.1.1.3. Compliance

1) Except as provided in Sentence (2), compliance with this Part shall be achieved by following

a) the prescriptive path described in Section 5.2., or

b) the performance path described in Section 5.4. (see Note A-3.1.1.3.(1)(c)).

(See Note A-5.1.1.3.(1).)

2) Back-up systems shall comply with the prescriptive requirements stated in Section 5.2. (See Note A-5.1.1.3.(2).)

5.1.1.4. Definitions

1) Words that appear in italics are defined in Article 1.4.1.2. of Division A.

Section 5.2. Prescriptive Path

5.2.1. Equipment Sizing

5.2.1.1. Load Calculations

1) *HVAC systems* shall be sized in accordance with the NBC. (See Note A-5.2.1.1.(1).)

5.2.2. Air Distribution Systems

5.2.2.1. Design, Construction and Installation

1) Air distribution systems shall be designed, constructed and installed in accordance with the NBC. (See Note A-5.2.2.1.(1).)

5.2.2.2. Provision for Balancing

1) All air distribution systems shall be designed so that they can be balanced. (See Note A-5.2.2.2.(1).)

5.2.2.3. Duct Sealing

1) Except as provided in Sentences (2) and (6), air-handling ducts and *plenums* forming part of an *HVAC system* shall be sealed like a Class A duct within the meaning of ANSI/SMACNA 006, "HVAC Duct Construction Standards – Metal and Flexible." (See Note A-5.2.2.3.(1).)

2) *Return ducts* located within *conditioned space* or in spaces used as return air *plenums* need not comply with Sentence (1).

3) Sealing tape shall not be used as the primary sealant for a section of air-handling duct or *plenum* with a static pressure of at least 250 Pa.

4) The joints of air-handling ducts and *plenums* shall have mechanical fasteners and be assembled so that no mechanical effort is transmitted to the sealant.

5) Sealing tape used to seal air-handling ducts and *plenums* shall comply with UL 181A, "Closure Systems for Use with Rigid Air Ducts," or UL 181B, "Closure Systems for Use with Flexible Air Ducts and Air Connectors."

6) A suspended ceiling void used as return air *plenum* need not be sealed in accordance with this Article.

5.2.2.4. Leakage Testing of Ducts

1) The following air-handling ducts and *plenums* shall be tested for leakage in conformance with ANSI/SMACNA 016, "HVAC Air Duct Leakage Test Manual," and comply with the maximum permitted leakage calculated in accordance with Sentence (2)

a) air-handling ducts and *plenums* designed to operate at a static pressure of more than 750 Pa, and
b) air-handling ducts and *plenums* located outside of the *building envelope*.

2) The maximum permitted leakage of air-handling ducts and *plenums* tested as described in Sentence (1) shall be calculated as follows:

$$L_{max} = C_L \cdot \left(\frac{P}{249}\right)^{0.65}$$

where
L_{max} = maximum permitted leakage, in L/s per m^2 of duct surface area, or *plenum*,
C_L = leakage class taken from Table 5.2.2.4., in L/s per m^2, and
P = maximum operating static pressure, in Pa.

3) The tests described in Sentence (1) shall

a) include the sections where leakage is predominant, such as sections with elbows, and
b) be performed over a minimum of 25% of the total surface area of the ducts and *plenums* referred to in Sentence (1).

Table 5.2.2.4.
Leakage Classes (C_L)
Forming Part of Sentence 5.2.2.4.(2)

Shape of Air-handling Ducts and *Plenums*	Maximum Operating Static Pressure, Pa	
	750 to 1000	> 1000
	C_L, L/s per m²	
Rectangular	0.41	0.20
Round	0.20	0.10

5.2.2.5. Duct and Plenum Insulation

1) Except as provided in Sentence (3), all air-handling ducts and *plenums* forming part of an *HVAC system* shall be thermally insulated in accordance with Table 5.2.2.5.

2) The insulation thickness used to determine compliance with Table 5.2.2.5. shall be the thickness of the insulation after installation. (See Note A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6).)

Table 5.2.2.5.
Insulation of Ducts and Plenums
Forming Part of Sentences 5.2.2.5.(1) and (2) and 5.2.4.2.(3)

Temperature Difference,(1) °C	Minimum Thermal Resistance of Insulation of Ducts not Exceeding 3 m in Length that Connect to Terminal Grilles or Diffusers, m²·K/W	Minimum Thermal Resistance of Insulation of *Plenums* and other Ducts, m²·K/W
< 5	0	0
5 to < 22	0.74	0.74
22 to < 29	0.74	1.06
29 to < 43	0.74	1.41
> 43	1.41	2.11

Notes to Table 5.2.2.5.:

(1) Refers to the temperature difference at design conditions between the space within which the duct or *plenum* is located and the design temperature of the air carried by the same duct or *plenum*. Where the duct or *plenum* is located outside the *building envelope*
- if used for heating purposes, the temperature difference shall be calculated using the 2.5% January design temperature of Table C-1, or
- if used for cooling purposes, the temperature difference shall be calculated using the 2.5% July design dry-bulb temperature of Table C-1.

Where a duct or *plenum* is used for both heating and cooling purposes, the larger temperature difference shall be used.

3) The following air-handling ducts and *plenums* need not comply with the requirements of Sentence (1):
a) *exhaust ducts*, *return ducts* and air *supply ducts* located within *conditioned space*, except as provided in Sentence 5.2.4.2.(3),
b) ducts and *plenums* located within *conditioned space* in a *dwelling unit* and serving only that *dwelling unit*,
c) air *supply ducts* located within return *plenums*,
d) provided they are insulated with a material having a thermal resistance of at least 0.74 m²·K/W:
   i) *exhaust ducts* crossing a space other than *conditioned space*,
   ii) *exhaust ducts* separated from *conditioned space* by an insulated *building* assembly in accordance with Section 3.2., and
   iii) ducts in which outdoor air not heated and not mixed to indoor air circulates, where they cross *conditioned space*.

5.2.2.6. Protection of Duct Insulation

1) Insulation on cold-air *supply ducts* shall be provided with vapour barrier protection to prevent condensation, where the surface temperature of the duct is below the dew point of the air surrounding the duct.

2) Duct insulation installed in areas where it may be subject to mechanical damage or weathering shall be protected.

5.2.2.7. Cooling with Outdoor Air

1) Except as provided in Sentence (2), each *HVAC system* that incorporates mechanical cooling shall be designed with at least one economizer system to use outdoor air to reduce mechanical cooling energy by one of the means covered in Articles 5.2.2.8. and 5.2.2.9.

2) An *HVAC system* need not comply with the requirements of Sentence (1) where
- a) it has a total cooling capacity less than 16 kW,
- b) it serves only server rooms and has a total cooling capacity less than 40 kW,
- c) it serves only a *dwelling unit* or a hotel or motel *suite*,
- d) it has a non-particle filtration system (see Note A-5.2.2.7.(2)(d)),
- e) it serves a hospital, provided that more than 75% of the distributed air is humidified at a wet-bulb temperature greater than 2°C,
- f) it recovers heat on the mechanical cooling equipment (see Note A-5.2.2.7.(2)(f)),
- g) it serves spaces maintained at a temperature of at least 26°C during operating hours (see Note A-5.2.2.7.(2)(g)),
- h) it is intended to operate or work according to operating hours of less than 20 h per week, or
- i) it distributes air using at least 80% of outdoor air.

3) Except as provided in Sentence (2), the economizer system shall be integrated to a mechanical cooling system so that
- a) the mechanical cooling be inactive when the economizer system can ensure alone all the cooling charge, and
- b) the mechanical cooling is partially activated when the economizer system cannot ensure alone all the cooling charge.

(See Note A-5.2.2.7.(3).)

4) Except as provided in Sentence (2), an *HVAC system* must at least use a water economizer system in accordance with Article 5.2.2.9. when the *HVAC system* includes
- a) a water loop mechanical cooling, and
- b) a humidification system that maintains indoor humidity at a wet-bulb temperature greater than 2°C.

(See Note A-5.2.2.7.(4).)

5.2.2.8. Cooling by Direct Use of Outdoor Air (Air Economizer System)

1) *HVAC systems* that use less mechanical cooling energy by direct use of outdoor air shall be capable of mixing return air with up to 100% outdoor air to produce the temperature required to condition the space.

2) Each system described in Sentence (1) shall
- a) be designed to automatically reduce the outdoor airflow to the minimum prescribed by the NBC to maintain acceptable indoor air quality when the use of outdoor air no longer allows the reduction of the cooling energy according to the conditions described in Table 5.2.2.8.-A,
- b) be controlled by only one of the types of controls provided for in Table 5.2.2.8.-A, and
- c) stop the direct use of outdoor air for cooling when any of the conditions resulting in the shut-off provided for in Table 5.2.2.8.-A is met.

(See Note A-5.2.2.8.(2).)

Table 5.2.2.8.-A
High-Limit Shut-off Control of Direct Use of Outdoor Air
Forming Part of Sentence 5.2.2.8.(2)

Type of Setting	Conditions Resulting in Shut-off	
	Parameters(1)	Description
Fixed dry bulb	T_{OA} > 21°C when HDD under 18°C < 6000	Outdoor air temperature exceeds 21°C in a locality where the number of degree-days under 18°C is under 6000
	T_{OA} > 24°C when HDD under 18°C ≥ 6000	Outdoor air temperature exceeds 24°C in a locality where the number of degree-days under 18°C is at least 6000
Differential dry bulb	T_{OA} > T_{RA}	Outdoor air temperature exceeds return air temperature
Fixed enthalpy with fixed dry bulb	H_{OA} > 47 kJ/kg or T_{OA} > 24°C	Outdoor air enthalpy exceeds 47 kJ/kg or outdoor air temperature exceeds 24°C
Differential enthalpy with fixed dry bulb	H_{OA} > h_{RA} or T_{OA} > 24°C	Outdoor air enthalpy exceeds return air enthalpy or outdoor air temperature exceeds 24°C

Notes to Table 5.2.2.8.-A:

(1) T_{OA} = temperature outdoor air,
T_{RA} = temperature return air,
H_{OA} = enthalpy outdoor air,
H_{RA} = enthalpy return air.

3) Except as provided in Sentence (4), an *HVAC system* including a *supply air handler* whose mechanical cooling is direct expansion shall have at least 2 cooling stages when the mechanical cooling
a) is integrated to cooling by direct use of outdoor air as described in Sentence (1),
b) has a total cooling capacity of more than 18 kW, and
c) is directly controlled from the space temperature.
(See Note A-5.2.2.8.(3).)

4) When an *HVAC system* including a *supply air handler* has direct expansion mechanical cooling in compliance with Table 5.2.2.8.-B, that system need not comply with Sentence (3). (See Note A-5.2.2.8.(4).)

Table 5.2.2.8.-B
Minimum Number of Direct Expansion Mechanical Cooling Stages
Forming Part of Sentence 5.2.2.8.(4)

Cooling Capacity(1)	Minimum Number of Mechanical Cooling Stages	Minimum Displacement of the First Cooling Stages(1)
≥ 18 kW and < 70 kW	3	≤ 33% of the total cooling capacity
≥ 70 kW	4	≤ 25% of the total cooling capacity

Notes to Table 5.2.2.8.-B:

(1) The values of the cooling capacity and minimum displacement of the first cooling stage apply to a variable-speed compressor.

5.2.2.9. Cooling by Indirect Use of Outdoor Air (Water Economizer System)

(See Note A-5.2.2.9.)

1) *HVAC systems* that reduce mechanical cooling energy use by using outdoor air to chill cooling distribution fluid by direct evaporation, indirect evaporation, or both, shall be capable of cooling supply air so as to provide 100% of the cooling load when the outdoor air wet-bulb temperature is 7°C or lower.

2) *HVAC systems* that reduce mechanical cooling energy use by using outdoor air to chill cooling distribution fluid by sensible heat transfer shall be capable of cooling supply air so as to provide 100% of the cooling load when the outdoor air dry-bulb temperature is 10°C or lower.

5.2.3. Fan System Design

5.2.3.1. Application

(See Note A-5.2.3.1. and 5.2.6.)

1) This Subsection applies to all fans of *HVAC systems* used alone or in a combination where the total rated capacities described in Sentence (4) are at least 4 kW. (See Note A-5.2.3.1.(1), (2) and (3).)

2) Except as provided in Sentence (3), the total of the rated capacities and the total of the brake horsepower of the fans of *HVAC systems* shall only include the fans that operate at design conditions requiring the highest capacity to supply air to the *conditioned space*. (See Note A-5.2.3.1.(1), (2) and (3).)

3) The following fans may not be included in the total rated capacities provided for in Sentence (4) and in the total brake horsepower provided for in Sentence (5):

a) an independent exhaust fan whose motor rated capacity is not more than 750 W,

b) an exhaust or transfer fan that serves spaces other than *conditioned spaces*, and

c) a fan that dissipates the heat of an *HVAC system* located outside the *building envelope*, such as a condenser or a cooling tower fan.

(See Note A-5.2.3.1.(1), (2) and (3).)

4) For the purposes of this Subsection, the total of the rated capacities of the fans of *HVAC systems*, TRC, in W, shall be the sum of the nameplate ratings of each motor.

5) For the purposes of this Subsection, the total brake horsepower of the fans of *HVAC systems*, TBHP, in W, is the sum of the brake horsepower of each fan established

a) according to the curves or tables provided by the fan manufacturers, or

b) using the following equation:

$$\mathrm{TBHP} = 0.001 \cdot \sum_{i=1}^{n} (\mathrm{D_i} \cdot \mathrm{PS_i}/\eta_i)$$

where

n = number of fans,

D_i = design flow rate of the i^{th} fan, in L/s,

PS_i = design static pressure difference between both sides of the i^{th} fan, in Pa, and

η_i = efficiency of the i^{th} fan, expressed as a decimal fraction.

6) For the purposes of Clauses 5.2.3.2.(1)(b) and 5.2.3.3.(1)(b), the values of the static pressure adjustment, SPA_i, in Pa, are those stated in Table 5.2.3.1.

Table 5.2.3.1.
Fan Design – Static Pressure Adjustment, SPA_i, in Pa
Forming Part of Sentences 5.2.3.1.(6) and 8.4.4.18.(3)

Description	Positive Adjustment(1)
All completely channelled *return ducts* and *exhaust ducts* of the *HVAC system*(2)	For a laboratory and vivarium *HVAC system*: + 535 Pa
	For other *HVAC system*: + 125 Pa
Pressure control damper installed in a *return duct* and/or *exhaust duct*(2)	For each damper: + 125 Pa
Filter on the *exhaust duct*, scrubber or other air treatment device on the *exhaust duct*	For each filter or device: + pressure loss value provided by the manufacturer at design conditions

Table 5.2.3.1. (Continued)

Description	Positive Adjustment(1)
Particle filter with a MERV(3) efficiency included between 9 and 15	For each filter: + (28.5 · MERV) − 174 Pa
Particle filter with a MERV ≥ 16 efficiency or electrostatic filter	For each filter: + double the pressure loss value provided by the manufacturer at design conditions
Carbon air purifier or using another gas phase	For each purifier: + pressure loss value provided by the manufacturer at design conditions
Biological safety cabinet	For each cabinet: + pressure loss value provided by the manufacturer at design conditions
Heat- or energy-recovery unit, except coil heat-recovery systems	For each airflow rate of the recovery unit: + (550 · recovery efficiency(4)) − 125 Pa
Coil heat-recovery system	For each airflow rate of the recovery system: + 150 Pa
Humidifier or evaporative cooler in series with another cooling coil	For each humidifier or cooler: + pressure loss value provided by the manufacturer at design conditions
Sound absorbing section	For each section: + 38 Pa
Exhaust equipment for hoods	For each equipment: + 85 Pa
Exhaust ducts installed in high *buildings* for laboratory and vivarium hoods	For each 30 m section of vertical duct, except the first 25 vertical metres: + 60 Pa
Natural gas or propane heat pump or *supply air handler*	For *HVAC system*: + 50 Pa
Description	**Negative Adjustment(1)**
HVAC system without cooling equipment in the *supply air handler*	For the *HVAC system*: − 150 Pa
HVAC system without heating equipment in the *supply air handler*	For the *HVAC system*: − 75 Pa

Notes to Table 5.2.3.1.:

(1) See Note A-Table 5.2.3.1.

(2) Static pressure adjustments in the air distribution system are included in the equations provided for in Clauses 5.2.3.2.(1)(b) and 5.2.3.3.(1)(b).

(3) MERV means “minimum efficiency reporting value;” it is a measurement scale to rate the effectiveness of air filters.

(4) Recovery unit efficiency established according to Sentence 5.2.10.1.(5).

5.2.3.2. Constant-Volume Fan Systems

1) Except as provided in Sentence (2), where fans produce a constant airflow rate,

a) the total of the rated capacities provided for in Sentence 5.2.3.1.(4), TRC, in W, shall not exceed the total allowable rated capacities, TARC, in W, established using the following equation:

$$TARC = D_a \cdot 1.61$$

where

D_a = air supply design flow rate, in L/s, or

b) the total of the brake horsepower provided for in Sentence 5.2.3.1.(5), TBHP, in W, shall not exceed the total allowable brake horsepower, TABHP, in W, established using the following equation:

$$TABHP = D_a \cdot 1.42 + \sum_{i=1}^{n} (D_i \cdot SPA_i/650)$$

where

D_a = air supply design flow rate, in L/s,

n = number of equipments requiring a static pressure adjustment,

D_i = flow from i^{th} equipment requiring a static pressure adjustment, in L/s (see Sentence 5.2.3.1.(5)), and

SPA_i = static pressure adjustment of i^{th} equipment, in Pa (see Sentence 5.2.3.1.(6)).

(See Note A-5.2.3.2.(1).)

2) Constant-flow fan systems used for hospitals, vivariums or laboratories and whose exhaust or return flow is controlled to maintain a specific pressure for health or safety reasons may use the limits of a variable volume fan. (See Note A-5.2.3.2.(2).)

5.2.3.3. Variable-Air-Volume Fan Systems

(See Note A-5.2.3.3.)

1) In the case of fans automatically varying the airflow rate based on static pressure,

a) the total of the rated capacities provided for in Sentence 5.2.3.1.(4), TRC, in W, shall not exceed the total allowable rated capacities, TARC, in W, established using the following equation:

$$TARC = D_a \cdot 2.31$$

where

D_a = air supply design flow rate, in L/s, or

b) the total of the brake horsepower provided for in Sentence 5.2.3.1.(5), TBHP, in W, shall not exceed the total allowable brake horsepower, TABHP, in W, established using the following equation:

$$TABHP = D_a \cdot 2.02 + \sum_{i=1}^{n} (D_i \cdot SPA_i/650)$$

where

D_a = air supply design flow rate, in L/s,

n = number of equipments requiring a static pressure adjustment,

D_i = flow from i^{th} equipment requiring a static pressure adjustment, in L/s (see Sentence 5.2.3.1.(5)), and

SPA_i = static pressure adjustment of i^{th} equipment, in Pa (see Sentence 5.2.3.1.(6)).

2) In variable-air-volume *HVAC systems*, every supply, discharge or return fan whose rated capacity is at least 7.4 kW shall operate at not more than 30% of its power demand at design conditions where the fan provides 50% of the air design flow rate. (See Note A-5.2.3.3.(2).)

3) Except as provided in Sentence (4), static pressure sensors used to control a variable-air-volume supply fan shall be

a) located so that the static pressure setpoint is not more than 300 Pa, and

b) installed downstream from the fan,

  i) in the main supply duct before any intersection, or

  ii) in each intersection of a main supply duct.

(See Note A-5.2.3.3.(3).)

4) The static pressure setpoint of an *HVAC system* supply fan shall be adjusted to the value of the *conditioned space* requiring the highest static pressure when the following conditions are met:

a) all the *conditioned spaces* of the *HVAC system* are individually served by terminal zone boxes,

b) a direct digital control system is installed on the terminal zone box of each *conditioned space*, and

c) each direct digital control system is centralized on the supply fan main control panel.

(See Note A-5.2.3.3.(4).)

5) The main control panel referred to in Clause (4)(c) shall

a) measure the opening degree of each terminal zone box,

b) signal terminal zone boxes that remain open the longest, and
c) permit the manual removal of the control logic of the terminal zone boxes referred to in Clause (b) to maximize the setpoint readjustment potential.

5.2.3.4. Deleted

5.2.4. Air Intake and Outlet Dampers

5.2.4.1. Required Dampers

1) Except as provided in Sentences (2) to (4), every duct or opening intended to discharge air from a *conditioned space* to the outdoors or to unconditioned space, and every outdoor air intake duct or opening shall be equipped with a motorized damper.

2) Where dampers are not permitted by other regulations, air intakes and outlets need not comply with Sentence (1).

3) Air intakes and outlets serving *HVAC systems* required to operate continuously need not comply with Sentence (1).

4) Where the duct or opening does not exceed 0.08 m^2, air intake and air exhaust dampers required by Sentence (1) are permitted to be gravity or spring-operated backflow dampers.

5.2.4.2. Type and Location of Dampers

1) Except as provided in Sentences (3) and (4), dampers required by Article 5.2.4.1. shall be
a) located as near as possible to the plane of the *building envelope*, and
b) designed to close automatically when the *HVAC system* is not in operation.

2) Motorized dampers required in Sentence 5.2.4.1.(1) shall be designed so that, when the damper is in the closed position, airflow does not exceed 15 L/s per m^2 of cross-sectional area at a pressure differential of 250 Pa, when tested in accordance with
a) ANSI/AMCA 500-D, "Testing Dampers for Rating," and
b) ANSI/AMCA 500-L, "Testing Louvers for Rating."

3) Dampers required in Article 5.2.4.1. are permitted to be located inboard of the *building envelope*, provided the thermal resistance of the duct insulation between the damper and the *building envelope* is that provided in Table 5.2.2.5. according to the applicable temperature difference, without being less than 0.74 $m^2 \cdot K/W$.

4) Dampers in air intakes and outlets serving air-heating or -cooling equipment located outside of the *building envelope* are permitted to be located within the equipment.

5.2.5. Piping for HVAC Systems

5.2.5.1. Design, Construction and Installation

1) Piping for *HVAC systems* shall be designed, constructed and installed in accordance with the NBC.

5.2.5.2. Provision for Balancing

1) All hydronic systems shall be designed so that they can be balanced. (See Note A-5.2.5.2.(1).)

5.2.5.3. Piping Insulation

1) Except as provided in Sentences (2) to (6), piping and accessories forming part of an *HVAC system* shall be thermally insulated in accordance with Table 5.2.5.3. (See Notes A-5.2.5.3.(1) and A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6).)

2) Except for suction-line piping of direct expansion systems, piping located within *conditioned space* in a *dwelling unit* and serving only that *dwelling unit* need not comply with Sentence (1).

3) Piping for *HVAC systems* need not comply with Table 5.2.5.3., if it
a) is located within a *conditioned space* and conveys fluids with design operating temperatures greater than 16°C and less than 41°C,
b) is used only to reject heat and is located outside the *building envelope*, or
c) is used for the circulation of a fluid that is neither heated nor cooled by electricity or a fossil fuel. (See Note A-5.2.5.3.(3)(c).)

4) Where piping insulation has a thermal conductivity that is greater than the ranges given in Table 5.2.5.3., the insulation thickness given in the Table shall be increased by the ratio u2/u1, where u1 is the value at the higher end of the conductivity range for the operating temperature and u2 is the measured thermal conductivity of the insulation at the mean rating temperature.

5) Where piping insulation has a thermal conductivity that is lower than the ranges given in Table 5.2.5.3., the insulation thickness given in the Table may be decreased by the ratio u2/u1, where u1 is the value at lower end of the conductivity range for the operating temperature and u2 is the measured thermal conductivity of the insulation at the mean rating temperature.

6) The thermal conductivity of piping insulation at a mean rating temperature shall be determined in conformance with ASTM C 335/C 335M, "Steady-State Heat Transfer Properties of Pipe Insulation."

7) Insulation material required in Sentence (1) shall be installed in accordance with good practice.

8) The insulation thickness used to determine compliance with Table 5.2.5.3. shall be the thickness of the insulation after installation. (See Note A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6).)

Table 5.2.5.3.
Minimum Thickness of Piping Insulation, in mm
Forming Part of Sentences 5.2.5.3.(1), (3) to (5), and (8)

Type of System	Design Operating Temperature Range, °C	Thermal Conductivity of Insulation		Nominal Pipe Diameter, mm (inches)		
		Conductivity Range, W/(m·K)	Mean Rating Temperature, °C	≤ 25.4 (≤ 1)	> 25.4 and ≤ 51 (> 1 and ≤ 2)	> 51 (> 2)
				Minimum Thickness of Piping Insulation, mm		
Heating Systems (Steam, Steam Condensate and Hot Water)	> 177	0.046–0.049	121	114	127	127
	122–177	0.042–0.045	93	76.2	101.6	114
	94–121	0.039–0.043	65	63.5	63.5	76.2
	61–93	0.036–0.042	52	38.1	50.8	50.8
	41–60	0.035–0.040	38	25.4	38.1	38.1
Cooling Systems (Chilled Water, Brine and Refrigerant)	4–16	0.030–0.039	24	25.4	25.4	25.4
	< 4	0.030–0.039	24	25.4	38.1	38.1

5.2.5.4. Protection of Piping Insulation

1) Insulation on piping conveying chilled fluid shall be provided with vapour barrier protection to prevent condensation, where the surface temperature of the pipe is below the dew point of the air.

2) Piping insulation installed in areas where it may be subject to mechanical damage or weathering shall be protected.

5.2.6. Pumping System Design

(See Note A-5.2.3.1. and 5.2.6.)

5.2.6.1. Application

1) This Subsection applies to pumping systems of *HVAC systems*
- a) with a total of the pump system motor power ratings in Sentence (2) of at least 7.5 kW, and
- b) including control valves designed to modulate or to open and close in steps as a function of thermal energy load.

2) For the purposes of this Subsection, the total of the pump motor power ratings of the *HVAC system* shall be the sum of the nameplate power ratings of each pump motor required to operate at design conditions to supply thermal energy to an *HVAC system* or *conditioned space*.

5.2.6.2. Requirements for Pumping Systems of HVAC Systems

1) Except as provided in Sentence (2), pumping systems that provide thermal energy to an *HVAC system* or a *conditioned space* shall be
- a) designed for variable fluid flow, and
- b) capable of reducing system flow to 50% or less of design flow.

(See Note A-5.2.6.2.(1).)

2) Sentence (1) does not apply to pumping systems that provide thermal energy to an *HVAC system* or a *conditioned space*
- a) in which a minimum flow greater than 50% of the design flow is required for the proper operation of the *HVAC system*,
- b) with a single control valve, or
- c) that include controls to reset the fluid supply temperature based on either outdoor temperature or *HVAC system* loads.

5.2.6.3. Deleted

5.2.7. Equipment Installed Outdoors

5.2.7.1. Manufacturer's Designation

1) Equipment installed outdoors or in a space other than a *conditioned space* shall be designated by the manufacturer for such installation.

5.2.8. Temperature Controls

5.2.8.1. Temperature Controls

1) Each *HVAC system* designed to heat or cool to provide comfort shall serve at least one *temperature-control zone*.

5.2.8.2. Temperature Control within Dwelling Units

1) Each *dwelling unit* shall be considered as at least one *temperature-control zone*.

5.2.8.3. Installation of Thermostats

1) Except as otherwise stated in the manufacturer's instructions and as required in barrier-free installations and for stratified ventilation, sensors for wall-mounted thermostats shall be installed
- a) between 1 400 mm and 1 500 mm above the floor,
- b) on interior *partitions* or walls, or on exterior walls with an *effective thermal resistance* of at least 3.60 $(m^2 \cdot K)/W$,
- c) away from direct exposure to sunlight and heat-producing sources, and
- d) away from drafts and dead pockets of air.

(See Note A-5.2.8.3.(1).)

5.2.8.4. Heat Pump Controls

1) Heat pumps equipped with supplementary heat elements shall incorporate controls to prevent supplementary heat element operation when the heating load can be met only by the heat pump, except during defrost cycles. (See Note A-5.2.8.4.(1).)

5.2.8.5. Space Temperature Control

1) Except as provided in Sentence (2), the supply of heating and cooling energy to a *temperature-control zone* shall be controlled by individual thermostatic controls responding to temperature within the zone.

2) An independent perimeter heating and cooling system designed to offset only *building envelope* heat losses or gains, or both, is permitted to be used, provided

a) it includes at least one thermostatic control for each *building* exposure having exterior walls facing only one orientation for an uninterrupted distance of 15 m or more, and
b) its heating and cooling energy supply is controlled by thermostat(s) located within the *temperature-control zone(s)* it serves.

(See Note A-5.2.8.5.(2).)

3) Where separate thermostatic controls are provided to control heating and cooling to a *temperature-control zone*, means shall be provided to prevent these controls from simultaneously calling for heating and cooling. (See Note A-5.2.8.5.(3).)

4) Where heating and cooling to a *temperature-control zone* are controlled by the same thermostatic control, the difference between the heating cycle shutdown temperature and the cooling cycle startup temperature shall be at least 1.5°C and conversely.

5) Vestibules between *conditioned spaces* and the outdoors shall have a temperature-control device that limits the maximum heating temperature in the vestibule to 15°C.

5.2.8.6. Ice- and Snow-Melting Heater Controls and Frost Protection Equipment

1) Ice- and snow-melting heating systems located outside the *building envelope* shall be provided with automatic controls that shut the systems down where

a) the outdoor temperature is more than 4.4°C, or
b) the temperature of the surface with a heating system is more than 10°C.

2) Equipment for protecting piping located outside the *building envelope* against frost using a heating cable shall be equipped with automatic controls that shut down the equipment

a) where the outdoor temperature is more than 4.4°C, or
b) where there is no risk of frost for the fluid circulating in the protected piping.

5.2.8.7. Control of Temperature of Air Leaving the Supply Air Handler

1) Except as provided in Sentences (2) and (3), a *supply air handler* shall be designed and equipped with controls to achieve the design supply air temperature without

a) heating previously cooled air,
b) cooling previously heated air, or
c) heating outdoor air, separately from the return air or mixed with it, in excess of the minimum required for ventilation.

2) Reheating supply air previously cooled to reach the required humidity level is permitted. (See Note A-5.2.8.7.(2).)

3) Reheating supply air is permitted where such reheating will not cause an increase in energy consumption. (See Note A-5.2.8.7.(3).)

5.2.8.8. Control of Space Temperature by Reheating or Recooling

1) Except as provided in Sentence (6), *HVAC systems* that control the temperature of a space by reheating previously cooled air shall be equipped with controls that automatically adjust the temperature of the cool air supply to the highest temperature that will satisfy the *temperature-control zone* requiring the coolest air.

2) Except as provided in Sentence (6), *HVAC systems* that control the temperature of a space by recooling previously heated air shall be equipped with controls that automatically adjust the temperature of the warm air supply to the lowest temperature that will satisfy the *temperature-control zone* requiring the warmest air.

3) Except as provided in Sentence (6), *HVAC systems* that control the temperature of a space by mixing heated supply air and cooled supply air shall be equipped with controls that

a) automatically adjust the temperature of the warm supply air to the lowest temperature that will satisfy the *temperature-control zone* requiring the warmest air, and
b) automatically adjust the temperature of the cool supply air to the highest temperature that will satisfy the *temperature-control zone* requiring the coolest air.

4) Except as provided in Sentence (6), the airflow rate that is reheated, cooled or mixed in the *temperature-control zones* without a direct digital control system shall not exceed the highest flow among the following:

a) 30% of the maximum supply flow in the *temperature-control zone*, or
b) the outdoor airflow rate required by the NBC to maintain acceptable indoor air quality.

(See Note A-5.2.8.8.(4) and (5).)

5) Except as provided in Sentence (6), *temperature-control zones* with a direct digital control system shall have

a) a supply airflow rate not exceeding the highest flow among the following, where the supply airflow rate of the *temperature-control zone* is neither heated nor cooled:
   i) 20% of the maximum supply flow of the *temperature-control zone*, or
   ii) the outdoor airflow rate required in the NBC to maintain acceptable indoor air quality,
b) an airflow reheated, cooled or mixed less than 50% of the maximum supply flow of the *temperature-control zone*, and
c) the following heating sequence:
   i) a first heating stage to modulate the zone temperature setpoint to the maximum supply temperature and to maintain an airflow rate equal to that established in Clause (5)(a), and
   ii) a second heating stage to maintain the zone temperature setpoint to its maximum value and to modulate the airflow rate to the airflow rate provided for in Clause (5)(b).

(See Note A-5.2.8.8.(4) and (5).)

6) Sentences (1) to (5) do not apply in *temperature-control zones* in which at least 75% of the energy necessary for heating shall be provided by

a) the energy recovered at the site, or
b) the solar energy produced at the site, except the energy due to passive heat gain created by *fenestration*.

(See Note A-5.2.8.8.(6).)

5.2.9. Humidification and Dehumidification

5.2.9.1. Humidification Controls

1) If an *HVAC system* is equipped with a means for adding or removing moisture to maintain specific humidity levels in a space, an automatic humidity control device shall be provided.

5.2.10. Heat or Energy Recovery

5.2.10.1. Heat or Energy Recovery

1) Except as provided in Sentence (3) and Articles 5.2.10.2. and 5.2.10.4., when the quantity of sensible heat of each exhaust air equipment as calculated in accordance with Sentence (4) exceeds 50 kW, the *HVAC system* shall be equipped with heat- or energy-recovery equipment compliant with Sentence (5). (See Note A-5.2.10.1.(1).)

2) Heat recovered in accordance with Sentence (1) shall be used in *building* systems.

3) The following equipment need not comply with Sentence (1):
a) specialized exhaust equipment, such as those used to exhaust smoke, grease-laden vapours, or toxic, flammable, paint, or corrosive fumes or dust,
b) exhaust equipment operated less than 20 h per week, and
c) exhaust equipment serving *conditioned spaces* with a temperature maintained at less than 16°C.

4) The sensible heat, in kW, referred to in Sentence (1), which is the sensible heat content of the total quantity of exhaust, shall be calculated as follows:

$$\text{Sensible Heat} = 0.00123 \cdot Q \cdot (T_e - T_o)$$

where
Q = rated capacity of exhaust system at normal exhaust air temperature, in L/s,
T_e = temperature of exhaust air before heat recovery, in °C, and
T_o = outdoor 2.5% January design temperature, in °C (see Note A-5.2.10.1.(4)).

5) Heat- or energy-recovery equipment shall have
a) a net sensible efficiency of at least 60% where the efficiency is
  i) established at 100% of the heating test flow,
  ii) measured according to ANSI/AHRI 1061 (SI), “Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment,” and
  iii) certified by AHRI, by Intertek Testing Services NA Ltd. or by Element Materials Technology Canada Inc., or
b) a sensible heat-recovery capacity of at least 55% where the recovery capacity is
  i) established at a flow of at least 22 L/s for a temperature at the supply air inlet of −25°C,
  ii) measured according to CAN/CSA-C439, “Rating the Performance of Heat/Energy-Recovery Ventilators,” and
  iii) certified by HVI or other certification body that is accredited by the Standards Council of Canada.

5.2.10.2. Swimming Pools

1) *HVAC systems* for swimming pools with a surface area of at least 10 m^2 located within *conditioned spaces* shall comply with Sentences (2) and (3).

2) Exhaust air equipment of the swimming pool referred to in Sentence (1) shall
a) have an exhaust airflow limited to the outdoor air required by the NBC to maintain acceptable indoor air quality, and
b) recover at least 60% of the sensible heat of the exhaust air at the design conditions in compliance with Sentence 5.2.10.1.(5).
(See Note A-5.2.10.2.(2).)

3) *HVAC systems* that serve a swimming pool referred to in Sentence (1) shall include mechanical dehumidification equipment that
a) ensures untreated dehumidification by the exhaust air equipment described in Sentence (2), and
b) rejects heat from dehumidification in *building* systems (see Note A-5.2.10.2.(3)(b)).

5.2.10.3. Refrigeration Systems

1) The following systems shall comply with Sentences (2) and (3):
- a) refrigeration systems for creating or maintaining an ice sheet in heated *buildings*, such as an ice arena or a curling rink, and
- b) refrigeration systems
  - i) for food conservation,
  - ii) installed in heated *buildings* with a *building* area of more than 2500 m^2, and
  - iii) composed of several equipment connected to a centralized refrigeration system (see Note A-5.2.10.3.(1)(b)).

2) The refrigeration systems referred to in Sentence (1) shall include heat-recovery equipment
- a) that recovers at least 25% of the heat before it is rejected to the condenser (see Note A-5.2.10.3.(2)(a)), or
- b) that meets at least 80% of the space heating or *service water* heating capacity (see Note A-5.2.10.3.(2)(b)).

3) The heat-recovery equipment described in Sentence (2) shall not increase the refrigerant saturation temperature beyond the temperature established at design conditions.

4) Auxiliary heating in a space heated by the heat-recovery equipment described in Sentence (2) is not permitted to operate where the equipment may completely ensure the heating load of that space.

5.2.10.4. Dwelling Units

1) The principal mechanical ventilation system of a *dwelling unit* shall be equipped with heat- or energy-recovery equipment. (See Note A-5.2.10.4.(1).)

2) The heat- or energy-recovery equipment referred to in Sentence (1) shall have
- a) for equipment serving only one *dwelling unit*, a sensible heat-recovery capacity of at least 55% in the case of a *building* located in a municipality whose number of degree-days under 18°C is less than 6000 and of at least 60% in the case of a *building* located in another municipality where the recovery capacity is
  - i) established at a flow of at least 22 L/s for a supply air inlet temperature of −25°C,
  - ii) measured according to CAN/CSA-C439, “Rating the Performance of Heat/Energy-Recovery Ventilators,” and
  - iii) certified by HVI or other cetification body that is accredited by the Standards Council of Canada (see Note A-5.2.10.4.(2)(a)), or
- b) in other cases, a net sensible efficiency of at least 60% in the case of a *building* located in a municipality whose number of degree-days under 18°C is less than 6000 and of at least 65% in the case of a *building* located in another municipality where the efficiency is
  - i) established at 100% of the heating test flow,
  - ii) measured according to ANSI/AHRI 1061 (SI), “Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment,” and
  - iii) certified by AHRI, by Intertek Testing Services NA Ltd. or by Element Materials Technology Canada Inc.

5.2.11. Shut-off and Setback Controls

5.2.11.1. Off-hours Controls

1) The following *HVAC systems* shall be equipped with automatic controls complying with Sentences (2) and (4):
- a) *HVAC systems* that are not intended to operate continuously,
- b) *HVAC systems* serving *dwelling units*,

c) *HVAC systems* whose heating or cooling capacity is more than 5 kW, or
d) *HVAC systems*
   i) whose heating or cooling capacity is 5 kW or less, and
   ii) serving *temperature-control zones* that are not equipped with readily accessible manual controls.

(See Note A-5.2.11.1.(1).)

2) Controls required by Sentence (1) shall be capable of
a) shutting down fan systems and/or heating and cooling equipment and auxiliaries, where appropriate, when heating, cooling or ventilation is not required by the *conditioned space* served,
b) setting back the *conditioned space* heating temperature setpoint,
c) increasing the setpoint of cooling equipment if the equipment is required to operate during periods when the *conditioned space* served is not in use,
d) reducing or shutting off outdoor air intake during heating or cooling system operation when the *conditioned space* is not in use (see Note A-5.2.11.1.(2)(d)), and
e) in the case of heat pumps, temporarily suppressing supplementary heating elements or anticipation of the reaching of the setpoint established during periods of occupancy (see Notes A-5.2.11.1.(2)(e) and A-5.2.8.4.(1)).

3) Deleted.

4) Controls required by Sentence (1) shall be designed so that lowering a heating thermostat setpoint will not cause energy for cooling to be expended to reach the lowered setting and raising a cooling thermostat setpoint will not cause energy for heating to be expended to reach the raised setting.

5.2.11.2. Airflow Control Areas

1) Except as provided in Sentences (7) and (8), each air distribution system serving multiple *temperature-control zones* shall be divided into *airflow control areas*. (See Note A-5.2.11.2.(1) and (2).)

2) Each *airflow control area* required by Sentence (1) shall serve a *floor surface area* of not more than 2300 m². (See Note A-5.2.11.2.(1) and (2).)

3) Each *airflow control area* required by Sentence (1) shall include only the *temperature-control zones* to be operated simultaneously.

4) Each *airflow control area* required by Sentence (1) shall not span more than one *storey*.

5) Each *airflow control area* required by Sentence (1) shall be equipped with controls meeting the requirements of Article 5.2.11.1. (See Note A-5.2.11.2.(5).)

6) The air distribution system shall be designed such that a reduction in air delivery of up to 50% of design flow results in at least a proportional reduction in fan power.

7) Means shall be provided to allow stable operation of all fan systems and associated *HVAC systems* for any length of time while they are serving a single *airflow control area*. (See Note A-5.2.11.2.(7).)

8) The following need not be incorporated into *airflow control areas*:
a) *temperature-control zones* in which outdoor air and exhaust requirements prevent the reduction or stopping of the air supply, or
b) *dwelling units*.

5.2.11.3. Seasonal Shutdown

1) *HVAC systems* that are used on a seasonal basis shall be equipped with
a) automatic controls, or
b) readily accessible and clearly labeled manual controls that allow them to be stopped when not required.

5.2.11.4. Boilers

1) *HVAC systems* with multiple *boilers* shall incorporate a means for preventing heat loss through a *boiler* when it is not operating. (See Note A-5.2.11.4.(1).)

2) Except as provided in Sentence (3), where the heating load of *boilers* of an *HVAC system* exceeds 176 kW, the *HVAC system* shall consist of

a) more than one *boiler*,
b) a multi-stage *boiler*, or.
c) a fully modulating *boiler*.

3) Where the heating load of the *boilers* of an *HVAC system* exceeds 352 kW, those *boilers* shall be fully modulating.

5.2.11.5. Loop Temperature Reset for Chilled- and Hot-Water Systems

1) Except as provided in Sentences (2) and (3), a system with a design capacity of more than 88 kW that provides chilled or hot water to an *HVAC system* used for comfort purposes shall be equipped with automatic controls that reset the temperature of each supply water loop

a) in relation to outdoor temperature, or
b) in relation to the *building* heating and cooling loads.

(See Note A-5.2.11.5.(1).)

2) Chilled- and hot-water systems described in Sentence (1) need not be equipped with loop temperature reset controls where such controls would cause the improper operation of heating, cooling, humidifying, or dehumidifying equipment or systems. (See Note A-5.2.11.5.(2).)

3) Chilled- and hot-water systems described in Sentence (1) that are designed with variable-flow pumping complying with Sentence 5.2.6.2.(1) need not be equipped with loop temperature reset controls.

5.2.12. Equipment Efficiency

5.2.12.1. Unitary and Packaged Equipment of an HVAC System

1) Unitary and packaged equipment and components that are part of a *building HVAC system* shall comply with the efficiency requirements provided for in the Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulations. (See Note A-5.2.12.1.(1), 6.2.2.1.(1), 7.2.3.1.(1) and 7.2.4.1.(1).)

5.2.12.2. Deleted

5.2.12.3. Deleted

5.2.12.4. Deleted

5.2.13. Commercial Cooking Ventilating System

5.2.13.1. Commercial Cooking Ventilating System

1) The make-up airflow introduced directly in the commercial cooking air exhaust system shall be less than 10% of the exhaust airflow. (See Note A-5.2.13.1.(1).)

2) Commercial cooking exhaust air systems with a cumulative flow of more than 2360 L/s shall comply with one of the following requirements:

a) at least 50% of the airflow rate necessary to offset the cooking exhaust rate shall come from available transfer air, in L/s, established using the following equation:

$$\text{Available transfer air} = D_a - D_w - D_e$$

where
D_a = outdoor airflow entering the *building*, excluding the make-up outdoor airflow directly serving the kitchen, in L/s,
D_w = airflow extracted from washrooms, in L/s, and
D_e = outdoor airflow to offset other exhaust equipment, in L/s (see Note A-5.2.13.1.(2)(a)),

b) at least 75% of the cooking exhaust rate shall come from an exhaust demand air system that shall
  i) detect cooking emissions (see Note A-5.2.13.1.(2)(b)(i)), and
  ii) reduce to at least 50% exhaust and make-up flows in the absence of cooking emission, or

c) at least 40% of the sensible heat shall be recovered over at least 50% of the cooking exhaust rate by a heat-recovery unit designed for that purpose.

Section 5.3. Reserved

Section 5.4. Performance Path

(See Note A-1.1.2.1.)

5.4.1. General

5.4.1.1. Scope

1) Subject to the limitations stated in Article 5.4.1.2., where the *HVAC system* does not comply with the requirements of Section 5.2., it shall comply with Part 8.

5.4.1.2. Limitations

1) The performance path shall not take into consideration the energy performance

a) of back-up *HVAC systems*,
b) air distribution systems,
c) air intake and outlet dampers,
d) piping of an *HVAC system*,
e) space temperature control, and
f) *airflow control areas*.

(See Note A-5.4.1.2.(1) and (2).)

2) The elements in Sentence (1) shall comply with Section 5.2. (See Note A-5.4.1.2.(1) and (2).)

Section 5.5. Objective and Functional Statements

5.5.1. Objective and Functional Statements

5.5.1.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in this Part shall be the objective and functional statements listed in Table 5.5.1.1. (See Note A-1.1.3.1.(1).)

Table 5.5.1.1.
Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 5
Forming Part of Sentence 5.5.1.1.(1)

Functional Statements and Objectives(1)	
5.2.2.2. Provision for Balancing	
(1)	[F95,F99-OE1.1]
5.2.2.3. Duct Sealing	
(1)	[F91,F99-OE1.1]
(2)	[F91,F99-OE1.1]
(3)	[F91,F99-OE1.1]
(4)	[F91,F99-OE1.1]
(5)	[F91,F99-OE1.1]
5.2.2.4. Leakage Testing of Ducts	
(1)	[F91,F99-OE1.1]
(2)	[F91,F99-OE1.1]
(3)	[F91,F99-OE1.1]
5.2.2.5. Duct and Plenum Insulation	
(1)	[F92,F93,F95-OE1.1]
(2)	[F93,F95-OE1.1]
5.2.2.6. Protection of Duct Insulation	
(1)	[F92,F93,F95-OE1.1]
(2)	[F92,F93,F95-OE1.1]
5.2.2.7. Cooling with Outdoor Air	
(1)	[F95-OE1.1]
(3)	[F95-OE1.1]
(4)	[F95-OE1.1]
5.2.2.8. Cooling by Direct Use of Outdoor Air (Air Economizer System)	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
(3)	[F95-OE1.1]
(4)	[F95-OE1.1]
5.2.2.9. Cooling by Indirect Use of Outdoor Air (Water Economizer System)	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
5.2.3.1. Application	
(2)	[F95,F97-OE1.1]
(4)	[F95,F97-OE1.1]
(5)	[F95,F97-OE1.1]
(6)	[F95,F97-OE1.1]
5.2.3.2. Constant-Volume Fan Systems	
(1)	[F95,F97-OE1.1]
5.2.3.3. Variable-Air-Volume Fan Systems	
(1)	[F95,F97-OE1.1]
(2)	[F95,F97-OE1.1]

Table 5.5.1.1. (Continued)

Functional Statements and Objectives(1)	
(3)	[F95,F97-OE1.1]
5.2.4.1. Required Dampers	
(1)	[F91,F95-OE1.1]
5.2.4.2. Type and Location of Dampers	
(1)	[F90,F91,F95-OE1.1]
(2)	[F90,F91,F95-OE1.1]
(3)	[F92,F95-OE1.1]
5.2.5.2. Provision for Balancing	
(1)	[F95,F99-OE1.1]
5.2.5.3. Piping Insulation	
(1)	[F92,F93-OE1.1]
(4)	[F92,F93-OE1.1]
(6)	[F92,F93-OE1.1]
(7)	[F92,F93-OE1.1]
(8)	[F93,F95-OE1.1]
5.2.5.4. Protection of Piping Insulation	
(1)	[F92,F93,F95-OE1.1]
(2)	[F92,F93,F95-OE1.1]
5.2.6.2. Requirements for Pumping Systems of HVAC Systems	
(1)	[F95,F97-OE1.1]
5.2.7.1. Manufacturer's Designation	
(1)	[F95,F99-OE1.1]
5.2.8.1. Temperature Controls	
(1)	[F95-OE1.1]
5.2.8.2. Temperature Control within Dwelling Units	
(1)	[F95-OE1.1]
5.2.8.3. Installation of Thermostats	
(1)	[F95-OE1.1]
5.2.8.4. Heat Pump Controls	
(1)	[F95,F97,F99-OE1.1]
5.2.8.5. Space Temperature Control	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
(3)	[F95-OE1.1]
(4)	[F95-OE1.1]
(5)	[F95-OE1.1]
5.2.8.6. Ice- and Snow-Melting Heater Controls and Frost Protection Equipment	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
5.2.8.7. Control of Temperature of Air Leaving the Supply Air Handler	
(1)	[F95-OE1.1]

Table 5.5.1.1. (Continued)

Functional Statements and Objectives[1]	
5.2.8.8. Control of Space Temperature by Reheating or Recooling	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
(3)	[F95-OE1.1]
(4)	[F95-OE1.1]
(5)	[F95-OE1.1]
5.2.9.1. Humidification Controls	
(1)	[F95-OE1.1]
5.2.10.1. Heat or Energy Recovery	
(1)	[F95,F100-OE1.1]
(2)	[F95,F100-OE1.1]
(5)	[F95,F100-OE1.1]
5.2.10.2. Swimming Pools	
(1)	[F95,F100-OE1.1]
(2)	[F95,F100-OE1.1]
(3)	[F95,F100-OE1.1]
5.2.10.3. Refrigeration Systems	
(1)	[F95,F96,F100-OE1.1]
(2)	[F95,F96,F100-OE1.1]
(3)	[F95,F96,F100-OE1.1]
5.2.10.4. Dwelling Units	
(1)	[F95,F100-OE1.1]
(2)	[F95,F100-OE1.1]
5.2.11.1. Off-hours Controls	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
(4)	[F95-OE1.1]
5.2.11.2. Airflow Control Areas	
(1)	[F95,F97-OE1.1]
(2)	[F95,F97-OE1.1]
(3)	[F95,F97-OE1.1]
(4)	[F95,F97-OE1.1]
(5)	[F95,F97-OE1.1]
(6)	[F95,F97-OE1.1]
(7)	[F95,F97,F99-OE1.1]
5.2.11.3. Seasonal Shutdown	
(1)	[F97-OE1.1]
5.2.11.4. Boilers	
(1)	[F93-OE1.1]
(2)	[F95-OE1.1]
(3)	[F95-OE1.1]
5.2.11.5. Loop Temperature Reset for Chilled- and Hot-Water Systems	
(1)	[F95,F98-OE1.1]
5.2.12.1. Unitary and Packaged Equipment of an HVAC System	
(1)	[F95,F98,F99-OE1.1]
5.2.13.1. Commercial Cooking Ventilating System	
(1)	[F97-OE1.1]
(2)	[F95,F100-OE1.1]
5.4.1.2. Limitations	
(1)	[F98,F99-OE1.1]
(2)	[F98,F99-OE1.1]

Notes to Table 5.5.1.1.:

(1) See Parts 2 and 3 of Division A.

Notes to Part 5
Heating, Ventilating and Air-conditioning Systems

A-5.1.1.2.(2) and (4) HVAC system and Process or Activities. An HVAC system fully dedicated to a process or an activity described in Sentence 5.1.1.2.(2) is exempted from complying with Part 5. The Code provides provisions to the contrary, in particular for HVAC systems serving the following rooms, processes and activities that are not exempted from Part 5 requirements:

- server rooms (Article 5.2.2.7.),
- laboratories and vivariums (Subsection 5.2.3.),
- hospitals (Article 5.2.2.7. and Subsection 5.2.3.),
- swimming pools (Article 5.2.10.2.),
- ice-making machines and food refrigeration equipment (Article 5.2.10.3.), and
- commercial cooking exhaust equipment (Subsection 5.2.13.).

In addition, Sentence 5.1.1.2.(4) provides that an HVAC system serving both a room that requires usual comfort conditions and a room in which a process calls for temperatures, airflows or humidity rates outside the normal range required cannot benefit from the exemption permitted in Sentence 5.1.1.2.(2).

In compliance with the performance path, process and activity HVAC systems must be modeled since they have an impact on the heating, cooling and/or humidification load of rooms adjacent to the process or activity.

A-5.1.1.3.(1) Compliance. The flow chart in Figure A-5.1.1.3.(1) illustrates the process for all two paths of compliance applicable to Part 5.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

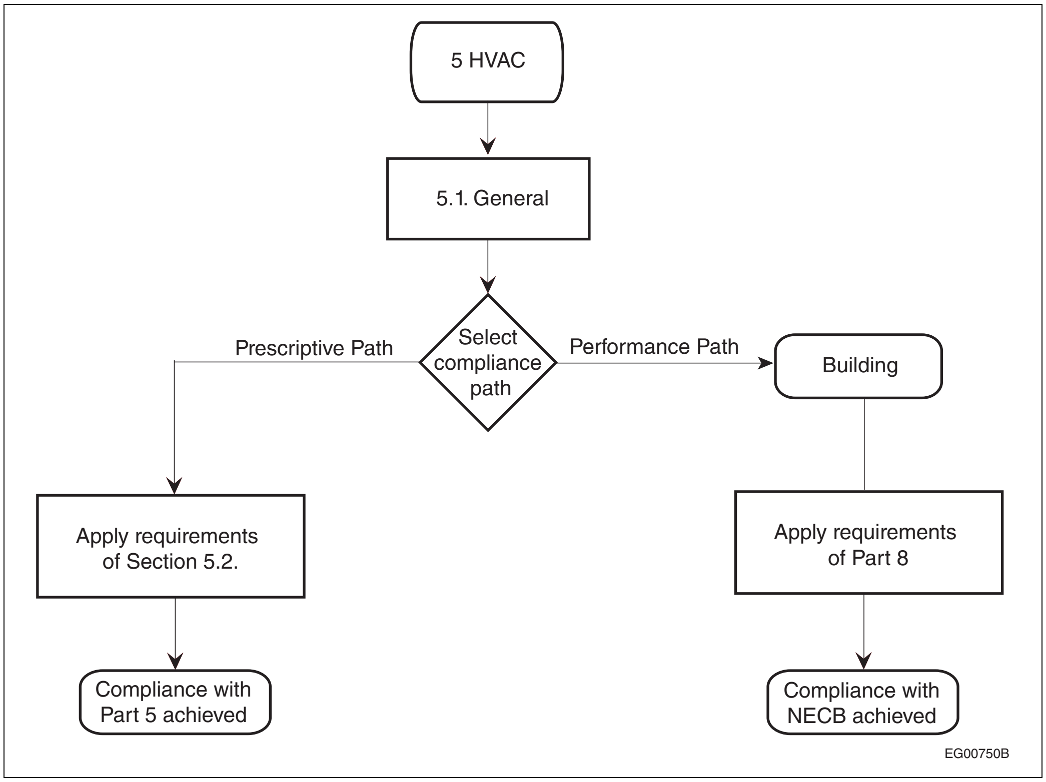

Figure A-5.1.1.3.(1)
Code compliance paths for HVAC

A-5.1.1.3.(2) Back-up Systems. "Back-up systems" are systems installed within a building for the sole purpose of operating in the event the building's HVAC systems is out of service due to malfunction or scheduled maintenance.

A-5.2.1.1.(1) Load Calculations. ASHRAE Handbooks and Standards and, for smaller buildings, the "HRAI Digest," are also useful sources of information on HVAC systems.

A-5.2.2.1.(1) Design and Installation of Ducts. The following publications are a useful source of additional information on this subject:

- Publications by ASHRAE:
  - –the ASHRAE Handbooks
- Publications by SMACNA:
  - –"HVAC Duct Construction Standards – Metal and Flexible"
  - –"Fibrous Glass Duct Construction Standards"
  - –"HVAC Systems – Duct Design"
  - –"HVAC Air Duct Leakage Test Manual"

A-5.2.2.2.(1) Provision for Balancing. Balancing an air distribution system is a means of fine-tuning it so that the correct amount of air for which the heating, ventilating or air-conditioning system is designed can be delivered. Except for systems having some other means of air-volume control, major supply air ducts must contain air-volume balancing dampers capable of being set for specified airflows.

A-5.2.2.3.(1) Duct Sealing. Even if ANSI/SMACNA 006, "HVAC Duct Construction Standards – Metal and Flexible," is less restrictive for certain sealing classes, all air ducts and plenums must be sealed as a class A duct, i.e. at every transversal joints, along all the longitudinal assembly lines and where the ducts penetrate walls, as required by Sentence 5.2.2.3.(1).

Sealing applies both to positive pressure ducts and negative pressure ducts.

A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6) Insulation Thickness. Insulation must be installed sufficiently tightly around ductwork to avoid leaving an air gap between the duct and the insulation. However, in doing so, care must be taken not to deform the insulation through excessive stretching or compression, as this will reduce its thickness and, consequently, its thermal performance.

The minimum insulation thicknesses required may have to be increased to eliminate condensation on ducts or to protect against burns.

A-5.2.2.7.(2)(d) Non-particle Filtration. Contrary to particle filtration, non-particle filtration is generally used where the outdoor air is polluted or where the indoor air quality must be controlled, such as a medical environment where a molecular filter is used to remove ozone and nitrogen oxides. That type of air handler uses energy and the addition of an economizer system requires to design the air handler not for the minimum new air but for 100% of the supply flow. In that case, the energy gain obtained by not operating the mechanical cooling may cancel itself or even transform itself into greater energy consumption.

A-5.2.2.7.(2)(f) Heat-Recovery Unit in Coolers. Where the cooler has a heat-recovery unit on its condenser, shutting down of the cooler for using the economizer system would cancel the heating savings due to recovery.

A-5.2.2.7.(2)(g) Semi-conditioned Spaces During Operating Hours. Energy savings related to an economizer system depend mostly on the cooling needs of the spaces during heating. In most cases, a cooling setpoint of at least 26°C does not generate sufficient cooling needs to justify the cost for the installation of an economizer system.

A-5.2.2.7.(3) Cooling by the Use of Outdoor Air Integrated to the Mechanical Cooling. Based on the outdoor air temperature and the cooling demand, the cooling load will be ensured only by the economizer system, by a combination of the economizer system and mechanical cooling or only by mechanical cooling.

A-5.2.2.7.(4) Water Economizer System where the HVAC System Includes Hydronic Loop Cooling and a Humidification System. The humidification systems used simultaneously with an air economizer system may consume a lot of energy because the introduction of dry air in winter adds a significant humidification load. To prevent excessive energy consumption, the economizer system, where required, must be on the water system and not on the air system. That requirement is limited to hydronic loop mechanical cooling and not to direct expansion cooling.

A-5.2.2.8.(2) Outdoor Airflow for Indoor Air Quality. Outdoor air requirements for acceptable indoor air quality are covered in Part 6 of Division B of the NBC.

Types of Shut-off Settings

As mentioned in Clause 5.2.2.8.(2)(b), only the shut-off settings in Table 5.2.2.8.-A are permitted.

Combining two types of settings or dividing one type of setting is not permitted.

A-5.2.2.8.(3) Minimum Mechanical Cooling Stage Controlled Directly from Room Temperature. When the direct expansion mechanical cooling activates in addition to the outdoor air cooling, the objective is not to reduce the supply temperature so as to create discomfort in the conditioned zone. That means that the mechanical cooling operates at a minimum of two stages, by the use of multiple compressors, by the use of only one two-stage compressor or by the use of a variable-speed compressor.

Sentence 5.2.2.8.(3) applies to mechanical cooling directly controlled from room temperature rather than the supply temperature of the air handler. In the latter case, the requirements of Sentence 5.2.2.8.(4) apply.

A-5.2.2.8.(4) Minimum Mechanical Cooling Stage. Sentence 5.2.2.8.(4) applies in particular to variable-air-volume HVAC systems controlled from the air handler supply air temperature. For example, where three mechanical cooling stages are required, the requirement may be complied with using a variable-speed compressor. In that case, the minimum displacement of the compressor must be less than or equal to 33% of the total cooling capacity.

Another possibility is to use two compressors, the first stage uses a compressor with a 33% total cooling capacity, the second stage uses a compressor with 66% displacement and the third stage uses the combination of two compressors to reach 100% of the total cooling capacity. In that case, the cooling capacity provided by the first stage is equivalent to the minimum displacement of 33% of a variable-speed compressor.

A-5.2.2.9. Water Economizer System. The water economizer system reduces the mechanical cooling load by cooling the heat transfer fluid of the cooling system with outdoor air. The energy savings are made by reducing the compressor use time. There are two typical compliant configurations for the water economizer system,

- evaporation cooling, also called “water precooling,” such as that shown in Figure A-5.2.2.9.-A, and
- sensible heat transfer cooling, also called “air precooling,” such as that shown in Figure A-5.2.2.9.-B.

The dotted lines represent the portion of the economizer system.

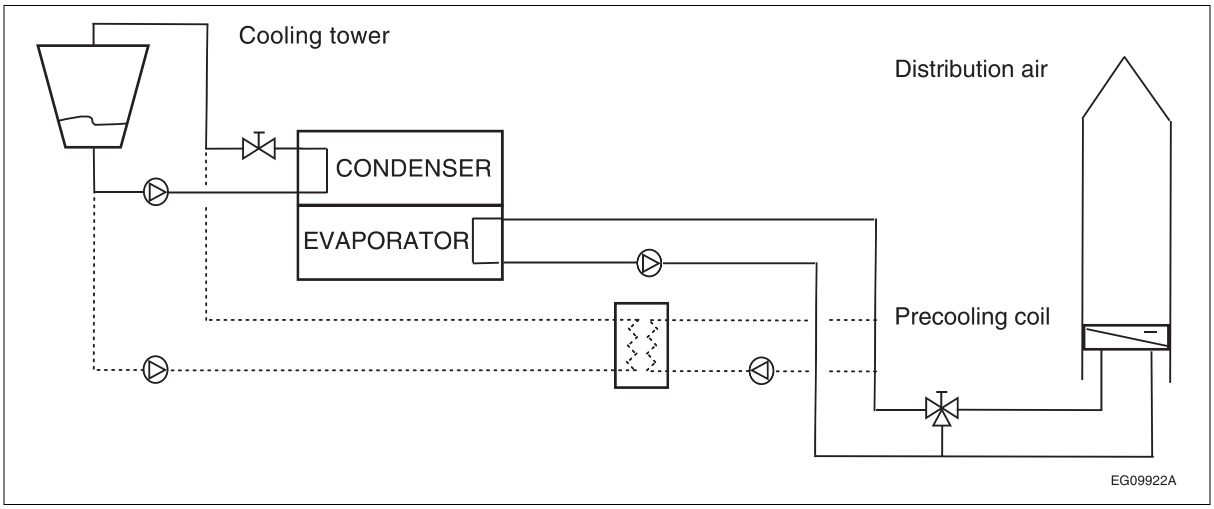

Figure A-5.2.2.9.-A
Evaporation cooling economizer system – water precooling by a water economizer system

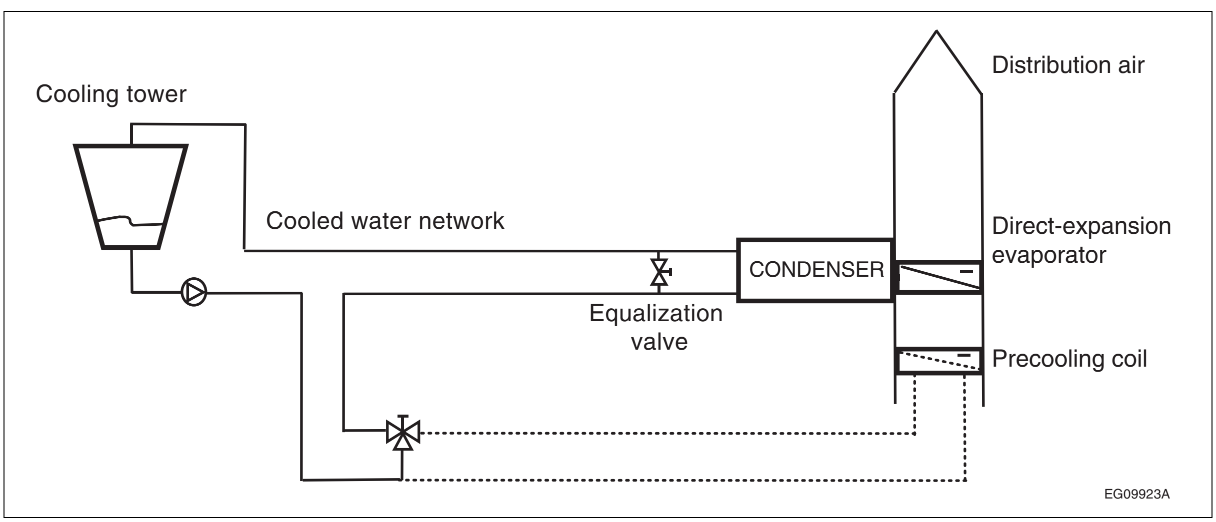

Figure A-5.2.2.9.-B
Sensible heat transfer cooling economizer system – air precooling by a water economizer system

A-5.2.3.1. and 5.2.6. Brake Horsepower, Rated Capacity and Power Demand. The capacity of a fan varies depending on the location where it is measured on a “fan, motor, variable-speed drive” set.

The brake horsepower is measured directly on the fan, on its drive shaft. It is sometimes expressed by the fan manufacturer in bhp. The brake horsepower is the power necessary to drive the fan blades.

The rated capacity is measured on the fan motor and is indicated on its nameplate. The rated capacity is the brake horsepower to which the power necessary to offset losses due to the strap and the internal losses of the electric motor is added.

The power demand is measured at the circuit breaker of the electrical panel. It is the electric power necessary to supply the “fan, motor, variable-speed drive” set. The power demand is the rated capacity to which the power necessary to offset the losses due to the variable-speed drive is added, where applicable.

For a “fan, motor, variable-speed drive” set, the brake horsepower is always less than the rated capacity, that is itself always less than the power demand.

Figure A-5.2.3.1. and 5.2.6. shows the various locations where the capacity of a fan can be measured.

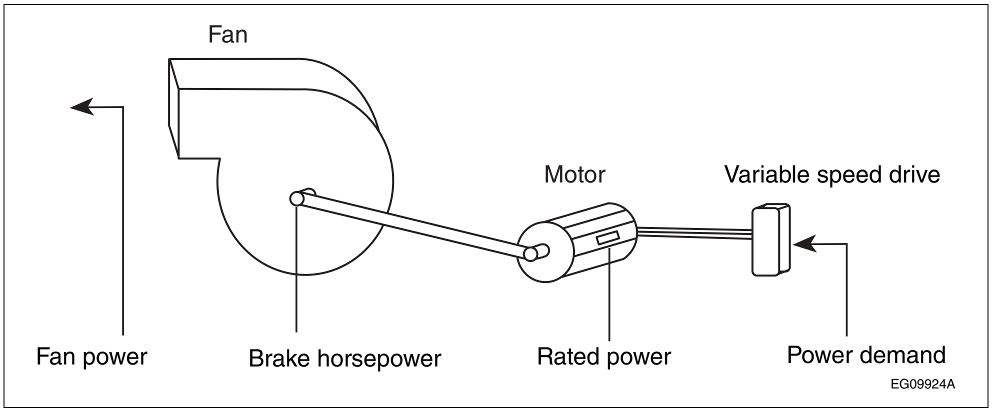

Figure A-5.2.3.1. and 5.2.6.
Power that may be measured on the “fan, motor, variable-speed drive” set

The pump capacities follow the same principles as those described above for fans, with the necessary modifications. For example, the power demand of a pump is also measured at the circuit breaker of an electrical panel. It is the electrical power necessary to supply the “turbine, motor, variable-speed drive” set.

A-5.2.3.1.(1), (2) and (3) Application. Fans to take into consideration in the calculation of the total of the powers are those that

- belong to the same HVAC system. Figure A-5.2.3.1.(1), (2) and (3) shows an example of an HVAC system with multiple fans. For example, if two HVAC systems have their own supply fans, their own heating and cooling coils and serve the same zone, they are considered to be two separate HVAC systems even if they serve the same zone. Two separate calculations must then be made to establish the total of the powers,
- operate when the two design conditions, heating and cooling, are met. The power limit of 4 kW applies to fans whose total rated capacity is the highest between the heating conditions and the cooling conditions, and
- carry heated or cooled air. The calculation must take into account all the supply fans, return fans, relief fans, and fans for series fan-terminal zone boxes.

Some fans may not be included in the calculation of the total of the power, such as the following:

- as mentioned in Clause 5.2.3.1.(3)(b), garage exhaust fans or server room transfer fans, where the spaces are not heated or cooled, and
- as mentioned in Sentence 5.2.3.1.(2), fans in parallel fan-terminal zone boxes where they do not operate at the cooling design conditions and the conditions are higher than the heating design conditions.

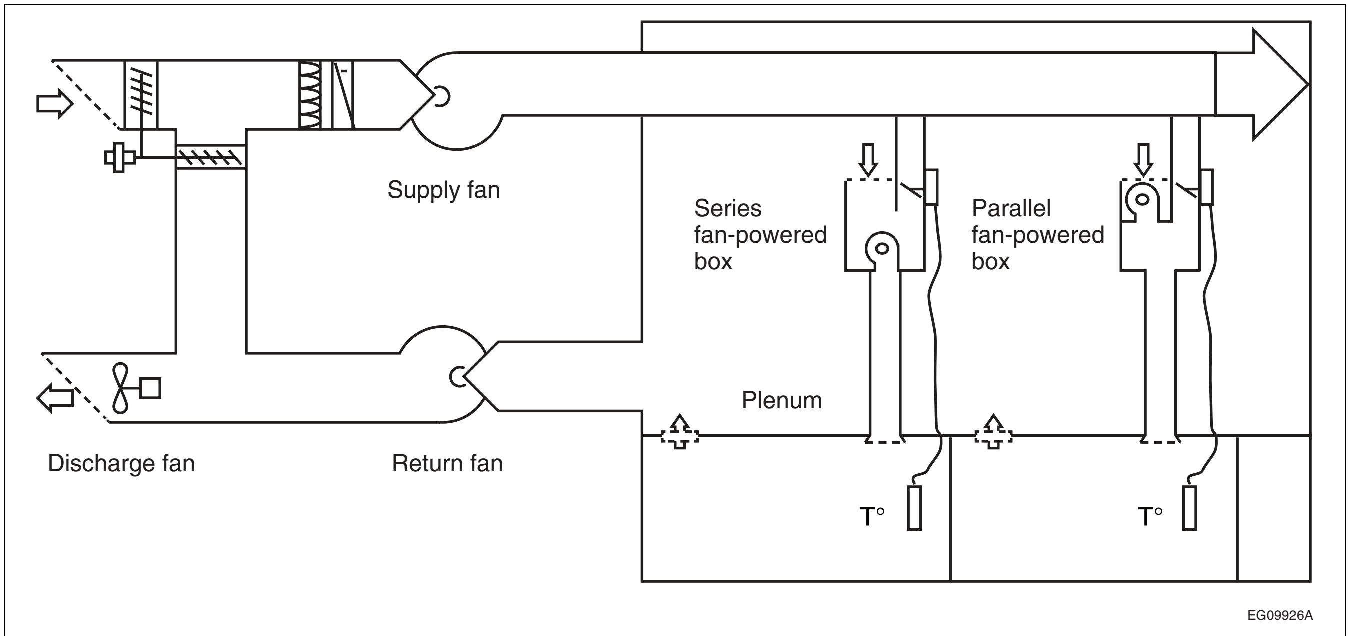

Figure A-5.2.3.1.(1), (2) and (3)
Example of an HVAC system with multiple fans

A-Table 5.2.3.1. Static Pressure Adjustments. Multiple units and accessories in the ventilation system create a significant pressure loss and therefore require that the fan have a greater power to provide the flow required by the design conditions. The list of static pressure positive adjustments makes it possible to increase the limit of the allowed brake horsepower based on the accessories installed on the ventilation system. Certain adjustments are however negative and lower the power limit permitted.

A-5.2.3.2.(1) Constant-Volume Fan Systems. This type of system is found in particular in bypass variable-air-volume systems in which the airflow through the fan is not varied.

A-5.2.3.2.(2) Maintenance of Pressure for Health or Safety Purposes. Constant-volume systems are common in hospitals, vivariums and laboratories. If a room needs to be kept under negative pressure so as not to contaminate the other rooms, a control will open the exhaust or return duct damper of the said room and will close the damper of the other rooms. The fans of such a system may use the power limits of variable-air-volume fan systems.

A-5.2.3.3. Variable-Air-Volume Fan Systems. A fan that automatically varies the airflow based on static pressure is controlled from the sensors in each terminal zone box. Consequently, the following systems cannot be considered variable-air-volume fans and must use the limit of the constant-volume fan established in Article 5.2.3.2.:
- a constant-volume fan serving multiple zones and equipped with a bypass duct between its inlet and outlet (called “changeover bypass”),
- a constant-volume fan serving multiple zones and equipped with terminal zone boxes bypassing supply air in the return plenum (called “bypass terminal unit”), and
- a constant-volume fan for which a variable-speed drive is used only at airflow balancing.

A-5.2.3.3.(2) Part-load Maximum Power. Generally, a forward curved fan with inlet vanes or a variable-speed motor fan meets the requirement.

A-5.2.3.3.(3) Location of Static Pressure Sensors. In a variable-volume system, the location of a static pressure sensor is critical for the good operation of terminal zone boxes. The pressure upstream from the terminal zone box must be greater than the pressure loss caused by that same box; otherwise, the airflow at the outlet of the terminal zone box will be less than the specified airflow. A pressure too high upstream of the terminal zone box will generate noise and a higher energy use at the location of the fan. The location of a static pressure sensor is therefore a compromise between control and energy saving. To guarantee savings with respect to a variable-volume system, the Code requires that the sensor be located so that the static pressure setpoint be at a maximum of 300 Pa. That pressure is sufficient to carry sensor air to conditioned zones. Where the system includes multiple main branches and it is impossible to comply with the requirement in Subclause 5.2.3.3.(3)(b)(i), the use of a static pressure sensor will be necessary at each branch of the main duct.

A-5.2.3.3.(4) Automatic Reset of Static Pressure Setpoint. Where the terminal zone boxes are equipped with direct digital controls centralized at the main control panel of the supply fan, the highest pressure among all the conditioned spaces of the system is the ideal pressure to be developed by the fan. The conditioned space with the highest pressure generally corresponds to the space where the terminal zone box damper is the most open. That pressure is ideal because it allows all the terminal zone boxes to have an inlet pressure sufficient to operate correctly and it allows the supply fan to develop the weakest pressure possible to minimize energy consumption. In that context, the static pressure setpoint must be constantly adjusted to follow the ideal pressure under the requirements of Sentence 5.2.3.3.(4).

A-5.2.5.2.(1) Provision for Balancing. The following publications are useful sources of information on hydronic systems:

- ANSI/ASHRAE 111, "Measurement, Testing, Adjusting and Balancing of Building HVAC Systems"
- the ASHRAE Handbooks
- publications by the National Environmental Balancing Bureau

A-5.2.5.3.(1) Other Considerations. The required minimum thicknesses of insulation do not take into consideration water vapour transmission and condensation, burn protection, and severe climatic conditions; additional insulation, vapour barriers, or both, may be required to limit these.

Piping

The accessories connected to pipes include in particular strainers and valves.

A-5.2.5.3.(3)(c) Piping in which the Fluid Conveyed is not Heated or Cooled by Electricity or Fossil Fuel. Natural gas or condensate pipes are examples of piping in which the fluid conveyed is not heated or cooled by electricity or fossil fuel.

A-5.2.6.2.(1) Requirements for Pumping Systems for HVAC Systems. During part-load operation, a constant-flow pumping system is more energy consuming because it uses three-way valves to divert the fluid from coils, thermal beams or any other type of appliance.

Flow may be varied by one of several methods such as variable-speed-driven pumps, staged multiple pumps or pumps riding their performance curves, (i.e. uncontrolled pumps).

A-5.2.8.3.(1) Mounting Height and Location of Thermostats.

Mounting Height of Thermostats

Article 3.8.1.5. of Division B of the NBC contains a specific requirement regarding the mounting height of thermostats located in a barrier-free path of travel; the use of thermostats with separate sensors and controls may be the best option in such spaces.

Location of Thermostats

Examples of locations to be avoided are exterior walls and locations near exterior entrances, corners and within throw of supply air diffusers. Installation should include all necessary settings and adjustments, including, in the case of electric heaters, setting of the heat anticipator to match the capacity of the heaters being controlled, as required on some thermostats for performance certification.

A-5.2.8.4.(1) Supplementary Heating Elements. For the purposes of Sentence 5.2.8.4.(1) and Clause 5.2.11.1.(2)(e), “supplementary” heat or heater refers to the provision of heat over and above the capacity of the heat pump in order to meet peak heating load demand.

A-5.2.8.5.(2) Thermostatic Controls for Perimeter Systems. Sentence 5.2.8.5.(2) is intended to prohibit the use of an outdoor sensor as the sole control that determines the heat supplied to a space. However, a single-zone thermostat is permitted to be used for each building exposure as input to control the heat supplied to the perimeter system.

A-5.2.8.5.(3) Heating and Cooling Controls. The requirement in Sentence 5.2.8.5.(3) can be met by means of software in a direct digital control system, or through the provision of a concealed, adjustable mechanical stop in each thermostat.

A-5.2.8.7.(2) Reheating Supply Air for Humidity Control. Sentence 5.2.8.7.(2) could apply to server rooms, operating rooms in health care institutions and museums. For those buildings, dehumidification is usually carried out by cooling mixture air under the dew point required to maintain humidity at the specified rate. However, that temperature may be too low in relation to the setpoint temperature in the space, so that reheating would be required at the cooling coil outlet to do so.

A-5.2.8.7.(3) Reheating Supply Air by Recovered Energy. The energy rejected by the mechanical cooling system may be used to heat supply air without increasing the energy consumption of the building.

A-5.2.8.8.(4) and (5) Zones with Limited Flow of Reheated, Cooled or Mixed Air. Simultaneous heating and cooling are permitted by Sentences 5.2.8.8.(4) and 5.2.8.8.(5) where the flow, during heating, cooling or mixture, is limited. The maximum limit has been established by the minimum opening of terminal zone boxes of variable-volume built-up systems. That minimum opening is necessary to ensure a differential pressure adequate for the control of the terminal zone box. The limits have been established at 20% for digital control systems and at 30% for other control systems (such as pneumatic control systems).

A-5.2.8.8.(6) Heat Recovery and Solar Energy. The energy recovered at the site designates the heat recovered in the building to prevent energy consumption purchased from an energy supplier.

Solar energy represents the thermal, chemical or electrical energy derived from the conversion of solar radiation. The conversion must be carried out on the site to prevent energy consumption purchased from an energy supplier.

A-5.2.10.1.(1) Heat Recovery. Building exhaust air is an important source of recoverable heat. However, heat recovery on small amounts of airflow is not always economical due to the costs involved in installing a heat-recovery apparatus, which will vary by project as will the actual savings realized for each project. To take that reality into account, the limit forcing heat recovery has been set at 50 kW of sensible heat in exhaust air extracted by exhaust air equipment considered individually.

Sentence 5.2.10.1.(1) allows the HVAC system to be equipped with only one heat-recovery equipment for a number of exhaust equipment of a same system.

A-5.2.10.1.(4) January Design Temperatures. The outdoor 2.5% January design temperature for many locations across Canada can be found in Table C-1.

A-5.2.10.2.(2) Heat Recovery from Exhaust Air from Swimming Pools. Controlling humidity levels of the swimming pool with outdoor air is an energy consuming process and difficult to control in Québec’s climate. The purpose of Clause 5.2.10.2.(2)(a) is to limit to a minimum air renewal of the swimming pool. The heat-recovery requirement in Clause 5.2.10.2.(2)(b) applies to a swimming pool even if the quantity of sensible heat recovered is less than the 50 kW limit in Sentence 5.2.10.1.(1).

A-5.2.10.2.(3)(b) Heat Rejection from the Mechanical Dehumidification Equipment. Heat rejection from the mechanical dehumidification equipment may be reused for heating swimming pool or shower water.

A-5.2.10.3.(1)(b) Heat Recovery from Grocery Store Refrigeration Systems. The requirement covers in particular large surface grocery stores that often have a large number of food counters connected to a refrigeration system.

A-5.2.10.3.(2)(a) Heat Recovery from Refrigeration Systems. The heat at the condenser may usually be calculated by multiplying the cooler refrigeration capacity by its heat rejection factor.

A-5.2.10.3.(2)(b) Heat Recovery from Refrigeration Systems in Ice Arenas and Curling Rinks. Heat recovered from refrigeration equipment can also be used for ice resurfacing or heating the soil beneath the ice's surface to prevent frost heave.

A-5.2.10.4.(1) Heat Recovery in Dwelling Units. Supplementary exhaust fans such as kitchen hoods or bathroom fans need not comply with the heat- or energy-recovery requirements.

A-5.2.10.4.(2)(a) Heat- or Energy-Recovery Ventilators. CAN/CSA-C439, "Rating the Performance of Heat/Energy-Recovery Ventilators," describes a laboratory test that determines the energy performance of a heat- or energy-recovery ventilator. Test results for many models are listed in HVI's "Certified Home Ventilating Products Directory." The results also usually appear on a label on the equipment itself or in the manufacturer's published literature.

A-5.2.11.1.(1) Off-hours Controls. For a system serving only a single dwelling unit, one way to satisfy Sentence 5.2.11.1.(1) is to use an automatic programmable thermostat that permits automatic setback of the thermostat setpoint. For larger buildings with more than one system, a central control is recommended.

A-5.2.11.1.(2)(d) Reducing or Shutting off Outdoor Air Intake. Off-hour and morning startup periods are examples of periods when outdoor air intake may be reduced or shut off.

A-5.2.11.1.(2)(e) Heat Pump Controls for Recovery from Off-hours. The requirements of Clause 5.2.11.1.(2)(e) can be achieved through several methods:
- installation of a separate exterior temperature sensor limiting or stopping the operation of the supplementary heating element where the heat pump capacity is sufficient to ensure heating load,
- setting a gradual rise of the temperature setpoint so that, at the end of the off-hours, the heat pump limits or stops the use of electrical backup, and
- installation of controls that "learn" when to start recovery based on stored data, such as a start-stop optimization controller equipped with a self-learning function.

A-5.2.11.2.(1) and (2) Airflow Control Area. Large central HVAC systems often serve temperature-control zones occupied by different commercial tenants according to different schedules. Where one central system is present and only part of the zones is occupied, energy for conditioning the unoccupied zones is wasted. The purpose of Sentence 5.2.11.2.(1) is to force the designer to separate from other zones those that are not operated simultaneously. Zones thus grouped form an airflow control area that, according to Sentences 5.2.11.2.(2) to 5.2.11.2.(4), may not exceed 2300 m² and may not span more than one storey.

Where the designer does not know the occupation schedule at the time of designing, an airflow control area for each commercial rental space is suggested.

A-5.2.11.2.(5) Control for Airflow Control Areas. Each airflow control area must include controls that allow to consider the area as having a separate HVAC system. Each airflow control area can operate according to occupation schedules different from other areas. Control of each area may be carried out by
- direct digital control systems installed on the terminal zone boxes,
- terminal zone boxes "normally closed," including a spring that closes the air supply damper where the terminal zone box actuator is no longer supplied with electricity, or
- a motorized damper in the supply duct.

A-5.2.11.2.(7) Stable Operation of Fans and Associated HVAC Systems. Dividing a central HVAC system into several airflow control areas requires that the designer design the system so that it operates adequately at part-load, e.g. for the whole time the smallest temperature-control zone is the only one occupied. During different zone occupation periods, the operation of the principal fan and the HVAC heating and cooling equipment must be stable, adapted to the different part-loads and designed to frequently cycle between stop and start.

Direct digital controls and variable-air-volume systems are means to comply with Sentence 5.2.11.2.(7).

A-5.2.11.4.(1) Prevention of Heat Loss Between Boilers. Devices that prevent the flow of heat-carrying fluids through the boilers and dampers installed in the flues are examples of devices for preventing heat loss between boilers.

Some boilers have a bypass. Because those boilers are in operation, they need not comply with Sentence 5.2.11.4.(1).

A-5.2.11.5.(1) Temperature Reset Methods. The 88 kW design capacity in Sentence 5.2.11.5.(1) applies to a system with a chilled water loop, a hot water loop or both.

Different methods allow the reset of the supply hot water loop temperature. For example, since the heating load of a building varies depending on outdoor temperature, an acceptable method could be the installation of a device that reduces the heating loop temperature where the outdoor temperature increases. However, that method on its own is not reliable for resetting the cooling loop temperature because most cooling loads do not vary on the basis of outdoor temperature.

Another method consists in taking into account the actual heating or cooling load by resetting the heating or cooling loop temperature so that the coil valve that has the higher demand is maintained at its maximum opening. A variant of that method consists in estimating the average load of the loop using the return temperature.

A-5.2.11.5.(2) Exemption of HVAC Equipment and Systems. Dehumidification systems that must operate continuously all year for health reasons, such as in a hospital, or for protecting art work, such as in a museum, are examples of systems that may use the exemption in Sentence 5.2.11.5.(2).

However, a coil temperature ill-adapted to the loop reset may not be considered as an acceptable exemption. The designer must ensure that all equipment will operate once the loop temperature is reset. More specifically, equipment must be designed to operate correctly at the hottest temperature of a chilled water system and at the coldest temperature of the hot water system.

A-5.2.12.1.(1), 6.2.2.1.(1), 7.2.3.1.(1) and 7.2.4.1.(1) Performance Requirements and Levels. In addition to various regulations concerning the building industry, there are regulations concerning the energy performance of devices and equipment.

In Canada, the Energy Efficiency Act (S.C. 1992, c. 36) and its regulations, the Energy Efficiency Regulations, 2016 (SOR/2016-311) concern energy-using equipment. The Act and the regulations prohibit dealers, for the purposes of sale or lease, from shipping an energy-using product from one province to another, or importing an energy-using product into Canada that does not comply with the applicable energy efficiency standard or that is not labelled in accordance with the regulations.

In Québec, the Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulation, the Regulation respecting the energy efficiency of electrical or hydrocarbon-fuelled appliances (chapter N-1.01, r. 1), prohibits the manufacturing, offering, selling or leasing of an appliance or otherwise disposing of it by gratuitous or onerous title by way of a commercial transaction if the appliance does not conform to the applicable energy efficiency and energy conservation standards.

The publication of revisions to those documents does not coincide with the publication of a new edition of the Code. That is why the Code does not specify the minimum performance of equipment or components. The information is provided for in the provincial Act and regulations.

A-5.2.13.1.(1) Make-up Air for Exhaust of Air by Hood. It is possible to offset with outdoor air directly in the hood. However, several studies have shown that, where the percentage of outdoor air exceeds 10%, hood air exhaust significantly reduces contaminant capture which forces users to increase hood flow. That increase results in a higher consumption to ensure exhaust of air and offset with outdoor air.

A-5.2.13.1.(2)(a) Transfer Air. Available transfer air is air that would have been discharged otherwise or that has first circulated in a space other than the kitchen.

A-5.2.13.1.(2)(b)(i) On Demand Exhaust. Cooking fumes may in particular be detected by smoke detectors, temperature detectors under the hood, cooktop temperature detectors or a combination of those detectors.

A-5.4.1.2.(1) and (2) Limitations. The HVAC systems and equipment listed in Sentence 5.4.1.2.(1) are covered by the prescriptive requirements in

- Sentence 5.1.1.3.(2) for back-up HVAC systems,
- Articles 5.2.2.1. to 5.2.2.6. for air duct systems,
- Subsection 5.2.4. for air intake and outlet dampers,
- Subsection 5.2.5. for piping for an HVAC system,
- Article 5.2.8.5. for space temperature control, and
- Article 5.2.11.2. for airflow control areas.

Part 6
Service Water Systems and Swimming Pools

Part 6
Service Water Systems and Swimming Pools

Section 6.1. General

6.1.1. General

6.1.1.1. Scope

1) This Part applies
a) to the systems used to heat *service water*,
b) to the pumping systems that are part of *service water* systems, and
c) to swimming pools.

6.1.1.2. Application

1) Except for systems and equipment used exclusively for firefighting services and except as provided in Sentence (2), this Part applies to *service water* heating and pumping systems.

2) This Part does not apply to existing parts of *service water* heating systems that are extended to serve *additions*.

6.1.1.3. Compliance

1) Except as provided in Sentence (2), compliance with this Part shall be achieved by following
a) the prescriptive path described in Section 6.2., or
b) the performance path described in Section 6.4. (see Note A-3.1.1.3.(1)(c)).
(See Note A-6.1.1.3.(1).)

2) Back-up systems shall comply with the prescriptive requirements stated in Section 6.2.

6.1.1.4. Definitions

1) Words that appear in italics are defined in Article 1.4.1.2. of Division A.

Section 6.2. Prescriptive Path

6.2.1. Reserved

6.2.2. Water Heating Equipment and Storage Vessels

6.2.2.1. Equipment Efficiency

1) Equipment and equipment components that are part of a *building service water* heating system shall comply with the efficiency requirements in the Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulations. (See Note A-5.2.12.1.(1), 6.2.2.1.(1), 7.2.3.1.(1) and 7.2.4.1.(1).)

6.2.2.2. Equipment Insulation

1) Except for tanks covered by Article 6.2.2.1., hot *service water* storage tanks shall be covered with insulation having a minimum thermal resistance of 2.22 $m^2·K/W$.

2) Tank insulation referred to in Sentence (1) that is installed in areas where it may be subject to mechanical damage shall be protected.

6.2.2.3. Deleted

6.2.2.4. Combination Service Water Heating and Space-Heating Equipment

1) Combination *service water* heating and space-heating equipment is permitted to be used only where combined maximum input capacity of air heating and *service water* heating is
a) less than 44 kW, or
b) less than twice the design *service water* heating load.
(See Note A-6.2.2.4.(1).)

6.2.2.5. Deleted

6.2.3. Piping

6.2.3.1. Insulation

1) All piping conveying hot *service water* in the following systems shall be insulated in accordance with Table 6.2.3.1. and Sentences (2) to (4):
a) circulating systems,
b) except as provided in Sentence (5), systems with a *storage-type service water heater*, and
c) systems equipped with electrical elements along pipes to maintain the temperature in the pipes.
(See Note A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6) and Note A-6.2.3.1.(1) and (5) and 6.2.3.2.(1).)

2) Where piping insulation has a thermal conductivity, as determined in accordance with Sentence (4), that is greater than the range given in Table 6.2.3.1., the thickness given in the Table shall be increased by the ratio u2/u1, where u1 is the value at the higher end of the conductivity range for the operating temperature and u2 is the measured thermal conductivity of the insulation at the mean rating temperature. (See Note A-6.2.3.1.(2) and (3).)

3) Where piping insulation has a thermal conductivity, as determined in accordance with Sentence (4), that is lower than the range given in Table 6.2.3.1., the thickness given in the Table may be decreased by the ratio u2/u1, where u1 is the value at the lower end of the conductivity range for the operating temperature and u2 is the measured thermal conductivity of the insulation at the mean rating temperature. (See Note A-6.2.3.1.(2) and (3).)

4) The thermal conductivity of piping insulation at the mean rating temperature shall be determined in conformance with ASTM C 335/C 335M, "Steady-State Heat Transfer Properties of Pipe Insulation."

5) In *service water* heating systems with a *storage-type service water heater*, non-circulating and equipped with *heat traps*, only the following piping sections shall be insulated in accordance with Table 6.2.3.1.:
a) hot water piping and cold water piping located between *heat traps* and the storage or expansion tank,
b) the piping forming the *heat traps*, and
c) the first 2.4 m of the hot water piping located after the *heat trap*.
(See Note A-6.2.3.1.(1) and (5) and 6.2.3.2.(1).)

6) The insulation thickness used to determine compliance with Table 6.2.3.1. shall be the thickness of the insulation after installation. (See Note A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6).)

7) Insulation on piping conveying hot *service water* that is installed in areas where it may be subject to mechanical damage or weathering shall be protected.

Table 6.2.3.1.
Minimum Thickness of Piping Insulation for Service Water Heating Systems
Forming Part of Sentences 6.2.3.1.(1) to (3), (5) and (6)

Location of Piping	Thermal Conductivity of Insulation		Nominal Pipe Diameter, in. (mm)	Minimum Thickness of Piping Insulation, mm
	Conductivity Range, W/m·K	Mean Rating Temperature, °C		
Conditioned space	0.035-0.040	38	≤ 1 (25.4)	25.4
			> 1 (25.4)	38.1
Space other than a *conditioned space* or outside of the *building envelope*	0.046-0.049	38	≤ 2 (51)	63.5
			> 2 and ≤ 4 (> 51 and ≤ 102)	76.2
			> 4 (102)	88.9

6.2.3.2. Heat Traps

1) A *storage-type service water heater* or a storage tank serving a non-circulating system shall include a *heat trap* on the hot water piping and cold water piping. (See Note A-6.2.3.1.(1) and (5) and 6.2.3.2.(1).)

6.2.3.3. Equipment for Protecting the Piping Against Freezing

1) The equipment for protecting the piping outside the *building envelope* against freezing using a heating cable shall be equipped with automatic controls to shut down the equipment
a) where the outdoor temperature is more than 4.4°C, or
b) where there is no risk that the fluid in the protected piping will freeze.

6.2.4. Controls

6.2.4.1. Deleted

6.2.4.2. Shutdown

1) Except for systems whose storage capacity is less than 100 L, each *service water* heating system shall be equipped with a readily accessible and clearly labeled shut-off device that allows the system, including any heating elements installed along the pipes to maintain temperature, to be shut-off. (See Note A-6.2.4.2.(1).)

6.2.4.3. Maintaining Temperature of Hot Service Water

1) Heating elements installed along *service water* heating system pipes to maintain the water temperature shall incorporate automatic controls that maintain the temperature of the hot water within the range required for the intended use.

6.2.5. Systems with More Than One End Use Design Temperature

6.2.5.1. Remote or Booster Heaters

1) Where less than 50% of the total design flow of a *service water* heating system has a design discharge temperature higher than 60°C, separate remote heaters or booster heaters shall be installed for those portions of the system with a design temperature higher than 60°C. (See Note A-6.2.5.1.(1).)

6.2.6. Reserved

6.2.7. Swimming Pools

6.2.7.1. Controls

1) Pool heaters shall be equipped with a readily accessible and clearly labeled device that allows

a) the heater to be shut off without adjusting the thermostat setting, and
b) where applicable, the heater to be restarted without manually relighting the pilot light.

2) Except for pool pumps required by public health standards to operate on a 24-h basis, swimming pool pumps and swimming pool heaters shall be equipped with time switches or other controls that can be set to automatically turn off the pumps and heaters when their operation is not required.

6.2.7.2. Pool and Hot Tub Covers

1) Heated outdoor swimming pools and tubs shall be equipped with covers capable of covering at least 90% of the water surface.

2) Where pools or tubs are heated to a temperature above 32°C, the covers described in Sentence (1) shall have a thermal resistance of at least 2.08 (m^2·K)/W.

6.2.8. Pressure Booster Systems

6.2.8.1. Deleted

6.2.8.2. Pressure Control

1) Pressure booster systems shall be provided with at least one pressure sensor that starts and stops their pumps or varies the pump speed so that the pressure required for operation of the *service water* system is maintained. (See Note A-6.2.8.2.(1).)

2) Except for safety devices, pressure-reducing devices shall not be installed on a pressure booster system.

3) Booster pumps shall be stopped when there is no demand for *service water*.

Section 6.3. Reserved

Section 6.4. Performance Path

(See Note A-1.1.2.1.)

6.4.1. General

6.4.1.1. Scope

1) Subject to the limitations stated in Article 6.4.1.2., where the *service water* heating system does not comply with the requirements of Section 6.2., it shall comply with Part 8.

6.4.1.2. Limitations

1) The performance path shall not take into consideration the energy performance of back-up *service water* heating systems.

2) Back-up *service water* heating systems shall comply with Sentence 6.1.1.3.(2).

Section 6.5. Objective and Functional Statements

6.5.1. Objective and Functional Statements

6.5.1.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in this Part shall be the objective and functional statements listed in Table 6.5.1.1. (See Note A-1.1.3.1.(1).)

Table 6.5.1.1.
Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 6
Forming Part of Sentence 6.5.1.1.(1)

Functional Statements and Objectives[1]	
6.2.2.1. Equipment Efficiency	
(1)	[F96,F98-OE1.1]
6.2.2.2. Equipment Insulation	
(1)	[F93,F96-OE1.1]
(2)	[F93,F96-OE1.1]
6.2.2.4. Combination Service Water Heating and Space-Heating Equipment	
(1)	[F95,F96,F98,F99-OE1.1]
6.2.3.1. Insulation	
(1)	[F92,F93-OE1.1]
(2)	[F92,F93-OE1.1]
(4)	[F92,F93-OE1.1]
(5)	[F92,F93-OE1.1]
(6)	[F93,F96-OE1.1]
(7)	[F93,F96-OE1.1]
6.2.3.2. Heat Traps	
(1)	[F96-OE1.1]
6.2.3.3. Equipment for Protecting the Piping Against Freezing	
(1)	[F95-OE1.1]
6.2.4.2. Shutdown	
(1)	[F96-OE1.1]
6.2.5.1. Remote or Booster Heaters	
(1)	[F96-OE1.1]
6.2.7.1. Controls	
(1)	[F95,F96,F99-OE1.1]
(2)	[F95,F96,F99-OE1.1]
6.2.7.2. Pool and Hot Tub Covers	
(1)	[F95-OE1.1]
(2)	[F95-OE1.1]
6.2.8.2. Pressure Control	
(1)	[F96,F97-OE1.1]
(2)	[F96,F97-OE1.1]
(3)	F96,F97-OE1.1]
6.4.1.2. Limitations	
(1)	[F98,F99-OE1.1]
(2)	F98,F99-OE1.1]

Notes to Table 6.5.1.1.:
(1) See Parts 2 and 3 of Division A.

Notes to Part 6
Service Water Systems and Swimming Pools

A-6.1.1.3.(1) Compliance. The flow chart in Figure A-6.1.1.3.(1) illustrates the process for both paths of compliance applicable to Part 6.

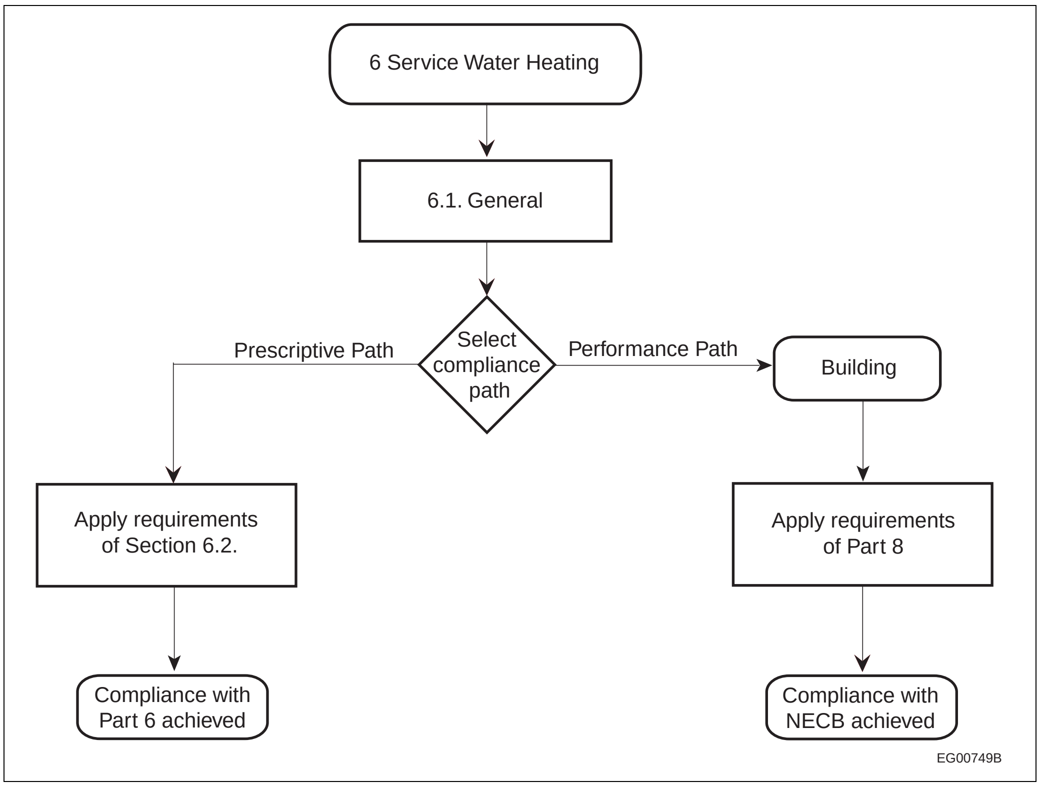

Figure A-6.1.1.3.(1)
Code compliance paths for service water heating

A-6.2.2.4.(1) Combined Heating of Spaces and Service Water. Systems designed to both heat space and heat service water meet respectively a seasonal load and a fixed load. In the summer, where only the hot service water fixed load must be satisfied, energy is wasted because the heating system is oversized in relation with the small hot service water load necessary. The purpose of Sentence 6.2.2.4.(1) is therefore to limit that practice.

For example, if the system considered has a combined maximum input power of air heating and service water heating of 45 kW, Clause 6.2.2.4.(1)(b) must be complied with. To do so, the design service water heating load must be greater than half the power of the system, i.e. 22.5 kW.

The requirement of Sentence (1) applies in particular to combined water heaters and to water heaters for which water is indirectly heated by a hot water system.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

A-6.2.3.1.(1) and (5) and 6.2.3.2.(1) Heat Traps. ASHRAE/IES 90.1, "User's Manual," defines a heat trap as follows:

"A heat trap is a device or arrangement of piping that keeps the buoyant hot water from circulating through a piping distribution system through natural convection. By restricting the flow from the storage tank, standby heat loss is minimized.

In all configurations heat traps can be a 360° loop of piping, a pre-manufactured device, or some arrangement of piping and elbows that forms an inverted "U" on the tank fittings. Tanks that have horizontal outlets need only a section of vertical pipe that turns downward after leaving the tank (an inverted "L")."

Figure A-6.2.3.1.(1) and (5) and 6.2.3.2.(1) illustrates two examples of site-built heat traps.

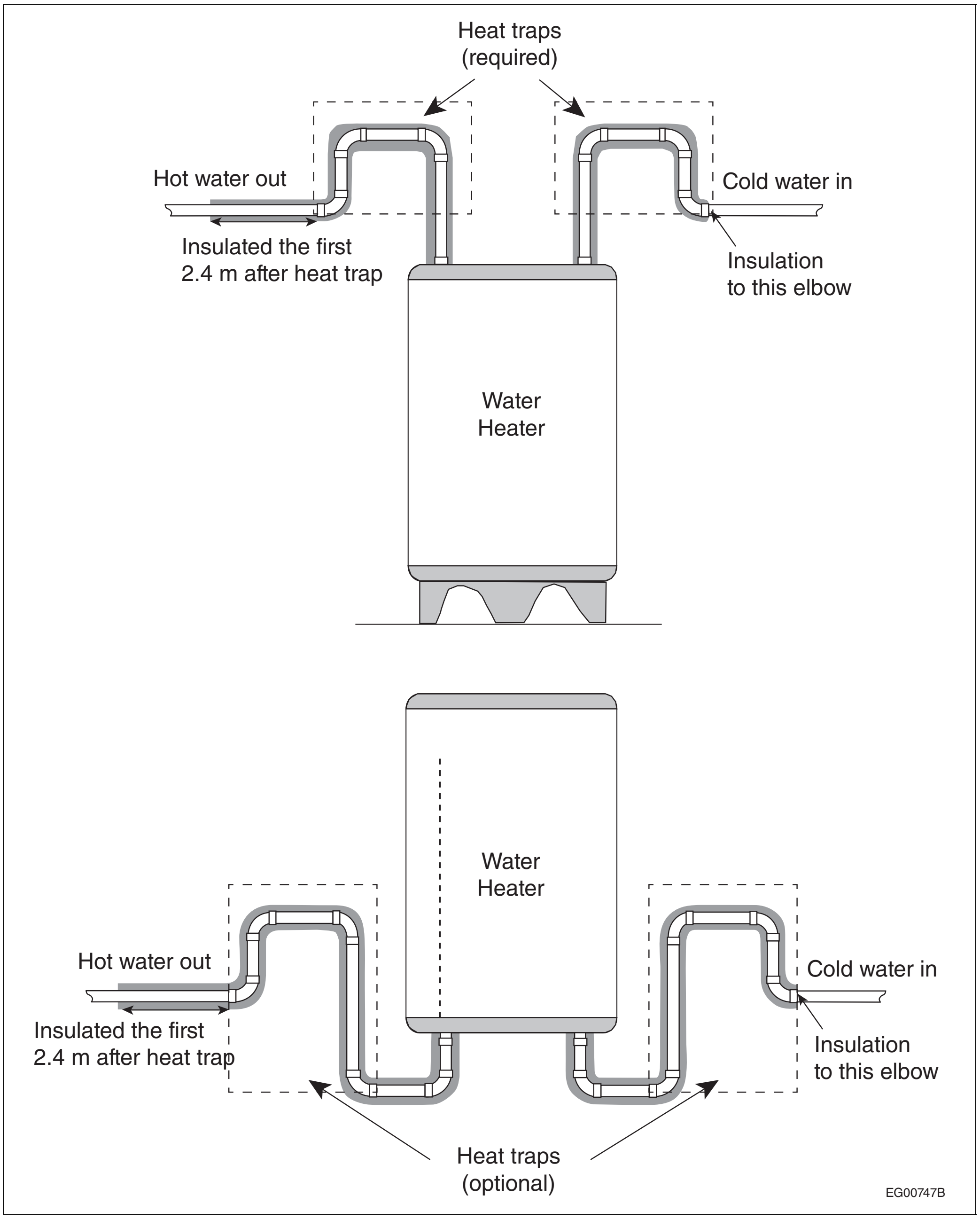

Figure A-6.2.3.1.(1) and (5) and 6.2.3.2.(1)
Heat traps

A-6.2.3.1.(2) and (3) Mean Rating Temperature (MRT). The mean rating temperature can be determined using the following equation:

$$MRT = \frac{(T_{ambient} + T_{operation})}{2}$$

where
$T_{ambient}$ = ambient temperature of room in which pipe is located, and
$T_{operation}$ = temperature of service water being conveyed in pipe.

A-6.2.4.2.(1) Shutdown. Sentence 6.2.4.2.(1) is intended to apply to seasonal or long-term shutdown of the service water heating system. For electrical water heaters, a breaker approved for use as a disconnect and installed in the distribution panel can act as the required shut-off device. For gas water heaters, a down position on the temperature control, which sets the heater to standby with only the pilot light running, meets this requirement.

A-6.2.5.1.(1) Remote or Booster Heaters. Sentence 6.2.5.1.(1) applies to appliances that require very hot water for their purpose such as dishwashers, etc. The intent is that the general water supply temperature not be raised to meet the hot water requirements of such appliances.

A-6.2.8.2.(1) Sensors for Pressure Booster Systems. Pressure booster systems should have one or more pressure sensors generally located near the fixtures that set the system design pressure, or another type of sensor capable of estimating the pressure near the fixtures.

Part 7
Transformers and Electrical Motors

Part 7
Transformers and Electrical Motors

Section 7.1. General

7.1.1. General

7.1.1.1. Scope

1) This Part is concerned with transformers and electrical motors.

7.1.1.2. Application

1) Except as provided in Sentence (2), this Part applies to all transformers and electrical motors that are connected to the *building*'s electrical service, including those installed outside the *building*.

2) This Part does not apply to existing transformers and electrical motors of electrical systems that are extended to serve *additions*.

7.1.1.3. Compliance

1) Compliance with this Part shall be achieved by following
a) the prescriptive path described in Section 7.2., or
b) the performance path described in Section 7.4. (see Note A-3.1.1.3.(1)(c)).

7.1.1.4. Definitions

1) Words that appear in italics are defined in Article 1.4.1.2. of Division A.

Section 7.2. Prescriptive Path

7.2.1. Deleted

7.2.2. Deleted

7.2.3. Transformers

7.2.3.1. Transformer Selection

1) Transformers shall conform to the efficiency requirements in the Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulations. (See Note A-5.2.12.1.(1), 6.2.2.1.(1), 7.2.3.1.(1) and 7.2.4.1.(1).)

7.2.4. Electrical Motors

7.2.4.1. Efficiency

1) Permanently wired polyphase motors serving the *building* shall have a nominal full-load motor efficiency compliant with the Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulations. (See Note A-5.2.12.1.(1), 6.2.2.1.(1), 7.2.3.1.(1) and 7.2.4.1.(1).)

Section 7.3. Reserved

Section 7.4. Performance Path

(See Note A-1.1.2.1.)

7.4.1. General

7.4.1.1. Scope

1) Where transformers and electrical motors do not comply with the requirements of Section 7.2., they shall comply with Part 8.

Section 7.5. Objective and Functional Statements

7.5.1. Objective and Functional Statements

7.5.1.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in this Part shall be the objective and functional statements listed in Table 7.5.1.1. (See Note A-1.1.3.1.(1).)

Table 7.5.1.1.
Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 7
Forming Part of Sentence 7.5.1.1.(1)

Functional Statements and Objectives[1]	
7.2.3.1. Transformer Selection	
(1)	[F97,F98-OE1.1]
7.2.4.1. Efficiency	
(1)	[F97,F98,F99-OE1.1]

Notes to Table 7.5.1.1.:

(1) See Parts 2 and 3 of Division A.

Part 8
Building Energy Performance Compliance Path

Part 8
Building Energy Performance Compliance Path

Section 8.1. General

8.1.1. General

8.1.1.1. Scope

1) Compliance with this Code is permitted to be achieved by applying the provisions of this Part. (See Note A-1.1.2.1.)

8.1.1.2. Application

(See Note A-8.1.1.2.)

1) This Part applies only to *buildings*
a) whose function is known,
b) for which the *building envelope* is defined in the plans and specifications, and
c) for which, except as provided in Sentence (2), sufficient information is known about their components, materials and assemblies that are covered by the scope of this Code.

2) Where insufficient information is known about the *building*'s components, materials and assemblies, the applicable prescriptive requirements in Sections 4.2., 5.2., 6.2. and 7.2. shall apply.

3) If, during construction, the design is found to be altered from the one used in the original performance assessment and the alteration reduces the *building*'s performance, the *building* shall be reassessed for compliance with this Part.

4) Except as provided in Sentence (5), the procedures stated in this Part shall be applied to a single *building* at a time.

5) Where the structure is divided by *firewalls* into multiple *buildings*, the whole structure is permitted to be treated as one *building*.

8.1.1.3. Definitions

1) Words that appear in italics are defined in Article 1.4.1.2. of Division A.

Section 8.2. Reserved

Section 8.3. Reserved

Section 8.4. Performance Path

8.4.1. Compliance

(See Note A-8.4.1.)

8.4.1.1. General

1) The performance path shall take into consideration the energy needs of the *building* components in accordance with the prescriptive requirements of Sections 3.2., 4.2., 5.2., 6.2. and 7.2. for the climate zone under consideration.

2) Where the construction techniques, systems or *building* components used are more energy-efficient than those prescribed by the prescriptive requirements, the performance compliance calculations are permitted to take this increased performance level into account in the determination of the *annual energy consumption*, provided it can be quantified and is not dependent on occupant behaviour.

3) *Exterior lighting* must be excluded from the performance compliance calculations.

8.4.1.2. Determination of Compliance

1) Subject to the limitations stated in Article 8.4.1.3., compliance with this Part shall be determined based on Sentences (2) to (4).

2) The *annual energy consumption* of the proposed *building*, as determined in accordance with this Part, shall not exceed the *building energy target* of the reference *building*.

3) The number of cumulative hours during which heating or cooling needs are not met shall not exceed 300 hours in a simulated year for both the proposed and reference *buildings*. (See Note A-8.4.1.2.(3) and (4).)

4) The number of cumulative hours during which the heating or cooling needs of the proposed *building* are not met during a simulated year shall be less than or equal to the number of hours corresponding to the reference *building*. (See Note A-8.4.1.2.(3) and (4).)

8.4.1.3. Limitations

1) Compliance with this Part shall be subject to the limitations stated in Sections 3.4., 4.4., 5.4., 6.4. and 7.4.

8.4.1.4. Treatment of Additions

1) For the purpose of performance compliance calculations, the assessment of *additions* shall be based on the *addition* being considered by itself.

2) Where the *HVAC systems* of the existing *building* are extended to serve the *addition*, they shall be modeled for the proposed *building*
a) as if they met the prescriptive requirements of the Code, or
b) using the characteristics of the existing *HVAC systems* (see Note A-8.4.1.4.(2)(b)).

3) Where the dividing *partition* between the existing *building* and the *addition* divides *conditioned spaces* that must be maintained at temperatures varying by more than 10°C at design conditions, the thermal exchanges between the *addition* and the existing *building* shall be considered in the modeling. (See Note A-8.4.1.4.(3).)

8.4.2. Compliance Calculations

(See Note A-8.4.2.)

8.4.2.1. General

1) Compliance with this Part shall be assessed through modeling that conforms to specifications detailed in this Part.

8.4.2.2. Calculation Methods

1) Except as provided in Article 8.4.3.9., only the programs that have not shown any major failure or limitation following tests provided for in ANSI/ASHRAE 140, "Evaluation of Building Energy Analysis Computer Programs," except Sections 7 and 8, may be used for the modeling provided for in this Part. (See Note A-8.4.2.2.(1).)

2) The same program shall be used to determine the *annual energy consumption* of the proposed *building* and the *building energy target* of the reference *building*.

3) The programs shall
- a) consider the internal loads, in particular those due to occupants, activities and processes
  - i) using actual values, when they are known, or
  - ii) in the absence of actual values, using representative values (see Note A-8.4.3.8.(1)), and
- b) include the energy consumption of the systems that have an impact on the energy consumption of the *building*, including those of
  - i) *HVAC systems*,
  - ii) *interior lighting* devices,
  - iii) *service water* heating equipment, and
  - iv) elevators, moving walkways and escalators.

(See Note A-8.4.2.2.(3).)

4) The programs shall account for
- a) sensible and latent heat transfers due to the internal loads in Sentence (3) other than those of *interior lighting* devices,
- b) the sensible heat transfer due to *interior lighting* devices
  - i) in their illumination space, and
  - ii) in return air in *HVAC systems*,
- c) the dynamic evolution of the temperature in the spaces,
- d) the effect of thermal mass, and
- e) air leaks through the *building envelope*.

5) The programs shall be performed for a one-year period (8 760 h) using time intervals no greater than one hour.

6) Operating schedules and climatic data input in the programs shall use a time interval no greater than one hour.

7) The internal loads shall be adjusted for each time interval referred to in Sentence (5) based on the applicable operating schedules. (See Notes A-8.4.3.2.(1) and A-8.4.3.8.(1).)

8) Energy consumption of back-up equipment is permitted to be excluded from the energy model, provided it is equipped with controls that operate the equipment only when the backed-up equipment is not operating.

8.4.2.3. Climatic Data

(See Note A-8.4.2.3.)

1) The programs shall use as input climatic data, whose temperature, humidity and insolation, derived from climatic data,
- a) were shown to be good representations of the climate at the *building* site compared to the average of at least 10 years of measured data, and
- b) were collected at the weather station nearest to the *building* site.

2) For urban regions with several climatic data sets and for locations where weather data are not available, the programs shall consider as input available weather data that best represents the climate at the *building* site.

8.4.2.4. Deleted

8.4.2.5. Deleted

8.4.2.6. Heat Transfer Between Thermal Blocks

1) Where the temperature difference between two adjacent *thermal blocks* is greater than 10°C, the programs shall account for heat transfer between those *thermal blocks*.

2) Where the adjacent *thermal blocks* referred to in Sentence (1) are not fully separated by solid *partitions* or solid *building* elements, the programs shall use a heat transfer coefficient of 0.35 W/(m^2·K).

8.4.2.7. Deleted

8.4.2.8. Building Envelope

(See Note A-8.4.2.8.)

1) Programs shall account for heat transfers through the *building envelope*, due to solar radiation and indoor and outdoor temperature difference of the *building envelope*.

2) Programs shall account for the thermodynamic behaviour of *opaque building assemblies* and other assemblies such as floors and interior walls.

3) Programs shall account for heat transfers due to solar absorptance and transmittance and the orientation and optical characteristics of each surface.

4) Except as provided in Sentence 8.4.3.3.(6), the *effective thermal resistance* of *opaque building assemblies* shall be derated in accordance with Sentences 3.3.1.3.(2) and (3). (See Note A-8.4.2.8.(4).)

5) The derated *effective thermal resistance*, calculated in accordance with Sentence (4), may be determined for an entire *opaque building assembly*, provided that the adjacent *temperature-control zones* are maintained at temperatures that vary by not more than 10°C. (See Note A-8.4.2.8.(5).)

8.4.2.9. Manually Operated Shading Devices

1) The energy model shall not include the effect of manually operated shading devices such as blinds and shades.

8.4.2.10. HVAC Systems

1) *HVAC systems* shall be modeled according to the established program conventions, without substituting their components with thermodynamically similar components or using approximated calculations.

2) Programs shall account for the effect of *HVAC systems* on supply and return air temperature and on that of *conditioned spaces* including

a) temperature rise of air due to heat from constant, variable or multiple speed fans,
b) fan power as a function of modulation of supply airflow,
c) temperature or humidity rise or drop of supply or return air due to sensible and latent heat transferred from a heat-recovery device, and
d) temperature rise of the outdoor air due to preheaters.

3) Programs shall account for the variation of efficiency and capacity of the *HVAC systems* as a function of part load of the systems. (See Note A-8.4.2.10.(3).)

4) Where the program requires an individual efficiency rate of an equipment component of an *HVAC system*, the global efficiency rate of the equipment shall be adjusted accordingly before being entered into the program. (See Note A-8.4.2.10.(4).)

5) Programs shall be able to assess the peak load according to the design conditions and to size accordingly the equipment and other components of the *HVAC system*.

8.4.3. Annual Energy Consumption of Proposed Building

8.4.3.1. General

1) The *annual energy consumption* of the proposed *building* shall be calculated as described in this Subsection.

2) Except as stated otherwise in this Subsection, the energy model shall be consistent with the proposed *building*'s plans and specifications including proper accounting of
a) *fenestration*, doors and *opaque building assembly* types and areas,
b) lighting systems and controls,
c) the delimitation of the *temperature-control zones*,
d) *HVAC system* types, capacities and controls,
e) *service water* heating system types, capacities and controls, and
f) electrical systems.

8.4.3.2. Operating Schedules

1) The operating schedules of the energy model shall be established
a) using the planned operating schedules, where they are known, or
b) in the absence of planned operating schedules, using operating schedules representative of the type of proposed *building* or functions of spaces.
(See Note A-8.4.3.2.(1).)

8.4.3.3. Building Envelope Components

1) Where the solar absorptance of an *opaque building assembly* is not known, the energy model shall use a constant value of 0.7.

2) Where the modeler takes into account *fenestration* shading effects, the following conditions shall be complied with:
a) the energy model shall include permanent shading devices, such as sun screens and reflective sills, and automated shading devices,
b) the energy model shall include the surrounding shading effects from, for example, nearby *buildings* and landscaping elements,
c) the energy model shall include the shading effects from the *building* itself, for example, caused by balconies, overhanging floors and the other wings of the *building*, and
d) the solar heat gain and the visible solar transmittance coefficient of the *fenestration* of all the *building* shall be multiplied by an adjustment factor of 0.9.
(See Note A-8.4.3.3.(2).)

3) Where the modeler does not take into account *fenestration* shading effects,
a) the solar heat gain coefficient and the visible solar transmittance coefficient of the *fenestration* of all the *building* shall be multiplied by an adjustment factor of 0.8. (see Note A-8.4.3.3.(3)(a)), and
b) two adjacent outside surfaces whose azimuth or slope differ by not more than 45° may be modeled as a single surface.

4) The air leakage rate of the total above-ground gross areas of walls and roofs shall be set to a constant value of 0.25 L/(s·m²). (See Note A-8.4.3.3.(4).)

5) Where an *opaque building assembly* covers less than 5% of the total area of a wall or roof, the assembly may be excluded from the energy model, provided that the area is included in the adjacent *opaque building assembly* with
a) an *effective thermal resistance* that differs by less than 20%, and
b) an azimuth or slope that differs by not more than 45°.

6) Where multiple *opaque building assemblies* have the same orientation, the energy model may use the same derated *effective thermal resistance* value for those assemblies, calculated as provided in Sentence 3.3.1.3.(2) using

a) the following three values:
   i) the least performing *effective thermal resistance*, RSI_{Ei}, in $(m^2 \cdot K)/W$, of the *opaque building assemblies*,
   ii) the least performing *linear thermal transmittance*, Ψ, in $W/(m \cdot K)$, of the *opaque building assemblies* for each of the types of intersections, and
   iii) the least performing *point thermal transmittance*, Χ, in W/K, of the *opaque building assemblies* for each of the types of penetrations, or

b) the following three values:
   i) the weighted *effective thermal resistance*, $RSI_{Eweighted}$, in $(m^2 \cdot K)/W$, calculated using the following equation:

$$RSI_{Eweighted} = \frac{\sum_{i=1}^{n} (A_i)}{\sum_{i=1}^{n} \left(\frac{A_i}{RSI_{Ei}} \right)}$$

where

n = total number of *opaque building assemblies*,

A_i = area of *opaque building assembly* i, calculated in accordance with the requirements of Article 3.1.1.6., in m^2, and

RSI_{Ei} = *effective thermal resistance* of *opaque building assembly* i, in $(m^2 \cdot K)/W$,

ii) the weighted *linear thermal transmittance* for each of the types j intersections, $\Psi_{weighted,j}$, in W/(m·K), calculated using the following equation:

$$\Psi_{weighted,j} = \frac{\sum_{i=1}^{n} (\Psi_i \cdot L_i)}{\sum_{i=1}^{n} (L_i)}$$

where

n = total number of *opaque building assemblies*,

Ψ_I = *linear thermal transmittance* of the type j intersection present on *opaque building assembly* i, in W/(m·K), and

L_I = length of the type j intersection occurring on *opaque building assembly* i, in m, and

iii) the weighted *point thermal transmittance* for each of the types j penetrations, $x_{weighted, j}$, in W/K, calculated using the following equation:

$$X_{weighted,j} = \frac{\sum_{i=1}^{n} (X_i \cdot N_i)}{\sum_{i=1}^{n} (N_i)}$$

where

n = total number of *opaque building assemblies*,

X_i = *point thermal transmittance* of the type j penetration occurring on *opaque building assembly* i, in W/K, and

N_i = number of type j point penetrations occurring on the *opaque building assembly*.

7) Performance exchanges with *opaque building assemblies* in contact with the ground may be considered in the model on the following conditions:

a) the program shall not use methods based on regression analyses or on analytical calculations to calculate the annual heat transfer of *opaque building assemblies* in contact with the ground,

b) the program shall permit accurate modeling of the arrangement of the insulation and the properties of *opaque building assemblies* in contact with the ground, and

c) the calculation methods implemented by the programs shall be identical for the proposed and reference *buildings*.

(See Note A-8.4.3.3.(7).)

8) Where the *effective thermal resistance* of the opaque section of curtain walls has not been determined in accordance with Sentence 3.1.1.5.(6), the values in Sentence 3.3.1.3.(4) shall be used in the proposed *building*.

8.4.3.4. Interior Lighting

1) *Dwelling units* shall be modeled with an installed lighting power density of 5 W/m².

2) Where the proposed *building* contains controls based on space occupancy, personal controls or photocontrols, the lighting power connected to the control shall be multiplied by the factor for occupancy control, $F_{occ,i}$, the factor for personal control,

$F_{pers,i}$, and the factor for photocontrol, F_{pho}, as determined in accordance with the following equations:

a) for the factor for occupancy control, $F_{occ,i}$:

$$F_{occ,i} = 1 - (C_{A,i} \cdot C_{occ,ctrl,i})$$

where

$C_{A,i}$ = factor to account for the relative absence of occupants in the space determined using Table 8.4.3.4.-A,

$C_{occ,ctrl,i}$ = factor to account for the occupancy-sensing mechanism determined using Table 8.4.3.4.-B,

b) for the factor for personal control, $F_{pers,i}$:

$$F_{pers,i} = 1 - C_{pers,ctrl,i}$$

where

$C_{pers,ctrl,i}$ = factor to account for personal control determined using Table 8.4.3.4.-A, and

c) for the factor for photocontrol, $F_{pho,i}$:

$$F_{pho,i} = 1 - C_{pho,i}$$

where

$C_{pho,i}$ = factor to account for the reduction of photocontrol power determined in accordance with Sentence (3).

(See Note A-8.4.3.4.(2).)

Table 8.4.3.4.-A
Factors for Relative Absence of Occupants and Personal Control According to Space Type
Forming Part of Sentence 8.4.3.4.(2)

Space Types	Factors	
	Relative Absence of Occupants, $C_{A,i}$	Personal Control(1), $C_{pers,ctrl,i}$
Common Space Types		
Atrium	0	0 0.1 where C2
Audience seating area – permanent		
for auditorium	0.3	0
for convention centre	0.2	0
for gymnasium	0	0
for motion picture *theatre*	0	0
for penitentiary	0	0
for performing arts *theatre*	0	0
for religious building	0.3	0
for sports arena	0	0
other	0	0
Banking activity area and offices	0	0
Classroom/Lecture hall/Training room		
for penitentiary	0.5	0 0.1 where C2
other	0.5	0 0.1 where C2

Table 8.4.3.4.-A (Continued)

Space Types	Factors	
	Relative Absence of Occupants, $C_{A,i}$	Personal Control[(1)], $C_{pers,ctrl,i}$
Conference/Meeting/Multi-purpose room	0.5	0 0.1 where C2
Confinement cell	0	0
Copy/Print room	0.2	0
Corridor/Transition area		
for hospital	0	0 0.1 where C2
for manufacturing facility	0	0 0.1 where C2
for space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living,” and used primarily by residents	0	0 0.1 where C2
other	0	0 0.1 where C2
Courtroom	0.2	0 0.1 where C2
Dining area		
for bar lounge/leisure dining	0	0 0.1 where C2
for cafeteria or fast-food dining	0	0 0.1 where C2
for family dining	0	0 0.1 where C2
for penitentiary	0	0 0.1 where C2
for space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living,” and used primarily by residents	0	0 0.1 where C2
other	0	0 0.1 where C2
Dressing room for performing arts *theatre*	0.4	0
Electrical/Mechanical room	0.9	0
Emergency vehicle garage	0.5	0 0.1 where C2
Food preparation area	0	0
Guest room	0	0
Laboratory		
for classroom	0.4	0 0.1 where C2
other	0	0
Laundry/Washing area	0	0
Loading dock – interior	0	0
Lobby		
for elevator	0	0 0.1 where C2
for hotel	0	0 0.1 where C2
for motion picture *theatre*	0	0 0.1 where C2
for performing arts *theatre*	0	0 0.1 where C2

Table 8.4.3.4.-A (Continued)

Space Types	Factors	
	Relative Absence of Occupants, $C_{A,i}$	Personal Control[(1)], $C_{pers,ctrl,i}$
for space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living," and used primarily by residents	0	0 0.1 where C2
other	0	0 0.1 where C2
Locker room	0.5	0
Lounge/Break room		
for health care facility	0	0
other	0	0
Office		
enclosed	0.3	0 0.05 where C1 or C2
open plan	0.2	0 0.05 where C1 or C2 0.25 where C3 0.3 where C4
Pharmacy area	0	0
Sales area	0	0
Seating area – general	0	0
Server room	0.7	0
Stairway, except stairwell	0	0
Stairwell	0	0
Storage garage – interior	0.4	0 0.1 where C2
Storage room	0.6	0
Vehicle maintenance area	0	0
Washroom		
for space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living," and used primarily by residents	0.5	0
other	0.5	0
Workshop	0	0
Building-Specific Space Types		
Space Types	Factors	
	Relative Absence of Occupants, $C_{A,i}$	Personal Control,[(1)] $C_{pers,ctrl,i}$
Convention centre – exhibit space	0	0
Dormitory – living quarters	0	0
Fire station – sleeping quarters	0	0
Gymnasium/Fitness centre		
exercise area	0	0.1 where C2
playing area	0	0.1 where C2

Table 8.4.3.4.-A (Continued)

Building-Specific Space Types		
Space Types	Factors	
	Relative Absence of Occupants, $C_{A,i}$	Personal Control,[1] $C_{pers,ctrl,i}$
Health care facility		
exam/treatment room	0.3	0
imaging room	0	0
medical supply room	0.5	0
nursery	0	0
nurses' station	0	0
operating room	0.1	0
patient room	0.1	0
physical therapy room	0.2	0
recovery room	0	0
Library		
reading area	0	0
stacks	0	0
Manufacturing facility		
detailed manufacturing area	0	0
equipment room	0.2	0
extra high bay area (> 15 m floor-to-ceiling height)	0	0
high bay area (7.5 m to 15 m floor-to-ceiling height)	0	0
low bay area (< 7.5 m floor-to-ceiling height)	0	0
Museum		
general exhibition area	0.2	0
restoration room	0.3	0
Post office – sorting area	0	0
Religious *building*		
fellowship hall	0.3	0
worship/pulpit/choir area	0.1	0
Retail facility		
dressing/fitting room	0.4	0
mall concourse	0	0 0.1 where C2
Space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living”		
chapel (used primarily by residents)	0.5	0
recreation room (used primarily by residents)	0.2	0
Sports arena – playing area		
playing area with facilities for more than 5000 spectators	0	0
playing area with facilities for more than 2000 spectators and not more than 5000 spectators	0	0
playing area with facilities for more than 200 spectators and not more than 2000 spectators	0	0
playing area with facilities for less than 200 spectators or without facilities for spectators	0	0

Table 8.4.3.4.-A (Continued)

Building-Specific Space Types		
Space Types	Factors	
	Relative Absence of Occupants, $C_{A,i}$	Personal Control,[1] $C_{pers,ctrl,i}$
Transportation facility		
airport concourse	0	0
baggage/carousel area	0	0
terminal ticket counter	0	0
Warehouse – storage area		
medium to bulky palletized items	0.5	0
small hand-carried items[2]	0.5	0

Notes to Table 8.4.3.4.-A:

(1) Controls C1, C2, C3 and C4 are defined in Table 4.2.1.6.

(2) See Note A-Table 4.2.1.6.

Table 8.4.3.4.-B
Factor to Account for Occupancy-Sensing Mechanism, $C_{occ,ctrl,i}$
Forming Part of Sentences 8.4.3.4.(2) and 8.4.4.5.(3)

Occupancy-Sensing Mechanism	$C_{occ,ctrl,i}$
Automatic full off (full on)	0.67
Automatic full off (restricted to manual on or automatic partial on)	0.75
Automatic partial off (restricted to manual on)	0.34
Manual (on/off or bi-level)	0.30
None	0

Table 8.4.3.4.-C
Factor to Account for Reduction of Photocontrol Power, $C_{pho,i}$
Forming Part of Sentences 8.4.3.4.(2) and (3)

Photocontrol Mechanism	$C_{pho,i}$
Bi-level photocontrol	0.1
Continuous dimming photocontrol	0.3
Multi-level photocontrol	0.2
None	0

3) The factor for photocontrol, $F_{pho,i}$, may be determined by
a) Table 8.4.3.4.-C, or
b) a program whose functions consist in performing detailed calculations of daylighting and the dynamic response of photocontrols.

4) The use of the factor for photocontrol, $F_{pho,i}$, is permitted to reduce the *installed interior lighting power*
a) where lighting devices are in a daylighted space and are connected to photocontrols, and
b) where the setpoint of lighting devices connected to photocontrols is representative of the use of the space without task lighting.
(See Note A-8.4.3.4.(4).)

8.4.3.5. Purchased Energy

(See Note A-8.4.3.5.)

1) Where the proposed *building* uses purchased energy for space heating or cooling or *service water* heating, Sentences (2) to (5) shall apply.

2) Where purchased energy is used for heating, the equipment used to provide this energy shall be modeled as an electrical modulating *boiler* that
a) is sized for the peak heating load provided by the purchased energy system, and
b) has a constant efficiency of 100% independently from the load.

3) Where purchased energy is used for cooling, the equipment used to provide this energy shall be modeled as an electric air-cooled chiller that
a) is sized for the peak cooling load provided by the purchased energy system, and
b) complies with Table 8.4.3.5.

Table 8.4.3.5.
Type and Performance Levels of Chiller Providing Purchased Energy
Forming Part of Sentences 8.4.3.5.(3) and 8.4.4.6.(2)

Cooling Capacity, kW (Btu/h)	Type	COP	IPLV
< 528 (1 800 000)	Scroll	2.802	3.664
≥ 528 (1 800 000)	Screw	2.802	3.737

4) Where purchased energy is used for *service water* heating, the equipment used to provide this energy shall be modeled as an electrical *service water heater* that
a) is sized for the peak heating capacity provided by the purchased energy system,
b) has a constant efficiency of 100% independently from the load, and
c) where the purchased energy is used to heat *service water* in a heater with a proposed storage tank, has the same storage capacity.

5) The operating schedule, priority of use and other operational characteristics of the purchased energy shall be included in the energy model.

8.4.3.6. HVAC Systems

1) Except as provided in Sentence (2), the program shall provide that the exhaust airflow and outdoor air ventilation of each *HVAC system* are not less than the minimum flows required by the NBC. (See Note A-8.4.3.6.(1).)

2) For the purposes of the energy model, it is permitted to consider that the air distribution flow of a *temperature-control zone* of the proposed *building* be divided by 1.2
a) where the distribution air is circulated
i) through the floor,
ii) at a temperature less than that of the *temperature-control zone*,
iii) unidirectionally, and
iv) at low velocity, and
b) where return air is captured by the ceilings.
(See Note A-8.4.3.6.(2).)

3) Part-load operation of *HVAC systems*' equipment of the proposed *building* shall be modeled
a) from the equipment technical characteristics, where they are known and the program is able to model the part load of *HVAC system*'s equipment, or
b) in other cases
i) in accordance with the performance curves under part load in Tables 8.4.4.21.-A to 8.4.4.21.-I, or
ii) with the operating curves under default part load provided for in the programs provided that they are representative.
(See Note A-8.4.3.6.(3).)

8.4.3.7. Temperature-control Zones

1) Each *temperature-control zone* of the proposed *building* shall be modeled in one of the following manners:
a) heated, if only heating *HVAC systems* are provided or planned,
b) cooled, if only cooling *HVAC systems* are provided or planned, or
c) heated and cooled, if heating and cooling *HVAC systems* are provided or planned.

2) Except as provided in Sentence (4), where the spaces served by the *HVAC system* are specified in the plans and specifications, each space shall be modeled as a single *temperature-control zone*.

3) Except as provided in Sentence (4), where the spaces served by the *HVAC system* are not entirely specified in the plans and specifications, the spaces shall be modeled in several *temperature-control zones* delimited as follows:
a) an indoor *temperature-control zone*, delimited at 4.5 m from the outdoor glazed facade,
b) one or more peripheral *temperature-control zones* delimited between
   i) the indoor *temperature-control zone* in Clause (a),
   ii) the outdoor glazed facades, and
   iii) the location where the azimuth of an outdoor glazed facade varies by more than 45° in relation to another adjacent outdoor glazed facade, and
c) *temperature-control zones* delimited by *storey*.
(See Note A-8.4.3.7.(3).)

4) The grouping of *temperature-control zones* in *thermal blocks* is permitted.

8.4.3.8. Internal and Service Water Heating Loads

1) The internal loads and the needs in *service water* used in calculating energy compliance shall be representative of the functions of the spaces or the type of proposed *building*. (See Note A-8.4.3.8.(1).)

8.4.3.9. Energy Recovered on Site and Renewable Energy Produced on Site

1) Where the proposed *building* uses technologies for recovering energy that are not required in Subsection 5.2.10., it is permitted to subtract that energy from the *annual energy consumption*, if it is not intended for sale. (See Note A-8.4.3.9.(1) and (2).)

2) Where the proposed *building* uses technologies for producing renewable energy on site, it is permitted to subtract that energy from the *annual energy consumption*, up to 5% of the *annual energy consumption*, if it is not intended for sale. (See Note A-8.4.3.9.(1) and (2).)

3) Where the program in Article 8.4.2.2. does not have the function of modeling the technology in Sentences (1) and (2), it is permitted to quantify the energy recovered on site or the renewable energy produced on site by using another tool or another calculation method covering a one-year period (8 760 h).

8.4.4. Building Energy Target of the Reference Building

8.4.4.1. General

1) The *building energy target* of the reference *building* shall be calculated based on the parameters described in this Subsection.

2) The components and systems of the reference *building* shall meet the prescriptive requirements of Sections 3.2., 4.2., 5.2., 6.2. and 7.2. (See Note A-8.4.4.1.(2).)

3) The energy model calculations shall include all the energy uses addressed in Sections 3.2., 4.2., 5.2., 6.2. and 7.2.

4) Except as noted otherwise in this Subsection and in Subsection 8.4.3., the following characteristics of the reference *building* shall be modeled as being identical to those of the proposed *building*:

a) total floor area of *conditioned* and unconditioned spaces,
b) use of *building* spaces,
c) number, type and need for heating or cooling *thermal blocks* and *temperature-control zones*,
d) shape and exterior dimensions, including contiguous ground level,
e) orientation,
f) air leakage rates,
g) solar heat gain coefficient and visible solar transmittance coefficient of *fenestration*,
h) *fenestration* shading effects due to surrounding elements and those from the *building* itself,
i) insulation arrangement and *effective thermal resistance* of *opaque building assemblies* in contact with the ground,
j) thermal mass of *building envelope*,
k) operating schedules,
l) setpoint temperatures and humidity of spaces,
m) setpoint *service water* heating temperature,
n) temperature of water from the public distribution network or a private source,
o) plug loads,
p) values associated to activities and processes, such as power, energy sources and heat produced,
q) *HVAC systems* associated only to processes,
r) densities of *installed interior lighting power* of *dwelling units*,
s) factor for occupancy control determined in accordance with Clause 8.4.3.4.(2)(a),
t) radiating and convective distribution of heat gains emitted by lighting,
u) *interior lighting* for the functions, spaces or equipment referred to in Sentence 4.2.1.4.(4),
v) occupancy densities,
w) sensible heat and latent heat produced by occupants,
x) location, orientation and dimensions of *fenestration*, and
y) thermal properties of ground, such as thermal conductivity, specific heat and density.

(See Note A-8.4.4.1.(4).)

5) Climatic data used in compliance calculations for the proposed *building* shall be applied as being identical in the reference *building*.

6) Where the proposed *building* uses an energy source, that energy source shall also be present for the same purposes in the modeling of the reference *building*.

7) Where the proposed *building* uses more than one energy source, the power ratios between the energy sources and priority of use of those sources in the proposed *building* shall be modeled as being identical in the reference *building*.

8) Except as provided in Sentence (9), the energy efficiency of the reference *building* equipment shall

a) comply with Articles 5.2.12.1., 6.2.2.1., 7.2.3.1. and 7.2.4.1., or
b) in the absence of applicable values under Clause (a), be identical to that of the proposed *building*'s corresponding equipment.

(See Note A-8.4.4.1.(8) and (9).)

9) The use, in modeling the reference *building*, of the minimum equipment energy efficiency provided for in the Energy Efficiency Act (S.C. 1992, c. 36) and its regulations, is permitted
a) where that equipment is covered by the Energy Efficiency Act (S.C. 1992, c. 36) and its regulations, and
b) where that equipment is not covered by the Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulations.
(See Note A-8.4.4.1.(8) and (9).)

8.4.4.2. Deleted

8.4.4.3. Building Envelope Components

1) The solar absorptance of *opaque building assemblies* shall be set at 0.7.

2) Where, in the proposed *building*, the ratio in Sentence 3.2.1.4.(1) is greater than 40%, the ratio shall be set, in the reference *building*, at 40% of the gross wall area
a) by proportionally reducing the area of each of the doors and each of the *fenestration* elements, excluding *skylights*, and
b) so that the relative opening proportion on each of the proposed *building* orientations is identical to that of the reference *building*.

3) Where, in the proposed *building*, the ratio in Sentence 3.2.1.4.(2) is greater than 3%, the ratio shall be set, in the reference *building*, at 3% of the gross roof area by proportionally reducing the area of each of the *skylights*.

4) Modeling permanent shading devices such as sun breakers and reflecting sills, and automated shading devices is not permitted. (See Note A-8.4.4.3.(4).)

5) Where performance exchanges with *opaque building assemblies* in contact with the ground shall be considered in the proposed *building*, in accordance with Sentence 8.4.3.3.(7), those assemblies shall be modeled in the reference *building* so as to comply with the requirements of Subsection 3.2.3.

8.4.4.4. Thermal Mass

1) The thermal characteristics of the reference *building*'s *building envelope* is permitted to be modeled as being identical to those of lightweight construction having a weight of 55 kg/m^2 and a thermal capacity of 50 kJ/(m^2·K). (See Note A-8.4.4.4.(1).)

2) The thermal characteristics of the reference *building*'s space shall be modeled as being identical to those of the proposed *building*. (See Note A-8.4.4.4.(2).)

8.4.4.5. Lighting

1) Except as provided in Sentences (2) and (3), the *installed interior lighting power* of the reference *building* shall be set at the *interior lighting power allowance* determined in Article 4.2.1.5. or 4.2.1.6., as applicable.

2) *Dwelling units* shall be modeled with an installed lighting power density of 5 W/m^2.

3) Where controls based on space occupancy are provided in the proposed *building*, the lighting power related to that control in the reference *building* shall be multiplied by the same factor for occupancy control, $F_{occ,i}$, as determined in accordance with Article 8.4.3.4. for the appropriate occupancy-sensing mechanism.

8.4.4.6. HVAC Systems and Water Heating Systems

1) The reference *building*'s corresponding equipment shall be modeled in accordance with the requirements in Sentences 8.4.3.5.(2) to (5)
a) where the heating equipment of the proposed *building* uses purchased energy, or
b) where the cooling equipment of the proposed *building* uses purchased energy.

2) Where the proposed *building* uses a heat pump for heating, the reference *building*'s corresponding equipment shall

a) be sized for the peak heating load of the heating system, in accordance with Sentence 8.4.2.10.(5), and

b) use electricity as energy source and be modeled

  i) in a hydronic loop compliant with the requirements of Sentence 8.4.4.9.(2), where the heat pump is on a water loop, a water-source or ground-source, or

  ii) as equipment with an electric resistance in accordance with the requirements of Sentence 8.4.4.9.(4), in the case of an air-source heat pump.

(See Note A-8.4.4.6.(2) and (3).)

3) Where the proposed *building* uses a heat pump for cooling, the reference *building*'s corresponding equipment shall be a chiller and shall

a) be sized for the peak cooling load of the cooling system, in accordance with Sentence 8.4.2.10.(5),

b) use electricity as energy source and be modeled as

  i) an air chiller, in accordance with Sentence 8.4.4.10.(2), where the heat pump is a water-source or ground-source heat pump,

  ii) a water chiller, in accordance with Sentence 8.4.4.10.(2), where the heat pump is a water-loop heat pump, or

  iii) a direct-expansion chiller, in accordance with Sentence 8.4.4.10.(3), where the heat pump is an air heat pump, and

c) have a COP varying depending on the load.

(See Note A-8.4.4.6.(2) and (3).)

4) The capacity or flow of an equipment of the *HVAC system* of the reference *building* shall be proportionally adjusted according to the corresponding equipment sizing factor of the proposed *building*'s equipment. (See Note A-8.4.4.6.(4).)

5) The performance characteristics of *HVAC systems* and *service water* heating devices shall be modeled in accordance with part-load performance curves in Tables 8.4.4.21.-A to 8.4.4.21.-I.

6) The reference *building*'s fans of the *HVAC system* shall

a) comply with the requirements of Subsection 5.2.3., or

b) where Subsection 5.2.3. does not apply, have a "peak/flow power demand" identical to that of the proposed *building*'s corresponding fans.

7) The reference *building*'s *HVAC systems* shall comply with the requirements of Subsection 5.2.10.

8) Where the proposed *building* is provided with a commercial cooking ventilation system, the system referred to in Sentence 5.2.13.1.(2) shall be modeled in the reference *building* so that exhaust and compensation flows are reduced to 50% of the rated flows during half of the operating hours.

9) The equipment of the *HVAC system* modeled in the reference *building* shall be controlled in accordance with the requirements of Subsection 5.2.8.

8.4.4.7. HVAC System Selection

1) Each *HVAC system* of the proposed *building* shall have a corresponding *HVAC system* for the reference *building* determined in accordance with Sentences (2) to (4).

2) Except as stated otherwise in this Subsection, each air distribution system modeled in the proposed *building* shall be present in the modeling of the reference *building*. (See Note A-8.4.4.7.(2) and (3).)

Table 8.4.4.7.-A
HVAC System Selection for the Reference Building
Forming Part of Sentence 8.4.4.7.(4)

HVAC System of the Proposed *Building*			*HVAC System* of the Reference *Building*
Type of Dominating Cooling(1) Supplied to One or a Number of *Temperature-control Zones*	Type of Dominating Heating(1) Supplied to One or a Number of *Temperature-control Zones*	Outdoor Air Supplied	
Central system distributing cooled air	Central system distributing heating air or air heated by one or more terminal zone boxes	One *temperature-control zone*	S1a/S1b – Single-zone
		Several *temperature-control zones*	S2a/S2b – Multi-zone
	Forced convection terminal system	One *temperature-control zone*	S1a/S1b/S1c – Single-zone
		Several *temperature-control zones*	S2a/S2b/S2c – Multi-zone
	Single natural convection perimeter system	One *temperature-control zone*	S1a/S1b – Single-zone
		Several *temperature-control zones*	S2a/S2b – Multi-zone
Forced convection terminal system	Central system distributing heating air or air heated by one or more terminal zone boxes	One *temperature-control zone*	S1c – Single-zone
		Several *temperature-control zones*	S2c – Multi-zone
	Forced convection terminal system	One *temperature-control zone*	S3a – 100% outdoor air with local ventilation
		Several *temperature-control zones*	S3b – 100% outdoor air with local ventilation
	Single natural convection perimeter system	One *temperature-control zone*	S3a – 100% outdoor air with local ventilation
		Several *temperature-control zones*	S3b – 100% outdoor air with local ventilation
Induction terminal system(2)	All types of heating	One *temperature-control zone*	S1b – Single-zone
		Several *temperature-control zones*	S2b – Multi-zone
No cooling	Central system distributing heating air or air heated by one or more terminal zone boxes	One *temperature-control zone*	S1d – Single-zone
		Several *temperature-control zones*	S2d – Multi-zone
	Forced convection terminal system	One *temperature-control zone*	S3a – 100% outdoor air with local ventilation
		Several *temperature-control zones*	S3b – 100% outdoor air with local ventilation
	Single natural convection perimeter system	One *temperature-control zone*	S4a – 100% outdoor air without local ventilation
		Several *temperature-control zones*	S4b – 100% outdoor air without local ventilation

Notes to Table 8.4.4.7.-A:

(1) System that takes most of the heating or cooling load, as the case may be.

(2) See Note A-Table 8.4.4.7.-A.

Table 8.4.4.7.-B
S1a, S1b, S1c and S1d Systems – Single-zone, Single-sleeve, Constant Flow
Forming Part of Sentences 8.4.4.7.(4) and 8.4.4.18.(3)

Description	Constant-air-volume system that varies the supply temperature. Control of the system is provided by a zone thermostat. It may be a combined heating and conditioning system installed on the roof or an integrated system served by a chiller-*boiler* assembly.
Supply airflow	Constant, as defined in Article 8.4.4.18.
Supply air temperature	Variable according to the load of the *temperature-control zone*.

Table 8.4.4.7.-B (Continued)

Supply fan	S1a – If the cooling system of the proposed *building* is direct-expansion, the supply fan must provide a static pressure of 325 Pa and have a combined energy efficiency of at least 40%.
	S1b – If the cooling system of the proposed *building* is hydronic, the supply fan must provide a static pressure of 500 Pa and have a combined energy efficiency of at least 50%.
	S1c and S1d – If cooling or heating of the zone is provided only by a forced or natural convection system, or if the proposed *building* does not have a cooling system, the supply fan must provide a static pressure of 200 Pa and have a combined energy efficiency of at least 40%.
	For S1a, S1b, S1c and S1d: – if the proposed *building* has a return fan, the reference *building* shall be modeled with a return fan providing a static pressure of 150 Pa and having an energy efficiency of at least 25%; – possibility of adjusting the reference static pressure in accordance with Sentence 8.4.4.18.(3).
Local fan	S1c – Fan providing the cooling or heating forced convection of the zone. The fan must provide a power of 0.6 W/L/s. Operates on demand when the system is operating.
Outdoor air	As described in Article 8.4.4.15. Where Article 5.2.2.7. applies, the supply is 100% of outdoor air controlled by a fixed dry bulb in accordance with Table 5.2.2.8.-A The economizer system is integrated with the mechanical cooling in accordance with Sentence 5.2.2.7.(3).
Operating schedule	As described in Article 8.4.3.2.
Heating system	As described in Article 8.4.4.9.
Cooling system	As described in Article 8.4.4.10.

Table 8.4.4.7.-C
S2a, S2b, S2c and S2d Systems – Multi-zone, Single-sleeve, Variable Flow
Forming Part of Sentences 8.4.4.7.(4) and 8.4.4.18.(3)

Description	Variable-air-volume and constant supply temperature system. The airflow is determined by the zone variable-air-volume terminal zone boxes. It may be a combined heating and conditioning system installed on the roof or an integrated system served by a chiller-*boiler* assembly type.
Terminal zone boxes	If the proposed *building*'s *temperature-control zone* is supplied by terminal zone boxes with fan, – refer to Sentence 8.4.4.17.(5) to size the minimum and maximum flow of the terminal zone box, – the terminal zone box fan must provide a combined power of 0.74 W/L/s.
	If the proposed *building*'s *temperature-control zone* is supplied by terminal zone boxes without fan, – refer to Sentence 8.4.4.17.(4) to size the minimum and maximum flow of the terminal zone box, – if the terminal zone box is controlled by a direct digital control system, the static pressure setpoint shall be adjusted in accordance with Sentence 5.2.3.3.(5).
Supply airflow	Variable, maximum flow as defined in Article 8.4.4.18.

Table 8.4.4.7.-C (Continued)

Supply air temperature	Variable according to outdoor temperature, – if the outdoor temperature is less than 13°C, the supply temperature is 18°C; – if the outdoor temperature is greater than 18°C, the supply temperature is 13°C; – where the outdoor temperature is between 13°C and 18°C, the supply temperature varies linearly between 18°C and 13°C.
Supply fan	S2a – If the proposed *building*'s cooling system is direct-expansion, the supply fan must provide a static pressure of 750 Pa and have a combined energy efficiency of 45%; if the proposed *building* has a return fan, the reference *building* shall be modeled with a return fan providing a static pressure of 150 Pa and have an energy efficiency of at least 25%.
	S2b – If the proposed *building*'s cooling system is hydronic, the supply fan must provide a static pressure of 1000 Pa and have a combined energy efficiency of 55%; if the proposed *building* has a return fan, the reference *building* shall be modeled with a return fan providing a static pressure of 250 Pa and have an energy efficiency of at least 45%.
	S2c and S2d – If the zone cooling or heating is provided only by a forced or natural convection system, or if the proposed *building* does not have a cooling system, the supply fan must provide a static pressure of 620 Pa and have a combined energy efficiency of 40%; if the proposed *building* has a return fan, the reference *building* shall be modeled with a return fan providing a static pressure of 150 Pa and have an energy efficiency of at least 25%.
	For S2a, S2b, S2c and S2d: – possibility of adjusting the reference static pressure as described in Sentence 8.4.4.18.(3), – part-load curve as described in Table 8.4.4.21.-I – the supply fan shall be modeled as a forward curved fan with inlet vanes.
Local fan	S2c – System fan providing the cooling or heating forced convection of the zone. The fan shall provide a power of 0.6 W/L/s. Operates on demand where the system is operating.
Outdoor air	As described in Article 8.4.4.15. Where Article 5.2.2.7. applies, the supply is 100% outdoor air controlled by a fixed dry bulb in accordance with Table 5.2.2.8.-A.The economizer system is integrated with the mechanical cooling in accordance with Sentence 5.2.2.7.(3).
Operating schedule	As described in Article 8.4.3.2.
Heating system	As described in Article 8.4.4.9.
Cooling system	As described in Article 8.4.4.10.

Table 8.4.4.7.-D
S3a, S3b Systems – 100% Outdoor Air with Local Ventilation for Heating
Forming Part of Sentences 8.4.4.7.(4) and 8.4.4.18.(3)

Description	System conveying 100% outdoor air to the *temperature-control zone*.
Outdoor airflow	Constant, as defined in Article 8.4.4.18.
Supply air temperature	Identical to that of the proposed *building*.

Table 8.4.4.7.-D (Continued)

Supply fan (100% outdoor air)	Operates continually when the system is operating.
	S3a – If the supply fan supplies only that *temperature-control zone*, the supply fan must provide a static pressure of 150 Pa and have a combined energy efficiency (fan-motor-drive) of at least 20%, without return fan.
	S3b – If the supply fan supplies several *temperature-control zones*, the supply fan must provide a static pressure of 325 Pa and have a combined energy efficiency of at least 40%, without return fan.
	Possibility of adjusting the static pressure as described in Sentence 8.4.4.18.(3).
Local fan	Fan providing a power of 0.6 W/L/s. Operates on demand where the system is operating.
Outdoor air	As described in Article 8.4.4.15.
Operating schedule	As described in Article 8.4.3.2.
Heating system	As described in Article 8.4.4.9.
Cooling system	As described in Article 8.4.4.10.

Table 8.4.4.7.-E
S4a, S4b Systems – 100% Outdoor Air without Local Ventilation for Heating
Forming Part of Sentences 8.4.4.7.(4) and 8.4.4.18.(3)

Description	System conveying 100% outdoor air to the *temperature-control zone*.
Outdoor airflow	Constant, as described in Article 8.4.4.18.
Supply air temperature	Identical to that of the proposed *building*.
Supply fan (100% outdoor air)	Operates continually when the system is operating.
	S4a – If the supply fan supplies only that *temperature-control zone*, the supply fan must provide a static pressure of 150 Pa and have a combined energy efficiency (fan-motor-drive) of at least 20%, without return fan.
	S4b – If the supply fan supplies several *temperature-control zones*, the supply fan must provide a static pressure of 325 Pa and have a combined energy efficiency of at least 40%, without return fan.
	Possibility of adjusting the static pressure as described in Sentence 8.4.4.18.(3).
Outdoor air	As described in Article 8.4.4.15.
Operating schedule	As described in Article 8.4.3.2.
Heating system	As described in Article 8.4.4.9.
Cooling system	As described in Article 8.4.4.10.

3) Except as stated otherwise in this Subsection, each hydronic loop of the proposed *building* shall be present in the modeling of the reference *building*. (See Note A-8.4.4.7.(2) and (3).)

4) Each *HVAC system* of the proposed *building* shall be modeled using the reference *building*'s corresponding *HVAC system*, determined in accordance with Table 8.4.4.7.-A, the corresponding descriptions shown in Tables 8.4.4.7.-B to 8.4.4.7.-E.

8.4.4.8. Deleted

8.4.4.9. Heating System

1) Where the proposed *building*'s *HVAC system* has no heating capacity, the reference *building*'s corresponding *HVAC system* shall have no heating capacity.

2) Where, in the proposed *building*, the heating system is hydronic, the reference *building*'s corresponding heating system shall be modeled using a hydronic loop on the following conditions:

a) the heating system shall be
   i) a single-stage *boiler*, where the heating capacity is not more than 176 kW,
   ii) a two-stage *boiler*, the lowest stage operating first at 50%, where the heating capacity is more than 176 kW but not more than 352 kW, or
   iii) a modulating *boiler* between 25% and 100% of its capacity, where the heating capacity is more than 352 kW,
b) the pumping system shall be modeled by a variable-flow pump on a single primary water loop, and that pump shall
   i) ride its performance curve, or
   ii) be variable-speed when the pumping system is referred to in Clause 5.2.6.1.(1)(a),
c) the peak pumping flow rate shall be sized using the following parameters:
   i) the heating capacity of the *boiler*,
   ii) a heat transfer fluid supply temperature of 82°C, and
   iii) a heat transfer fluid return temperature of 54°C, (see Note A-8.4.4.9.(2)(c), 8.4.4.10.(2)(d) and 8.4.4.11.(4)(b)),
d) the peak pumping power demand shall be identical to the sum of the peak pumping power demands used for the proposed *building* heating loop (see Note A-8.4.4.9.(2)(d), 8.4.4.10.(2)(e) and 8.4.4.11.(4)(c)), and
e) the hot water supply temperature shall be set to
   i) at least 82°C for an outside air temperature of not more than -16°C, and
   ii) not more than 60°C for an outside air temperature of at least 0°C.

3) Where the heating system of the proposed *building* is a *furnace*, the reference *building*'s corresponding heating system shall be a *furnace* and it shall be modeled as follows:

a) where the heating capacity is not more than 66 kW, the *furnace* shall be modeled as a two-stage heating device of equal capacity, and
b) where the heating capacity is more than 66 kW, the *furnace* shall be modeled as a device whose number of heating stages is equal to its capacity divided by 66 kW, then rounded to the next whole number.

4) Where the heating system of the proposed *building* is an electric resistance, the reference *building*'s corresponding heating system shall be an electric resistance having a constant efficiency of 100% independently of load.

8.4.4.10. Cooling Systems

1) Where the proposed *building*'s *HVAC system* has no cooling capacity, the reference *building*'s *HVAC system* shall have no cooling capacity.

2) Where the cooling system of the proposed *building* is hydronic, the cooling system of the reference *building* shall be hydronic and shall be modeled according to the following conditions:

a) the number and type of chillers shall be determined using Table 8.4.4.10.,
b) a single primary chilled water loop shall be modeled with as many pumps as there are chillers defined in Clause (a),
c) the pumping system shall be modeled with variable flow, and its pumps shall
   i) ride their performance curve, or
   ii) be variable-speed where the pumping system is referred to in Clause 5.2.6.1.(1)(a),
d) the peak pumping flow shall be sized using the following parameters:
   i) the total cooling capacity of the reference *building*'s system,

ii) a heat transfer fluid supply temperature of 7°C, and
iii) a heat transfer fluid return temperature of 13°C (see Note A-8.4.4.9.(2)(c), 8.4.4.10.(2)(d) and 8.4.4.11.(4)(b)), and

e) the peak pumping power demand shall be identical to the sum of the peak pumping power demands used for the proposed *building*'s cooling loop (see Note A-8.4.4.9.(2)(d), 8.4.4.10.(2)(e) and 8.4.4.11.(4)(c)).

Table 8.4.4.10.
Number and Type of Chillers
Forming Part of Sentence 8.4.4.10.(2)

Total Cooling Capacity	Number	Type
≤ 352 kW	1	Reciprocating, water-cooled
> 352 kW and ≤ 1055 kW	1	Screw, water-cooled
> 1055 kW and ≤ 2110 kW	2, of equal cooling capacity	Screw, water cooled
> 2110 kW	2 or more, of equal cooling capacity; the cooling capacity of each chiller shall be not more than 2813 kW	Centrifugal, water-cooled

3) Where the cooling system of the proposed *building* is a direct-expansion system, the reference *building*'s cooling system shall be a direct-expansion system and that system shall be modeled as follows:

a) where the cooling capacity of the system is not more than 66 kW, the system shall be modeled as a two-stage system of equal capacity, and
b) where the cooling capacity is more than 66 kW, the system shall be modeled as a system whose number of stages is equal to its capacity divided by 66 kW and rounded up to the next whole number.

8.4.4.11. Cooling Tower Systems

1) Water-cooled systems shall be paired to an axial-fan, direct-contact cooling tower that has

a) a capacity equal to the nominal heat rejection rate of the equipment,
b) inlet and outlet water temperatures of 35°C and 29°C, respectively, and
c) an inlet outside air wet bulb temperature of 24°C.

2) A cooling tower with a capacity not greater than 1 750 kW shall be modeled with one cell.

3) A cooling tower with a capacity greater than 1 750 kW shall be modeled with a number of cells equal to its capacity divided by 1 750 and rounded up to the nearest integer.

4) The cooling tower pumping system shall be modeled

a) as a constant-speed system,
b) with a flow rate sized using the following parameters:
   i) the cooling tower's capacity,
   ii) a rise of the heat transfer fluid temperature of 6°C (see Note A-8.4.4.9.(2)(c), 8.4.4.10.(2)(d) and 8.4.4.11.(4)(b)), and
c) with a peak pumping power demand identical to the sum of the peak pumping power demands used for the proposed *building* loop (see Note A-8.4.4.9.(2)(d), 8.4.4.10.(2)(e) and 8.4.4.11.(4)(c)).

5) The fan of each cooling tower cell shall be modeled as a constant-speed axial fan

a) with a stop-start control that maintains the tower outlet water temperature at 29°C, and
b) whose motor has a rated capacity equal to 1.5% of the cell cooling capacity, in kW.

8.4.4.12. Deleted

8.4.4.13. Deleted

8.4.4.14. Pumps

1) Except as provided in Sentences 8.4.4.9.(2), 8.4.4.10.(2), 8.4.4.11.(4) and 8.4.4.20.(4), pumps shall be modeled in the reference *building* so that, for each pump, the ratio between the peak power demand and the peak pumping flow is identical to that of the proposed *building*'s corresponding pump.

2) Where the pumping system is a variable-flow system, the pumps referred to in Sentence (1) shall be modeled in accordance with Table 8.4.4.21.-H as
a) pumps that ride their performance curve, or
b) pumps with variable speed drive, where the pumping system is referred to in Clause 5.2.6.1.(1)(a).

8.4.4.15. Outdoor Air

1) Except as provided in Sentence (2), the outdoor air ventilation rates for the reference *building* shall be modeled as being identical to those determined for the proposed *building* in Sentence 8.4.3.6.(1).

2) Where the outdoor air ventilation rate of a *temperature-control zone* is diminished in accordance with Sentence 8.4.3.6.(2), the outdoor air ventilation rate of the reference *building*'s corresponding zone shall be the minimum flow required under the NBC to maintain acceptable indoor air quality in the *temperature-control zone*.

8.4.4.16. Deleted

8.4.4.17. Fans

1) Where the *HVAC system* of a *thermal block* of the proposed *building* includes a fan that exhausts air directly to the outside and that is covered by either of Sentence 5.2.3.1.(3) or 5.2.10.1.(3), its flow rate, power demand, operating schedule and part-load performance shall be modeled identically in the reference *building*.

2) Constant-volume fans shall be modeled as airfoils without inlet vanes riding their performance curves, in accordance with Table 8.4.4.21.-I.

3) Variable-air-volume fans shall be modeled as forward curved with inlet vanes, in accordance with Table 8.4.4.21.-I.

4) The terminal zone boxes without fan of a variable-flow *HVAC system* shall be modeled taking into consideration a minimum flow as being the greater of
a) 30% of the peak flow of the *temperature-control zone*, or
b) the outdoor airflow required by the NBC to maintain acceptable indoor air quality in the *temperature-control zone*.

5) The terminal zone boxes with fan of a variable-flow *HVAC system* shall be modeled as having
a) a minimum flow equal to the outdoor airflow required by the NBC to maintain acceptable indoor air quality in the *temperature-control zone*, and
b) a parallel fan
   i) whose maximum flow is set at 50% of the peak flow of the *temperature-control zone*, and
   ii) whose ratio between the peak power demand and the flow is 0.74 W(L/s).

6) Return or relief fans shall be modeled with a peak flow as being the greater of
a) the supply fan peak flow less the outdoor airflow rate, and
b) 90% of the supply fan peak flow.

8.4.4.18. Air Supply System

1) The supply airflow rate provided by *HVAC systems* shall be modeled as being equal to the sum of the airflow rates supplied to each *temperature-control zone* calculated in accordance with Sentences (2) and (3).

2) The supply airflow rate to a *temperature-control zone* shall be modeled as being the greatest of

a) the airflow rate for heating, based on the peak heating load and a temperature difference of 21°C,

b) the airflow rate for cooling, based on the peak cooling load and a temperature difference of 11°C, or

c) the outdoor air ventilation rate supplied to the *temperature-control zone*, in accordance with Article 8.4.4.15.

3) Where a fan of the proposed *building* is part of an *HVAC system* whose total fan power ratings is at least 4 kW, the static pressure of the reference *building*'s corresponding fan is permitted to be adjusted using the following equation:

$$P_{\text{Ref adjusted}} = P_{\text{Ref}} + \sum_{i=1}^{n} \frac{SPA_i \cdot D_{i,\text{Prop}}}{D_{vi,\text{Prop}}}$$

where

$P_{\text{Ref adjusted}}$ = adjusted pressure of the fan in the reference *building*, in Pa,

P_{Ref} = pressure of the fan in the reference *building* as established in Tables 8.4.4.7.-B to 8.4.4.7.-E, in Pa,

SPA_i = static pressure adjustment due to the i^{th} equipment as established in Table 5.2.3.1., in Pa,

n = number of equipment requiring static pressure adjustment,

$D_{i,\text{Prop}}$ = flow through the i^{th} equipment of the proposed *building*, in L/s, and

$D_{vi,\text{Prop}}$ = design flow rate of fan serving the i^{th} equipment of the proposed *building*, in L/s.

8.4.4.19. Heat Recovery

1) Where the *HVAC system* must be equipped with heat- or energy-recovery equipment under Sentence 5.2.10.1.(1), that equipment shall be modeled to the following conditions:

a) the static pressures of fans shall be adjusted according to Sentence 8.4.4.18.(3), and

b) the heat-recovery efficiency shall be

i) 60%, or

ii) 65% for *dwelling units* located in a municipality whose number of heating degree-days under 18°C is 6 000 or more.

2) Where the proposed *building* has refrigeration systems referred to in Article 5.2.10.3., the reference *building*'s refrigeration system shall be modeled to the following conditions:

a) the operating and performance characteristics, capacity, part-load performance and pumping flows shall be identical to those of the proposed *building*'s refrigeration system,

b) peak load and demand schedules shall be identical to those of the proposed *building*;

c) the heat-recovery equipment shall have
   i) the capacity to reject recovered heat to the hydronic heating systems, and
   ii) the same means to reject unrecovered heat as that of the proposed *building*, and
d) the efficiency of the heat-recovery equipment shall be the smaller of the following values:
   i) 25% of the recovery efficiency, or
   ii) 80% of the space heating capacity and *service water* heating capacity.

(See Note A-8.4.4.19.(2).)

3) Where the proposed *building* has a pool referred to in Sentence 5.2.10.2.(1), the dehumidification equipment referred to in Sentence 5.2.10.2.(3) serving that *temperature-control zone* shall be modeled in the reference *building* as an electric air-cooled chiller
a) sized for the peak dehumidification load,
b) to the conditions described in Sentence 8.4.4.10.(2),
c) having a COP varying according to the load, and
d) equipped with a heat-recovery unit compliant with Sentence 5.2.10.2.(2).

8.4.4.20. Service Water Heating System

1) The reference *building*'s *service water* heating system shall be modeled as being identical to that of the proposed *building* as regards the following characteristics:
a) storage capacity, and
b) power input.

2) Where the proposed *building*'s *service water* heating system includes a storage tank, the *service water* setpoint temperature of the reference *building*'s storage tank shall be identical to that of the proposed *building*.

3) Where the proposed *building*'s *service water* heating system comprises multiple water heaters, the reference *building*'s *service water* heating system shall be modeled with the same number of water heaters.

4) Where the proposed *building*'s *service water* heating system is a recirculation system, the reference *building*'s circulation pumps shall be modeled as pumps with
a) constant speed operation, and
b) a flow rate identical to that of the proposed *building*'s circulation pumps.

8.4.4.21. Part-Load Performance Curves

1) In the absence of equivalent functionalities of programs modeling the part-load operation of *HVAC system*'s equipment or *service water* heating systems, the part-load performance curves for the reference *building*'s equipment shall be calculated in accordance with Tables 8.4.4.21.-A to 8.4.4.21.-I, as applicable. (See Note A-8.4.4.21.(1).)

Table 8.4.4.21.-A
Heating Equipment Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

<table>
<tr><td>Boiler Part-Load Performance Curve(s)</td><td>The fuel consumption at part-load conditions, derived by applying an adjustment factor to the fuel consumption at design conditions, shall be calculated using the following equation. Condensing and non-condensing boiler curves fit the quadratic equation of FHeatPLC defined therein. For modulating boilers, values for $Q_{partload}/Q_{design}$ and corresponding values for FHeatPLC shall be those listed in the last row of this Table.

$$\mathrm{Fuel_{partload}} = \mathrm{Fuel_{design}} \cdot \mathrm{FHeatPLC} \quad (1)$$
where
$Fuel_{partload}$ = fuel consumption at part-load conditions, in Btu/h,
$Fuel_{design}$ = fuel consumption at design conditions, in Btu/h, and
FHeatPLC = fuel heating part-load efficiency curve determined using Equation (2) or values from the last row of this Table, as applicable.

$$\mathrm{FHeatPLC} = \left(\mathrm{a} + \mathrm{b} \cdot \frac{\mathrm{Q_{partload}}}{\mathrm{Q_{design}}} + \mathrm{c} \cdot \left(\frac{\mathrm{Q_{partload}}}{\mathrm{Q_{design}}}\right)^2\right) \quad (2)$$
where
$Q_{partload}$ = boiler capacity at part-load conditions, in Btu/h, or values from the last row of this Table, as applicable,
Q_{design} = boiler capacity at design conditions, in Btu/h, or values from the last row of this Table, as applicable, and
a, b, c = applicable values as follows:

Variable | Condensing Boiler | Non-condensing Boiler
a | 0.00533 | 0.082597
b | 0.904 | 0.996764
c | 0.09066 | –0.079361</td></tr>
<tr><td>Furnace Part-Load Performance Curve(s)</td><td>The fuel consumption at part-load conditions, derived by applying an adjustment factor to the fuel consumption at rated conditions, shall be calculated using the following equation. Condensing and atmospheric furnace curves fit the quadratic equation of FHeatPLC defined therein. For modulating furnaces, values for $Q_{partload}/Q_{rated}$ and corresponding values for FHeatPLC shall be those listed in the last row of this Table.

$$\mathrm{Fuel_{partload}} = \mathrm{Fuel_{rated}} \cdot \mathrm{FHeatPLC} \quad (3)$$
where
$Fuel_{partload}$ = fuel consumption at part-load conditions, in Btu/h,
$Fuel_{rated}$ = fuel consumption at rated conditions, in Btu/h, and
FHeatPLC = fuel heating part-load efficiency curve determined using Equation (4) or values from the last row of this Table, as applicable.

$$\mathrm{FHeatPLC} = \left(\mathrm{a} + \mathrm{b} \cdot \frac{\mathrm{Q_{partload}}}{\mathrm{Q_{rated}}} + \mathrm{c} \cdot \left(\frac{\mathrm{Q_{partload}}}{\mathrm{Q_{rated}}}\right)^2\right) \quad (4)$$
where
$Q_{partload}$ = furnace capacity at part-load conditions, in Btu/h, or values from the last row of this Table, as applicable,
Q_{rated} = furnace capacity at rated conditions, in Btu/h, or values from the last row of this Table, as applicable, and
a, b, c = applicable values as follows:

Variable | Condensing Furnace | Atmospheric Furnace
a | 0.00533 | 0.0186100
b | 0.904 | 1.0942090
c | 0.09066 | –0.1128190</td></tr>
</table>

Table 8.4.4.21.-A (Continued)

Modulating *Boilers* and *Furnaces*	$Q_{partload}$, Q_{rated} and Q_{design} (Part-Load Ratio)	FHeatPLC
	0.1	0.118
	0.2	0.209
	0.3	0.308
	0.4	0.407
	0.5	0.506
	0.6	0.605
	0.7	0.704
	0.8	0.802
	0.9	0.901
	1	1

Table 8.4.4.21.-B
Direct-Expansion Cooling Equipment Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

Electric Direct-Expansion (DX) Coil Cooling Capacity Adjustment Curve(s)	This curve or group of curves represents the available total cooling capacity of a DX coil as a function of cooling coil and condenser conditions. $$Q_{available} = CAP\_FT_{EDX} \cdot Q_{rated} \quad (1)$$ where $Q_{available}$ = available cooling capacity at present evaporator and condenser conditions, in MBH, CAP_FT_{EDX} = cooling capacity adjustment determined using Equation (2), and Q_{rated} = rated capacity at ARI conditions, in MBH. $$CAP\_FT_{EDX} = a + b \cdot t_{wb} + c \cdot {t_{wb}}^2 + d \cdot t_{odb} + e \cdot {t_{odb}}^2 + f \cdot t_{wb} \cdot t_{odb} \quad (2)$$ where t_{wb} = entering coil wet-bulb temperature, in °F, t_{odb} = outside-air dry-bulb temperature, in °F (If an air-cooled unit uses an evaporative condenser, t_{odb} is the effective dry-bulb temperature of the air leaving the evaporative cooling unit.), a = 0.8740302, b = –0.0011416, c = 0.0001711, d = –0.0029570, e = 0.0000102, and f = –0.0000592.
Electric Direct-Expansion (DX) Coil Cooling Efficiency Adjustment Curve(s)	This curve or group of curves varies the cooling efficiency of a DX coil as a function of evaporator and condenser conditions and part-load ratio. $$P_{operating} = P_{rated} \cdot EIR\_FPLR \cdot EIR\_FT \cdot CAP\_FT_{EDX} \quad (3)$$ where $P_{operating}$ = power draw at specified operating conditions, in kW, P_{rated} = rated power draw at ARI conditions, in kW, EIR_FPLR = electric input ratio adjustment to rated efficiency due to changes in coil load determined using Equation (4), EIR_FT = electric input ratio adjustment to rated efficiency due to environmental variables determined using Equation (6), and CAP_FT_{EDX} = cooling capacity adjustment determined using Equation (2).

Table 8.4.4.21.-B (Continued)

	$$\mathrm{EIR\_FPLR} = a + b \cdot \mathrm{PLR} + c \cdot \mathrm{PLR}^2 + d \cdot \mathrm{PLR}^3 \quad (4)$$ where PLR = part-load ratio based on available capacity (not rated capacity) determined using Equation (5), a = 0.2012301, b = –0.0312175, c = 1.9504979, and d = –1.1205105. $$\mathrm{PLR} = \frac{Q_{operating}}{Q_{available}} \quad (5)$$ where $Q_{operating}$ = present load, in Btu/h, and $Q_{available}$ = available capacity at present evaporator and condenser conditions, in Btu/h, determined using Equation (1). $$\mathrm{EIR\_FT} = a + b \cdot t_{wb} + c \cdot {t_{wb}}^2 + d \cdot t_{odb} + e \cdot {t_{odb}}^2 + f \cdot t_{wb} \cdot t_{odb} \quad (6)$$ where t_{wb} = entering coil wet-bulb temperature, in °F, t_{odb} = outside-air dry-bulb temperature, in °F (If an air-cooled unit uses an evaporative condenser, t_{odb} is the effective dry-bulb temperature of the air leaving the evaporative cooling unit.), a = –1.0639310, b = 0.0306584, c = –0.0001269, d = 0.0154213, e = 0.0000497, and f = –0.0002096.

Table 8.4.4.21.-C
Electric Chiller Cooling Equipment Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

Electric Chiller Cooling Capacity Adjustment Curve(s)

This curve or group of curves represents the available total cooling capacity of an electric chiller as a function of evaporator and condenser conditions.

$$Q_{available} = CAP\_FT_{EC} \cdot Q_{rated} \quad (1)$$

where

$Q_{available}$ = available cooling capacity at present evaporator and condenser conditions, in MBH,
CAP_FT_{EC} = cooling capacity adjustment determined using Equation (2), and
Q_{rated} = rated capacity at ARI conditions, in MBH.

$$CAP\_FT_{EC} = a + b \cdot t_{chws} + c \cdot t_{chws}{}^2 + d \cdot t_{cws} + e \cdot t_{cws}{}^2 + f \cdot t_{chws} \cdot t_{cws} \quad (2)$$

where

t_{chws} = chilled water supply temperature, in °F,
t_{cws} = condenser water supply temperature, in °F, and
a-f = applicable coefficient values as follows:

Capacity Coefficients for Calculation of CAP_FT_{EC}

Type of Chiller		a	b	c	d	e	f
Air-Cooled	Scroll	0.40070684	0.01861548	0.00007199	0.00177296	–0.00002014	–0.00008273
	Reciprocating	0.57617295	0.02063133	0.00007769	–0.00351183	0.00000312	–0.00007865
	Screw	–0.09464899	0.03834070	–0.00009205	0.00378007	–0.00001375	–0.00015464
	Centrifugal	n/a	n/a	n/a	n/a	n/a	n/a
Water-Cooled	Scroll	0.36131454	0.01855477	0.00003011	0.00093592	–0.00001518	–0.00005481
	Reciprocating	0.58531422	0.01539593	0.00007296	–0.00212462	–0.00000715	–0.00004597
	Screw	0.332669598	0.00729116	–0.00049938	0.01598983	–0.00028254	0.00052346
	Centrifugal	–0.29861975	0.02996076	–0.00080125	0.01736268	–0.00032606	0.00063139

Electric Chiller Cooling Efficiency Adjustment Curve(s)

This curve or group of curves varies the cooling efficiency of an electric chiller as a function of evaporator and condenser conditions and part-load ratio.

$$P_{operating} = P_{rated} \cdot EIR\_FPLR \cdot EIR\_FT \cdot CAP\_FT_{EC} \quad (3)$$

where

$P_{operating}$ = power draw at specified operating conditions, in kW,
P_{rated} = rated power draw at ARI conditions, in kW,
EIR_FPLR = electric input ratio adjustment to rated efficiency due to changes in load determined using Equation (4),
EIR_FT = electric input ratio adjustment to rated efficiency due to environmental variables determined using Equation (6), and
CAP_FT_{EC} = value determined using Equation (2).

Table 8.4.4.21.-C (Continued)

$$EIR\_FPLR = a + b \cdot PLR + c \cdot PLR^2 \quad (4)$$

where

PLR = part-load ratio based on available capacity (not rated capacity) determined using Equation (5), and

a-c = applicable coefficient values as follows:

Efficiency Coefficients for Calculation of EIR_FPLR				
Type of Chiller		a	b	c
Air-cooled	Scroll	0.06369119	0.58488832	0.35280274
	Reciprocating	0.1143742	0.5459334	0.34229861
	Screw	0.03648722	0.73474298	0.21994748
	Centrifugal	n/a	n/a	n/a
Water-cooled	Scroll	0.04411957	0.64036703	0.31955532
	Reciprocating	0.08144133	0.41927141	0.49939604
	Screw	0.33018833	0.23554291	0.46070828
	Centrifugal	0.17149273	0.58820208	0.23737257

$$PLR = \frac{Q_{operating}}{Q_{available}} \quad (5)$$

where

$Q_{operating}$ = present load on chiller, in Btu/h, and

$Q_{available}$ = chiller available capacity at present evaporator and condenser conditions, in Btu/h, determined using Equation (1).

$$EIR\_FT = a + b \cdot t_{chws} + c \cdot t_{chws}{}^2 + d \cdot t_{cws} + e \cdot t_{cws}{}^2 + f \cdot t_{chws} \cdot t_{cws} \quad (6)$$

where

t_{chws} = chilled water supply temperature, in °F,

t_{cws} = condenser water supply temperature, in °F, and

a-f = applicable coefficient values as follows:

Efficiency Coefficients for Calculation of EIR_FT							
Type of Chiller		a	b	c	d	e	f
Air-Cooled	Scroll	0.99006553	–0.00584144	0.00016454	–0.00661136	0.00016808	–0.00022501
	Reciprocating	0.66534403	–0.01383821	0.00014736	0.00712808	0.00004571	–0.00010326
	Screw	0.013545636	0.02292946	–0.00016107	–0.00235396	0.00012991	–0.00018585
	Centrifugal	n/a	n/a	n/a	n/a	n/a	n/a
Water-Cooled	Scroll	1.00121431	–0.01026981	0.00016703	–0.0128136	0.00014613	–0.00021959
	Reciprocating	0.46140041	–0.0882156	0.00008223	0.00926607	0.00005722	–0.00011594
	Screw	0.66625406	0.00068584	0.00028496	–0.00341677	0.00025484	–0.00048195
	Centrifugal	0.51777196	–0.00400363	0.00002026	0.00698793	0.00008290	–0.00015467

Table 8.4.4.21.-D
Cooling Tower Equipment Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

Cooling Tower Capacity Adjustment Curve(s)	This curve or group of curves represents the available total cooling capacity of a cooling tower as a function of outdoor air wet-bulb, condenser water supply and condenser water return temperatures. $$Q_{available} = Q_{rated} \cdot FWB \cdot \left(\frac{t_R}{10}\right) \quad (1)$$ where $Q_{available}$ = available cooling capacity at present outside air and condenser water conditions, in MBH, Q_{rated} = rated cooling capacity at CTI test conditions, in MBH, FWB = ratio of available capacity to rated capacity, in gpm/gpm, determined using Equation (2), and t_R = tower range, in °F, determined using Equation (4). $$FWB = a + b \cdot FRA + c \cdot FRA^2 + d \cdot t_{cwb} + e \cdot {t_{cwb}}^2 + f \cdot FRA \cdot t_{cwb} \quad (2)$$ where FRA = intermediate capacity curve based on range and approach determined using Equation (3), t_{cwb} = outside-air wet-bulb temperature, in °F, a = 0.60531402, b = –0.03554536, c = 0.00804083, d = –0.02860259, e = 0.00024972, and f = 0.00490857. $$FRA = \frac{-d - f \cdot t_R + \sqrt{(d + f \cdot t_R)^2 - 4 \cdot e \cdot (a + b \cdot t_R + c \cdot {t_R}^2 - t_A)}}{2 \cdot e} \quad (3)$$ where t_R = tower range, in °F, determined using Equation (4), t_A = tower approach, in °F, determined using Equation (5), a = –2.22888899, b = 0.16679543, c = –0.01410247, d = 0.03222333, e = 0.18560214, and f = 0.24251871. $$t_R = t_{cwr} - t_{cws} \quad (4)$$ and $$t_A = t_{cws} - t_{owb} \quad (5)$$ where t_{cwr} = condenser water return temperature, in °F, t_{cws} = condenser water supply temperature, in °F, and t_{owb} = outside-air wet-bulb temperature, in °F.

Table 8.4.4.21.-E
Electric Air-Source Heat Pump Equipment Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

Electric Air-Source Heat Pump Heating Capacity Adjustment Curve(s)	This curve or group of curves represents the available heating capacity of the heat pump as a function of evaporator and condenser conditions. $$Q_{available} = CAP\_FT_{EAS} \cdot Q_{rated} \quad (1)$$ where $Q_{available}$ = available heating capacity at present evaporator and condenser conditions, in MBH, CAP_FT_{EAS} = heating capacity adjustment determined using Equation (2), and Q_{rated} = rated capacity at ARI conditions, in MBH. $$CAP\_FT_{EAS} = a + b \cdot t_{odb} + c \cdot t_{odb}{}^2 + d \cdot t_{odb}{}^3 \quad (2)$$ where t_{odb} = outside-air dry-bulb temperature, in °F, a = 0.2536714, b = 0.0104351, c = 0.0001861, and d = –0.0000015.
Electric Air-Source Heat Pump Heating Efficiency Adjustment Curve(s)	This curve or group of curves varies the heating efficiency of the heat pump as a function of evaporator and condenser conditions and part-load ratio. $$P_{operating} = P_{rated} \cdot EIR\_FPLR \cdot EIR\_FT \cdot CAP\_FT_{EAS} \quad (3)$$ where $P_{operating}$ = power draw at specified operating conditions, in kW, P_{rated} = rated power draw at ARI conditions, in kW, EIR_FPLR = electric input ratio adjustment to rated efficiency due to changes in heat pump load determined using Equation (4), EIR_FT = electric input ratio adjustment to rated efficiency due to environmental variables determined using Equation (6), and CAP_FT_{EAS} = heating capacity adjustment determined using Equation (2). $$EIR\_FPLR = a + b \cdot PLR + c \cdot PLR^2 + d \cdot PLR^3 \quad (4)$$ where PLR = part-load ratio based on available capacity (not rated capacity) determined using Equation (5), a = 0.0856522, b = 0.9388137, c = –0.1834361, and d = 0.1589702. $$PLR = \frac{Q_{operating}}{Q_{available}} \quad (5)$$ where $Q_{operating}$ = present load on heat pump, in Btu/h, and $Q_{available}$ = heat pump available capacity at present evaporator and condenser conditions, in Btu/h, determined using Equation (1). $$EIR\_FT = a + b \cdot t_{odb} + c \cdot t_{odb}{}^2 + d \cdot t_{odb}{}^3 \quad (6)$$ where t_{odb} = outside-air dry-bulb temperature, in °F, a = 2.4600298, b = –0.0622539, c = 0.0008800, and d = –0.0000046.

Table 8.4.4.21.-F
Absorption Chiller Cooling Equipment Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

<table>
<tr><td>Absorption Chiller Cooling Capacity Adjustment Curve(s)</td><td>This curve or group of curves represents the available total cooling capacity of the absorption chiller as a function of evaporator and condenser conditions.

$$Q_{available} = CAP\_FT_{AC} \cdot Q_{rated} \quad (1)$$

where
$Q_{available}$ = available cooling capacity at present evaporator and condenser conditions, in MBH,
CAP_FT_{AC} = cooling capacity adjustment determined using Equation (2), and
Q_{rated} = rated capacity at ARI conditions, in MBH.

$$CAP\_FT_{AC} = a + b \cdot t_{chws} + c \cdot {t_{chws}}^2 + d \cdot t_{cws} + e \cdot {t_{cws}}^2 + f \cdot t_{chws} \cdot t_{cws} \quad (2)$$

where
t_{chws} = chilled water supply temperature, in °F,
t_{cws} = condenser water supply temperature, in °F, and
a-f = applicable coefficients as follows:
<table>
<tr><td colspan="7">Capacity Coefficients for Calculation of CAP_FT_{AC}</td></tr>
<tr><td>Absorption</td><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>Single-effect</td><td>0.723412</td><td>0.079006</td><td>0.000897</td><td>–0.025285</td><td>–0.000048</td><td>0.000276</td></tr>
<tr><td>Double-effect</td><td>–0.816039</td><td>–0.038707</td><td>0.000450</td><td>0.071491</td><td>–0.000636</td><td>0.000312</td></tr>
<tr><td>Direct-fired</td><td>1.0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Absorption Chiller: Steam-driven, Single- and Double-effect Chiller Efficiency Curve(s)</td><td>This curve or group of curves varies the cooling efficiency of a steam-driven, single- and double-effect absorption chiller as a function of evaporator and condenser conditions and part-load ratio.

$$Fuel_{partload} = Fuel_{rated} \cdot FIR\_FPLR \cdot FIR\_FT \cdot CAP\_FT_{AC} \quad (3)$$

where
$Fuel_{partload}$ = fuel consumption at specified operating conditions, in Btu/h,
$Fuel_{rated}$ = rated fuel consumption at ARI conditions, in Btu/h,
FIR_FPLR = fuel input ratio adjustment to rated efficiency due to changes in load determined using Equation (4),
FIR_FT = fuel input ratio adjustment to rated efficiency due to environmental variables determined using Equation (6), and
CAP_FT_{AC} = value determined using Equation (2).

$$FIR\_FPLR = a + b \cdot PLR + c \cdot PLR^2 \quad (4)$$

where
PLR = part-load ratio based on available capacity (not rated capacity) determined using Equation (5), and
a-c = applicable coefficients as follows:
<table>
<tr><td colspan="4">Efficiency Coefficients for Calculation of FIR_FPLR</td></tr>
<tr><td>Absorption</td><td>a</td><td>b</td><td>c</td></tr>
<tr><td>Single-effect</td><td>0.098585</td><td>0.583850</td><td>0.560658</td></tr>
<tr><td>Double-effect</td><td>0.013994</td><td>1.240449</td><td>–0.914883</td></tr>
</table>

$$PLR = \frac{Q_{operating}}{Q_{available}} \quad (5)$$

where
$Q_{operating}$ = present load on chiller, in Btu/h, and
$Q_{available}$ = chiller available capacity at present evaporator and condenser conditions, in Btu/h, determined using Equation (1).

$$FIR\_FT = a + b \cdot t_{chws} + c \cdot {t_{chws}}^2 + d \cdot t_{cws} + e \cdot {t_{cws}}^2 + f \cdot t_{chws} \cdot t_{cws} \quad (6)$$
</td></tr>
</table>

Table 8.4.4.21.-F (Continued)

<table>
<tr>
<td></td>
<td>
where
t_{chws} = chilled water supply temperature, in °F,
t_{cws} = condenser water supply temperature, in °F, and
a-f = applicable coefficients as follows:
<table>
<tr><th colspan="7">Efficiency Coefficients for Calculation of FIR_FT</th></tr>
<tr><th>Absorption</th><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th>f</th></tr>
<tr><td>Single-effect</td><td>0.652273</td><td>0</td><td>0</td><td>–0.000545</td><td>0.000055</td><td>0</td></tr>
<tr><td>Double-effect</td><td>1.658750</td><td>0</td><td>0</td><td>–0.29</td><td>0.000250</td><td>0</td></tr>
</table>
</td>
</tr>
<tr>
<td>Absorption Chiller: Direct-fired, Double-effect Chiller Efficiency Adjustment Curve(s)</td>
<td>
This curve or group of curves varies the cooling efficiency of a direct-fired, double-effect absorption chiller as a function of evaporator and condenser conditions and part-load ratio.

$$\mathrm{Fuel_{partload} = Fuel_{rated} \cdot FIR\_FPLR \cdot FIR\_FT1 \cdot FIR\_FT2 \cdot CAP\_FT_{AC}} \quad (7)$$

where
$Fuel_{partload}$ = fuel consumption at specified operating conditions, in Btu/h,
$Fuel_{rated}$ = rated fuel consumption at ARI conditions, in Btu/h,
FIR_FPLR = fuel input ratio adjustment to rated efficiency due to changes in load determined using Equation (8),
FIR_FT1 = fuel input ratio adjustment to rated efficiency due to environmental variables determined using Equation (10),
FIR_FT2 = fuel input ratio adjustment to rated efficiency due to environmental variables determined using Equation (11), and
CAP_FT_{AC} = value determined using Equation (2).

$$\mathrm{FIR\_FPLR = a + b \cdot PLR + c \cdot PLR^2} \quad (8)$$

where
PLR = part-load ratio based on available capacity (not rated capacity) determined using Equation (9),
a = 0.13551150,
b = 0.61798084, and
c = 0.24651277.

$$\mathrm{PLR = \frac{Q_{operating}}{Q_{available}}} \quad (9)$$

where
$Q_{operating}$ = present load, in Btu/h, and
$Q_{available}$ = chiller available capacity at present evaporator and condenser conditions, in Btu/h, determined using Equation (1).

$$\mathrm{FIR\_FT1 = a + b \cdot t_{chws} + c \cdot {t_{chws}}^2} \quad (10)$$

and

$$\mathrm{FIR\_FT2 = d + e \cdot t_{cws} + f \cdot {t_{cws}}^2} \quad (11)$$

where
t_{chws} = chilled water supply temperature, in °F,
t_{cws} = condenser water supply temperature, in °F,
a = 4.42871284,
b = –0.13298607,
c = 0.00125331,
d = 0.86173749,
e = –0.00708917, and
f = 0.0010251.
</td>
</tr>
</table>

Table 8.4.4.21.-G
Fuel-Fired Service Water Heater Part-Load Performance Characteristics
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5) and 8.4.4.21.(1)

<table>
<tr><td>Fuel-Fired Service Water Heater Part-Load Efficiency Curve(s)</td><td>The fuel consumption at part-load conditions, derived by applying an adjustment factor to the fuel consumption at full load, shall be calculated using the following equation:

$$\mathrm{Fuel_{partload}} = \mathrm{Fuel_{design}} \cdot \mathrm{FHeatPLC} \qquad (1)$$
where
$Fuel_{partload}$ = fuel consumption at part-load conditions, in Btu/h,
$Fuel_{design}$ = fuel consumption at design conditions, in Btu/h, and
FHeatPLC = fuel heating part-load efficiency curve determined using Equation (2).

$$\mathrm{FHeatPLC} = \left(a + b \cdot \frac{Q_{partload}}{Q_{design}} + c \cdot \left(\frac{Q_{partload}}{Q_{design}}\right)^2\right) \qquad (2)$$
where
$Q_{partload}$ = service water heater capacity at part-load conditions, in Btu/h,
Q_{design} = service water heater capacity at design conditions, in Btu/h,
a = 0.021826,
b = 0.977630, and
c = 0.000543.</td></tr>
</table>

Table 8.4.4.21.-H
Part-load Pump Characteristic
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5), 8.4.4.14.(2) and 8.4.4.21.(1)

<table>
<tr><td rowspan="5">Pump Part-load Capacity Curve</td><td colspan="6">The curve or group of curves describes the pump part-load capacity.
Pump capacity $P_{partload}$ shall be calculated using one of the following equations:
If $V_{partload}/V_{rated} < d$, then = $P_{rated} \cdot e$
If $V_{partload}/V_{rated} \geq d$, then $P_{partload} = P_{rated} \cdot (a + b \cdot (V_{partload}/V_{rated}) + c \cdot (V_{partload}/V_{rated})^2)$
where
$V_{partload}$ = flow rate at part-load conditions, in L/s,
V_{rated} = flow rate at rated conditions, in L/s,
$P_{partload}$ = power draw at part-load conditions, in kW,
P_{rated} = power draw at rated conditions, in kW, and
a, b, c, d, e = coefficients defined in the following Table:</td></tr>
<tr><td rowspan="2">Type of Pump</td><td colspan="5">Power Coefficients</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>Pump riding its curve</td><td>0.227143</td><td>1.178929</td><td>−0.41071</td><td>0.47</td><td>0.68</td></tr>
<tr><td>Pump with variable speed drive</td><td>0.00153028</td><td>0.00520806</td><td>1.0086242</td><td>0.20</td><td>0.04</td></tr>
</table>

Table 8.4.4.21.-I
Part-load Fan Characteristic
Forming Part of Sentences 8.4.3.6.(2), 8.4.4.6.(5), 8.4.4.17.(2) and (3) and 8.4.4.21.(1)

Power Curve/Part-load Fan Flow	The curve or group of curves describes the power ratio/part-load fan flow ratio. The fan power ratio (P)/flow ratio (F) shall be calculated using one of the following equations: If $P < d$, then $F = e$ If $P \geq d$, then $F = a + b \cdot P + c \cdot P^2$ where P = output/rated F = outlet flow/rated flow a, b, c, d, e = coefficients defined in the following Table				
	Type of Fan	Coefficients			
		a	b	c	d	e
	Airfoil without inlet vane riding its performance curve Backward inclined fan without inlet vane riding its performance curve	0.227143	1.178929	–0.41071	0.47	0.68
	Airfoil with inlet vanes Backward inclined fan with inlet vanes	0.584345	–0.57917	0.970238	0.35	0.5
	Forward curved fan with inlet vanes	0.339619	–0.84814	1.495671	0.25	0.22
	Variable speed drive	0.00153028	0.00520806	1.0086242	0.20	0.04

8.4.4.22. Energy Recovered on Site and Renewable Energy Produced on Site

1) Except as provided in Sentence (2), where the proposed *building* uses energy recovered on site or renewable energy produced on site to serve an *HVAC system* or a *service water* heating system, the corresponding *HVAC system* or *service water* heating system modeled in the reference *building* shall

a) be the same type as the proposed *building*'s system,
b) use the same primary supply energy source as the system used in the proposed *building*, and
c) be sized to fully meet the load.

2) Where no supply energy source is used in the proposed *building*, the reference *building* shall consist of

a) an electric resistance sized for the peak heating load, where the energy recovered on site or the renewable energy produced on site is used for heating purposes, or
b) an electric air-cooled chiller sized for the peak cooling load, where the energy recovered on site or the renewable energy produced on site is used for cooling purposes.

3) Where the energy recovered on site or the renewable energy produced on site is electricity, that electricity shall not be accounted for in modeling the reference *building*.

Section 8.5. Objective and Functional Statements

8.5.1. Objective and Functional Statements

8.5.1.1. Attributions to Acceptable Solutions

1) For the purpose of compliance with this Code as required in Clause 1.2.1.1.(1)(b) of Division A, the objective and functional statements attributed to the acceptable solutions in this Part shall be the objective and functional statements listed in Table 8.5.1.1. (See Note A-1.1.3.1.(1).)

Table 8.5.1.1.
Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 8
Forming Part of Sentence 8.5.1.1.(1)

Functional Statements and Objectives(1)	
8.1.1.2. Application	
(1)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
8.4.1.1. General	
(1)	[F99-OE1.1]
(2)	[F92,F93,F94,F95,F96,F97,F98,F99,F100-OE1.1]
8.4.1.2. Determination of Compliance	
(2)	[F92,F93,F94,F95,F96,F97,F98,F99,F100-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
8.4.1.4. Treatment of Additions	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
8.4.2.1. General	
(1)	[F99-OE1.1]
8.4.2.2. Calculation Methods	
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
8.4.2.3. Climatic Data	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
8.4.2.6. Heat Transfer Between Thermal Blocks	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
8.4.2.8. Building Envelope	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]
8.4.2.9. Manually Operated Shading Devices	
(1)	[F99-OE1.1]
8.4.2.10. HVAC Systems	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]

Table 8.5.1.1. (Continued)

Functional Statements and Objectives(1)	
8.4.3.1. General	
(2)	[F99-OE1.1]
8.4.3.2. Operating Schedules	
(1)	[F99-OE1.1]
8.4.3.3. Building Envelope Components	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	F99-OE1.1]
(5)	F99-OE1.1]
(7)	F99-OE1.1]
(8)	F99-OE1.1]
8.4.3.4. Interior Lighting	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
8.4.3.5. Purchased Energy	
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]
8.4.3.6. HVAC Systems	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
8.4.3.7. Temperature-control Zones	
(1)	[F99-OE1.1]
8.4.3.8. Internal and Service Water Heating Loads	
(1)	[F99-OE1.1]
8.4.3.9. Energy Recovered on Site and Renewable Energy Produced on Site	
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
8.4.4.1. General	
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]
(6)	[F99-OE1.1]
(7)	[F99-OE1.1]
(8)	[F99-OE1.1]
(9)	[F99-OE1.1]
8.4.4.3. Building Envelope Components	
(1)	[F99-OE1.1]

Table 8.5.1.1. (Continued)

Functional Statements and Objectives[1]	
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(5)	[F99-OE1.1]
8.4.4.5. Lighting	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
8.4.4.6. HVAC Systems and Water Heating Systems	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]
(6)	[F99-OE1.1]
(7)	[F99-OE1.1]
(9)	[F99-OE1.1]
8.4.4.7. HVAC System Selection	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
8.4.4.9. Heating System	
(1)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
8.4.4.10. Cooling Systems	
(1)	[F99-OE1.1]
(3)	[F99-OE1.1]
8.4.4.11. Cooling Tower Systems	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]
8.4.4.14. Pumps	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
8.4.4.15. Outdoor Air	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
8.4.4.17. Fans	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]

Table 8.5.1.1. (Continued)

Functional Statements and Objectives[1]	
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
(5)	[F99-OE1.1]
(6)	[F99-OE1.1]
8.4.4.18. Air Supply System	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
8.4.4.19. Heat Recovery	
(1)	[F99,F100-OE1.1]
(2)	[F99,F100-OE1.1]
(3)	(a), (b), (c) [F99,F100-OE1.1]
	(d) [F100-OE1.1]
8.4.4.20. Service Water Heating System	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]
(4)	[F99-OE1.1]
8.4.4.21. Part-Load Performance Curves	
(1)	[F99-OE1.1]
8.4.4.22. Energy Recovered on Site and Renewable Energy Produced on Site	
(1)	[F99-OE1.1]
(2)	[F99-OE1.1]
(3)	[F99-OE1.1]

Notes to Table 8.5.1.1.:

(1) See Parts 2 and 3 of Division A.

Notes to Part 8
Building Energy Performance Compliance Path

A-8.1.1.2. Application. The provisions of Sentence 8.1.1.2.(2) make compulsory compliance of electrical or mechanical systems with the relevant prescriptive requirements of Sections 4.2., 5.2., 6.2. and 7.2., and any other applicable provision in Section 8.4. where they are not defined in the plans and specifications. That means that, if at the time of assessment of compliance with the Code using this Part, the information on the systems is insufficient or incomplete, the prescriptive requirements must be applied. For the purposes of energy simulations, the system concerned of the reference building will have to be identical to that of the proposed building. Thus, the energy performance compliance path allows to consider only the energy performance of systems and components defined in the plans and specifications.

Because the envelope has a very significant impact on energy consumption, the thermal and geometric characteristics of the envelope are essential to assess compliance of the building.

A-8.4.1. Compliance. The energy performance compliance path offers designers an alternative to the prescriptive requirements and trade-offs in Parts 3 to 7 of the Code. Those prescriptive requirements and trade-offs constitute compliance demonstration means relatively simple to apply, but offer less flexibility to designers who wish to design projects meeting the regulatory objectives without necessarily applying all the prescriptive requirements of the Code. For example, the energy performance compliance path allows the increase of the fenestration area of an immovable above the prescribed limit. In return, the designer may choose a heat-recovery unit with an efficiency greater than the minimum prescribed requirements that will make up for energy efficiency losses caused by the increase of the fenestration area. The objective is that the annual energy consumption of the proposed building is lower or equal to the building energy target of the reference building, determined according to the energy performance compliance path provided for in this Part.

Contrary to the prescriptive requirements and trade-offs, the energy performance compliance path allows accounting the cross effects and interdependence of solutions implemented in the proposed building. For example, the importance of thermal gains of indoor lighting systems will have an impact on the sizing of the HVAC systems and their subsequent energy consumption. Similarly, the efficiency of a heating system will influence the choice of a designer to insulate more the building envelope in order to reach the building energy target.

A-8.4.1.2.(3) and (4) Determination of Compliance. The sizing of the HVAC systems of a building has a significant impact on energy consumption. In practice, it may be justified, depending on circumstances, to oversize or undersize the HVAC systems of a project. To achieve equivalence in the comparison, the same sizing rules must apply to the reference building and the proposed building.

To prevent unjustified transfer of "energy credits" caused by an abusive undersizing of the HVAC systems of the proposed building, the HVAC systems of the proposed and reference buildings must meet the same thermal comfort needs of the spaces served. To that end, the Code does not permit considering a proposed building whose thermal discomfort hours exceed those of the reference building or considering that the proposed and reference buildings have more than 300 hours of heat discomfort in a simulated year.

A-8.4.1.4.(2)(b) Existing Equipment Characteristics. Where the HVAC systems of the existing building serve the addition, the existing systems are modeled as they are, i.e. in accordance with the original plans and specifications, in accordance with the applicable regulatory requirements at the time of their installation or from on-site readings.

These Notes are included for explanatory purposes only and do not form part of the requirements. The number that introduces each Note corresponds to the applicable requirement in this Part of this Division.

A-8.4.1.4.(3) Addition. The dividing partition of the existing building will be modeled without heat gain or loss, unless the temperature difference between both sides of the wall is greater than 10°C, in which case heat exchanges between the addition and the existing building will be considered in the modeling.

A-8.4.2. Compliance Calculation. The annual energy consumption is evaluated by an energy modeling software, also called energy simulation software. The software includes at least one program, also called calculation engine. The software often includes graphic interfaces facilitating data entry and result analysis.

A-8.4.2.2.(1) Major Program Deficiencies and Limitations. The addenda of ANSI/ASHRAE 140, "Evaluation of Building Energy Analysis Computer Programs," make it possible to verify whether a program has major deficiencies or limitations.

A-8.4.2.2.(3) Internal Loads. Normal internal loads include loads due to lighting, the presence of occupants, equipment directly used by occupants such as personal computers, automatic equipment such as computer servers, and other loads that do not consume energy such as food that must be kept in a freezer. Internal loads normally produce heat gains in the form of sensible heat, latent heat or radiant heat.

Except for lighting, internal loads are not covered by the prescriptive paths of the Code. However, internal loads add cooling and/or heating loads to the building's HVAC systems and service water heating systems. For that reason, internal loads representative of the building type or space function must be included in the compliance calculations. It will make it possible to correctly evaluate part-load performance of the HVAC systems and service water heating systems, and, by extension, the energy consumption of the proposed and reference buildings.

Sentence 8.4.4.1.(4) provides that the internal loads must be modeled identically in the proposed and reference building energy models; only the energy consumed by the equipment and systems regulated by the Code can be modeled differently in the proposed and reference buildings.

Tables A-8.4.3.8.(1)-A and A-8.4.3.8.(1)-B provide default values that are generally representative of the internal loads based on building or space type.

It must be evaluated whether expected internal loads are correctly represented by the default values. Generally, if the default values provided in Note A-8.4.3.8.(1) appear too small compared to the expected internal loads, some commercial and/or industrial operations and/or processes will not be correctly represented.

The following loads, often associated to processes and/or activities, are examples of loads that are not represented in the default values in Tables A-8.4.3.8.(1)-A and A-8.4.3.8.(1)-B:
- manufacturing machinery in an industrial building,
- medical imaging equipment in a hospital,
- computer servers in a data centre of an office building,
- swimming pool water heating in a recreation centre, and
- cooking appliances and refrigeration equipment in a commercial kitchen or restaurant.

HVAC systems of processes and/or activities that require temperatures, airflows or a humidity rate that do not correspond to the usual comfort conditions are excluded from the prescriptive path; there is no requirement for their operation or efficiency. In the performance path, those HVAC systems must be modeled because they have an impact on the cooling or humidification heating load of zones adjacent to the process.

A-8.4.2.3. Climatic Data. The following data formats are acceptable to represent climatic data:
- TMY2 (Typical Meteorological Year 2),
- TMY3 (Typical Meteorological Year 3),
- WYEC2 (Weather Year for Energy Calculation 2),
- CWEC (Canadian Weather Year for Energy Calculations),
- IWEC (International Weather for Energy Calculations), and
- CWEEDS (Canadian Weather Energy and Engineering Datasets).

The CWEC represent average heating and cooling degree-days which impact heating and cooling loads in buildings. The CWEC follow the ASHRAE WYEC2 format and were derived from the CWEEDS of hourly weather information for Canada from the 1953-1995 period of record. The CWEC are available from Environment Canada at www.climate.weather.gc.ca/prods_servs/engineering_e.html.

Where climatic data for a target location are not available, climatic data for a representative alternative location should be selected based on the following considerations: same climatic zone, same geographic area or characteristics, heating degree-days (HDD) of the alternative location are within 10% of the target location's

HDD, and the January 1% heating design criteria of the alternative location is within 2°C of the target location's same criteria (see Table C-1). Where several alternative locations are representative of the climatic conditions at the target location, their proximity to the target location should also be a consideration.

A-8.4.2.8. Modeling of Building Envelope Assemblies. The programs generally permit modeling opaque building assemblies by a succession of materials in continuous layers. For example, a metal-frame wall construction could be modeled with three layers of materials representing the exterior cladding, the insulation and the interior finish. In order for the material assembly to have the value of the derated effective thermal resistance calculated in accordance with Sentence 8.4.2.8.(4), the thickness of the insulating layer will generally be adjusted by the program for each opaque building assembly of the proposed building having a different derated effective thermal resistance. Similarly, the thickness of the insulating layer will be adjusted by the program in the reference building to reach the value of the derated effective thermal resistance calculated from the values of the effective thermal resistance, the linear thermal transmittance and the point thermal transmittance required in Part 3.

A-8.4.2.8.(4) Calculation of Effective Thermal Resistance. Sentence 8.4.2.8.(4) indicates that the effective thermal resistance of opaque building assemblies must be derated in accordance with Sentences 3.3.1.3.(2) and (3) to consider supplementary heat losses caused by partial or complete penetrations of the envelope and by transitions between constructive systems of the envelope.

Thus, the effective thermal resistance will be derated in the proposed building according to the proposed construction details. It will also be derated in the reference building by using the default values defined in Sentence 3.3.1.3.(3). Even if the proposed building has a penetration or an intersection that complies with the prescriptive requirements, the derating of the thermal resistance must be carried out in the proposed building as well as the reference building since that adjustment will have a different impact on the annual energy consumption of each of the buildings.

A-8.4.2.8.(5) Derated Effective Thermal Resistance According to Temperature-control Zones. In order to facilitate modeling, the derated effective thermal resistance may be considered for each opaque building assembly, independently of the adjacent temperature-control zones, where they are maintained at a temperature differential of not more than 10°C.

For example, in an apartment building, if several sections of walls have been simplified to be considered as only one wall and that wall is in contact with eight temperature-control zones representing eight dwelling units, then the effective thermal resistance may be derated globally for that wall. Thus, a single value of the derated thermal resistance is entered in the energy modeling for the eight zones. That single value of the effective thermal resistance for that wall considers all the partial or complete penetrations of the envelope and the transitions between the different constructive systems of the envelope.

However, in the case of a mixed-use building including a grocery store on the first floor having six temperature-control zones maintained at 21°C and two grocery storage zones maintained at 4°C, the effective thermal resistance is derated separately for the section of wall in contact with the first six zones and for the section of wall in contact with the other two zones.

A-8.4.2.10.(3) Part-load Parameters. The part-load of an HVAC system may vary in particular due to a change in climate conditions or in the fluid inlet temperature in the system.

A-8.4.2.10.(4) Independent Modeling of an HVAC System's Equipment Components. Generally, the modeling of an HVAC system in a program requires to enter the individual efficiency rates of some components of the systems, such as supply fans, cooling compressors and condensers. However, energy or efficiency indexes of some HVAC equipment such as the EER (energy-efficiency ratio), may include, for example, the efficiency rate of a supply fan. The energy efficiency rate of the component must be isolated from the EER of the equipment and entered in the program. Consequently, the equipment efficiency, measured, for example, by the EER, must be adjusted to reflect the separate processing of the components before entering that value in the program. It is possible to calculate the adjusted EER or to obtain it by contacting the equipment manufacturer.

A-8.4.3.2.(1) Operating Schedules. Operating schedules generally account for the following elements:
- the presence of occupants,
- the operation of interior lighting,
- the operation of receptacle equipment,
- the operation of HVAC systems, and

- the operation of service water systems.

Tables A-8.4.3.2.(1)-A to A-8.4.3.2.(1)-K provide for default operating schedules that are generally representative of the type of building or space. Those schedules may be used with Table A-8.4.3.8.(1)-A or A-8.4.3.8.(1)-B if more accurate information is not available. The proposed operating schedules must be evaluated to determine if they are correctly represented by the default values.

Table A-8.4.3.2.(1)-A
Operating Schedule A

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0	0	0	0	0	0	0.1	0.7	0.9	0.9	0.9	0.5	0.5	0.9	0.9	0.9	0.7	0.3	0.1	0.1	0.1	0.1	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interior lighting, fraction "on"																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.3	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.5	0.3	0.3	0.1	0.1	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Receptacle Equipment, fraction of load																								
Mon - Fri	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.5	0.3	0.3	0.2	0.2	0.2	0.2
Sat	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Sun	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Fans																								
Mon - Fri	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Heating System, °C																								
Mon - Fri	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	18	18	18	18
Sat	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Sun	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Service Water Heating System, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.5	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.3	0.2	0.2	0.2	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Table A-8.4.3.2.(1)-B
Operating Schedule B

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0.1	0	0	0	0	0	0	0	0.1	0.2	0.5	0.9	0.8	0.5	0.2	0.2	0.3	0.6	0.9	0.9	0.9	0.6	0.4	0.3
Sat	0.3	0	0	0	0	0	0	0	0.1	0.2	0.5	0.9	0.8	0.5	0.2	0.2	0.3	0.6	0.9	0.9	0.9	0.6	0.6	0.5
Sun	0.3	0	0	0	0	0	0	0	0	0.1	0.4	0.5	0.5	0.4	0.2	0.2	0.2	0.5	0.7	0.7	0.5	0.3	0.1	0.1
Interior lighting, fraction "on"																								
Mon - Fri	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.5	0.5
Receptacle Equipment, fraction of load																								
Mon - Fri	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.5	0.5
Fans																								
Mon - Fri	On	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sat	On	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sun	On	Off	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sat	Off	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sun	Off	Off	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off
Heating System, °C																								
Mon - Fri	22	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sat	22	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sun	22	18	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	18	18
Service Water Heating System, fraction of load																								
Mon - Fri	0.5	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.7	0.7	0.4	0.5	0.6	0.6	0.4	0.3	0.3	0.4	0.5	0.8	0.8	0.9	0.9	0.6
Sat	0.6	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.7	0.7	0.4	0.5	0.6	0.6	0.4	0.3	0.3	0.4	0.5	0.8	0.8	0.9	0.9	0.7
Sun	0.6	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.7	0.7	0.4	0.5	0.6	0.6	0.4	0.3	0.3	0.4	0.5	0.8	0.8	0.5	0.5	0.5

Table A-8.4.3.2.(1)-C
Operating Schedule C

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0	0	0	0	0	0	0	0.1	0.2	0.5	0.5	0.7	0.7	0.7	0.7	0.8	0.7	0.5	0.3	0.3	0	0	0	0
Sat	0	0	0	0	0	0	0	0.1	0.2	0.5	0.6	0.8	0.9	0.9	0.9	0.8	0.7	0.5	0.2	0.2	0	0	0	0
Sun	0	0	0	0	0	0	0	0.1	0.2	0.5	0.6	0.8	0.9	0.9	0.9	0.8	0.7	0.5	0	0	0	0	0	0
Interior lighting, fraction "on"																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.5	0.05	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.5	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.05	0.05	0.05	0.05	0.05	0.05
Receptacle Equipment, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.5	0.05	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.5	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.05	0.05	0.05	0.05	0.05	0.05
Fans																								
Mon - Fri	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off	Off	Off	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off	Off	Off	Off	Off
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	18	18	18	18
Sat	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	18	18	18	18
Sun	18	18	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	18	18	18	18	18	18
Service Water Heating System, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2	0.3	0.4	0.8	0.8	0.8	0.8	0.6	0.4	0.3	0.2	0.2	0.05	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2	0.3	0.5	0.9	0.9	0.9	0.9	0.7	0.5	0.3	0.2	0.2	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2	0.3	0.5	0.9	0.9	0.9	0.9	0.9	0.5	0.3	0.05	0.05	0.05	0.05	0.05	0.05

Table A-8.4.3.2.(1)-D
Operating Schedule D

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0	0	0	0	0	0	0	0.1	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.5	0.2	0.1	0.3	0.3	0.3	0.1	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interior lighting, fraction "on"																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.5	0.7	0.7	0.7	0.3	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Receptacle Equipment, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.5	0.7	0.7	0.7	0.3	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fans																								
Mon - Fri	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	18	18
Sat	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Sun	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Service Water Heating System, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.3	0.5	0.5	0.5	0.3	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Table A-8.4.3.2.(1)-E
Operating Schedule E

Day	Time of Day																						
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0	0	0	0	0	0	0	0.2	0.7	0.9	0.9	0.9	0.9	0.5	0.9	0.8	0.8	0.2	0	0	0	0	0	0
Sat	0	0	0	0	0	0	0	0	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interior lighting, fraction "on"																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.4	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.4	0.05	0.05	0.05	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Receptacle Equipment, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.4	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.4	0.05	0.05	0.05	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fans																								
Mon - Fri	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	Off	Off	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	Off	Off	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	18	18	18	18	18	18
Sat	18	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	18	18	18	18	18	18	18	18
Sun	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Service Water Heating System, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.4	0.5	0.5	0.7	0.9	0.8	0.7	0.8	0.3	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.2	0.4	0.2	0.2	0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Table A-8.4.3.2.(1)-F
Operating Schedule F

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0.63	0.63	0.63	0.63	0.63	0.63	0.49	0.28	0.28	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.35	0.35	0.35	0.49	0.49	0.56	0.63	0.63
Sat	0.63	0.63	0.63	0.63	0.63	0.63	0.49	0.28	0.28	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.35	0.35	0.35	0.49	0.49	0.56	0.63	0.63
Sun	0.63	0.63	0.63	0.63	0.63	0.63	0.49	0.28	0.28	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.35	0.35	0.35	0.49	0.49	0.56	0.63	0.63
Interior lighting, fraction "on"																								
Mon - Fri	0.14	0.14	0.07	0.07	0.07	0.14	0.28	0.35	0.28	0.28	0.21	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.56	0.63	0.56	0.42	0.21
Sat	0.14	0.14	0.07	0.07	0.07	0.14	0.28	0.35	0.28	0.28	0.21	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.56	0.63	0.56	0.42	0.21
Sun	0.14	0.14	0.07	0.07	0.07	0.14	0.28	0.35	0.28	0.28	0.21	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.56	0.63	0.56	0.42	0.21
Receptacle Equipment, fraction of load																								
Mon - Fri	0.14	0.14	0.07	0.07	0.07	0.14	0.28	0.35	0.28	0.28	0.21	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.56	0.63	0.56	0.42	0.21
Sat	0.14	0.14	0.07	0.07	0.07	0.14	0.28	0.35	0.28	0.28	0.21	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.56	0.63	0.56	0.42	0.21
Sun	0.14	0.14	0.07	0.07	0.07	0.14	0.28	0.35	0.28	0.28	0.21	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.56	0.63	0.56	0.42	0.21
Fans																								
Mon - Fri	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sat	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sun	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Cooling System, °C																								
Mon - Fri	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sat	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sun	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sat	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sun	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Service Water Heating System, fraction of load																								
Mon - Fri	0.21	0.14	0.07	0.07	0.14	0.28	0.42	0.63	0.49	0.35	0.35	0.28	0.35	0.28	0.21	0.21	0.21	0.21	0.35	0.49	0.49	0.49	0.49	0.35
Sat	0.21	0.14	0.07	0.07	0.14	0.28	0.42	0.63	0.49	0.35	0.35	0.28	0.35	0.28	0.21	0.21	0.21	0.21	0.35	0.49	0.49	0.49	0.49	0.35
Sun	0.21	0.14	0.07	0.07	0.14	0.28	0.42	0.63	0.49	0.35	0.35	0.28	0.35	0.28	0.21	0.21	0.21	0.21	0.35	0.49	0.49	0.49	0.49	0.35

Table A-8.4.3.2.(1)-G
Operating Schedule G

Day	Times of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Interior lighting, fraction "on"																								
Mon - Fri	0	0	0	0	0	0.2	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0.9	0.9	0.9	0.8	0.6	0.3
Sat	0	0	0	0	0	0.2	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0.9	0.9	0.9	0.8	0.6	0.3
Sun	0	0	0	0	0	0.2	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0.9	0.9	0.9	0.8	0.6	0.3
Receptacle Equipment, fraction of load																								
Mon - Fri	0.2	0.2	0.2	0.2	0.2	0.2	0.8	0.8	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.2	0.9	0.9	0.7	0.5	0.5	0.5	0.3
Sat	0.2	0.2	0.2	0.2	0.2	0.2	0.8	0.8	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.2	0.9	0.9	0.7	0.5	0.5	0.5	0.3
Sun	0.2	0.2	0.2	0.2	0.2	0.2	0.8	0.8	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.2	0.9	0.9	0.7	0.5	0.5	0.5	0.3
Fans																								
Mon - Fri	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sat	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sun	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Cooling System, °C																								
Mon - Fri	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sat	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sun	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sat	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sun	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Service Water Heating System, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.2	0.8	0.7	0.5	0.4	0.2	0.2	0.2	0.3	0.5	0.5	0.7	0.7	0.4	0.4	0.2	0.2	0.1	0.1
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.7	0.9	0.7	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.3	0.3	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.4	0.3	0.2	0.2	0.2	0.2	0.1

Table A-8.4.3.2.(1)-H
Operating Schedule H

Day	Time of Day																						
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Interior lighting, fraction "on"																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Receptacle Equipment, fraction of load																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Fans																								
Mon - Fri	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sat	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sun	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Cooling System, °C																								
Mon - Fri	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sat	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sun	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sat	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sun	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Service Water Heating System, fraction of load																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Table A-8.4.3.2.(1)-I
Operating Schedule I

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.4	0.8	0.8	0.8	0.6	0.4	0.1
Sat	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.4	0.6	0.8	0.6	0.4	0.2	0.4	0.8	0.8	0.6	0.4	0.1
Sun	0	0	0	0	0	0	0	0.2	0.4	0.8	0.8	0.4	0.2	0	0	0	0	0	0	0	0	0	0	0
Interior lighting, fraction "on"																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.5	0.8	0.9	0.9	0.9	0.9	0.9	0.5
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.5	0.8	0.9	0.9	0.9	0.8	0.6	0.8	0.9	0.9	0.9	0.9	0.5
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.9	0.9	0.9	0.9	0.5	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Receptacle Equipment, fraction of load																								
Mon - Fri	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.8	0.8	0.8	0.8	0.8	0.8	0.1
Sat	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.1
Sun	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	0.8	0.8	0.8	0.8	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fans																								
Mon - Fri	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sun	Off	Off	Off	Off	Off	Off	On	On	On	On	On	On	On	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	Off
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	24	24	24	24	24	24	24	Off
Sun	Off	Off	Off	Off	Off	Off	24	24	24	24	24	24	24	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Heating System, °C																								
Mon - Fri	18	18	18	18	18	18	18	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	18
Sat	18	18	18	18	18	18	18	18	18	20	22	22	22	22	22	22	22	22	22	22	22	22	22	18
Sun	18	18	18	18	18	18	20	22	22	22	22	22	22	18	18	18	18	18	18	18	18	18	18	18
Service Water Heating System, fraction of load																								
Mon - Fri	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.2	0.2	0.4	0.9	0.9	0.9	0.8	0.6	0.2
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.2	0.2	0.4	0.8	0.9	0.8	0.6	0.4	0.4	0.9	0.9	0.8	0.6	0.2
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2	0.4	0.4	0.2	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Table A-8.4.3.2.(1)-J
Operating Schedule J

Day	Time of Day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.9	0.9
Interior lighting, fraction "on"																								
Mon - Fri	0.1	0.1	0.1	0.1	0.3	0.5	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.3	0.1
Sat	0.1	0.1	0.1	0.1	0.3	0.5	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.3	0.1
Sun	0.1	0.1	0.1	0.1	0.3	0.5	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.3	0.1
Receptacle Equipment, fraction of load																								
Mon - Fri	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.6	0.7	0.7	0.5	0.3	0.1
Sat	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.6	0.7	0.7	0.5	0.3	0.1
Sun	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.6	0.7	0.7	0.5	0.3	0.1
Fans																								
Mon - Fri	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sat	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Sun	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Cooling System, °C																								
Mon - Fri	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sat	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Sun	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Heating System, °C																								
Mon - Fri	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sat	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Sun	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Service Water Heating System, fraction of load																								
Mon - Fri	0.1	0.1	0.1	0.1	0.2	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.1	0.1	0.1
Sat	0.3	0.2	0.1	0.1	0.2	0.4	0.5	0.8	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.3	0.5	0.7	0.7	0.7	0.7	0.5
Sun	0.3	0.2	0.1	0.1	0.2	0.4	0.4	0.6	0.9	0.7	0.5	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.4	0.6	0.6	0.6	0.6	0.5

Table A-8.4.3.2.(1)-K
Operating Schedule K

Day	Time of Day																						
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
Occupants, fraction occupied																								
Mon - Fri	0	0	0	0	0.1	0.5	0.9	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.7	0.9	0.6	0.2	0.1	0.1	0.1	0	0
Sat	0	0	0	0	0.1	0.5	0.9	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.7	0.9	0.6	0.2	0.1	0.1	0.1	0	0
Sun	0	0	0	0	0.1	0.5	0.9	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.7	0.9	0.6	0.2	0.1	0.1	0.1	0	0
Interior lighting, fraction “on”																								
Mon - Fri	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sat	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sun	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Receptacle Equipment, fraction of load																								
Mon - Fri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fans																								
Mon - Fri	Off	Off	Off	Off	Off	On	On	On	On	Off	Off	Off	Off	Off	Off	On	On	On	Off	Off	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	On	On	On	On	Off	Off	Off	Off	Off	Off	On	On	On	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	On	On	On	On	Off	Off	Off	Off	Off	Off	On	On	On	Off	Off	Off	Off	Off	Off
Cooling System, °C																								
Mon - Fri	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sat	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Sun	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Heating System, °C																								
Mon - Fri	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Sat	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Sun	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Service Water Heating System, fraction of load																								
Mon - Fri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A-8.4.3.3.(2) Energy Modeling of the Proposed Building Considering the Fenestration Shading Effects. Where the modeler considers the effect of shading on fenestration, the existing surrounding elements that have an impact on the building must be considered in the modeling. For example, the potential energy gain due to the sun breaker system is partly cancelled where a neighbouring immovable or structure casts its shadow on the proposed building.

The 10% reduction of sun gain and visible sun transmittance coefficients of the fenestration considers the darkening due to dirt and dust present on the fenestration.

A-8.4.3.3.(3)(a) Solar Heat Gain and Visible Sun Transmittance Coefficients of Fenestration. The 20% reduction of solar heat gain and visible sun transmittance coefficients of the fenestration is explained by the darkening effect set at 10% due to dirt and dust on the fenestration and by the darkening effect set at 10% due to surrounding elements, the building itself and the permanent automated shading devices. Those adjusted coefficients allow the modeler to not model the shading in the program as provided in Sentence 8.4.3.3.(2).

A-8.4.3.3.(4) Air Leakage Rate of the Building Envelope. The air leakage rate of 0.25 L/(s·m²), which is a typical infiltration rate at 5 Pa, is used in the energy consumption model and may not reflect the real value encountered under operating conditions. That rate is based on pressure differentials typically encountered under operating conditions.

A-8.4.3.3.(7) Modeling of Building Assemblies in Contact with the Ground. The detailed calculation of the annual heat transfer of building assemblies in contact with the ground is complex and may require a significant investment of time. Indeed, the heat transfer with the ground varies in particular based on the geometry of the building, the depth of the foundations, the climate zone, and the arrangement of the materials composing the opaque building assemblies in contact with the ground. In addition, thermal conductivity of the ground, the most important parameter for quantifying the heat transfer with the ground, varies significantly based on several factors such as ground humidity rate, type of ground, ground temperature and ground density. The effect of frost, snow cover and depth of the groundwater may also have an influence on heat transfer.

The calculation of heat transfer of the building assemblies in contact with the ground is treated in different manners in programs. Some programs implement detailed calculation methods while others use simplified methods to estimate the annual heat transfer of opaque building assemblies in contact with the ground. The purpose of Sentence 8.4.3.3.(7) is to prohibit performance exchanges with building assemblies in contact with the ground where simplified methods for calculating heat transfer with the ground are used by the program. Although simplified methods generally allow the definition of the properties of the insulation under the slab and those at the foundation wall level, those methods are not sufficiently accurate to quantify heat transfer with the ground. Such simplified methods are described in the ASHRAE Handbook – Fundamentals, Chapter 18. Another example of a simplified method, defined from regression analyses and used in some programs, takes into account factors representing heat transfer through the floor and walls (factors F and C).

For performance exchanges of building assemblies in contact with the ground to be considered in the performance path, Sentence 8.4.3.3.(7) requires that the program be capable to accurately represent the arrangement of the insulation and the properties of the building assemblies in contact with the ground such as dimensions, specific heat, density and thermal conductivity.

Before considering modeling performance exchanges of building assemblies in contact with the ground, compliance of the calculation method used with Sentence 8.4.3.3.(7) must be verified. If it does not, as specified in Article 3.4.1.2., the prescriptive requirements of Subsection 3.2.3. apply to building assemblies in contact with the ground of the proposed building. In accordance with Clause 8.4.4.1.(4)(i), those assemblies will be modeled in the same manner as the reference building.

A-8.4.3.4.(2) Occupancy Control Factors. As provided in Sentence 4.4.1.2.(2), the interior lighting controls in Subsection 4.2.2. are mandatory and cannot be exchanged. That means that the controls must be present in the plans and specifications and must be modeled in the same manner for both the proposed and reference buildings. It concerns in particular controls in Table 4.2.1.6., listed in the columns under "Type of Lighting Control."

Contrary to the occupancy control factors, personal control factors and photocontrol factors may reduce the power of the installed lighting power of the proposed building but will not reduce the interior lighting power of the reference building.

A-8.4.3.4.(4) Illumination Set-points. See Tables A-8.4.3.8.(1)-A and A-8.4.3.8.(1)-B for representative illuminance levels to be used as modeling guidance.

A-8.4.3.5. Purchased Energy. Purchased energy is typically defined as thermal energy produced from a source outside the site of the proposed building. It is used as heating and/or cooling energy in an HVAC or service water heating system—as a heat source and/or sink—that is provided either directly or through a heat exchanger or other equipment.

A-8.4.3.6.(1) Outdoor Air Ventilation Rates and Exhaust Rates. The effectiveness of demand control ventilation varies significantly according to occupant density and sensor type, placement and calibration.

The increase or reduction of outdoor air ventilation and exhaust rates are not means to comply with the energy performance compliance path.

A-8.4.3.6.(2) Displacement Ventilation. Displacement ventilation is a type of diffusion that requires little energy. Where a temperature-control zone meets the criteria set out in Clauses 8.4.3.6.(2)(a) and (b), the distribution airflow may be reduced by dividing it by 1.2. In accordance with Sentence 8.4.4.15.(2), the distribution airflow of the corresponding reference building zone will not be reduced.

A-8.4.3.6.(3) Part-load HVAC System's Equipment Operation. HVAC system's equipment rarely operates at full load. Consequently, the part-load efficiency must be adequately modeled. The designer must use available part-load performance curves of the proposed equipment, generally provided by the manufacturer, and must adapt those curves to the requirements of the programs. That adaptation is necessary since to model part-load equipment operation, each program includes its own mathematical models, generally in the form of a polynomial equation.

Where the program does not have the function of modeling the part-load operation of HVAC system's equipment (for example, due to an atypical curve), Tables 8.4.4.21.-A to 8.4.4.21.-I or the default curves of the programs may be used.

A-8.4.3.7.(3) Temperature-control Zone Delimitation. Where the temperature-control zones and HVAC systems are not entirely stated in the plans, modeling of those zones in accordance with the requirements of Sentence 8.4.3.7.(3) is necessary. Those requirements must be applied, for example, in the case of a commercial building whose layout of rental suites is unknown at the time of modeling.

A-8.4.3.8.(1) Internal and Service Water Heating Loads and Illuminance Levels. Tables A-8.4.3.8.(1)-A and A-8.4.3.8.(1)-B contain default values for internal and service water heating loads and their operating schedules for simulations purposes.

Table A-8.4.3.8.(1)-A
Modeling Guidance for Loads, Operating Schedules and Illuminance Levels by Building Type

Building Type	Occupant Density, m²/occupant	Peak Receptacle Load, W/m²	Service Water Heating Load, W/occupant	Operating Schedule from A-8.4.3.2.(1)	Illuminance Levels, lx(1)
Automotive facility	20	5	90	E	400
Convention centre	8	2.5	30	C	300
Courthouse	15	5	60	A	400
Dining					
bar lounge/leisure	10	1	115	B	125
cafeteria/fast food	10	1	115	B	300
family	10	1	115	B	300
Dormitory	30	2.5	500	G	100
Exercise centre	10	1	90	B	350
Fire station	25	2.5	400	F	400
Gymnasium	10	1	90	B	500
Health care clinic	20	7.5	90	A	600
Hospital	20	7.5	90	H	350
Hotel/Motel	25	2.5	500	F	150
Library	20	2.5	90	C	500
Long-term care					
dwelling units	25	1.5	500	J	400

Table A-8.4.3.8.(1)-A (Continued)

Building Type	Occupant Density, m²/occupant	Peak Receptacle Load, W/m²	Service Water Heating Load, W/occupant	Operating Schedule from A-8.4.3.2.(1)	Illuminance Levels, lx(1)
other	25	1.5	500	B	400
Manufacturing facility	30	10	90	A	450
Motion picture *theatre*	8	1	30	C	150
Multi-unit residential building	25	5	500	G	125
Museum	20	2.5	60	C	100
Office	25	7.5	90	A	400
Penitentiary	30	2.5	400	H	250
Performing arts *theatre*	8	1	30	C	250
Police station	25	7.5	90	H	400
Post office	25	7.5	90	A	400
Religious building	5	1	15	I	250
Retail area	30	2.5	40	C	450
School/university	8	5	60	D	400
Sports arena	10	1	90	B	400
Storage garage	1000	0	0	K	75
Town hall	25	7.5	90	D	400
Transportation facility	15	1	65	H	225
Warehouse	1500	1	300	A	150
Workshop	30	10	90	A	500

Notes to Table A-8.4.3.8.(1)-A:

(1) The values are weighted averages that correspond to typical overall illuminance levels recommended for the buildings types listed and include both general lighting and task lighting. They are based on recommendations published by the IES.

Table A-8.4.3.8.(1)-B
Modeling Guidance for Loads, Operating Schedules and Illuminance Levels by Space Type

Common Space Types					
Space Type	Occupant Density, m²/occupant	Peak Receptacle Load, W/m²	Service Water Heating Load, W/occupant	Operating Schedule(1) from A-8.4.3.2.(1)	Illuminance Levels, lx(2)
Atrium (any height)	10	2.5	0	*	250
Audience seating area – permanent					
for auditorium	5	2.5	30	C	100
for convention centre	5	2.5	30	C	350
for gymnasium	5	0	30	B	350
for motion picture theatre	5	2.5	30	C	250
for penitentiary	5	2.5	30	C	250
for performing arts theatre	7.5	2.5	30	C	250
for religious building	5	1	15	I	150
for sports arena	5	0	30	B	150
other	5	1	15	*	100
Banking activity area and offices	25	5	60	A	400
Classroom/Lecture hall/Training room	7.5	5	65	D	400

Table A-8.4.3.8.(1)-B (Continued)

Common Space Types					
Space Type	Occupant Density, m^2/occupant	Peak Receptacle Load, W/m^2	Service Water Heating Load, W/occupant	Operating Schedule(1) from A-8.4.3.2.(1)	Illuminance Levels, lx(2)
Conference/Meeting/Multi-purpose room	5	1	45	C	350
Confinement cell	25	0	325	G	400
Copy/Print room	100	60	90	A	400
Corridor/Transition area	100	0	0	*	150
Courtroom	5	2.5	30	A	400
Dining area					
for bar lounge/leisure dining	10	1	90	B	100
for cafeteria/fast food dining	10	1	120	B	200
for family dining	10	1	120	B	200
for penitentiary	10	1	120	B	200
for space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living," and used primarily by residents	10	1	120	B	200
other	10	1	120	B	200
Dressing/Fitting room for performing arts theatre	30	2.5	40	C	250
Electrical/Mechanical room	200	1	0	*	350
Emergency vehicle garage	25	2.5	325	H	350
Food preparation area	20	10	120	B	500
Guest room	25	2.5	600	F	200
Laboratory					
for classrooms	20	10	180	D	500
other	20	10	180	A	650
Laundry/Washing area	20	0	60	C	350
Loading dock – interior	500	0	0	H	200
Lobby					
for elevator	10	1	0	C	200
for hotel	10	2.5	30	H	250
for motion picture theatre	10	1	0	C	150
for performing arts theatre	10	1	0	C	200
for space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living," and used primarily by residents	10	2.5	30	B	150
other	10	1	0	C	150
Locker room	10	2.5	0	*	100
Lounge/Break room					
for health care facility	10	1	60	B	150
other	10	1	60	B	150
Office	20	7.5	90	A	400
Pharmacy area	20	2.5	45	C	400

Table A-8.4.3.8.(1)-B (Continued)

Common Space Types					
Space Type	Occupant Density, m²/occupant	Peak Receptacle Load, W/m²	Service Water Heating Load, W/occupant	Operating Schedule[1] from A-8.4.3.2.(1)	Illuminance Levels, lx[2]
Sales area	30	2.5	40	C	500
Seating area – general	10	0	65	*	150
Server room	100	200	90	* or H[3]	350
Stairway/Stairwell	200	0	0	*	150
Storage garage – interior	1000	0	0	K	75
Storage room					
≥ 5 m²	100	1	300	*	100
< 5 m²	100	0	0	*	100
Vehicle maintenance area	20	5	90	E	500
Washroom					
for space designed to ANSI/IES RP-28, “Lighting and the Visual Environment for Senior Living,” and used primarily by residents	30	1	0	*	150
other	30	1	0	*	150
Workshop	30	10	90	A	500
Building-Specific Space Types					
Space Type	Occupant Density, m²/occupant	Peak Receptacle Load, W/m²	Service Water Heating Load, W/occupant	Operating Schedule[1] from A-8.4.3.2.(1)	Illuminance Levels, lx[2]
Convention centre – exhibit space	10	2.5	30	C	500
Dormitory – living quarters	25	2.5	500	G	125
Dwelling units					
general	25	5	500	G	125
long-term	25	2.5	500	J	300
Fire station – sleeping quarters	25	2.5	500	G	150
Gymnasium/Fitness centre					
exercise area	5	1	90	B	350
playing area	5	1.5	90	B	350
Health care facility					
exam/treatment room	20	10	90	C	600
imaging room	20	10	90	H	225
medical supply room	20	1	0	H	400
nursery	20	10	90	H	400
nurses' station	20	2.5	45	H	400
operating room	20	10	300	H	1000
patient room	20	10	90	H	400
physical therapy room	20	10	45	C	350
recovery room	20	10	180	H	250
Library					
reading area	20	1	90	C	500
stacks	20	0	90	C	500

Table A-8.4.3.8.(1)-B (Continued)

Building-Specific Space Types					
Space Type	Occupant Density, m^2/occupant	Peak Receptacle Load, W/m^2	Service Water Heating Load, W/occupant	Operating Schedule(1) from A-8.4.3.2.(1)	Illuminance Levels, lx(2)
Manufacturing facility					
detailed manufacturing area	30	10	90	A	600
equipment room	30	10	90	A	250
extra high bay area (> 15 m floor-to-ceiling height)	30	10	90	A	400
high bay area (7.5 to 15 m floor-to-ceiling height)	30	10	90	A	400
low bay area (< 7.5 m floor-to-ceiling height)	30	10	90	A	400
Museum					
general exhibition area	5	2.5	60	C	250
restoration room	20	5	50	A	600
Post office – sorting area	20	7.5	90	A	400
Religious building					
fellowship hall	5	1	45	C	250
worship/pulpit/choir area	5	1	15	I	250
Retail facility					
dressing/fitting room	30	2.5	40	C	350
mall concourse	20	1	30	C	400
Space designed to ANSI/IES RP-28, "Lighting and the Visual Environment for Senior Living"					
chapel (used primarily by residents)	10	1	15	I	150
recreation room (used primarily by residents)	20	1	60	B	150
Sports arena – playing area					
playing area with facilities for more than 5000 spectators	5	1.5	90	B	1600
playing area with facilities for more than 2000 spectators but not more than 5000 spectators	5	1.5	90	B	1000
playing area with facilities for more than 200 spectators but not more than 2000 spectators	5	1.5	90	B	800
playing area with facilities for not more than 200 spectators or without facilities for spectators	5	1.5	90	B	500
Transportation facility					
airport concourse	20	0	65	H	150
baggage/carousel area	20	2.5	65	H	250
terminal ticket counter	10	2.5	65	H	250
Warehouse – storage area					
medium to bulky palletized items	100	1	65	A	200
small hand-carried items(4)	50	1	65	A	300

Table A-8.4.3.8.(1)-B (Continued)

Notes to Table A-8.4.3.8.(1)-B:

(1) An asterisk (*) in this column indicates that there is no recommended default schedule for the space type listed. In general, such space types will be simulated using a schedule that is similar to the adjacent spaces served: e.g. a corridor space serving an adjacent office space will be simulated using a schedule that is similar to that of the office space.

(2) The values are weighted averages that correspond to typical overall illuminance levels recommended for the buildings/space types listed and include both general lighting and task lighting. They are based on recommendations published by the IES.

(3) A server room that serves a single building or a limited group of users would tend to have operating schedules matching those of that group or building. Server rooms that serve as data centres operating independently of the building in which they are located would tend to operate continuously.

(4) See Note A-Table 4.2.1.6.

A-8.4.3.9.(1) and (2) Energy Recovered on Site and Renewable Energy Produced on Site. Sentence 8.4.3.9.(1) applies, for example, in the case of heat recovery from an exothermic process. Where heat-recovery technology is provided for in Subsection 5.2.10., the highest performance of the heat-recovery equipment planned in the proposed building is not permitted to be considered. In such a case, since that equipment must be modeled in the reference building under Article 8.4.4.19., the highest performance of that equipment in the proposed building will be considered by the program.

Sentence 8.4.3.9.(2) applies, for example, for the production of electricity by a photovoltaic panel.

A-8.4.4.1.(2) Prescriptive Compliance. The basic principle guiding the modeling of the reference building is that every component, device or system included in the building must comply with the applicable prescriptive requirements of Sections 3.2., 4.2., 5.2., 6.2. and 7.2. The requirements of Subsection 8.4.4. clarify the specific treatment of parameters some of which are not covered by the prescriptive requirements of the Code.

A-8.4.4.1.(4) Building Characteristics. The characteristics in Sentence 8.4.4.1.(4) are two-fold. Some characteristics of the building do not have specific prescriptive requirements but have considerable influence on energy consumption: the shape of the building, its orientation, receptacle loads, heat from a process, the consumption of an HVAC system dedicated only to a process, etc. The modeler cannot take into account those characteristics to improve the performance of the proposed building; they must be modeled identically in the proposed and reference buildings.

Other building characteristics, for example, the airtightness rate, have specific prescriptive requirements but their compliance is difficult to verify in the building once built. That is why the modeler is not permitted to use those characteristics to improve the performance of the proposed building. They must also be modeled identically in the proposed and the reference buildings.

Some indications to the contrary may be provided for in Subsections 8.4.3. and 8.4.4., in particular

- for Clause (4)(i), Sentence 8.4.4.3.(5) (see Note A-8.4.3.3.(7)),
- for Clause (4)(j), Sentence 8.4.4.4.(1), and
- for Clause (4)(x), Sentences 8.4.4.3.(2) and (3).

A-8.4.4.1.(8) and (9) Equipment Energy Efficiency for Modeling the Reference Building. The Energy Efficiency Act (S.C. 1992, c. 36) and its regulations fall under federal jurisdiction. The Act respecting energy efficiency and energy conservation standards for certain electrical or hydrocarbon-fuelled appliances (chapter N-1.01) and its regulations fall under Quebec's jurisdiction. They provide minimum levels for some types of equipment.

Where a minimum energy efficiency level for equipment is provided for in Quebec legislation, Sentences 8.4.4.1.(8) and (9) provide for the use of that value for modeling the reference building.

Where no minimum level is provided in Quebec legislation, the energy efficiency of the equipment must be identical to that of the corresponding equipment in the proposed building or that provided for in the federal legislation.

A-8.4.4.3.(4) Energy Modeling of the Reference Building Considering Fenestration Shading Effects. Where the modeler takes into consideration fenestration shading effects in the proposed building, the permanent and automated shading devices are not modeled in the reference building. However, as provided in Clause 8.4.4.1.(4)(h), shading effects due to surrounding elements and to the building itself must be modeled in the same manner as the proposed building.

As provided in Sentence 8.4.2.9.(1), manually-operated interior shading devices, such as blinds, must not be modeled in neither the proposed building nor the reference building.

A-8.4.4.4.(1) Thermal Mass. Sentence 8.4.4.4.(1) allows the modeling of the thermal mass of the reference building by specifying the thermal characteristics of a lightweight assembly rather than considering a thermal mass identical to that of the proposed building. Where the reference building is modeled with a thermal mass different from that of the proposed building, the parameters determining thermal inertia of the elements of the reference building envelope, such as specific heat and the density of a constructive layer, must be adjusted in accordance with that Sentence to reflect a lightweight construction having an overall weight of 55 kg/m² and a heat capacity of 50 kJ/(m²·K).

A-8.4.4.4.(2) Thermal Characteristics of the Space. The following are examples of space components that affect thermal mass: layout, furnishings, interior wall and floor construction, library stacks, etc.

A-8.4.4.6.(2) and (3) Types of Heat Pumps. The following types of heat pumps are the most commonly used:

- Water-loop heat pump: a heat pump connected to an internal water loop used as a heat source and/or sink. The loop may include an auxiliary heat source (e.g. a boiler) and/or heat rejection device (e.g. a cooling tower).
- Water-source heat pump: a heat pump using as a heat source and/or sink
  - surface water (e.g. river, pond or lake),
  - groundwater,
  - a water loop directly carrying waste heat generated outside the building, or
  - a water loop indirectly carrying waste heat generated outside the building using a heat exchanger that separates the heat source and/or sink from an internal water loop.
- Ground-source heat pump: a heat pump using the ground as a heat source and/or sink through the use of a ground-heat exchanger in which circulates either a refrigerant supplied by the heat pump or a heat transfer fluid coming from an internal water loop.
- Air-source heat pump: a heat pump using the outside air as a heat source and/or sink.

A-8.4.4.6.(4) Automatic Sizing of HVAC System's Equipment. It is possible that, so as not to exceed the annual maximum number of discomfort hours provided for in Sentences 8.4.1.2.(3) and (4), the program requires oversizing or undersizing of the HVAC system's equipment for modeling purposes.

If the HVAC systems of the proposed building are oversized or undersized in respect of the plans and specifications, the corresponding systems of the reference building must be similarly oversized or undersized.

The Note "Equipment sizing (11.5.2.(i) and 11.5.2.(j))" in ASHRAE/IES 90.1, "User's Manual," proposes a procedure to facilitate the adjustment of sizing that could be required by the program.

A-8.4.4.7.(2) and (3) Modeling of Air Distribution and Hydronic Loop Systems. The requirements of Sentences 8.4.4.7.(2) and (3) do not aim to represent accurately the number of fans and individual pumps of a project but rather seek to match the distribution principles used for a temperature-control zone of the proposed building to those of the reference building corresponding zone.

A-Table 8.4.4.7.-A HVAC System for the Proposed Building. An example of the induction cooling system is an active chilled beam designed to recover ambient air from a room, cool it then return it to the room. Outdoor air, which comes in the chilled beam by the ventilation system, carries by induction the room ambient air that passes through a cooling coil.

A-8.4.4.9.(2)(c), 8.4.4.10.(2)(d) and 8.4.4.11.(4)(b) Pumping Flow. Where the pumping flow rate, PFR, in L/min, is not calculated by the program, it may be evaluated using the following equation:

$$PFR = \frac{P \cdot 60\,000}{Cp \cdot \rho \cdot \triangle T}$$

where

P = power of the heating or cooling equipment, in kW,
C_p = specific heat of the heat transfer fluid, in kJ/(kg·K),
ΔT = difference between the supply and return temperature of the heat transfer fluid, in °C, and
ρ = density of the heat transfer fluid, in kg/m³.

The specific heat and the density vary based on the temperature and composition of the heat transfer fluid. Consequently, those two values will be different whether it is a hot or cool water loop, and will also vary based on the percentage of glycol in the heat transfer fluid. To take into account that reality, those values may be evaluated by considering the average temperature of the liquid circulating in the loop. For example, for a hot water loop with a supply at 82°C and a return at 54°C, the average will be 68°C. Water at a temperature of 68°C has a density of 978.87 kg/m³ and a specific heat of 4.19 kJ/(kg·K).

A-8.4.4.9.(2)(d), 8.4.4.10.(2)(e) and 8.4.4.11.(4)(c) Pumping Power Demand. Where the pumping power demand, PPD, in W, is not defined by the program, it may be established using the following equation:

$$\mathrm{PPD} = \frac{\mathrm{PFR} \cdot \mathrm{H} \cdot \rho \cdot \mathrm{g}}{60\,000 \cdot \eta}$$

where

- PFR = pumping flow rate, in L/min (see Note A-8.4.4.9.(2)(c), 8.4.4.10.(2)(d) and 8.4.4.11.(4)(b)),
- H = loss of pressure in the system, in m of pressure head,
- ρ = density of the liquid, in kg/m³,
- g = gravitational constant of 9.81 m/s², and
- η = combined efficiency turbine-motor-variable speed drive of pump.

The reference building pump must have a power demand equivalent to the sum of the power demands of each hydronic loop pump of the proposed building.

A-8.4.4.19.(2) Heat Recovery from Ice-making Machines. A water-cooled, double-bundle water chiller having a load profile corresponding to the load planned on the ice-making machine is adequate for the purposes of Part 8 and allows the modeling of heat recovery.

The following documents may be helpful in setting a more detailed model using refrigeration equipment rather than a water chiller and modeling the ice sheet itself and its interaction with adjacent components and spaces:

- Zmeureanu, R., E.M. Zelaya and D. Giguère. (2002). Simulation de la consommation d'énergie d'un aréna à l'aide du logiciel DOE-2.lE. ESim 2002 Conference, Montréal.
- Ouzzane, M. et al. Cooling Load and Environmental Measurements in a Canadian Indoor Ice Rink. ASHRAE Transactions, Vol. 112, Pt. 2, Paper no. QC-06-008, pp. 538-545, 2006.
- Sunyé, R. et al. ASHRAE Research Report 1289, Develop and Verify Methods For Determining Ice Sheet Cooling Loads, 2007.
- Teyssedou, G., R. Zmeureanu, and D. Giguère. (2009). Thermal Response of the Concrete Slab of an Indoor Ice Rink. ASHRAE HVAC&R Research, Vol. 15, No. 3, May 2009.

Since ice-making for rinks and curling rinks is often associated with resurfacing activities, which require a significant amount of heated service water, the energy models of the proposed and reference buildings should account for the load in accordance with Clause 8.4.4.1.(4)(b).

A-8.4.4.21.(1) Fan Part-Load Curves. Figure A-8.4.4.21.(1) illustrates the equations of Table 8.4.4.21.-I as a graph.

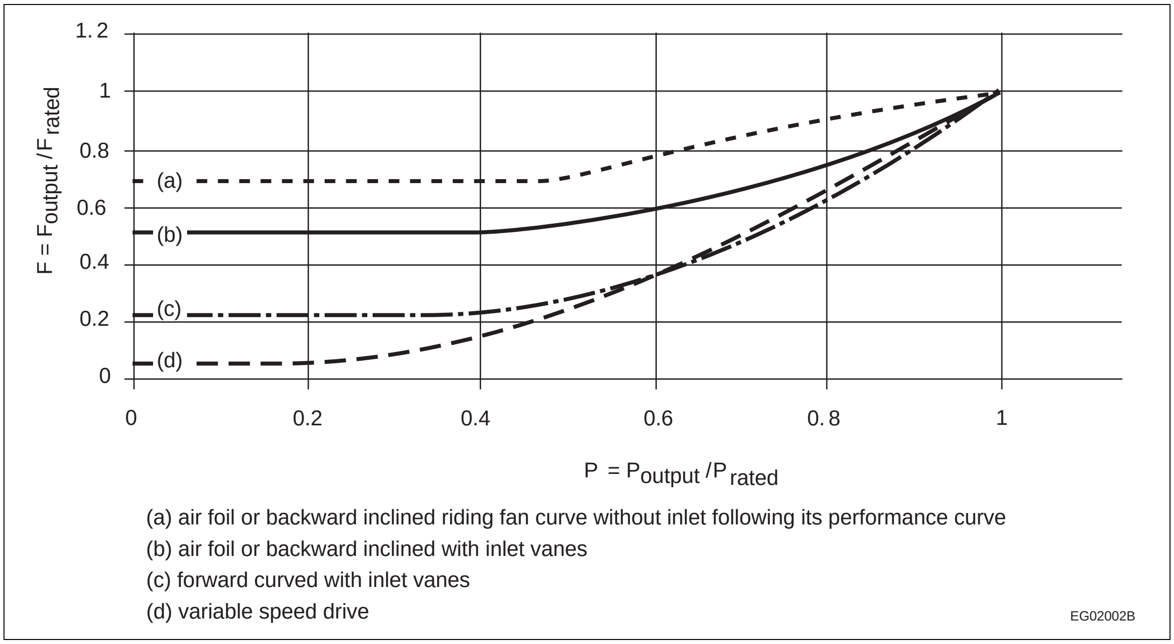

Figure A-8.4.4.21.(1)
Fan part-load curves

Climatic Information for Building Design in Canada

Table C-1
Design Data for Selected Locations in Canada

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
British Columbia								
100 Mile House	1040	-30	-32	29	17	5030	0.27	0.35
Abbotsford	70	-8	-10	29	20	2860	0.34	0.44
Agassiz	15	-9	-11	31	21	2750	0.36	0.47
Alberni	12	-5	-8	31	19	3100	0.25	0.32
Ashcroft	305	-24	-27	34	20	3700	0.29	0.38
Bamfield	20	-2	-4	23	17	3080	0.39	0.50
Beatton River	840	-37	-39	26	18	6300	0.23	0.30
Bella Bella	25	-5	-7	23	18	3180	0.39	0.50
Bella Coola	40	-14	-18	27	19	3560	0.30	0.39
Burns Lake	755	-31	-34	26	17	5450	0.30	0.39
Cache Creek	455	-24	-27	34	20	3700	0.30	0.39
Campbell River	20	-5	-7	26	18	3000	0.40	0.52
Carmi	845	-24	-26	31	19	4750	0.29	0.38
Castlegar	430	-18	-20	32	20	3580	0.27	0.34
Chetwynd	605	-35	-38	27	18	5500	0.31	0.40
Chilliwack	10	-9	-11	30	20	2780	0.36	0.47
Comox	15	-7	-9	27	18	3100	0.40	0.52
Courtenay	10	-7	-9	28	18	3100	0.40	0.52
Cranbrook	910	-26	-28	32	18	4400	0.25	0.33
Crescent Valley	585	-18	-20	31	20	3650	0.25	0.33
Crofton	5	-4	-6	28	19	2880	0.31	0.40
Dawson Creek	665	-38	-40	27	18	5900	0.31	0.40
Dease Lake	800	-37	-40	24	15	6730	0.23	0.30
Dog Creek	450	-28	-30	29	17	4800	0.27	0.35
Duncan	10	-6	-8	28	19	2980	0.30	0.39
Elko	1065	-28	-31	30	19	4600	0.31	0.40
Fernie	1010	-27	-30	30	19	4750	0.31	0.40
Fort Nelson	465	-39	-42	28	18	6710	0.23	0.30
Fort St. John	685	-35	-37	26	18	5750	0.30	0.39
Glacier	1145	-27	-30	27	17	5800	0.25	0.32
Gold River	120	-8	-11	31	18	3230	0.25	0.32
Golden	790	-27	-30	30	17	4750	0.27	0.35
Grand Forks	565	-19	-22	34	20	3820	0.31	0.40
Greenwood	745	-20	-23	34	20	4100	0.31	0.40
Hope	40	-13	-15	31	20	3000	0.48	0.63
Jordan River	20	-1	-3	22	17	2900	0.43	0.55
Kamloops	355	-23	-25	34	20	3450	0.31	0.40

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Kaslo	545	-17	-20	30	19	3830	0.24	0.31
Kelowna	350	-17	-20	33	20	3400	0.31	0.40
Kimberley	1090	-25	-27	31	18	4650	0.25	0.33
Kitimat Plant	15	-16	-18	25	16	3750	0.37	0.48
Kitimat Townsite	130	-16	-18	24	16	3900	0.37	0.48
Ladysmith	80	-7	-9	27	19	3000	0.31	0.40
Langford	80	-4	-6	27	19	2750	0.31	0.40
Lillooet	245	-21	-23	34	20	3400	0.34	0.44
Lytton	325	-17	-20	35	20	3300	0.33	0.43
Mackenzie	765	-34	-38	27	17	5550	0.25	0.32
Masset	10	-5	-7	17	15	3700	0.48	0.61
McBride	730	-29	-32	29	18	4980	0.27	0.35
McLeod Lake	695	-35	-37	27	17	5450	0.25	0.32
Merritt	570	-24	-27	34	20	3900	0.34	0.44
Mission City	45	-9	-11	30	20	2850	0.33	0.43
Montrose	615	-16	-18	32	20	3600	0.27	0.35
Nakusp	445	-20	-22	31	20	3560	0.25	0.33
Nanaimo	15	-6	-8	27	19	3000	0.39	0.50
Nelson	600	-18	-20	31	20	3500	0.25	0.33
Ocean Falls	10	-10	-12	23	17	3400	0.46	0.59
Osoyoos	285	-14	-17	35	21	3100	0.31	0.40
Parksville	40	-6	-8	26	19	3200	0.39	0.50
Penticton	350	-15	-17	33	20	3350	0.35	0.45
Port Alberni	15	-5	-8	31	19	3100	0.25	0.32
Port Alice	25	-3	-6	26	17	3010	0.25	0.32
Port Hardy	5	-5	-7	20	16	3440	0.40	0.52
Port McNeill	5	-5	-7	22	17	3410	0.40	0.52
Port Renfrew	20	-3	-5	24	17	2900	0.40	0.52
Powell River	10	-7	-9	26	18	3100	0.39	0.51
Prince George	580	-32	-36	28	18	4720	0.29	0.37
Prince Rupert	20	-13	-15	19	15	3900	0.42	0.54
Princeton	655	-24	-29	33	19	4250	0.28	0.36
Qualicum Beach	10	-7	-9	27	19	3200	0.41	0.53
Queen Charlotte City	35	-6	-8	21	16	3520	0.48	0.61
Quesnel	475	-31	-33	30	17	4650	0.24	0.31
Revelstoke	440	-20	-23	31	19	4000	0.25	0.32
Salmon Arm	425	-19	-24	33	21	3650	0.30	0.39
Sandspit	5	-4	-6	18	15	3450	0.60	0.78
Sechelt	25	-6	-8	27	20	2680	0.37	0.48
Sidney	10	-4	-6	26	18	2850	0.33	0.42
Smith River	660	-45	-47	26	17	7100	0.23	0.30
Smithers	500	-29	-31	26	17	5040	0.31	0.40
Sooke	20	-1	-3	21	16	2900	0.37	0.48
Squamish	5	-9	-11	29	20	2950	0.39	0.50
Stewart	10	-17	-20	25	16	4350	0.28	0.36
Tahsis	25	-4	-6	26	18	3150	0.26	0.34
Taylor	515	-35	-37	26	18	5720	0.31	0.40
Terrace	60	-19	-21	27	17	4150	0.28	0.36
Tofino	10	-2	-4	20	16	3150	0.53	0.68

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Trail	440	-14	-17	33	20	3600	0.27	0.35
Ucluelet	5	-2	-4	18	16	3120	0.53	0.68
Vancouver Region								
Burnaby (Simon Fraser Univ.)	330	-7	-9	25	17	3100	0.36	0.47
Cloverdale	10	-8	-10	29	20	2700	0.34	0.44
Haney	10	-9	-11	30	20	2840	0.34	0.44
Ladner	3	-6	-8	27	19	2600	0.36	0.46
Langley	15	-8	-10	29	20	2700	0.34	0.44
New Westminster	10	-8	-10	29	19	2800	0.34	0.44
North Vancouver	135	-7	-9	26	19	2910	0.35	0.45
Richmond	5	-7	-9	27	19	2800	0.35	0.45
Surrey (88 Ave & 156 St.)	90	-8	-10	29	20	2750	0.34	0.44
Vancouver (City Hall)	40	-7	-9	28	20	2825	0.35	0.45
Vancouver (Granville & 41 Ave)	120	-6	-8	28	20	2925	0.35	0.45
West Vancouver	45	-7	-9	28	19	2950	0.37	0.48
Vernon	405	-20	-23	33	20	3600	0.31	0.40
Victoria Region								
Victoria (Gonzales Hts)	65	-4	-6	24	17	2700	0.44	0.57
Victoria (Mt Tolmie)	125	-6	-8	24	16	2700	0.48	0.63
Victoria	10	-4	-6	24	17	2650	0.44	0.57
Whistler	665	-17	-20	30	20	4180	0.25	0.32
White Rock	30	-5	-7	25	20	2620	0.34	0.44
Williams Lake	615	-30	-33	29	17	4400	0.27	0.35
Youbou	200	-5	-8	31	19	3050	0.25	0.32
Alberta								
Athabasca	515	-35	-38	27	19	6000	0.28	0.36
Banff	1400	-31	-33	27	16	5500	0.25	0.32
Barrhead	645	-33	-36	27	19	5740	0.34	0.44
Beaverlodge	730	-36	-39	28	18	5700	0.28	0.36
Brooks	760	-32	-34	32	20	4880	0.40	0.52
Calgary	1045	-30	-32	28	17	5000	0.37	0.48
Campsie	660	-33	-36	27	19	5750	0.34	0.44
Camrose	740	-33	-35	29	19	5500	0.30	0.39
Canmore	1320	-31	-33	28	17	5400	0.29	0.37
Cardston	1130	-29	-32	30	19	4700	0.56	0.72
Claresholm	1030	-30	-32	30	18	4680	0.45	0.58
Cold Lake	540	-35	-38	28	19	5860	0.29	0.38
Coleman	1320	-31	-34	29	18	5210	0.48	0.63
Coronation	790	-32	-34	30	19	5640	0.29	0.37
Cowley	1175	-29	-32	29	18	4810	0.78	1.01
Drumheller	685	-32	-34	30	18	5050	0.34	0.44
Edmonton	645	-30	-33	28	19	5120	0.35	0.45
Edson	920	-34	-37	27	18	5750	0.36	0.46
Embarras Portage	220	-41	-43	28	19	7100	0.29	0.37
Fairview	670	-37	-40	27	18	5840	0.27	0.35

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Fort MacLeod	945	-30	-32	31	19	4600	0.53	0.68
Fort McMurray	255	-38	-40	28	19	6250	0.27	0.35
Fort Saskatchewan	610	-32	-35	28	19	5420	0.33	0.43
Fort Vermilion	270	-41	-43	28	18	6700	0.23	0.30
Grande Prairie	650	-36	-39	27	18	5790	0.33	0.43
Habay	335	-41	-43	28	18	6750	0.23	0.30
Hardisty	615	-33	-36	30	19	5640	0.28	0.36
High River	1040	-31	-32	28	17	4900	0.50	0.65
Hinton	990	-34	-38	27	17	5500	0.36	0.46
Jasper	1060	-31	-34	28	17	5300	0.25	0.32
Keg River	420	-40	-42	28	18	6520	0.23	0.30
Lac la Biche	560	-35	-38	28	19	6100	0.28	0.36
Lacombe	855	-33	-36	28	19	5500	0.31	0.40
Lethbridge	910	-30	-32	31	19	4500	0.51	0.66
Manning	465	-39	-41	27	18	6300	0.23	0.30
Medicine Hat	705	-31	-34	32	19	4540	0.37	0.48
Peace River	330	-37	-40	27	18	6050	0.25	0.32
Pincher Creek	1130	-29	-32	29	18	4740	0.75	0.96
Ranfurly	670	-34	-37	29	19	5700	0.28	0.36
Red Deer	855	-32	-35	28	19	5550	0.31	0.40
Rocky Mountain House	985	-32	-34	27	18	5640	0.28	0.36
Slave Lake	590	-35	-38	26	19	5850	0.29	0.37
Stettler	820	-32	-34	30	19	5300	0.28	0.36
Stony Plain	710	-32	-35	28	19	5300	0.35	0.45
Suffield	755	-31	-34	32	20	4770	0.38	0.49
Taber	815	-31	-33	31	19	4580	0.48	0.63
Turner Valley	1215	-31	-32	28	17	5220	0.50	0.65
Valleyview	700	-37	-40	27	18	5600	0.33	0.42
Vegreville	635	-34	-37	29	19	5780	0.28	0.36
Vermilion	580	-35	-38	29	19	5740	0.28	0.36
Wagner	585	-35	-38	26	19	5850	0.29	0.37
Wainwright	675	-33	-36	29	19	5700	0.28	0.36
Wetaskiwin	760	-33	-35	29	19	5500	0.30	0.39
Whitecourt	690	-33	-36	27	19	5650	0.29	0.37
Wimborne	975	-31	-34	29	18	5310	0.31	0.40
Saskatchewan								
Assiniboia	740	-32	-34	31	21	5180	0.38	0.49
Battrum	700	-32	-34	32	20	5080	0.42	0.54
Biggar	645	-34	-36	30	20	5720	0.35	0.45
Broadview	600	-34	-35	30	21	5760	0.36	0.46
Dafoe	530	-35	-37	29	21	5860	0.29	0.37
Dundurn	525	-35	-37	30	21	5600	0.36	0.46
Estevan	565	-32	-34	32	22	5340	0.40	0.52
Hudson Bay	370	-36	-38	29	21	6280	0.29	0.37
Humboldt	565	-36	-38	28	21	6000	0.30	0.39
Island Falls	305	-39	-41	27	20	7100	0.27	0.35
Kamsack	455	-34	-37	29	22	6040	0.31	0.40
Kindersley	685	-33	-35	31	20	5550	0.36	0.46
Lloydminster	645	-34	-37	28	20	5880	0.31	0.40

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Maple Creek	765	-31	-34	31	20	4780	0.35	0.45
Meadow Lake	480	-38	-40	28	20	6280	0.31	0.40
Melfort	455	-36	-38	28	21	6050	0.28	0.36
Melville	550	-34	-36	29	21	5880	0.31	0.40
Moose Jaw	545	-32	-34	31	21	5270	0.40	0.52
Nipawin	365	-37	-39	28	21	6300	0.29	0.38
North Battleford	545	-34	-36	29	20	5900	0.36	0.46
Prince Albert	435	-37	-40	28	21	6100	0.29	0.38
Qu'Appelle	645	-34	-36	30	22	5620	0.33	0.42
Regina	575	-34	-36	31	21	5600	0.38	0.49
Rosetown	595	-34	-36	31	20	5620	0.38	0.49
Saskatoon	500	-35	-37	30	21	5700	0.33	0.43
Scott	645	-34	-36	30	20	5960	0.35	0.45
Strasbourg	545	-34	-36	30	22	5600	0.33	0.42
Swift Current	750	-31	-34	31	20	5150	0.42	0.54
Uranium City	265	-42	-44	26	19	7500	0.28	0.36
Weyburn	575	-33	-35	31	23	5400	0.37	0.48
Yorkton	510	-34	-37	29	21	6000	0.31	0.40
Manitoba								
Beausejour	245	-33	-35	29	23	5680	0.32	0.41
Boissevain	510	-32	-34	30	23	5500	0.40	0.52
Brandon	395	-33	-35	30	22	5760	0.38	0.49
Churchill	10	-38	-40	25	18	8950	0.43	0.55
Dauphin	295	-33	-35	30	22	5900	0.31	0.40
Flin Flon	300	-38	-40	27	20	6440	0.27	0.35
Gimli	220	-34	-36	29	23	5800	0.31	0.40
Island Lake	240	-36	-38	27	20	6900	0.29	0.37
Lac du Bonnet	260	-34	-36	29	23	5730	0.29	0.37
Lynn Lake	350	-40	-42	27	19	7770	0.29	0.37
Morden	300	-31	-33	30	24	5400	0.40	0.52
Neepawa	365	-32	-34	29	23	5760	0.34	0.44
Pine Falls	220	-34	-36	28	23	5900	0.30	0.39
Portage la Prairie	260	-31	-33	30	23	5600	0.36	0.46
Rivers	465	-34	-36	29	23	5840	0.36	0.46
Sandilands	365	-32	-34	29	23	5650	0.31	0.40
Selkirk	225	-33	-35	29	23	5700	0.32	0.41
Split Lake	175	-38	-40	27	19	7900	0.30	0.39
Steinbach	270	-33	-35	29	23	5700	0.31	0.40
Swan River	335	-34	-37	29	22	6100	0.27	0.35
The Pas	270	-36	-38	28	21	6480	0.29	0.37
Thompson	205	-40	-43	27	19	7600	0.28	0.36
Virden	435	-33	-35	30	23	5620	0.36	0.46
Winnipeg	235	-33	-35	30	23	5670	0.35	0.45
Ontario								
Ailsa Craig	230	-17	-19	30	23	3840	0.39	0.50
Ajax	95	-20	-22	30	23	3820	0.37	0.48
Alexandria	80	-24	-26	30	23	4600	0.31	0.40
Alliston	220	-23	-25	29	23	4200	0.28	0.36
Almonte	120	-26	-28	30	23	4620	0.32	0.41

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Armstrong	340	-37	-40	28	21	6500	0.23	0.30
Arnprior	85	-27	-29	30	23	4680	0.29	0.37
Atikokan	400	-33	-35	29	22	5750	0.23	0.30
Attawapiskat	10	-37	-39	28	21	7100	0.32	0.41
Aurora	270	-21	-23	30	23	4210	0.34	0.44
Bancroft	365	-28	-31	29	23	4740	0.25	0.32
Barrie	245	-24	-26	29	23	4380	0.28	0.36
Barriefield	100	-22	-24	28	23	3990	0.36	0.47
Beaverton	240	-24	-26	30	23	4300	0.28	0.36
Belleville	90	-22	-24	29	23	3910	0.33	0.43
Belmont	260	-17	-19	30	24	3840	0.36	0.47
Big Trout Lake (Kitchenuhmay-koosib)	215	-38	-40	26	20	7450	0.33	0.42
CFB Borden	225	-23	-25	29	23	4300	0.28	0.36
Bracebridge	310	-26	-28	29	23	4800	0.27	0.35
Bradford	240	-23	-25	30	23	4280	0.28	0.36
Brampton	215	-19	-21	30	23	4100	0.34	0.44
Brantford	205	-18	-20	30	23	3900	0.33	0.42
Brighton	95	-21	-23	29	23	4000	0.37	0.48
Brockville	85	-23	-25	29	23	4060	0.34	0.44
Burk's Falls	305	-26	-28	29	22	5020	0.27	0.35
Burlington	80	-17	-19	31	23	3740	0.36	0.46
Cambridge	295	-18	-20	29	23	4100	0.28	0.36
Campbellford	150	-23	-26	30	23	4280	0.32	0.41
Cannington	255	-24	-26	30	23	4310	0.28	0.36
Carleton Place	135	-25	-27	30	23	4600	0.32	0.41
Cavan	200	-23	-25	30	23	4400	0.34	0.44
Centralia	260	-17	-19	30	23	3800	0.38	0.49
Chapleau	425	-35	-38	27	21	5900	0.23	0.30
Chatham	180	-16	-18	31	24	3470	0.33	0.43
Chesley	275	-19	-21	29	22	4320	0.37	0.48
Clinton	280	-17	-19	29	23	4150	0.38	0.49
Coboconk	270	-25	-27	30	23	4500	0.27	0.35
Cobourg	90	-21	-23	29	23	3980	0.38	0.49
Cochrane	245	-34	-36	29	21	6200	0.27	0.35
Colborne	105	-21	-23	29	23	3980	0.38	0.49
Collingwood	190	-21	-23	29	23	4180	0.30	0.39
Cornwall	35	-23	-25	30	23	4250	0.32	0.41
Corunna	185	-16	-18	31	24	3600	0.36	0.47
Deep River	145	-29	-32	30	22	4900	0.27	0.35
Deseronto	85	-22	-24	29	23	4070	0.33	0.43
Dorchester	260	-18	-20	30	24	3900	0.36	0.47
Dorion	200	-33	-35	28	21	5950	0.30	0.39
Dresden	185	-16	-18	31	24	3750	0.33	0.43
Dryden	370	-34	-36	28	22	5850	0.23	0.30
Dundalk	525	-22	-24	29	22	4700	0.33	0.42
Dunnville	175	-15	-17	30	24	3660	0.36	0.46
Durham	340	-20	-22	29	22	4340	0.34	0.44
Dutton	225	-16	-18	31	24	3700	0.36	0.47

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Earlton	245	-33	-36	29	22	5730	0.35	0.45
Edison	365	-34	-36	28	22	5740	0.24	0.31
Elliot Lake	380	-26	-28	29	21	4950	0.29	0.38
Elmvale	220	-24	-26	29	23	4200	0.28	0.36
Embro	310	-19	-21	30	23	3950	0.37	0.48
Englehart	205	-33	-36	29	22	5800	0.32	0.41
Espanola	220	-25	-27	29	21	4920	0.33	0.42
Exeter	265	-17	-19	30	23	3900	0.38	0.49
Fenelon Falls	260	-25	-27	30	23	4440	0.28	0.36
Fergus	400	-20	-22	29	23	4300	0.28	0.36
Forest	215	-16	-18	31	23	3740	0.37	0.48
Fort Erie	180	-15	-17	30	24	3650	0.36	0.46
Fort Erie (Ridgeway)	190	-15	-17	30	24	3600	0.36	0.46
Fort Frances	340	-33	-35	29	22	5440	0.24	0.31
Gananoque	80	-22	-24	28	23	4010	0.36	0.47
Geraldton	345	-36	-39	28	21	6450	0.23	0.30
Glencoe	215	-16	-18	31	24	3680	0.33	0.43
Goderich	185	-16	-18	29	23	4000	0.43	0.55
Gore Bay	205	-24	-26	28	22	4700	0.34	0.44
Graham	495	-35	-37	29	22	5940	0.23	0.30
Gravenhurst (Muskoka Airport)	255	-26	-28	29	23	4760	0.28	0.36
Grimsby	85	-16	-18	30	23	3520	0.36	0.46
Guelph	340	-19	-21	29	23	4270	0.28	0.36
Guthrie	280	-24	-26	29	23	4300	0.28	0.36
Haileybury	210	-32	-35	30	22	5600	0.34	0.44
Haldimand (Caledonia)	190	-18	-20	30	23	3750	0.34	0.44
Haldimand (Hagersville)	215	-17	-19	30	23	3760	0.36	0.46
Haliburton	335	-27	-29	29	23	4840	0.27	0.35
Halton Hills (Georgetown)	255	-19	-21	30	23	4200	0.29	0.37
Hamilton	90	-17	-19	31	23	3460	0.36	0.46
Hanover	270	-19	-21	29	22	4300	0.37	0.48
Hastings	200	-24	-26	30	23	4280	0.32	0.41
Hawkesbury	50	-25	-27	30	23	4610	0.32	0.41
Hearst	245	-35	-37	29	21	6450	0.23	0.30
Honey Harbour	180	-24	-26	29	23	4300	0.30	0.39
Hornepayne	360	-37	-40	28	21	6340	0.23	0.30
Huntsville	335	-26	-29	29	22	4850	0.27	0.35
Ingersoll	280	-18	-20	30	23	3920	0.37	0.48
Iroquois Falls	275	-33	-36	29	21	6100	0.29	0.37
Jellicoe	330	-36	-39	28	21	6400	0.23	0.30
Kapuskasing	245	-34	-36	29	21	6250	0.24	0.31
Kemptville	90	-25	-27	30	23	4540	0.32	0.41
Kenora	370	-33	-35	28	22	5630	0.24	0.31
Killaloe	185	-28	-31	30	22	4960	0.27	0.35
Kincardine	190	-17	-19	28	22	3890	0.43	0.55
Kingston	80	-22	-24	28	23	4000	0.36	0.47
Kinmount	295	-26	-28	29	23	4600	0.27	0.35
Kirkland Lake	325	-33	-36	29	22	6000	0.30	0.39
Kitchener	335	-19	-21	29	23	4200	0.29	0.37

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Lakefield	240	-24	-26	30	23	4330	0.29	0.38
Lansdowne House	240	-38	-40	28	21	7150	0.25	0.32
Leamington	190	-15	-17	31	24	3400	0.36	0.47
Lindsay	265	-24	-26	30	23	4320	0.29	0.38
Lion's Head	185	-19	-21	27	22	4300	0.37	0.48
Listowel	380	-19	-21	29	23	4300	0.36	0.47
London	245	-18	-20	30	24	3900	0.36	0.47
Lucan	300	-17	-19	30	23	3900	0.39	0.50
Maitland	85	-23	-25	29	23	4080	0.34	0.44
Markdale	425	-20	-22	29	22	4500	0.32	0.41
Markham	175	-21	-23	31	24	4000	0.34	0.44
Martin	485	-35	-37	29	22	5900	0.23	0.30
Matheson	265	-33	-36	29	21	6080	0.30	0.39
Mattawa	165	-29	-31	30	22	5050	0.25	0.32
Midland	190	-24	-26	29	23	4200	0.30	0.39
Milton	200	-18	-20	30	23	3920	0.33	0.43
Milverton	370	-19	-21	29	23	4200	0.33	0.43
Minden	270	-27	-29	29	23	4640	0.27	0.35
Mississauga	160	-18	-20	30	23	3880	0.34	0.44
Mississauga (Lester B. Pearson Int'l Airport)	170	-20	-22	31	24	3890	0.34	0.44
Mississauga (Port Credit)	75	-18	-20	29	23	3780	0.37	0.48
Mitchell	335	-18	-20	29	23	4100	0.37	0.48
Moosonee	10	-36	-38	28	22	6800	0.27	0.35
Morrisburg	75	-23	-25	30	23	4370	0.32	0.41
Mount Forest	420	-21	-24	28	22	4700	0.32	0.41
Nakina	325	-36	-38	28	21	6500	0.23	0.30
Nanticoke (Jarvis)	205	-17	-18	30	23	3700	0.37	0.48
Nanticoke (Port Dover)	180	-15	-17	30	24	3600	0.37	0.48
Napanee	90	-22	-24	29	23	4140	0.33	0.43
New Liskeard	180	-32	-35	30	22	5570	0.33	0.43
Newcastle	115	-20	-22	30	23	3990	0.37	0.48
Newcastle (Bowmanville)	95	-20	-22	30	23	4000	0.37	0.48
Newmarket	185	-22	-24	30	23	4260	0.29	0.38
Niagara Falls	210	-16	-18	30	23	3600	0.33	0.43
North Bay	210	-28	-30	28	22	5150	0.27	0.34
Norwood	225	-24	-26	30	23	4320	0.32	0.41
Oakville	90	-18	-20	30	23	3760	0.36	0.47
Orangeville	430	-21	-23	29	23	4450	0.28	0.36
Orillia	230	-25	-27	29	23	4260	0.28	0.36
Oshawa	110	-19	-21	30	23	3860	0.37	0.48
Ottawa (Metropolitan)								
Ottawa (City Hall)	70	-25	-27	30	23	4440	0.32	0.41
Ottawa (Barrhaven)	98	-25	-27	30	23	4500	0.32	0.41
Ottawa (Kanata)	98	-25	-27	30	23	4520	0.32	0.41
Ottawa (M-C Int'l Airport)	125	-25	-27	30	23	4500	0.32	0.41
Ottawa (Orleans)	70	-26	-28	30	23	4500	0.32	0.41
Owen Sound	215	-19	-21	29	22	4030	0.37	0.48

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Pagwa River	185	-35	-37	28	21	6500	0.23	0.30
Paris	245	-18	-20	30	23	4000	0.33	0.42
Parkhill	205	-16	-18	31	23	3800	0.39	0.50
Parry Sound	215	-24	-26	28	22	4640	0.30	0.39
Pelham (Fonthill)	230	-15	-17	30	23	3690	0.33	0.42
Pembroke	125	-28	-31	30	23	4980	0.27	0.35
Penetanguishene	220	-24	-26	29	23	4200	0.30	0.39
Perth	130	-25	-27	30	23	4540	0.32	0.41
Petawawa	135	-29	-31	30	23	4980	0.27	0.35
Peterborough	200	-23	-25	30	23	4400	0.32	0.41
Petrolia	195	-16	-18	31	24	3640	0.36	0.47
Pickering (Dunbarton)	85	-19	-21	30	23	3800	0.37	0.48
Picton	95	-21	-23	29	23	3980	0.38	0.49
Plattsville	300	-19	-21	29	23	4150	0.33	0.42
Point Alexander	150	-29	-32	30	22	4960	0.27	0.35
Port Burwell	195	-15	-17	30	24	3800	0.36	0.47
Port Colborne	180	-15	-17	30	24	3600	0.36	0.46
Port Elgin	205	-17	-19	28	22	4100	0.43	0.55
Port Hope	100	-21	-23	29	23	3970	0.37	0.48
Port Perry	270	-22	-24	30	23	4260	0.34	0.44
Port Stanley	180	-15	-17	31	24	3850	0.36	0.47
Prescott	90	-23	-25	29	23	4120	0.34	0.44
Princeton	280	-18	-20	30	23	4000	0.33	0.42
Raith	475	-34	-37	28	22	5900	0.23	0.30
Rayside-Balfour (Chelmsford)	270	-28	-30	29	21	5200	0.35	0.45
Red Lake	360	-35	-37	28	21	6220	0.23	0.30
Renfrew	115	-27	-30	30	23	4900	0.27	0.35
Richmond Hill	230	-21	-23	31	24	4000	0.34	0.44
Rockland	50	-26	-28	30	23	4600	0.31	0.40
Sarnia	190	-16	-18	31	24	3750	0.36	0.47
Sault Ste. Marie	190	-25	-28	29	22	4960	0.34	0.44
Schreiber	310	-34	-36	27	21	5960	0.30	0.39
Seaforth	310	-17	-19	30	23	4100	0.37	0.48
Shelburne	495	-22	-24	29	23	4700	0.31	0.40
Simcoe	210	-17	-19	30	24	3700	0.35	0.45
Sioux Lookout	375	-34	-36	28	22	5950	0.23	0.30
Smiths Falls	130	-25	-27	30	23	4540	0.32	0.41
Smithville	185	-16	-18	30	23	3650	0.33	0.42
Smooth Rock Falls	235	-34	-36	29	21	6250	0.25	0.32
South River	355	-27	-29	29	22	5090	0.27	0.35
Southampton	180	-17	-19	28	22	4100	0.41	0.53
St. Catharines	105	-16	-18	30	23	3540	0.36	0.46
St. Mary's	310	-18	-20	30	23	4000	0.36	0.47
St. Thomas	225	-16	-18	31	24	3780	0.36	0.47
Stirling	120	-23	-25	30	23	4220	0.31	0.40
Stratford	360	-18	-20	29	23	4050	0.35	0.45
Strathroy	225	-17	-19	31	24	3780	0.36	0.47
Sturgeon Falls	205	-28	-30	29	21	5200	0.27	0.35
Sudbury	275	-28	-30	29	21	5180	0.36	0.46

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Sundridge	340	-27	-29	29	22	5080	0.27	0.35
Tavistock	340	-19	-21	29	23	4100	0.35	0.45
Temagami	300	-30	-33	30	22	5420	0.29	0.37
Thamesford	280	-19	-21	30	23	3950	0.37	0.48
Thedford	205	-16	-18	31	23	3710	0.39	0.50
Thunder Bay	210	-31	-33	29	21	5650	0.30	0.39
Tillsonburg	215	-17	-19	30	24	3840	0.34	0.44
Timmins	300	-34	-36	29	21	5940	0.27	0.35
Timmins (Porcupine)	295	-34	-36	29	21	6000	0.29	0.37
Toronto Metropolitan Region								
Etobicoke	160	-20	-22	31	24	3800	0.34	0.44
North York	175	-20	-22	31	24	3760	0.34	0.44
Scarborough	180	-20	-22	31	24	3800	0.36	0.47
Toronto (City Hall)	90	-18	-20	31	23	3520	0.34	0.44
Trenton	80	-22	-24	29	23	4110	0.36	0.47
Trout Creek	330	-27	-29	29	22	5100	0.27	0.35
Uxbridge	275	-22	-24	30	23	4240	0.33	0.42
Vaughan (Woodbridge)	165	-20	-22	31	24	4100	0.34	0.44
Vittoria	215	-15	-17	30	24	3680	0.36	0.47
Walkerton	275	-18	-20	30	22	4300	0.39	0.50
Wallaceburg	180	-16	-18	31	24	3600	0.35	0.45
Waterloo	330	-19	-21	29	23	4200	0.29	0.37
Watford	240	-17	-19	31	24	3740	0.36	0.47
Wawa	290	-34	-36	26	21	5840	0.30	0.39
Welland	180	-15	-17	30	23	3670	0.33	0.43
West Lorne	215	-16	-18	31	24	3700	0.36	0.47
Whitby	85	-20	-22	30	23	3820	0.37	0.48
Whitby (Brooklin)	160	-20	-22	30	23	4010	0.35	0.45
White River	375	-39	-42	28	21	6150	0.23	0.30
Wiarton	185	-19	-21	29	22	4300	0.37	0.48
Windsor	185	-16	-18	32	24	3400	0.36	0.47
Wingham	310	-18	-20	30	23	4220	0.39	0.50
Woodstock	300	-19	-21	30	23	3910	0.34	0.44
Wyoming	215	-16	-18	31	24	3700	0.36	0.47
Quebec								
Acton-Vale	95	-24	-27	30	23	4620	0.27	0.35
Alma	110	-31	-33	28	22	5800	0.27	0.35
Amos	295	-34	-36	28	21	6160	0.25	0.32
Asbestos	245	-26	-28	29	22	4800	0.27	0.35
Aylmer	90	-25	-28	30	23	4520	0.32	0.41
Baie-Comeau	60	-27	-29	25	19	6020	0.39	0.50
Baie-Saint-Paul	20	-27	-29	28	21	5280	0.37	0.48
Beauport	45	-26	-29	28	22	5100	0.33	0.42
Bedford	55	-24	-26	29	23	4420	0.32	0.41
Beloeil	25	-24	-26	30	23	4500	0.29	0.37
Brome	210	-25	-27	29	23	4730	0.29	0.37
Brossard	15	-24	-26	30	23	4420	0.33	0.42
Buckingham	130	-26	-28	30	23	4880	0.31	0.40
Campbell's Bay	115	-28	-30	30	23	4900	0.25	0.32

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Chambly	20	-24	-26	30	23	4450	0.31	0.40
Coaticook	295	-25	-27	28	22	4750	0.27	0.35
Contrecoeur	10	-25	-27	30	23	4500	0.33	0.43
Cowansville	120	-25	-27	29	23	4540	0.32	0.41
Deux-Montagnes	25	-25	-27	29	23	4440	0.29	0.37
Dolbeau	120	-32	-34	28	22	6250	0.27	0.35
Drummondville	85	-26	-28	30	23	4700	0.27	0.35
Farnham	60	-24	-26	29	23	4500	0.29	0.37
Fort-Coulonge	110	-28	-30	30	23	4950	0.25	0.32
Gagnon	545	-34	-36	24	19	7600	0.30	0.39
Gaspé	55	-25	-26	26	20	5500	0.37	0.48
Gatineau	95	-25	-28	30	23	4600	0.32	0.41
Gracefield	175	-28	-31	30	23	5080	0.25	0.32
Granby	120	-25	-27	29	23	4500	0.27	0.35
Harrington-Harbour	30	-27	-29	19	16	6150	0.56	0.72
Havre-St-Pierre	5	-27	-29	22	18	6100	0.48	0.63
Hemmingford	75	-24	-26	30	23	4380	0.31	0.40
Hull	65	-25	-28	30	23	4550	0.32	0.41
Iberville	35	-24	-26	29	23	4450	0.32	0.41
Inukjuak	5	-36	-38	21	15	9150	0.47	0.60
Joliette	45	-26	-28	29	23	4720	0.28	0.36
Kuujjuaq	25	-37	-39	24	17	8550	0.47	0.60
Kuujjuarapik	20	-36	-38	25	17	7990	0.43	0.55
La Pocatière	55	-24	-26	28	22	5160	0.39	0.50
La-Malbaie	25	-26	-28	28	21	5400	0.37	0.48
La-Tuque	165	-30	-32	29	22	5500	0.27	0.35
Lac-Mégantic	420	-27	-29	27	22	5180	0.27	0.35
Lachute	65	-26	-28	29	23	4640	0.31	0.40
Lennoxville	155	-28	-30	29	22	4700	0.25	0.32
Léry	30	-24	-26	29	23	4420	0.33	0.42
Loretteville	100	-26	-29	28	22	5200	0.32	0.41
Louiseville	15	-25	-28	29	23	4900	0.33	0.43
Magog	215	-26	-28	29	23	4730	0.27	0.35
Malartic	325	-33	-36	29	21	6200	0.25	0.32
Maniwaki	180	-30	-32	29	22	5280	0.24	0.31
Masson	50	-26	-28	30	23	4610	0.31	0.40
Matane	5	-24	-26	24	20	5510	0.47	0.60
Mont-Joli	90	-24	-26	26	21	5370	0.40	0.52
Mont-Laurier	225	-29	-32	29	22	5320	0.23	0.30
Montmagny	10	-25	-28	28	22	5090	0.36	0.47
Montréal Region								
Beaconsfield	25	-24	-26	30	23	4440	0.33	0.42
Dorval	25	-24	-26	30	23	4400	0.33	0.42
Laval	35	-24	-26	29	23	4500	0.33	0.42
Montréal (City Hall)	20	-23	-26	30	23	4200	0.33	0.42
Montréal-Est	25	-23	-26	30	23	4470	0.33	0.42
Montréal-Nord	20	-24	-26	30	23	4470	0.33	0.42
Outremont	105	-23	-26	30	23	4300	0.33	0.42
Pierrefonds	25	-24	-26	30	23	4430	0.33	0.42

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
St-Lambert	15	-23	-26	30	23	4400	0.33	0.42
St-Laurent	45	-23	-26	30	23	4270	0.33	0.42
Ste-Anne-de-Bellevue	35	-24	-26	29	23	4460	0.33	0.42
Verdun	20	-23	-26	30	23	4200	0.33	0.42
Nicolet (Gentilly)	15	-25	-28	29	23	4900	0.33	0.42
Nitchequon	545	-39	-41	23	19	8100	0.29	0.37
Noranda	305	-33	-36	29	21	6050	0.27	0.35
Percé	5	-21	-24	25	19	5400	0.56	0.72
Pincourt	25	-24	-26	29	23	4480	0.33	0.42
Plessisville	145	-26	-28	29	23	5100	0.27	0.35
Port-Cartier	20	-28	-30	25	19	6060	0.42	0.54
Puvirnituq	5	-36	-38	23	16	9200	0.47	0.60
Québec City Region								
Ancienne-Lorette	35	-25	-28	28	23	5130	0.32	0.41
Lévis	50	-25	-28	28	22	5050	0.32	0.41
Québec	120	-25	-28	28	22	5080	0.32	0.41
Sillery	10	-25	-28	28	23	5070	0.32	0.41
Ste-Foy	115	-25	-28	28	23	5100	0.32	0.41
Richmond	150	-25	-27	29	22	4700	0.25	0.32
Rimouski	30	-25	-27	26	20	5300	0.40	0.52
Rivière-du-Loup	55	-25	-27	26	21	5380	0.39	0.50
Roberval	100	-31	-33	28	21	5750	0.27	0.35
Rock-Island	160	-25	-27	29	23	4850	0.27	0.35
Rosemère	25	-24	-26	29	23	4550	0.31	0.40
Rouyn	300	-33	-36	29	21	6050	0.27	0.35
Saguenay	10	-30	-32	28	22	5700	0.28	0.36
Saguenay (Bagotville)	5	-31	-33	28	21	5700	0.29	0.38
Saguenay (Jonquière)	135	-30	-32	28	22	5650	0.27	0.35
Saguenay (Kenogami)	140	-30	-32	28	22	5650	0.27	0.35
Saint-Eustache	35	-25	-27	29	23	4500	0.29	0.37
Saint-Jean-sur-Richelieu	35	-24	-26	29	23	4450	0.32	0.41
Salaberry-de-Valleyfield	50	-23	-25	29	23	4400	0.33	0.42
Schefferville	550	-37	-39	24	16	8550	0.33	0.42
Senneterre	310	-34	-36	29	21	6180	0.25	0.32
Sept-Îles	5	-29	-31	24	18	6200	0.42	0.54
Shawinigan	60	-26	-29	29	23	5050	0.27	0.35
Shawville	170	-27	-30	30	23	4880	0.27	0.35
Sherbrooke	185	-28	-30	29	23	4700	0.25	0.32
Sorel	10	-25	-27	29	23	4550	0.33	0.43
St-Félicien	105	-32	-34	28	22	5850	0.27	0.35
St-Georges-de-Cacouna	35	-25	-27	26	21	5400	0.39	0.50
St-Hubert	25	-24	-26	30	23	4490	0.33	0.42
Saint-Hubert-de-Rivière-du-Loup	310	-26	-28	26	21	5520	0.31	0.40

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
St-Hyacinthe	35	-24	-27	30	23	4500	0.27	0.35
St-Jérôme	95	-26	-28	29	23	4820	0.29	0.37
St-Jovite	230	-29	-31	28	22	5250	0.25	0.33
St-Lazare-Hudson	60	-24	-26	30	23	4520	0.33	0.42
St-Nicolas	65	-25	-28	28	22	4990	0.33	0.42
Ste-Agathe-des-Monts	360	-28	-30	28	22	5390	0.27	0.35
Sutton	185	-25	-27	29	23	4600	0.32	0.41
Tadoussac	65	-26	-28	27	21	5450	0.40	0.52
Témiscaming	240	-30	-32	30	22	5020	0.25	0.32
Terrebonne	20	-25	-27	29	23	4500	0.31	0.40
Thetford Mines	330	-26	-28	28	22	5120	0.27	0.35
Thurso	50	-26	-28	30	23	4820	0.31	0.40
Trois-Rivières	25	-25	-28	29	23	4900	0.33	0.43
Val-d'Or	310	-33	-36	29	21	6180	0.25	0.32
Varennes	15	-24	-26	30	23	4500	0.31	0.40
Verchères	15	-24	-26	30	23	4450	0.33	0.43
Victoriaville	125	-26	-28	29	23	4900	0.27	0.35
Ville-Marie	200	-31	-34	30	22	5550	0.31	0.40
Wakefield	120	-27	-30	30	23	4820	0.27	0.34
Waterloo	205	-25	-27	29	23	4650	0.27	0.35
Windsor	150	-25	-27	29	23	4700	0.25	0.32
New Brunswick								
Alma	5	-21	-23	26	20	4500	0.37	0.48
Bathurst	10	-23	-26	30	22	5020	0.37	0.48
Campbellton	30	-26	-28	29	22	5500	0.35	0.45
Edmundston	160	-27	-29	28	22	5320	0.29	0.38
Fredericton	15	-24	-27	29	22	4670	0.29	0.38
Gagetown	20	-24	-26	29	22	4460	0.31	0.40
Grand Falls	115	-27	-30	28	22	5300	0.29	0.38
Miramichi	5	-24	-26	30	22	4950	0.32	0.41
Moncton	20	-23	-25	28	21	4680	0.39	0.50
Oromocto	20	-24	-26	29	22	4650	0.30	0.39
Sackville	15	-22	-24	27	21	4590	0.38	0.49
Saint Andrews	35	-22	-24	25	20	4680	0.35	0.45
Saint George	35	-21	-23	25	20	4680	0.35	0.45
Saint John	5	-22	-24	25	20	4570	0.41	0.53
Shippagan	5	-22	-24	28	21	4930	0.48	0.63
St. Stephen	20	-24	-26	28	22	4700	0.33	0.42
Woodstock	60	-26	-29	30	22	4910	0.29	0.37
Nova Scotia								
Amherst	25	-21	-24	27	21	4500	0.37	0.48
Antigonish	10	-17	-20	27	21	4510	0.42	0.54
Bridgewater	10	-15	-17	27	20	4140	0.43	0.55
Canso	5	-13	-15	25	20	4400	0.48	0.61
Debert	45	-21	-24	27	21	4500	0.37	0.48
Digby	35	-15	-17	25	20	4020	0.43	0.55
Greenwood (CFB)	28	-18	-20	29	22	4140	0.42	0.54
Halifax Region								

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Dartmouth	10	-16	-18	26	20	4100	0.45	0.58
Halifax	55	-16	-18	26	20	4000	0.45	0.58
Kentville	25	-18	-20	28	21	4130	0.42	0.54
Liverpool	20	-16	-18	27	20	3990	0.48	0.61
Lockeport	5	-14	-16	25	20	4000	0.47	0.60
Louisburg	5	-15	-17	26	20	4530	0.50	0.65
Lunenburg	25	-15	-17	26	20	4140	0.48	0.61
New Glasgow	30	-19	-21	27	21	4320	0.43	0.55
North Sydney	20	-16	-19	27	21	4500	0.46	0.59
Pictou	25	-19	-21	27	21	4310	0.43	0.55
Port Hawkesbury	40	-17	-19	27	21	4500	0.57	0.74
Springhill	185	-20	-23	27	21	4540	0.37	0.48
Stewiacke	25	-20	-22	27	21	4400	0.39	0.50
Sydney	5	-16	-19	27	21	4530	0.46	0.59
Tatamagouche	25	-20	-23	27	21	4380	0.43	0.55
Truro	25	-20	-22	27	21	4500	0.37	0.48
Wolfville	35	-19	-21	28	21	4140	0.42	0.54
Yarmouth	10	-14	-16	22	19	3990	0.43	0.56
Prince Edward Island								
Charlottetown	5	-20	-22	26	21	4460	0.43	0.56
Souris	5	-19	-21	27	21	4550	0.45	0.58
Summerside	10	-20	-22	27	21	4600	0.47	0.60
Tignish	10	-20	-22	27	21	4770	0.51	0.66
Newfoundland								
Argentia	15	-12	-14	21	18	4600	0.58	0.75
Bonavista	15	-14	-16	24	19	5000	0.65	0.84
Buchans	255	-24	-27	27	20	5250	0.47	0.60
Cape Harrison	5	-29	-31	26	16	6900	0.47	0.60
Cape Race	5	-11	-13	19	18	4900	0.81	1.05
Channel-Port aux Basques	5	-13	-15	19	18	5000	0.60	0.78
Corner Brook	35	-16	-18	26	20	4760	0.43	0.55
Gander	125	-18	-20	27	20	5110	0.47	0.60
Grand Bank	5	-14	-15	20	18	4550	0.57	0.74
Grand Falls	60	-26	-29	27	20	5020	0.47	0.60
Happy Valley-Goose Bay	15	-31	-32	27	19	6670	0.33	0.42
Labrador City	550	-36	-38	24	17	7710	0.31	0.40
St. Anthony	10	-25	-27	22	18	6440	0.67	0.87
St. John's	65	-15	-16	24	20	4800	0.60	0.78
Stephenville	25	-16	-18	24	19	4850	0.45	0.58
Twin Falls	425	-35	-37	24	17	7790	0.31	0.40
Wabana	75	-15	-17	24	20	4750	0.58	0.75
Wabush	550	-36	-38	24	17	7710	0.31	0.40
Yukon								
Aishihik	920	-44	-46	23	15	7500	0.29	0.38
Dawson	330	-50	-51	26	16	8120	0.24	0.31
Destruction Bay	815	-43	-45	23	14	7800	0.47	0.60
Faro	670	-46	-47	25	16	7300	0.27	0.35
Haines Junction	600	-45	-47	24	14	7100	0.26	0.34
Snag	595	-51	-53	23	16	8300	0.24	0.31

Table C-1 (Continued)

Province and Location	Elev., m	Design Temperature				Degree-Days Below 18°C	Hourly Wind Pressures, kPa	
		January		July 2.5%				
		2.5% °C	1% °C	Dry °C	Wet °C		1/10	1/50
Teslin	690	-42	-44	24	15	6770	0.26	0.34
Watson Lake	685	-46	-48	26	16	7470	0.27	0.35
Whitehorse	655	-41	-43	25	15	6580	0.29	0.38
Northwest Territories								
Aklavik	5	-42	-44	26	17	9600	0.37	0.48
Echo Bay / Port Radium	195	-42	-44	22	16	9300	0.41	0.53
Fort Good Hope	100	-43	-45	28	18	8700	0.34	0.44
Fort McPherson	25	-44	-46	26	17	9150	0.31	0.40
Fort Providence	150	-40	-43	28	18	7620	0.27	0.35
Fort Resolution	160	-40	-42	26	18	7750	0.30	0.39
Fort Simpson	120	-42	-44	28	19	7660	0.30	0.39
Fort Smith	205	-41	-43	28	19	7300	0.30	0.39
Hay River	45	-38	-41	27	18	7550	0.27	0.35
Holman/ Ulukhaqtuuq	10	-39	-41	18	12	10700	0.66	0.86
Inuvik	45	-43	-45	26	17	9600	0.37	0.48
Mould Bay	5	-44	-46	11	8	12900	0.45	0.58
Norman Wells	65	-43	-45	28	18	8510	0.34	0.44
Rae-Edzo	160	-42	-44	25	17	8300	0.36	0.47
Tungsten	1340	-49	-51	26	16	7700	0.34	0.44
Wrigley	80	-42	-44	28	18	8050	0.30	0.39
Yellowknife	160	-41	-44	25	17	8170	0.36	0.47
Nunavut								
Alert	5	-43	-44	13	8	13030	0.58	0.75
Arctic Bay	15	-42	-44	14	10	11900	0.43	0.55
Arviat / Eskimo Point	5	-40	-41	22	16	9850	0.45	0.58
Baker Lake	5	-42	-44	23	15	10700	0.42	0.54
Cambridge Bay/Iqaluktuuttiaq	15	-41	-44	18	13	11670	0.42	0.54
Chesterfield Inlet/Igluligaarjuk	10	-40	-41	20	14	10500	0.43	0.56
Clyde River /Kanngiqtugaapik	5	-40	-42	14	10	11300	0.56	0.72
Coppermine (Kugluktuk)	10	-41	-43	23	16	10300	0.36	0.46
Coral Harbour /Salliq	15	-41	-42	20	14	10720	0.54	0.69
Eureka	5	-47	-48	12	8	13500	0.43	0.55
Iqaluit	45	-40	-41	17	12	9980	0.45	0.58
Isachsen	10	-46	-48	12	9	13600	0.47	0.60
Nottingham Island	30	-37	-39	16	13	10000	0.60	0.78
Rankin Inlet (Kangiqiniq)	10	-41	-42	21	15	10500	0.47	0.60
Resolute	25	-42	-43	11	9	12360	0.54	0.69
Resolution Island	5	-32	-34	12	10	9000	0.95	1.23

Division C

Administrative Provisions

Part 1
General

Part 1
General

Section 1.1. Application

1.1.1. Application

1.1.1.1. Application

1) This Part applies to all *buildings* and *building* systems covered in this Code. (See Article 1.1.1.1. of Division A.)

Section 1.2. Terms and Abbreviations

1.2.1. Definitions of Words and Phrases

1.2.1.1. Non-defined Terms

1) Words and phrases used in Division C that are not included in the list of definitions in Article 1.4.1.2. of Division A shall have the meanings that are commonly assigned to them in the context in which they are used, taking into account the specialized use of terms by the various trades and professions to which the terminology applies.

2) Where objectives and functional statements are referred to in Division C, they shall be the objectives and functional statements described in Parts 2 and 3 of Division A.

3) Where acceptable solutions are referred to in Division C, they shall be the provisions stated in Parts 3 to 8 of Division B.

4) Where alternative solutions are referred to in Division C, they shall be the alternative solutions mentioned in Clause 1.2.1.1.(1)(b) of Division A.

1.2.1.2. Defined Terms

1) The words and terms in italics in Division C shall have the meanings assigned to them in Article 1.4.1.2. of Division A.

1.2.2. Symbols and Other Abbreviations

1.2.2.1. Symbols and Other Abbreviations

1) The symbols and other abbreviations in Division C shall have the meanings assigned to them in Article 1.4.2.1. of Division A.

Part 2
Administrative Provisions

Part 2
Administrative Provisions

Section 2.1. Application

2.1.1. Application

2.1.1.1. Application

1) This Part applies to all *building*s and *building* systems covered in this Code. (See Article 1.1.1.1. of Division A.)

Section 2.2. Administration

2.2.1. Administration

2.2.1.1. Deleted

2.2.2. Information Required for Proposed Work

2.2.2.1. General Information Required

1) The information available for verification purposes shall be provided to show that the proposed work will conform to this Code and indicate the compliance paths that were used. (See Note A-1.1.2.1. of Division B.)

2) Plans shall be drawn to scale and shall indicate the nature and extent of the work and proposed function in sufficient detail to establish that, when completed, the work and the proposed function will conform to this Code.

3) If proposed work is changed during construction, information on the changes shall comply with the requirements of this Section for proposed work.

2.2.2.2. Design Calculations and Analysis

1) The calculations and analysis carried out in the process of ensuring conformity with the requirements of this Code shall be available for verification upon request.

2) The documentation provided for verification purposes shall contain the climatic data applicable to the location of the *building*, in accordance with Table C-1 of Division B.

2.2.2.3. Documentation on the Building Envelope

1) The following documentation on the *building envelope* shall be provided for verification purposes:
a) gross wall area,
b) total *fenestration* and door area excluding *skylights*,
c) total automatic sliding door, revolving door and fire shutter area,
d) gross roof area,
e) total *skylight* area,
f) ratio of total *skylight* area to gross roof area,
g) exposed floor areas,
h) ratio of total *fenestration* and door area excluding *skylights* to gross wall area,

i) the *effective thermal resistance* of *building* assemblies other than *fenestration* and doors, and the calculation method used to determine the *effective thermal resistance*,
j) *overall thermal transmittance* of
   i) *fenestration*,
   ii) doors with or without glazing forming part of the *building envelope*, and
   iii) access hatches,
k) description and location of *air barrier assemblies* in *opaque building assemblies*,
l) details on the reduction of thermal bridging required in Article 3.2.1.2.,
m) where Sentence 3.2.1.3.(2) of Division B applies, the indoor design temperature, and
n) where Sentence 3.2.1.3.(2) of Division B applies, the heating setpoint in winter months.

2) Where Section 3.3. of Division B is applied, calculation details shall be provided for verification purposes and shall contain the information necessary to ensure compliance with the requirements of that Section.

2.2.2.4. Documentation on Lighting Systems

1) The following documentation on the lighting systems shall be provided for verification purposes:
a) an as-built single-line diagram of the lighting control system showing the location of each illuminated zone and associated switches and controls,
b) deleted.
c) method used to determine the total *interior lighting power allowance* in each space assembly,
d) where the *building* area method is used, for each space assembly,
   i) the *floor surface area*, in m²,
   ii) the density of the *interior lighting power allowance*, in W/m²,
   iii) the total *interior lighting power allowance*, in kW, and
   iv) the total installed *installed interior lighting power*, in kW,
e) where the space-by-space method is used, for each space assembly,
   i) the *floor surface area*, in m², of each space,
   ii) the density of the *interior lighting power allowance*, in W/m², of each space,
   iii) the total *interior lighting power allowance*, in kW, and
   iv) the total *installed interior lighting power*, in kW,
f) deleted.
g) installed interior automatic controls,
h) adjustment and additional *interior lighting* power used,
i) list of functions, spaces and/or equipment that are not included in the calculation of the *installed interior lighting power* and their controls,
j) lighting zone used to determine *exterior lighting* power allowances,
k) list of installed photocontrols and controlled indoor spaces,
l) for each exterior application,
   i) the *exterior lighting* power allowance, in kW, and
   ii) the installed *exterior lighting* power, in kW, and
m) installed exterior automatic controls.

2) Where Section 4.3. of Division B is applied, calculation details shall be provided for verification purposes and shall contain the information necessary to ensure compliance with the requirements of that Section.

2.2.2.5. Documentation on HVAC Systems

1) The following documentation on the *HVAC systems* shall be provided for verification purposes:
a) a description of each system, detailing its function, design details, performance characteristics and distribution arrangement,
b) schematic and control diagrams and sequence of operation,
c) start/stop and adjustment procedures,

d) proposed temperature control devices in the spaces,
e) details on heat-recovery equipment, if applicable,
f) details on ice-making machines, if applicable,
g) details on food refrigeration equipment, if applicable,
h) details on commercial cooking equipment, if applicable,
i) temperature setpoints of the spaces,
j) thermal resistance of the installed duct and *plenum* insulation and that of piping insulation, and
k) limits of *temperature-control zones*, if applicable.

2.2.2.6. Documentation on Service Water Heating Systems

1) The following documentation on the *service water* heating system shall be provided for verification purposes:
a) a description of each system detailing its function, design details, performance characteristics and distribution arrangement,
b) schematic and control diagrams and sequences of operation,
c) start/stop and adjustment procedures, and
d) thermal resistance of piping insulation.

2.2.2.7. Information on Transformers and Electric Motors

1) Information on the performance characteristics of the transformers and electric motors in Part 7 shall be provided for verification purposes.

2.2.2.8. Documentation Requirements for Building Performance Compliance

1) If Part 8 of Division B is used to demonstrate compliance with Parts 3 to 7 of Division B, a *building* performance compliance calculation report shall be produced in accordance with this Article in addition to the documentation required by Articles 2.2.2.3. to 2.2.2.7.

2) Deleted.

3) The following information shall be included in the *building* performance compliance calculation report:
a) the project information section of the report shall contain:
  i) project name or identifier,
  ii) project description,
  iii) project address,
  iv) geographic region in which proposed design is to be built,
  v) identifier for climate data set used for analysis, and
  vi) floor area of *conditioned spaces* of the proposed design,
b) the *building envelope* data summary section of the report shall contain the documentation required in Article 2.2.2.3. for both the proposed *building* and the reference *building*,
c) the lighting systems data summary section of the report shall contain the documentation required in Article 2.2.2.4. for both the proposed *building* and the reference *building* and, if daylight calculations are made, the calculation method and the results,
d) the *HVAC system*'s data summary section of the report shall contain the documentation required in Article 2.2.2.5. for the proposed *building* and the reference *building*,
e) the *service water* heating data summary section of the report shall contain the documentation required in Article 2.2.2.6. for the proposed *building* and the reference *building*, and
f) the energy performance data summary section of the report shall contain the results of the following *building* performance calculations:
  i) the amount of each energy source used by the proposed *building*, in MJ,
  ii) the amount of each energy source used by the reference *building*, in MJ,
  iii) the *annual energy consumption* of the proposed *building* (sum of all energy sources), in MJ,

iv) the *building energy target* of the reference *building* (sum of all energy sources), in MJ, and
v) a breakdown of energy usage, per energy source, for the following *building* components and systems: space-heating equipment, space-cooling equipment, *interior lighting*, *service water* heating equipment, elevators and escalators, fans, pumps and other HVAC equipment, miscellaneous equipment and receptacle power equipment.

4) The climatic data and the modeling file of the proposed *building* and the reference *building* containing inputs for the programs shall be provided for verification purposes.

5) If the energy usage of the proposed *building* is no greater than the energy usage of the reference *building*, the report shall state that the proposed *building* satisfies the *building energy target* calculation requirements and complies with the Code.

6) The report shall indicate that the analysis was performed in accordance with Part 8 of Division B of the NECB.

7) The report shall contain a complete list of all the inputs on which the compliance analysis for both the proposed *building* and reference *building* is based.

8) The report shall contain a list of system data that were excluded for both the reference *building* and the proposed *building*, citing one of the following reasons:
a) system was excluded because it complies with the prescriptive requirements of the Code and has no effect on other *building* components, or
b) system was excluded because of an exemption permitted by the Code.

9) The report shall contain a description of any adaptations made to the compliance calculations, if applicable.

10) The report shall provide an explanation for each program error message.

11) The report shall specify any portion of energy that reduces the *annual energy consumption* of the proposed *building*, as a reduction due to renewable energy produced on site and/or a reduction due to energy recovered on site.

12) The report shall indicate the program(s) used.

Section 2.3. Alternative Solutions

2.3.1. Approval of Alternative Solutions

2.3.1.1. Conditions for Approval

1) The proposed alternative solutions shall be approved by the Board on the conditions it sets pursuant to section 127 of the Building Act (chapter B-1.1).

Index

A

[A] – Reference occurs in Division A. [C] – Reference occurs in Division C. All other references occur in Division B.

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Conversions

SI Units	Imperial Units	To convert SI units to imperial units, multiply by	To convert imperial units to SI units, multiply by
Temperature			
°C	°F	1.8 and add 32	subtract 32 divide by 1.8
Length			
mm	in.	0.03937	25.4
cm	in.	0.3937	2.54
m	ft.	3.281	0.3048
Area			
mm^2	$in.^2$	0.00155	645.16
cm^2	$in.^2$	0.155	6.4516
m^2	$ft.^2$	10.76	0.092903
Volume			
cm^3	$in.^3$	0.061	16.3871
m^3	$ft.^3$	35.31	0.02832
L	gal. (Imp)	0.22	4.55
L	gal. (US)	0.2642	3.785
Flow			
L/s	$ft.^3$/min. (cfm)	2.11889	0.471947
L/min.	$ft.^3$/min. (cfm)	0.0353	28.329
m^3/h	$ft.^3$/min. (cfm)	0.5886	1.699
Power			
W	Btu/h	3.413	0.2930711
Heat Flux			
W/m^2	Btu/h · $ft.^2$	0.317	3.154591
Overall Heat Transfer Coefficient (U-value)			
W/m^2 · K	Btu/h · $ft.^2$ · °F	0.17612	5.678263
W/m^2 · °C	Btu/h · $ft.^2$ · °F	0.17612	5.678263
Thermal Resistance			
m^2 · °C/W (RSI)	$ft.^2$ · h · °F/Btu (R)	5.678	0.17611
Thermal Conductivity, k			
W/m · K	Btu · in./h · $ft.^2$ · °F	6.93347	0.1442279
W/m^2 · °C (per m thickness)	Btu · ft./h · $ft.^2$ · °F	0.5777	1.731
W/m^2 · °C (per m thickness)	Btu · in./h · $ft.^2$ · °F	6.9444	0.144
Pressure			
Pa	in. of water	0.004014	249
kPa	psi	0.145	6.895
kPa	psf	20.88	0.04788
Energy			
MJ	kWh	0.278	3.6
J	Btu	0.0009478	1055.056