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National Research Council of Canada. Canadian Commission on Building and Fire Codes

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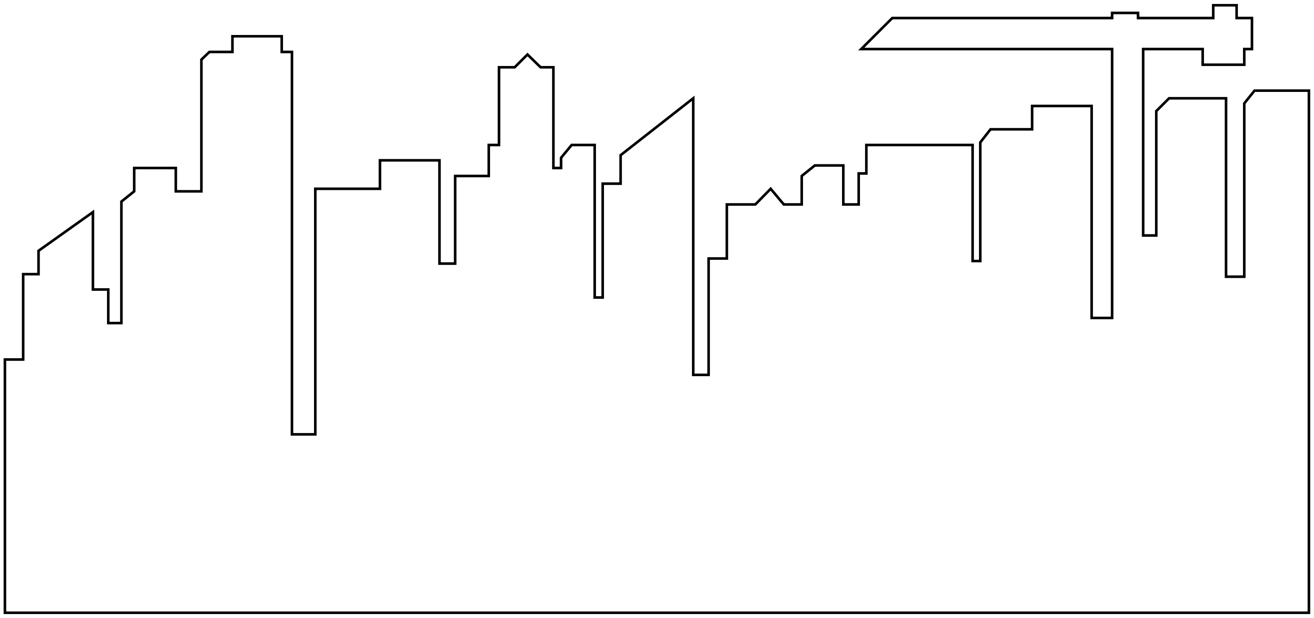
# *Performance Compliance for Buildings*

## *Specifications for Calculation Procedures for Demonstrating Compliance to the Model National Energy Code for Buildings Using Whole Building Performance*

May 1999



# PREFACE

The Model National Energy Code for Buildings 1997 (MNECB) features two types of requirements: mandatory, mostly qualitative, requirements which must be met by all *proposed design*s; and prescriptive, quantitative, requirements for which the MNECB provides three optional paths to show compliance:

1. Prescriptive Compliance
2. Trade-off Compliance
3. Performance Compliance

## Prescriptive Compliance

A *proposed design* will comply with the prescriptive requirements of the MNECB if the thermal characteristics relating to space heating and cooling; e.g. *overall thermal transmittance* of walls, HRV (heat recovery ventilator) efficiency, are equal to or lower than the prescriptive requirements provided in Sections 3.3., 4.3., 5.3. and 6.3. of the MNECB. This is the simplest compliance path and requires no performance calculation.

## Trade-off Compliance

Section 3.4. of the MNECB allows deviation from some of the prescribed envelope requirements, provided that other envelope components compensate so that the net space heating and cooling requirement is less than or equal to that which would result from the prescriptions. Two methods of envelope trade-off compliance are provided. Subsection 3.4.2. of the MNECB states that compliance can be achieved by showing that the sum of the areas of all above-ground assemblies multiplied by their respective *overall thermal transmittances* is no greater than it would be if all assemblies complied with prescriptions. Subsection 3.4.3. of the MNECB allows compliance to be demonstrated using computer software that evaluates envelope trade-offs using a specified calculation procedure.

## Performance Compliance

Performance compliance is an option (described in Part 8 of the MNECB) that permits a *proposed design* to deviate from prescriptive requirements provided that the *proposed design* can be shown, using computer software (compliance software), to have an *annual adjusted energy consumption* for space heating no greater than that of a *reference case* that satisfies the prescriptive requirements. The MNECB specifies that software used for this purpose comply with this specification.

This document specifies the various functions that the compliance software must be capable of performing in order to assist a user in demonstrating that a *proposed design* complies with the MNECB. The intended audience for this specification is the software development agency that will develop or adapt software and related manuals for this purpose.

## Statement of Intent

In general, the purpose of the performance compliance procedure is not to develop an accurate prediction of annual energy use for space heating. Rather, the purpose is to develop fair and consistent evaluations of the effects of deviations (in whatever direction) from MNECB prescriptive requirements. As such, many simplifying assumptions were made to rationalize the modeling exercise without compromising the intent.

Further, a number of occupant practices may result in energy conservation; for example, lowering or setting back thermostats. The performance analysis will not account for these measures. Since the performance path is used to allow deviations from MNECB prescriptive requirements, it was felt that occupant behavior should not be relied upon to achieve consistent and permanent reductions in *building* energy consumption. As well, some energy saving measures depend on the occupant for proper functioning to save energy; for example, insulating shutters for windows, and attached sun spaces that don’t incorporate heating systems. It is generally acknowledged that such devices can save energy when used for that purpose, and the MNECB will not discourage their use; nevertheless, it was felt that the overall intent of the MNECB would be compromised if the removal of other, more permanent energy efficient measures (such as envelope insulation) were to be allowed in favour of occupant-sensitive measures.

In summary, a wide range of characteristics determine the energy efficiency of a building. The MNECB will require some of these to meet prescribed levels of energy efficiency, and will allow some others to be used instead of the prescriptive requirements through the trade-off and performance paths. Beyond these minimum requirements, it is expected that many conservation features not required by the MNECB and not included in the scope of the performance compliance path will continue to be demanded by the consuming public and contribute to the overall energy efficiency of buildings.

# TABLE OF CONTENTS

# CHAPTER 1
# INTRODUCTION

This document is a supplement to Part 8 of the Model National Energy Code for Buildings (MNECB) 1997, which will herein be referred to as the *Code*. Parts 1 to 7 of the *Code* contain mandatory and prescriptive requirements for *building envelope*, lighting and electrical systems, space conditioning and *service water* heating. Part 8 is provided as an alternative to the prescriptive requirements in order to permit more flexibility in design while still achieving the objectives of the *Code*.

The basic principle of Part 8 is that a design may depart from the prescriptive requirements if it can be shown, using an approved computerized analysis procedure, that the energy performance of the *proposed design* is as good or better than a *building energy target* that is based on the prescriptive requirements.

The *building energy target* is determined by modeling a *reference case* that has the same geometry and size as the *proposed design*, and in which envelope and lighting are based on the prescriptive requirements. Mechanical systems for the *reference building* are defined to be reasonable performance targets and are also based on the prescriptive requirements.

The *building energy target* is defined as the sum of the “adjusted” annual energy consumption for space conditioning, lighting, and *service water* heating. The adjustment is needed in order to bring energy from different sources, such as electricity and gas, to a common basis for comparison. This is necessary because the *proposed design* may, for example, use less cooling (electricity) but more heating (gas) than the *reference case*.

The *energy source adjustment factors* are contained in the *Code* and are based on a valuation (by provincial authorities) of each source. This is usually consistent with the relative costs of energy, sometimes with an additional allowance to account for environmental factors.

The process of defining a *reference case*, and from this calculating the *building energy target,* is transparent to the user of the *Code*. This is automatically done by the *compliance software*. The *Code* user simply defines the *proposed design*, along with the necessary *Code* information. The software then:

- defines the *reference case*, models its energy performance and performs the energy source adjustment to determine the *building energy target*;
- models the *proposed design* and performs the energy source adjustment to determine *annual adjusted energy consumption*; and
- compares the *annual adjusted energy consumption* to the *building energy target* to determine whether the design complies (if *annual adjusted energy consumption* is no greater than the *building energy target*, then it passes).

To comply with Part 8 of the *Code*, the applicant must: use *compliance software* that complies with these specifications; input data to describe the *proposed design*; and achieve a passing result from the *compliance software*.

Chapters 3 through 7 of this document describe the requirements for the *compliance software*. Chapter 3 contains general requirements. Chapters 4 and 5 describe requirements for input data checking and the rules for defining the *reference case*. Chapter 6 contains reporting requirements and Chapter 7 describes the required characteristics of the energy calculation method used by the *compliance software*.

## Precedence of the MNECB

This document describes the calculation procedure for performance compliance as given in Part 8 of the MNECB and is subject to changes made necessary by revisions to the MNECB. It must be read in conjunction with the relevant requirements of the MNECB, which is a binding document that establishes the rules for performance compliance. Where discrepancies occur between the present document and the MNECB, the MNECB shall govern.

# CHAPTER 2
# TERMINOLOGY

## 2.1. Terms Italicized in the Text

Words or phrases that appear in italics in this document are defined terms intended to have a specific meaning. Terms that are defined in Section 2.2., Definitions, of this document shall have the meaning given in those definitions. Terms in italics that are not defined in Section 2.2. of this document shall have their meaning defined in the MNECB.

Words and phrases used in this document that are not defined in Section 2.2. of this document and are not defined in Article 1.1.3.2. of the MNECB shall have the meanings that are commonly assigned to them in the context in which they are used in this document and in the MNECB, taking into account the specialized use of terms within the various trades and professions to which the terminology applies.

## 2.2. Definitions

The words and terms in italics in this document are defined as follows, or are defined under Article 1.1.3.2. of the MNECB:

***Building type*** means one of the categories in Table 4.3.2.A. of this document.

***Code*** means the Model National Energy Code for Buildings 1997.

***Primary system*** means a system that consists of the equipment to convert electricity or fuel to heating or cooling and distribute it to one or more *secondary systems*, where such equipment is not already defined as part of the *secondary system* (e.g. *boilers* and chillers).

***Proposed design*** means the *building*, group of *buildings* or portions of the *building* for which construction approval is being sought. The *proposed design* includes the *building envelope*, lighting and electrical systems, and mechanical systems to provide space conditioning and *service water* heating.

***Reference case*** means a generic *building* design of the same size and shape as the *proposed design* that complies with the prescriptive requirements of the MNECB and has prescribed assumptions, as given in Chapter 5 of this document, used to generate the energy target.

***Secondary system*** means a system that provides air (for ventilation as well as distribution of heating and cooling) to the *thermal block* (i.e. fan system). *Secondary system*s may include equipment dedicated to the system that converts electricity or fuel to heating or cooling. *Secondary system*s may be “single zone” (serving only a single *thermal block)*, or multiple zone (serving one or more *thermal blocks*).

***Space function*** means one of the categories given in Table 4.3.2.B. of this document.

***Space use classification*** is used to identify the characteristics of the space in a *thermal block*. Selected according to either *building* type from Table 4.3.2.A. or *space function* from Table 4.3.2.B. of this document, *space use classification* determines the default values of occupant density, lighting power, receptacle power, ventilation rate and operating schedules.

***Terminal characteristics*** means those features and parameters that pertain only to the *thermal block* served, and are not included in the definition of the *secondary system*.

***Thermal block:*** a space, or group of spaces, that is considered as one homogeneous space for modeling purposes. A *thermal block* should be:

- (a) one temperature controlled zone; or
- (b) a group of temperature controlled zones that:
  - (i) are served by the same air handling system, or by systems that can be considered to be identical;
  - (ii) are operated and controlled in the same way; and
  - (iii) have space use and envelope characteristics that 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 than would be obtained by summing the results for the individual zones modeled separately; or
- (c) a zone consisting entirely of indirectly conditioned space (see Article 4.3.1.3.).

# CHAPTER 3
# COMPLIANCE SOFTWARE:  GENERAL

## 3.1. General

This chapter contains a general description of the requirements for compliance software that can be used to show compliance with Part 8 of the MNECB.  More details on specific functions are given in Chapters 4 to 7 of the present document.

The purpose of the compliance software is to check whether the energy use of the *proposed design* exceeds its *building energy target*.  If it does not, then the *proposed design* complies; if it does, then the *proposed design* fails to comply.  The compliance software calculates the energy use of the *proposed design* as input by the user.  The compliance software also automatically calculates the *building energy target* that corresponds to the input for the *proposed design*.  It does this by defining a *reference case* based on the input for the *proposed design* and the prescriptive requirements of the *Code*, as detailed in Chapter 5.

The basic functions of the compliance software are to:

- provide a user interface to permit data for the *proposed design* to be entered;
- check the data input for consistency and ensure that restrictions are satisfied;
- process user input by adding fixed values and providing a default so as to create complete input data needed to simulate the energy performance of the *proposed design*;
- on error, abort the rest of the procedure and generate error messages and diagnostic information for the user;
- calculate the annual consumption of each energy source for the *proposed design*, ensuring that the proper climate data is used for analysis;
- adjust the energy consumption of the *proposed design* using the *energy source adjustment factor* for each source;
- sum the adjusted energy consumption for all sources used in the *proposed design* to obtain the energy use;
- generate data to define a *reference case*, using input data for the *proposed design* and the prescriptive requirements of the *Code*;
- calculate the annual consumption of each energy source for the *reference case*, ensuring that the proper climate data is used for analysis;
- adjust the energy consumption for the *reference case* using the *energy source adjustment factor* for each source;
- sum the adjusted energy consumption of the *reference case* for all sources used to obtain the *building energy target*;
- compare the energy use to the *building energy target* to determine compliance;

- if the compliance check passes, then generate compliance reports for submission to the building official;
- if the compliance check fails, then generate a report showing non-compliance and information to help the designer determine what design changes are needed to comply;
- generate diagnostic and information reports.

## 3.2. Compliance Shell & Energy Analysis Module

The compliance software must perform a detailed energy simulation of both the *proposed design* and the *reference case*. This involves rather complicated and sophisticated calculations. Energy analysis programs exist that perform these calculations; these programs were developed as tools to assist in the design of *buildings*. Since these programs already exist, it is possible to incorporate one of them into the compliance software to perform the energy analysis function, rather than develop the calculation routines specifically for *Code* compliance.

Therefore, this document considers the compliance software to be composed of two separate entities:

(1) an energy analysis module that performs all the energy simulation calculations; and

(2) a compliance shell that provides input/output functions, performs error checking, defines the *reference case*, calls on the energy analysis module to perform the simulations of both the *proposed design* and the *reference case,* and generates special compliance/non-compliance reports.

Figure 3.2.A. illustrates how the compliance software might be structured if it used an existing computer program for the energy analysis module. The compliance shell processes input from the user and generates internal data files that serve as input for the energy analysis module. When the energy analysis module is executed (under the control of the compliance shell) it reads data from this internal input file, performs the simulation using the climate data specified by the compliance shell, and saves the results in internal report files. The compliance shell then reads these report files, processes the data to determine compliance, and generates reports for the user.

## 3.3. Processing Input for Proposed Design

The compliance shell processes input data from the user to define the *proposed design*. Chapter 4 contains details of requirements for input processing. These requirements include:

- Required inputs: the compliance shell must ensure that the user enters a value for these parameters.
- Input restrictions: the compliance shell must enforce restrictions on inputs, such as range limits on numeric values, or selection from a discrete list of alternatives.
- Default values: the compliance shell must provide default values, where appropriate. The default value will be used in the absence of a user input.
- Fixed inputs: The compliance shell must not permit user input for these parameters to be used for demonstrating *Code* compliance, but instead must set them to values established in either this document or in the *Code*.
- Inputs not permitted: The compliance shell must not permit input for these parameters to be used for demonstrating *Code* compliance. This may be because they represent features or

phenomena for which the *Code* deliberately does not permit credit for compliance. It also includes features for which provision has not yet been made in this document (these may be added at a later date, when the technique for modeling them has been agreed on).

Chapter 4 does not define the form of user interface for the compliance shell; this is left to the software developer.

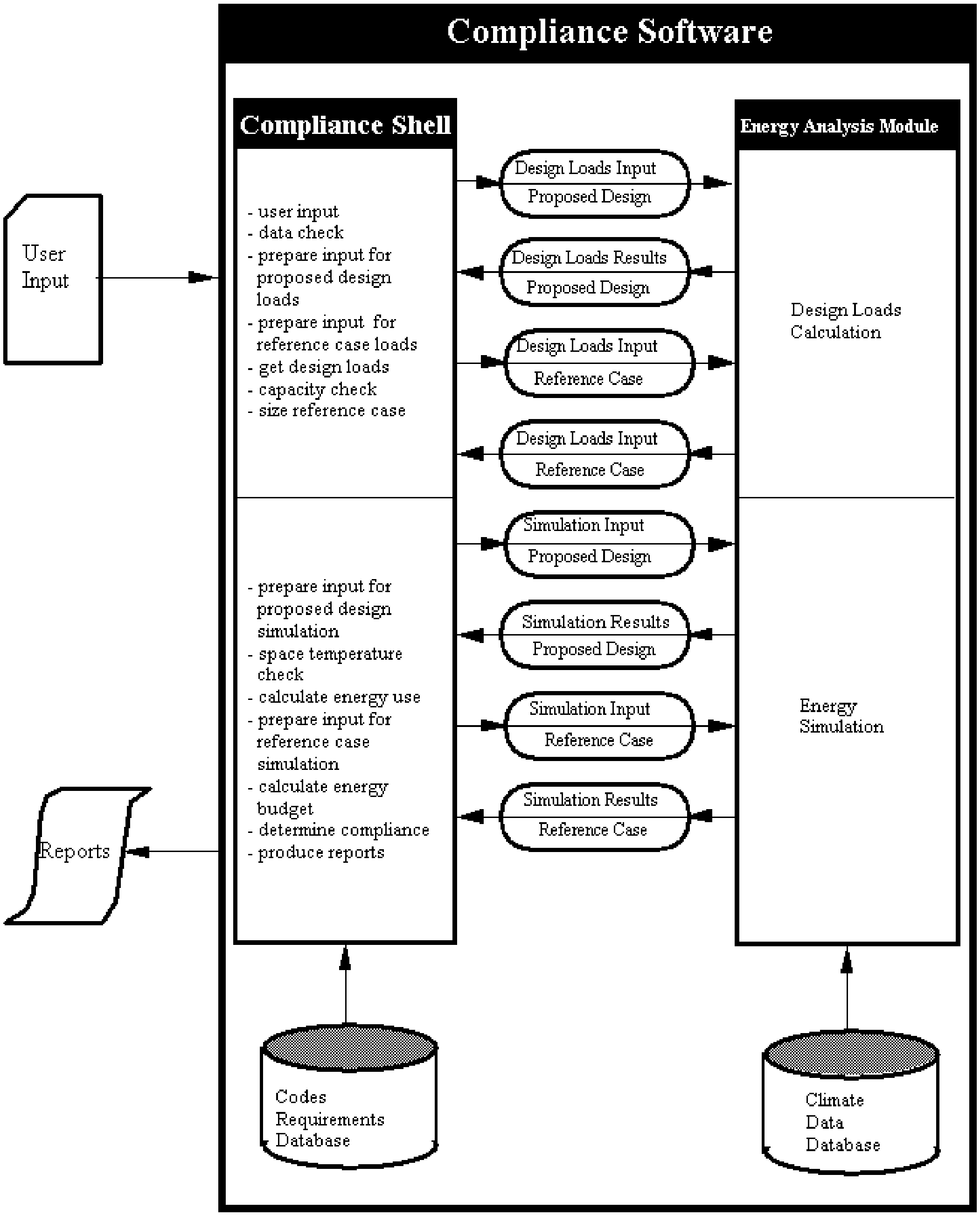


Figure 3.2.A. Software Structure 1

## 3.4. Checking Input Data

Chapter 4 specifies error and limit checking that must be performed on the user input. The compliance shell is required to ensure that input satisfies the given restrictions, and to perform checks on data integrity. This input data checking can be of the following types:

- Restrictions on a parameter or group of related parameters can be checked at the time of data entry. The user may be prevented from continuing until the error has been corrected;
- Consistency checking must be performed after all of the input data has been entered. This includes a check that heating equipment capacity meets the calculated (peak) design heating loads (see Section 3.5.). The compliance shell must issue an error message and not continue with compliance analysis until all consistency checks and input restriction checks are satisfied.
- Input for which a warning (advisory) message is to be issued must be identified. This is optional input to which the building official should be alerted; he or she may require supporting information to justify the input. The performance analysis will proceed, but warning messages must appear in the output report.
- Additional checks must be performed to ensure that the space conditioning system defined in the input is capable of maintaining the required heating temperature conditions. These checks take place after the energy analysis module has completed the simulation of the *proposed design*. The compliance shell must examine the results of the simulation and check that the temperature in each *thermal block* was not lower than that specified in the heating temperature schedule. (This is to prevent attaining low energy consumption by operating the system in such a way as to not fully heat the *building*.) On this error condition the compliance shell shall issue an error message and shall not produce a compliance report.

## 3.5. Design Load and Sizing Calculations

The compliance software must perform design load and system sizing calculations for both the *proposed design* and the *reference case*. The design heating/cooling load calculations can either be performed by the compliance shell itself, or the compliance shell can call on the energy analysis module to perform the loads calculations. (Most of the energy analysis programs have this capability.)

The calculation for the *proposed design* is needed for two reasons.

First, it is necessary in order to perform the heating capacity check described in Section 3.4. For the purpose of Part 8 of the *Code*, heating equipment is not permitted to be undersized in the *proposed design*.

The second reason has to do with defining heating and cooling capacities for the *reference case* that will provide a fair basis of comparison for establishing the *building energy target*. The *Code* recognizes that there are legitimate reasons for oversizing heating capacities, as well as cooling capacities. It also recognizes that cooling capacities may be deliberately undersized, so as to provide comfort conditions most, but not all, of the time.

The principle behind the determination of capacities for the reference system is that the *reference case* will be oversized to the same degree as the *proposed design*. When cooling is undersized in the *proposed design*, the *reference case* will be undersized to the same degree. This means that both will result in space temperatures not being maintained, again to about the same degree. The energy analysis module will model both *proposed design* and *reference case* with undersized cooling capacities and simulate the resultant space temperature (the energy analysis module must have this capability).

The procedure for the compliance shell to define the system capacities for the *reference case* is as follows:

- calculate the sizing factor for the *proposed design*; this is the ratio of proposed capacity divided by calculated design load;
- calculate the design (peak) loads for the *reference case*;
- determine the *reference case* capacities by multiplying the calculated design load for the *reference case* by the sizing factor.

## 3.6. Calculation of Energy Use

The compliance shell must execute the *energy analysis module* with data defined for the *proposed design* and the climate data required by the *Code* for the location in which the *building* is to be constructed. After the energy analysis module has completed the simulation of the *proposed design*, the compliance shell must obtain the resulting annual energy consumption in energy units (MJ) for each energy source and must adjust each consumption by multiplying by the *energy source adjustment factor* for that source as given in Appendix D of the *Code* for the region in which the *proposed design* is to be constructed.

For the purpose of performance compliance calculations, electric heat pumps shall not be considered as energy sources separate from electricity. Rather, the electricity consumption of heat pumps shall be adjusted by the ESAP for electricity like any other electricity consumption.

The compliance shell determines the energy use by summing the adjusted energy consumption of all sources used.

## 3.7. Generation of Reference Case

The compliance shell automatically generates the *reference case* from the input data for the *proposed design*. Chapter 5 specifies the rules for creating the *reference case*. Since the basis for the *reference case* is the prescriptive *Code* requirements, the compliance shell must be able to access the *Code* requirements that apply to the *proposed design*. The user must not be able to modify this data.

## 3.8. Calculation of Building Energy Target

The compliance shell must execute the energy analysis module with data defined for the *reference case* and the climate data required by the *Code* for the location in which the *building* is to be constructed. After the energy analysis module has completed the simulation of the *reference case*, the compliance shell must obtain the resulting annual energy consumption in energy units (MJ) for each energy source and must adjust each consumption by multiplying by the *energy source adjustment factor* for that source as given in Appendix D of the *Code* for the region in which the *proposed design* is to be constructed.

For the purpose of performance compliance calculations, electric heat pumps shall not be considered as energy sources separate from electricity. Rather, the electricity consumption of heat pumps shall be adjusted by the ESAP for electricity like any other electricity consumption.

The compliance shell determines the *building energy target* by summing the adjusted energy consumption of all sources used.

## 3.9. Determination of Compliance

If no input errors are encountered, and the energy use of the *proposed design* (from Section 3.6.) is not greater than the *building energy target* (from Section 3.8.), then the *proposed design* complies.

## 3.10. Reports

The compliance shell must produce a compliance report, as described in Chapter 6, only if the *proposed design* complies. This report must include warning messages for any of the data identified in the data checks in Section 3.4.

If the *proposed design* does not comply, the compliance shell must produce a non-compliance report, as described in Chapter 6.

Chapter 6 also describes minimum requirements for other reporting capabilities. Additional reporting options for diagnostics or user information are permitted.

# CHAPTER 4
# COMPLIANCE SHELL: PROCESSING INPUT FOR THE PROPOSED DESIGN

## 4.1. General

### 4.1.1. Scope

**1)** This chapter specifies requirements for the following functions of the compliance shell:

a) accept user inputs for the *proposed design*;
b) perform data checking and verification;
c) enforce restrictions on inputs;
d) if the data satisfies all data checks and restrictions, then create a complete data set for the *proposed design* and transfer that data to the energy analysis module so that it can perform the analysis and compute the energy use of the *proposed design*;
e) if input fails any of the data checks or restrictions, then generate diagnostic messages indicating the input errors.

**2)** Other functions of the compliance shell are given in Chapters 3, 5, and 6.

### 4.1.2. Compliance

#### 4.1.2.1. Compliance Software

**1)** The compliance shell shall control the execution of an energy analysis module that satisfies the requirements of Chapter 7.

**2)** The compliance shell shall not permit input for any features not fully supported by the energy analysis module it controls to be used to demonstrate compliance with the *Code*.

#### 4.1.2.2. Required Input

**1)** The compliance shell shall provide a means for the user to enter all of the required inputs.

**2)** The compliance shell shall perform data checking to prevent the omission of required inputs by the user.

#### 4.1.2.3. Optional Input

**1)** The compliance shell shall provide a means of entering the optional inputs for all required capabilities (see Article 4.1.2.5.) and for those optional capabilities (see Article 4.1.2.6.) that are provided by the software.

Note that some optional inputs may represent optional capabilities and therefore might not be offered by all compliance software.

#### 4.1.2.4. Input Not Permitted

**1)** The compliance shell shall perform data checking to prevent data identified as “input not permitted” from being used in the compliance analysis.

**2)** Features that are not included in this chapter shall be considered to be inputs that are not permitted.

#### 4.1.2.5. Required Capabilities

**1)** Unless otherwise stated, the compliance shell must have the input processing capability for all items contained in this chapter.

#### 4.1.2.6. Optional Capabilities

**1)** The compliance software may, but is not required to, have the capabilities identified as optional capabilities. The software documentation shall clearly identify the optional capabilities contained in the software.

### 4.1.3. Project Identification

**1)** The compliance shell shall accept project identification input, including:

(a) the project name, address, and owner; and
(b) the “designer” who has the responsibility for certifying that the performance analysis complies with the *Code*.

There is no default.

### 4.1.4. Administrative Region and Climate Data

**1)** The compliance shell shall accept input of geographic region. This input shall be restricted to a selection from the list of Province/Territory and administrative regions given in Appendix A of the *Code*.

**2)** For the purpose of demonstrating compliance with the *Code*, the compliance shell shall attach the climate data for the representative weather station corresponding to the Province/Territory and administrative region considered (see Appendix B of this document) to the energy analysis module so that this climate data is used for the performance analysis of both the *reference case* and the *proposed design*. It shall not permit any other climate data to be used for compliance analysis.

CWEC (Canadian Weather for Energy Calculations) data has been produced for this purpose and will be available for the defined climatic regions.

The compliance shell may permit optional input of other climate data for non-compliance use. However, it must ensure that this data is not used to show compliance.

### 4.1.5. Basis for Space Use Classification

**1)** The compliance shell shall permit the user to choose the basis of *space use classification* according to either "*building type"* or "*space function*."

**2)** The user's choice shall be limited to either the *building types* listed in Table 4.3.2.A. or the *space functions* listed in Table 4.3.2.B.

**3)** This selection determines the method of *space use classification* for all *thermal blocks* in the *proposed design* (see Subsection 4.3.2.).

Can't use *building type* in one *thermal block* and *space function* in another.

### 4.1.6. Calendar

**1)** The calendar year for analysis shall be fixed as 1996.

**2)** No inputs for statutory holidays shall be used for compliance analysis.

Different provinces have different holidays. In any case it is of no significance for showing compliance.

Note: This is not meant to prevent definition of schedules as permitted by exceptional conditions (Subsection 4.3.3.).

## 4.2. Division into Thermal Blocks

**1)** Input shall be accepted and processed for each *thermal block,* to the maximum number of *thermal blocks* permitted by the energy analysis module.

## 4.3. Modeling Thermal Loads

**1)** The input detailed in Subsections 4.3.1. through 4.3.7. shall be accepted and processed for each *thermal block*.

## 4.3.1. General

### 4.3.1.1. *Thermal Block* Identification

**1)** The compliance shell shall accept input for *thermal block* identification and description as follows: Input is required and there is no default.

a) a unique identifier (name) that can be used to identify the *thermal block*; and

b) a description indicating which of the spaces shown on the plans make up the *thermal block*.

This is needed to specify *thermal blocks* between which heat transfer occurs, as well as to link *thermal blocks* to systems.

This description helps a building official check the zoning against the plans.

### 4.3.1.2. Heating Source Classification

**1)** The compliance shell shall accept input identifying the *principal heating source* for each *thermal block*. This input must be restricted to a selection from a list of those for which an *energy source adjustment factor* is defined in Appendix D of the *Code* for the region selected in Subsection 4.1.4.

### 4.3.1.3. Indirectly Conditioned *Thermal Block*

**1)** The compliance shell shall accept input to select either “indirectly conditioned” or “directly conditioned” for the *thermal block*.

Note definitions of directly conditioned and indirectly conditioned in the *Code*.

**2)** If input for the *thermal block* is “indirectly conditioned,” then the compliance shell shall set the following values to zero:

a) number of occupants;
b) receptacle power;
c) *service water* heating; and
d) minimum outdoor air requirement.

### 4.3.1.4. Floor Area

**1)** The compliance shell shall accept input for the floor area of each *thermal block*. A positive non-zero value is required and there is no default.

## 4.3.2. Space Use Classification

**1)** For each *thermal block* that is “directly conditioned,” the compliance shell shall process input for *space use classification* according to the basis for *space use classification* entered in Subsection 4.1.5.

**2)** If input for the *thermal block* is “indirectly conditioned,” then the compliance shell shall not accept input for *space use classification*.

### 4.3.2.1. Building Type Categories

**1)** If the basis for *space use classification* is according to *“building type”* (see Subsection 4.1.5.), then the compliance shell shall accept input of *space use classification*, which is restricted to a selection from the list of *building type* categories given in Table 4.3.2.A.

**2)** The compliance shell shall automatically set the default values according to Table 4.3.2.A. for the following, based on the *building type* selected and the floor area of the *thermal block* :

a) number of occupants;
b) receptacle power;
c) *service water* heating;
d) minimum outdoor air requirement;
e) space temperature schedule; and
f) *occupancy*, lighting, and operation schedules.

### 4.3.2.2. Space Function Categories

**1)** If the basis of *space use classification* is according to *“space function”* (see Subsection 4.1.5.), then the compliance shell shall accept input of *space use classification*, which is restricted to either:

a) selection of one of the list of *space function* categories given in Table 4.3.2.B.; or
b) “combined.”

**2)** If *space use classification* was selected as one of the *space function categories,* then the compliance shell shall automatically set default values according to Table 4.3.2.B. for the following, based on the *space function* selected and the floor area of the *thermal block*:

a) number of occupants;
b) receptacle power;
c) *service water* heating;
d) minimum outdoor air requirement;
e) space temperature schedule; and
f) *occupancy*, lighting, and operation schedules.

**3)** If *space use classification* for a *thermal block* was selected as “combined,” then the compliance shell shall accept input of up to four selections from the list of *space functions* given in Table 4.3.2.B., and the floor area associated with each. The compliance shell shall ensure that all of the *space functions* selected have the same operating schedules. *Space functions* for which the operating schedule is shown in Table 4.3.2.B. as an asterisk (*) may be combined with any other *space function*. However, at least one of the *space function*s to be combined must have a defined operating schedule (i.e. not an asterisk).

**4)** If *space use classification* for a *thermal block* was selected as “combined,” then the compliance shell shall:

a) check that the sum of the floor areas of the combined *space functions* equals the floor area of the *thermal block*, and treat as an error if it does not;

b) set the values for operating schedules according to Table 4.3.2.B.; and

c) set fixed values for the following as an area weighted average of the values for the combined *space functions* according to Table 4.3.2.B.:
  - i) number of occupants;
  - ii) receptacle power;
  - iii) *service water* heating; and
  - iv) minimum outdoor air requirement.

### 4.3.2.3. Heat Gain Due to Occupants

**1)** In calculating heat gain from occupants, the number of which is determined in Article 4.3.2.1. for all *building types* and Article 4.3.2.2. for all *space function* types, a uniform value of 75 watts per occupant shall be used for sensible heat gain and a value of 55 watts per occupant shall be used for latent heat gain.

## Table 4.3.2.A. Building Type Categories: Default Assumptions

| Building Type | Occupant Density ($m^2$/person) (1) | Receptacle Power ($W/m^2$) (2) | Service Water Heating (W-person) (3) | Minimum O.A. ($L/s/m^2$) (4) | Operating Schedule (Table 4.3.2.C.) (5) | Lighting Power Density ($W/m^2$) (6) |
|---|---|---|---|---|---|---|
| **Office** | 25 | 7.5 | 90 | 0.4 | A | 18 |
| **Restaurant** | 10 | 1 | 115 | 1.25 | B | 15 |
| **Retail** | 30 | 2.5 | 40 | 1.0 | C | 30 |
| **Mall/Concourse/Atria** | 30 | 2.5 | 40 | 1.0 | C | 16 |
| **School** | 8 | 5 | 60 | 1.0 | D | 19 |
| **Service Establishment** | 30 | 2.5 | 80 | 1.0 | C | 22 |
| **Warehouse** | 1 500 | 1 | 300 | 0.25 | E | 6 |
| **Hotel/motel** | 25 | 2.5 | 500 | 0.60 | F | 15 |
| **Multifamily Residential** | 60 | 5 | 500 | 0.30 | G | 9 |

**NOTES: (Apply to both Tables 4.3.2.A. and 4.3.2.B.)**

(1) Values from ASHRAE/IES Standard 90.1-1989 User's Manual - November 1992.

(2) Values from ASHRAE/IES Standard 90.1-1989 User's Manual - November 1992.

(3) Values from ASHRAE/IES Standard 90.1-1989 User's Manual - November 1992. Note that this table determines the total hot water usage to satisfy occupant needs. It does not mean that the hot water is actually used in that space. For example, hot water shown for office would actually be used in washrooms.

(4) Values based on ASHRAE 62-89.

(5) Where operating schedule is shown as an asterisk (*), this indicates that *space function* must be combined with another to form a *thermal block* and the operating schedule is determined by the *space function* with which it is combined.

(6) Values from the MNECB.

## Table 4.3.2.B. Space Functions: Default Assumptions

| Space Function | Occupant Density ($m^2$/person) (1) | Receptacle Power ($W/m^2$) (2) | Service Water Heating (W-person) (3) | Minimum O.A. ($L/s/m^2$) (4) | Operating Schedule (Table 4.3.2.C.) (5) | Lighting Power Density ($W/m^2$) (6) |
|---|---|---|---|---|---|---|
| **Assembly** | | | | | | |
| Auditorium/Exhibit | 5 | 2.5 | 30 | 1.5 | C | 17.2 |
| Religious Worship | 5 | 1 | 15 | 1.5 | I | 26.9 |
| Theater - Performance | 7.5 | 2.5 | 30 | 1.0 | I | 16.2 |
| Theater - Motion Picture | 5 | 2.5 | 30 | 1.5 | I | 16.2 |
| Lobby | 10 | 1 | 0 | 1.0 | C | 10.8 |
| Atria | 10 | 2.5 | 0 | 0.5 | C | 7.5 |
| Recreation/Lounge | 10 | 1 | 60 | 3.0 | B | 7.5 |
| Conference/Meeting | 5 | 1 | 45 | 2.0 | C | 19.4 |
| Indoor Athletics Seating | 5 | 0 | 30 | 1.5 | I | 10.8 |
| Recreational Sports Area | 5 | 1 | 90 | 2.0 | I | 13.0 |
| Professional Sports Area | 5 | 1.5 | 60 | 2.0 | I | 28.0 |
| Locker Room and Shower | 10 | 2.5 | 0 | 2.5 | * | 8.6 |
| **Heath/Institutional** | | | | | | |
| Dental *Suite*/Exam | 20 | 10 | 90 | 0.4 | C | 22.6 |
| Emergency | 20 | 10 | 180 | 0.75 | H | 24.7 |
| Laboratory | 20 | 10 | 180 | 0.75 | H | 20.4 |
| Medical Supplies | 20 | 1 | 0 | 0.75 | H | 25.8 |
| Nursery | 20 | 10 | 90 | 0.6 | H | 21.5 |
| Nurse Station | 20 | 2.5 | 45 | 0.4 | H | 22.6 |
| Occupational/Physical Therapy | 20 | 10 | 45 | 0.6 | C | 17.2 |
| Patient Rooms | 20 | 10 | 90 | 0.6 | H | 15.1 |
| Pharmacy | 20 | 2.5 | 45 | 0.4 | C | 18.3 |
| Radiology | 20 | 10 | 90 | 0.4 | H | 22.6 |
| Surgical/O.B. *Suites* | 20 | 10 | 180 | 0.75 | H | 22.6 |
| Operating Room | 20 | 10 | 300 | 0.75 | H | 75.3 |
| Recovery | 20 | 10 | 180 | 0.4 | H | 24.8 |

**NOTES: See Notes to Table 4.3.2.A.**

## Table 4.3.2.B. Space Functions: Default Assumptions (cont.)

| **Space Function** | **Occupant Density** (m$^2$/person) (1) | **Receptacle Power** (W/m$^2$) (2) | **Service Water Heating** (W-person) (3) | **Minimum O.A.** (L/s/m$^2$) (4) | **Operating Schedule** (Table 4.3.2.C.) (5) | **Lighting Power Density** (W/m$^2$) (6) |
|---|---|---|---|---|---|---|
| **Hotel/Motel** | | | | | | |
| Banquet Room | 10 | 1 | 90 | 0.75 | B | 25.8 |
| Hotel Prefunction | 10 | 2.5 | 60 | 0.75 | C | 25.8 |
| Guest Rooms | 25 | 2.5 | 600 | 0.6 | F | 15.1 |
| Exhibition Hall | 10 | 2.5 | 60 | 0.75 | C | 28.0 |
| Lobby/Reception Desk | 10 | 2.5 | 30 | 0.75 | H | 21.5 |
| **Shop (Non-industrial)** | | | | | | |
| Machinery | 30 | 1 | 50 | 2.5 | C | 26.9 |
| Electrical/Electronic | 30 | 10 | 50 | 1.25 | C | 26.9 |
| Painting | 30 | 10 | 90 | 5.0 | C | 17.2 |
| Carpentry | 30 | 10 | 50 | 1.25 | C | 24.8 |
| Welding | 30 | 10 | 90 | 5.0 | C | 12.9 |
| Auto Repair | 20 | 5 | 90 | 7.5 | C | 10.8 |
| **Office** | | | | | | |
| *Category 1:*<br>*Enclosed offices, all open plan offices without partitions or with partitions lower than 1.37 m below the ceiling. Offices less than 84 m$^2$.* | 20 | 7.5 | 90 | 0.5 | A | 19.4 |
| *Category 2:*<br>*Open plan offices 84 m$^2$ or larger with partitions 1.07 m to 1.37 m below the ceiling.* | 20 | 7.5 | 90 | 0.5 | A | 20.4 |
| *Category 3:*<br>*Open plan offices 84 m$^2$ or larger with partitions higher than 1.07 m below the ceiling.* | 20 | 7.5 | 90 | 0.5 | A | 23.7 |
| Computer/Office Equipment | 20 | 7.5 | 90 | 0.5 | A | 22.6 |
| Filing, Inactive | 50 | 0 | 0 | 0.2 | A | 10.8 |
| Sorting and Mailing | 20 | 7.5 | 90 | 0.5 | A | 19.4 |
| Bank Business Area | 20 | 7.5 | 90 | 0.2 | A | 30.1 |
| Bank Customer Area | 30 | 2.5 | 0 | 0.25 | A | 11.8 |

**NOTES: See Notes to Table 4.3.2.A.**

## Table 4.3.2.B. Space Functions: Default Assumptions (cont.)

| **Space Function** | **Occupant Density** **($m^2$/person)** (1) | **Receptacle Power** **(W/$m^2$)** (2) | **Service Water Heating** **(W-person)** (3) | **Minimum O.A.** **(L/s/$m^2$)** (4) | **Operating Schedule** **(Table 4.3.2.C.)** (5) | **Lighting Power Density** **(W/$m^2$)** (6) |
|---|---|---|---|---|---|---|
| **Retail** | | | | | | |
| *Type A: Jewelry merchandising, where minute examination of displayed merchandise is critical.* | 30 | 2.5 | 40 | 1.0 | C | 53.8 |
| *Type B: Fine merchandising, such as fine apparel and accessories, china, art, crystal and silver, where detailed display and examination of merchandise is important.* | 30 | 2.5 | 40 | 1.0 | C | 34.4 |
| *Type C: Mass merchandising, such as general apparel, variety, stationery, books, sporting goods, hobby, cameras, gifts and luggage, displayed in a warehouse type of building, where focused display and detailed examination of merchandise is important.* | 30 | 2.5 | 40 | 1.0 | C | 33.4 |
| *Type D: General merchandising, such as general apparel, variety, stationery, books, sporting goods, hobby, cameras, gifts and luggage, displayed in a department store type of building, where general display and examination of merchandise is adequate.* | 30 | 2.5 | 40 | 1.0 | C | 35.5 |
| *Type E: Food and miscellaneous, such as bakeries, hardware and housewares, grocery, appliances and furniture, where appetizing appearance is important.* | 30 | 2.5 | 40 | 1.0 | C | 30.1 |
| *Type F: Service establishments where functional performance is important.* | 30 | 2.5 | 40 | 1.0 | C | 29.1 |
| Tailoring | 30 | 2.5 | 40 | 1.0 | C | 22.6 |
| Dressing/Fitting Rooms | 30 | 0 | 40 | 0.25 | C | 15.1 |

**NOTES: See Notes to Table 4.3.2.A.**

## Table 4.3.2.B. Space Functions: Default Assumptions (cont.)

| **Space Function** | **Occupant Density** **($m^2$/person)** (1) | **Receptacle Power** **(W/$m^2$)** (2) | **Service Water Heating** **(W-person)** (3) | **Minimum O.A.** **(L/s/$m^2$)** (4) | **Operating Schedule** **(Table 4.3.2.C.)** (5) | **Lighting Power Density** **(W/$m^2$)** (6) |
|---|---|---|---|---|---|---|
| **Food Service** | | | | | | |
| Bar/Lounge | 10 | 1 | 90 | 1.5 | B | 26.9 |
| Leisure Dining | 10 | 1 | 90 | 1.0 | B | 26.9 |
| Fast Food/Cafeteria | 10 | 1 | 120 | 1.0 | B | 14.0 |
| Kitchen | 20 | 10 | 120 | 1.5 | B | 15.1 |
| **Dormitory** | | | | | | |
| Bedroom | 25 | 2.5 | 500 | 0.3 | G | 11.8 |
| Bedroom/Study | 25 | 2.5 | 500 | 0.3 | G | 15.1 |
| Study Hall | 25 | 2.5 | 90 | 0.3 | C | 19.4 |
| **Education** | | | | | | |
| Classroom | 7.5 | 5 | 65 | 1.0 | D | 21.5 |
| **Library** | | | | | | |
| Audio/Visual | 20 | 5 | 90 | 0.4 | C | 11.8 |
| Stack - Stack Mounted Lighting | 20 | 0 | 90 | 0.4 | C | 16.2 |
| Stack - Ceiling Lighting | 20 | 0 | 90 | 0.4 | C | 32.3 |
| Card File/Cataloguing | 20 | 2.5 | 90 | 0.4 | C | 17.2 |
| Reading | 20 | 1 | 90 | 0.4 | C | 20.4 |
| **Laboratories** | | | | | | |
| Laboratories | 20 | 10 | 180 | 0.5 | A | 24.8 |
| **Storage/Warehouse** | | | | | | |
| Inactive Storage | 1750 | 0 | 300 | 0.25 | E | 3.2 |
| Active Storage, Bulky | 100 | 1 | 65 | 0.25 | E | 3.2 |
| Active Storage, Fine | 50 | 1 | 65 | 0.25 | E | 7.5 |
| Material Handling | 20 | 1 | 65 | 0.4 | E | 10.8 |

**NOTES: See Notes to Table 4.3.2.A.**

## Table 4.3.2.B. Space Functions: Default Assumptions (cont.)

| **Space Function** | **Occupant Density** (m$^2$/person) (1) | **Receptacle Power** (W/m$^2$) (2) | **Service Water Heating** (W-person) (3) | **Minimum O.A.** (L/s/m$^2$) (4) | **Operating Schedule** (Table 4.3.2.C.) (5) | **Lighting Power Density** (W/m$^2$) (6) |
|---|---|---|---|---|---|---|
| **Service and Common** | | | | | | |
| Mechanical/electrical room | 200 | 1 | 0 | 0.25 | * | 7.5 |
| Corridors | 100 | 0 | 0 | 0.25 | * | 8.6 |
| Toilet and Washrooms | 30 | 1 | 0 | 1.0 | * | 8.7 |
| Active Stairway | 100 | 0 | 0 | 0.25 | * | 6.5 |
| Emergency Stairway *Exit* | 500 | 0 | 0 | 0.25 | * | 4.3 |
| **Air/Bus/Rail Terminals** | | | | | | |
| Baggage Area | 20 | 2.5 | 65 | 0.5 | H | 10.8 |
| Concourse/Main Thruway | 20 | 0 | 65 | 0.5 | H | 9.7 |
| Ticket Counter | 10 | 2.5 | 65 | 1.0 | H | 26.9 |
| Waiting and Lounge | 10 | 0 | 65 | 1.0 | H | 12.9 |
| **Fire/Police** | | | | | | |
| Fire Engine Room | 25 | 2.5 | 325 | 0.4 | H | 8.6 |
| Jail Cell | 25 | 2.5 | 325 | 0.4 | H | 8.6 |
| **Museum/Gallery** | | | | | | |
| General Exhibition | 5 | 2.5 | 60 | 1.5 | C | 20.4 |
| Inspection/Restoration | 20 | 5 | 50 | 0.5 | A | 42.0 |
| Storage (Artifacts) - Inactive | 1000 | 0 | 60 | 0.25 | E | 6.5 |
| Storage (Artifacts) - Active | 100 | 1 | 60 | 0.25 | E | 7.5 |
| **Laundry** | | | | | | |
| Washing | 20 | 20 | 60 | 0.6 | C | 9.7 |
| Ironing and Sorting | 20 | 20 | 60 | 0.5 | C | 14.0 |
| **Multifamily Residential** | | | | | | |
| *Dwelling units* | 60 | 5 | 500 | 1.7 | G | 9 |

**NOTES: See Notes to Table 4.3.2.A.**

## Table 4.3.2.C.  Operating Schedule 'A'

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 4.3.2.C.  Operating Schedule 'B'

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 4.3.2.C.  Operating Schedule ‘C’

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 0 | 0.1 | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 0.05 | 0.05 | 0.5 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.6 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Receptacle** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 0.05 | 0.05 | 0.5 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.6 | 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 | Off | Off | On | On | On | On | On | On | On | On | On | On | Off | Off | Off | Off | Off | Off |
| **Cooling** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | Off | Off | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | Off | Off | Off | Off | Off | Off |
| **Heating** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 0.05 | 0.05 | 0.1 | 0.2 | 0.4 | 0.8 | 0.8 | 0.6 | 0.4 | 0.3 | 0.2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

## Table 4.3.2.C.  Operating Schedule ‘D’

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 4.3.2.C.  Operating Schedule 'E'

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 4.3.2.C.  Operating Schedule 'F'

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mon - Fri | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.7 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.5 | 0.5 | 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 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 |
| Sun | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mon - Fri | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.6 | 0.8 | 0.9 | 0.8 | 0.6 | 0.3 |
| Sat | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.6 | 0.7 | 0.7 | 0.7 | 0.6 | 0.3 |
| Sun | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.7 | 0.8 | 0.6 | 0.5 | 0.3 |
| **Receptacle** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mon - Fri | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.6 | 0.8 | 0.9 | 0.8 | 0.6 | 0.3 |
| Sat | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.6 | 0.7 | 0.7 | 0.7 | 0.6 | 0.3 |
| Sun | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.7 | 0.8 | 0.6 | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mon - Fri | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 | 0.4 | 0.6 | 0.9 | 0.7 | 0.5 | 0.5 | 0.4 | 0.5 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 |
| 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 4.3.2.C. Operating Schedule ‘G’

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 4.3.2.C. Operating Schedule ‘H’

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 4.3.2.C. Operating Schedule 'I'

| | 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mon - Fri | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.40 | 0.80 | 0.80 | 0.80 | 0.60 | 0.40 | 0.10 |
| Sat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0.10 | 0.10 | 0.40 | 0.60 | 0.80 | 0.60 | 0.40 | 0.20 | 0.40 | 0.80 | 0.80 | 0.60 | 0.40 | 0.10 |
| Sun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.20 | 0.40 | 0.80 | 0.80 | 0.40 | 0.20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Lighting** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 0.50 | 0.50 | 0.50 | 0.80 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.50 |
| Sat | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.50 | 0.50 | 0.50 | 0.80 | 0.90 | 0.90 | 0.90 | 0.80 | 0.60 | 0.80 | 0.90 | 0.90 | 0.90 | 0.90 | 0.50 |
| Sun | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.50 | 0.90 | 0.90 | 0.90 | 0.90 | 0.50 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Receptacle** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mon - Fri | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.20 | 0.20 | 0.20 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.10 |
| Sat | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.20 | 0.20 | 0.20 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.10 |
| Sun | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.20 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| **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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 |
| **Hot Water** | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 0.20 | 0.20 | 0.20 | 0.40 | 0.90 | 0.90 | 0.90 | 0.80 | 0.60 | 0.20 |
| Sat | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.20 | 0.20 | 0.20 | 0.40 | 0.80 | 0.90 | 0.80 | 0.60 | 0.40 | 0.40 | 0.90 | 0.90 | 0.80 | 0.60 | 0.20 |
| Sun | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.10 | 0.20 | 0.40 | 0.40 | 0.20 | 0.10 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

## 4.3.3. Exceptional Conditions

### 4.3.3.1. General

**1)** The compliance shell shall allow the optional inputs described in Subsection 4.3.3. only for *thermal blocks* that are “directly conditioned” and for which the space use is one of the *space function* categories from Table 4.3.2.B. (not “combined”).

**2)** When exceptional conditions are entered, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

### 4.3.3.2. Process Heat Gains

**1)** This is an optional input. The default value is no process heat gains.

**2)** If process heat is entered, the compliance shell shall accept input for:

a) values for maximum sensible and latent heat gain from the process; and
b) sufficient information to define the hourly variation of gains in the form of the schedules in Table 4.3.2.C.

**3)** If process heat is entered, the compliance shell shall replace the default with the input data.

### 4.3.3.3. Service Water

**1)** This is an optional input. The default value is determined by *space use classification* as described in Subsection 4.3.2.

**2)** If *service water* is entered, the compliance shell shall accept input for:

a) value for maximum *service water* heating load; and
b) sufficient information to define the hourly variation of load in the form of the schedules in Table 4.3.2.C.

**3)** If *service water* is entered, the compliance shell shall replace the default with the input data.

### 4.3.3.4. Minimum Outdoor Air

**1)** This is an optional input. The default value is determined by the *space use classification* as described in Subsection 4.3.2.

**2)** If minimum outdoor air flow rate is entered, the compliance shell shall accept input with the restriction that the value be no less than the default value.

**3)** If outdoor air flow rate is entered, the compliance shell shall replace the default with the input data.

#### 4.3.3.5. Space Temperature Schedule

**1)** This is an optional input. The default value is determined by the *space use classification* as described in Subsection 4.3.2.

**2)** If space temperature schedule is entered, the compliance shell shall accept input of sufficient information to define the hourly variation of space temperature, in the form given in Table 4.3.2.C.

**3)** If space temperature schedule is entered, the compliance shell shall replace the default with the input data.

#### 4.3.3.6. Lighting Area Factor

**1)** This is an optional input. The default value is 1.0.

This is an alternative to permitting input of the lighting power allowance, and is easier to check.

**2)** If lighting area factor is entered, the compliance shell shall accept a value with the restriction that it shall be not greater than 1.8.

This is used in defining the *reference case* (see Chapter 5).

### 4.3.4. Lighting

**1)** The compliance shell shall provide a means for the user to indicate that lighting is not specified in the *proposed design* (“lighting not specified”). The compliance shell shall permit this input only when the *space use classification* is by *building type*.

**2)** If the *space use classification* by *building type* is “multifamily residential,” the user shall be prompted to indicate that lighting is not specified in the *proposed design* (“lighting not specified”), in which case any other input shall be flagged in the report.

This rule is related to Sentence 4.2.3.2.(1) of the *Code*, which states that lighting within *dwelling units* is exempt from allowances and limits on *interior lighting* power.

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**This is an optional software capability:**

**3)** The compliance shell shall accept optional input to identify the lighting as “existing.”

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The *Code* provides for the option of modeling both existing and new components of an *addition* to an existing *building*. Some software may not offer this capability.

#### 4.3.4.1. Lighting of the Proposed Design

**1)** Except when input indicates “lighting not specified,” or when the *space function category* is “*dwelling unit*,” the compliance shell shall accept the following input:

- a) connected lighting power;
- b) type of light source, selected from either “incandescent” or “non-incandescent”;
- c) the location of lighting fixtures selected from:
  - i) suspended in the space;
  - ii) recessed into a ceiling that is not used as a return air *plenum*;
  - iii) recessed into a ceiling that is used as a return air *plenum*; or
  - iv) recessed into a ceiling that is used as a return air *plenum* and has return air ducted directly through the tube-space portion of the fixture to extract heat from the lights.
- d) if the location of lighting fixtures selected is (iv) above, then the compliance shell shall accept an additional input for the proportion of heat from lights that goes to return air.

**2)** If lighting data is input, then the compliance shell shall transfer data to the energy analysis module as follows:

- a) connected lighting power as input;
- b) data to allow the energy analysis module to assign the correct proportion of radiant and convective heat, depending on type of lighting (“incandescent” or “non-incandescent”) input;
- c) the fraction of heat from lights that goes to the space, according to input of location of fixtures as follows:
  - i) for lights suspended in the space, or recessed into a ceiling not used as a return air *plenum*, 100% to the space;
  - ii) for lights recessed into a ceiling used as a return air *plenum* – 85% to the space,15% to return air;
  - iii) for lights recessed into return air ducted directly through the fixture – the proportion of heat from lights going to return air as input.

**3)** If return air is ducted directly through the fixture, then the compliance shell shall generate a notice in the output report to alert the building official that this input was chosen and that supporting documentation may be required.

#### 4.3.4.2. Lighting Not Specified

**1)** If input is “lighting not specified,” then the compliance shell shall transfer the following data for the *thermal block* to the energy analysis module:

a) connected lighting power calculated as the product of floor area and lighting power density for the *space use classification* according to *building type* from Table 4.3.2.A.,

b) type of lighting as non-incandescent;

c) 100% of heat from lights to the space.

(i.e. fluorescent)

#### 4.3.4.3. Lighting Within *Dwelling Units*

**1)** If input to the *space function category* is “*dwelling unit*,” then the compliance shell shall transfer the following data for the *thermal block* to the energy analysis module:

a) connected lighting power calculated as the product of *dwelling unit* floor area and lighting power density for *dwelling units* according to Table 4.3.2.B;

b) type of lighting as incandescent;

c) 100% of heat from lights to the space.

This rule is related to Sentence 4.2.3.2.(1) of the *Code*, which states that lighting within *dwelling units* is exempt from allowances and limits on *interior lighting* power.

**2)** As an alternative to Sentence (1), input according to the procedure in Sentence 4.3.4.1.(1) is permitted, but the user shall be prompted to input the values specified in Sentence 4.3.4.3.(1) and any other input shall be flagged in the report.

### 4.3.5. Envelope Components

#### 4.3.5.1. Exterior Walls

**1)** For each wall of the *thermal block*, the compliance shell shall accept the following as required input with no default:

a) the orientation, specified as the azimuth and tilt of the surface, with the restriction that the tilt must be greater than 60° from horizontal;

b) the gross surface area of the wall, defined as the opaque wall area plus the areas of any windows and doors contained in the wall; and

c) the *overall thermal transmittance (U-value)* or, as an optional software capability, the wall construction defined in accordance with Sentence (5).

Requires gross wall plus windows and doors to be defined in order to be able to create *reference case* when FWR > 0.4.

**2)** For each wall of the *thermal block*, the compliance shell shall accept optional input to identify the wall as “*solid masonry*” from *Code* requirements.

**3)** For each wall of the *thermal block*, the compliance shell shall accept optional input to identify the wall as “above ground portion of *foundation* wall.”

The *Code* permits above ground portion less than 1.2 m above ground level to be insulated to below *grade* requirements.

**This is an optional software capability:**

**4)** The compliance shell shall accept optional input to identify the wall as “existing.”

The *Code* provides for the option of modeling both existing and new components of an *addition* to an existing building. Some software may not offer this capability.

**This is an optional software capability:**

**5)** The compliance shell shall accept input to define wall construction as a series of layers. For each layer, required input is the thickness and the material of the layer. The compliance shell shall permit materials to be input as either:

a) a selection from a list of those in Table 4, Thermal Properties of Typical Building and Insulating Materials – (Design Values), of Chapter 24 of the ASHRAE 1997 Handbook–Fundamentals, or

b) a material defined by user input specifying the density, specific heat and thermal conductivity. If a material is user defined, as in Clause (5)(b) above, then the compliance shell shall generate a notice in the output report to alert the building official that this input was entered and that supporting documentation may be required.

Sentences (5) and (6) are an optional software capability. Some software may not offer this capability.

Need to justify any super insulating materials.

**6)** When defining wall construction in accordance with Sentence (5), the compliance shell shall provide a means to define thermal bridging of material layers by framing members. When the input for a wall includes framing members, the compliance shell shall define the wall construction characteristics such that the *overall thermal transmittance (U-value)* used in performance analysis equals that calculated in accordance with Article 2.2.2.2. of the *Code,* and the thermal response of the wall accounts for the thermal mass of the framing members.

One way to do this is to make the layer have a density and specific heat that are the effective value of the insulating material plus the framing member, and a thermal resistance that makes the total *U-value* of the wall equal to that calculated in accordance with Article 2.2.2.2. of the *Code* (thermal bridging calculation). Another is to modify the coefficients in the numerator of the z-transfer function.

**7)** Except when a wall is "existing" or "*solid masonry*," the compliance shell shall restrict the input to prevent use in the analysis of any wall having a thermal transmittance greater than 167% of that permitted in Appendix A of the *Code*, according to the *principal heating source* and administrative region in which the *proposed design* is to be constructed.

**8)** The compliance shell shall accept as an optional input the absorptance of the exterior surface of the wall, restricted to a value between 0.2 and 0.9. The default is 0.7. If a value is input for absorptance, then the compliance shell shall generate a notice in the output report to alert the building official that this input was chosen and that supporting documentation may be required.

This is the same for both the *proposed design* and the *reference case* and therefore won't be a substantial credit.

**9)** The compliance shell shall calculate the opaque wall area by subtracting the areas of windows and doors contained in the wall from the gross area.

**10)** Except when a wall is "existing," if the wall *U-value* was specified as input, then the compliance shell shall generate data to describe the wall as having the construction given in Table 5.3.5.A. adjusted to have an *overall thermal transmittance* equal to the input *U-value*.

**11)** If input for wall construction was entered in accordance with Sentence (5), then the compliance shell shall ensure that the input is accurately converted to the form used by the energy analysis module to calculate the dynamic thermal response characteristics (transfer functions) used in the performance analysis.

### 4.3.5.2. Roofs

**1)** For each roof, the compliance shell shall accept the following as required input with no default:

a) the orientation, specified as the azimuth and tilt of the surface, with the restriction that tilt must be between 0 and 60° from horizontal;

b) the gross surface area of the roof, defined as the opaque roof area plus the areas of any *skylights* contained in the roof;

c) the *overall thermal transmittance (U-value)* or, as an optional software capability, the roof construction defined in accordance with Sentence (3).

Requires gross roof plus *skylights* to be defined in order to be able to create the *reference case* when FWR > 0.4.

**2)** For each roof, the compliance shell shall:

a) accept as required input with no default, the roof type classification, restricted to a selection from the roof types given in Table 3.3.1.1.A. of the *Code*; or

Type of roof (e.g. *attic*, built up, or other) is needed to determine the value for the *reference case*.

**This is an optional software capability:**

b) accept optional input to identify the roof as "existing."

The *Code* provides for the option of modeling both existing and new components of an *addition* to an existing *building*. Some software may not offer this capability.

**This is an optional software capability:**

Sentences (3) and (4) are an optional software capability.

**3)** The compliance shell shall accept input to define roof construction as a series of layers. For each layer, required input is the thickness and the material of the layer. The compliance shell shall permit materials to be input as either:

a) a selection from a list of those in Table 11, Thermal Properties and Code Numbers of Layers Used in Wall and Roof Descriptions for Tables 12 and 13, of Chapter 26 of the ASHRAE 1993 Handbook–Fundamentals, or

b) a material defined by user input of the density, specific heat and thermal conductivity.

If a material is user-defined, as in (3)(b) above, then the compliance shell shall generate a notice in the output report to alert the building official that this input was entered and that supporting documentation may be required.

Need to justify any super insulating materials.

**4)** When defining roof construction in accordance with Sentence (3), the compliance shell shall provide a means to define thermal bridging of material layers by framing members. When the input for a roof includes framing members, the compliance shell shall define the roof construction characteristics such that the *overall thermal transmittance* (*U-value)* used in the performance analysis equals that calculated in accordance with Article 2.2.2.2. of the *Code,* and the thermal response of the roof accounts for the thermal mass of the framing members.

One way to do it is to make the layer have a density and specific heat that are the effective value of the insulating material plus the framing member, and a thermal resistance that makes the total *U-value* of the roof equal to that calculated in accordance with Article 2.2.2.2. of the *Code* (thermal bridging calculation).

Another is to modify the coeficients in the numerator of the z-transfer function.

**5)** Except when a roof is "existing," the compliance shell shall restrict the input to prevent use in the analysis of any roof having a thermal transmittance greater than 167% of that permitted in Table 3.3.1.1.A. of the *Code* for that roof type, according to the *principal heating source* and administrative region in which the *proposed design* is to be constructed.

**6)** Except when the roof type is "*attic*," the compliance shell shall accept as an optional input the absorptance of the exterior surface of the roof, restricted to a value between 0.2 and 0.9. The default is 0.7. If a value is input for absorptance the compliance shell shall include a message in the output report to alert the building official.

This is the same for both the *proposed design* and the *reference case*.

If the roof type is "*attic*," the compliance shell shall set the absorptance of the exterior surface of the roof to 0.0.

**7)** The compliance shell shall accept an optional input to indicate that the space beneath the roof is a return air *plenum*. The default is to consider the heat transfer through the roof to be to the room space. When input for a return air *plenum* is provided, the compliance shell shall generate data to ensure that the energy analysis module simulates the *plenum* as follows:

a) all return air from the space (*thermal block*) passes through the *plenum*;
b) the heat from lights that does not go to the space (see Article 4.3.4.2.) is added to the air in the *plenum*;
c) roof transmission gain/loss is to the *plenum*;
d) heat transfer between the space and the *plenum* is through a surface having an area equal to the roof area and a thermal transmittance of 1.8 $W/m^2$•°K.

Using this option would generally permit reducing insulation in the roof.

**8)** The compliance shell shall calculate the opaque roof area by subtracting the areas of *skylights* contained in the roof.

**9)** If the roof *U-value* was specified as input, then the compliance shell shall generate data to describe the roof as having the construction given in Table 5.3.5.B., according to the roof type and adjusted to have an *overall thermal transmittance* equal to the input *U-value*.

**10)** If input for roof construction was entered in accordance with Sentence (3), then the compliance shell shall ensure that the input is accurately converted to the form used by the energy analysis module to calculate the dynamic thermal response characteristics (transfer functions) used in the performance analysis.

### 4.3.5.3. Exposed Floors:

**1)** For each exposed floor, the compliance shell shall accept the following as required input with no default:

a) the surface area of the floor;

b) the *overall thermal transmittance (U-value)* or, as an optional software capability, the floor construction, defined in accordance with Sentence (3).

**2)** For each floor, the compliance shell shall either:

a) accept as required input with no default, the floor type classification, restricted to a selection from the floor types given in Table 3.3.1.1.A. of the *Code*; or

b) if optional software capability associated with modeling *additions* is offered, then accept optional input to identify the floor as "existing."

Type of floor (e.g. joist, truss, or other) is needed to determine the value for the *reference case*.

The *Code* provides for the option of modeling both existing and new components of an *addition* to an existing *building*.

**This is an optional software capability:**

Sentences (3) and (4) are an optional software capability.

**3)** The compliance shell shall accept input to define floor construction as a series of layers. For each layer the required input is the thickness and the material of the layer. The compliance shell shall permit materials to be input as either:

a) a selection from a list of those in Table 11, Thermal Properties and Code Numbers of Layers Used in Wall and Roof Descriptions for Tables 12 and 13, of Chapter 26 of the ASHRAE 1993 Handbook–Fundamentals, or

b) a material defined by user input of the density, specific heat and thermal conductivity.

If a material is user defined as in (3)(b) above, then the compliance shell shall generate a notice in the output report to alert the building official that this input was entered and that supporting documentation may be required.

**4)** When defining floor construction in accordance with Sentence (3), the compliance shell shall provide a means to define thermal bridging of material layers by framing members. When the input for a floor includes framing members, the compliance shell shall define the floor construction characteristics such that the *overall thermal transmittance (U-value)* used in performance analysis equals that calculated in accordance with Article 2.2.2.2. of the *Code* and the thermal response of the floor accounts for the thermal mass of the framing members.

One way to do it is to make the layer have a density and specific heat that are the effective value of the insulating material plus the framing member, and a thermal resistance that makes the total *U-value* of the floor equal to that calculated in accordance with Article 2.2.2.2. of the *Code* (thermal bridging calculation).

Another is to modify the coefficients in the numerator of the z-transfer function

**5)** Except when a floor is "existing," the compliance shell shall restrict the input from Sentences (3) and (4) to prevent use in the analysis of any floor having a thermal transmittance greater than 167% of that permitted in Table 3.3.1.1.A of the *Code* for that floor type, according to the *principal heating source* and administrative region in which the *proposed design* is to be constructed.

**6)** The absorptance of the exterior surface of the floor is fixed at a value of 0. No input shall be permitted.

**7)** If the floor *U-value* was specified as input, then the compliance shell shall generate data to describe the floor as having the construction given in Table 5.3.5.C. according to the floor type and adjusted to have an *overall thermal transmittance* equal to the input *U-value*.

**8)** If input for floor construction was entered in accordance with Sentence (3), then the compliance shell shall ensure that the input is accurately converted to the form used by the energy analysis module to calculate the dynamic thermal response characteristics (transfer functions) used in the performance analysis.

### 4.3.5.4. Doors

**1)** The compliance shell shall accept optional input for doors. The default is no doors.

**2)** If input for a door is chosen, then the compliance shell shall require the following input for that door:

a) the wall in which the door is contained;
b) the area of the door; and
c) the *overall thermal transmittance (U-value)* of the door.

Orientation of the door is the same as that of the wall in which it is contained.

### 4.3.5.5. Windows

**1)** For each window, the compliance shell shall accept the following as required input with no default:

a) the wall in which the window is contained;
b) the area of the window;
c) the *overall thermal transmittance (U-value)*; and
d) the solar heat gain coefficient (SHGC).

Orientation of the window is the same as that of the wall in which it is contained.

**2)** For each window, the compliance shell shall:

a) accept as required input with no default, the window type classification, selected as either “fixed window” or “operable window” (see Table 3.3.1.B. of the *Code*), or “glass block”;

b) accept optional input to identify the window as “exempted” from *Code* requirements; or

Some *fenestration*, e.g. glass doors, is exempted from *Code* requirements.

**This is an optional software capability:**

c) if optional software capability associated with modeling *additions* is offered, then accept optional input to identify the window as “existing.”

The *Code* provides for the option of modeling both existing and new components of an *addition* to an existing *building*. Some software may not have this capability.

**3)** The compliance shell shall accept optional input to define shading by exterior shading devices such as by overhangs and side fins. The default is no shading. If input for such shading is provided, then the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

Note that the energy analysis module must have the capability of modeling shading devices.

The *reference case* has no shading, so this becomes a potential credit.

**4)** The compliance shell shall transfer the data input for windows to the energy analysis module, with the following adjustments:

a) if the energy analysis module uses SHGC in calculations, then transfer an adjusted value as follows:

$$SHGC_{adjusted} = 0.8 \bullet SHGC;$$

Factor of 0.8 is to account for incidental shading.

b) if the energy analysis module uses shading coefficient (SC) in calculations, then transfer an adjusted value as follows:

$$SC = SHGC \bullet 0.8 \bullet 1.15.$$

Factor of 1.15 is to convert SHGC to SC.

**This is an optional software capability:**

**5)** The compliance shell shall accept optional input to define shading of a window by other parts of the proposed *building*, or by *buildings* or structures that are not part of the *proposed design*.

The default is no shading from such objects. The input shall be consistent with the capabilities of the energy analysis module.

If such shading is input, then the compliance shell shall transfer the data to the energy analysis module and shall include a message in the output report to alert the building official that supporting documentation may be required.

This is different from Sentence (2) above. It will be modeled the same in both the *proposed design* and the *reference case*.

### 4.3.5.6. Skylights

**1)** For each *skylight*, the compliance shell shall accept the following as required input with no default:

a) the roof in which the *skylight* is contained;

b) the surface area;

c) the *overall thermal transmittance (U-value)*; and

d) the solar heat gain coefficient (SHGC).

Orientation of the *skylight* is the same as that of the roof in which it is contained.

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**This is an optional software capability:**

**2)** The compliance shell shall accept optional input to identify the *skylight* as "existing."

The *Code* provides for the option of modeling both existing and new components of an *addition* to an existing building.

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**3)** The compliance shell shall accept optional input to define shading by exterior shading devices (such as by overhangs and side fins) or by other parts of the *building*. The default is no shading. If such shading is input, then the compliance shell shall include a message in the output report to alert the building official.

Note that a precondition of this option is that the energy analysis module must have the capability. Some cannot handle shading on a horizontal or tilted surface.

The *reference case* has no shading, so this becomes a potential credit or penalty.

**4)** The compliance shell shall transfer the data input for *skylights* to the energy analysis module, with the following adjustments:

a) if the energy analysis module uses SHGC in calculations, then transfer an adjusted value as follows:

$SHGC_{adjusted} = 0.8 \bullet SHGC$;

b) if the energy analysis module uses shading coefficient (SC) in calculations, then transfer an adjusted value as follows:

$SC = SHGC \bullet 0.8 \bullet 1.15$.

Factor of 0.8 is to account for incidental shading.

Factor of 1.15 is to convert SHGC to SC.

---

**This is an optional software capability:**

5) The compliance shell shall accept optional input to define shading of a *skylight* by *buildings* or structures that are not part of the *proposed design*. The default is no shading from such objects. The input shall be consistent with the capabilities of the energy analysis module.

If input is provided for such shading, then the compliance shell shall transfer the data to the energy analysis module and shall include a message in the output report to alert the building official.

Note that the energy analysis module must have the capability.

This is different from Sentence (2) above. It will be modeled the same in both the *proposed design* and the *reference case.*

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### 4.3.5.7. Walls in Contact with the Ground

**1)** The compliance shell shall accept optional input to define area and depth with respect to ground level for each wall in contact with the ground. No input shall be permitted for thermal properties.

**2)** If input is entered, then the compliance shell shall:

a) assign to each wall in contact with the ground the thermal insulation required by Table 3.2.3.1. of the *Code* according to the *principal heating source* and administrative region; and

b) transfer the data to the energy analysis module.

### 4.3.5.8. Floors in Contact with the Ground

**1)** The compliance shell shall accept optional input to define area and depth with respect to ground level for each floor in contact with the ground. No input shall be permitted for thermal properties.

**2)** If input is entered, then the compliance shell shall:

a) assign to each floor on ground the thermal insulation required by Table 3.2.3.1. of the *Code* according to the input for *principal heating source* and administrative region; and

b) transfer the data to the energy analysis module.

If the *Code* has no requirement for insulation, then model as uninsulated floor on ground.

### 4.3.5.9. Air Leakage (Infiltration)

**1)** The compliance shell shall transfer data to the energy analysis module so that the analysis for each *thermal block* of the *proposed design* that contains exterior walls is performed with air leakage (infiltration) set to a constant value of 0.25 L/S per $m^2$ (0.05 $cfm/ft^2$) of gross wall area.

Air leakage corresponds to the HVAC accepted term “infiltration.”

## 4.3.6. Thermal Mass

**1)** The compliance shell shall accept optional input of thermal mass or thermal response characteristics for each *thermal block*. Input data must be consistent with the capabilities of the energy analysis module.

**2)** If no input is entered, then the compliance shell shall transfer to the energy analysis module, input that defines the thermal response characteristics of the *thermal block* as the equivalent of “medium weight” construction (see Tables 25 and 26 of Chapter 26 of the ASHRAE 1993 Handbook–Fundamentals)

**3)** If input is entered, then the compliance shell shall:

a) transfer to the energy analysis module the input to define thermal response; and
b) print a message to this effect in the output report to alert the building official.

## 4.3.7. Heat Transfer Between Thermal Blocks

**1)** The ability to define heat transfer between *thermal blocks* is an optional software capability.

**2)** If this optional capability is not offered, then the compliance shell shall:

a) prevent input of “indirectly conditioned” *thermal blocks* (see Article 4.3.1.3.); and
b) prevent input of exceptional conditions for space temperature schedule (see Article 4.3.3.5.).

**3)** If this optional capability is offered and a *thermal block* is “indirectly conditioned,” then the compliance shell shall ensure that there is input for interzone heat transfer between that *thermal block* and at least one adjacent *thermal block*.

**4)** If this optional capability is offered, then the compliance shell shall accept input as provided in Sentences (5) and (6).

**This is an optional software capability:**

**5)** For each *partition* that separates a *thermal block* from an adjacent *thermal block* the compliance shell shall accept the following input:

a) the identity of the adjacent *thermal block;*

b) the area of the *partition* wall; and

c) the construction of the *partition* wall as described for exterior walls in Article 4.3.5.1.

**6)** For heat transfer between a *thermal block* and adjacent *thermal blocks* that are not separated by *partitions*, the compliance shell shall accept the following input:

a) the identity of adjacent *thermal blocks;*

b) the area of the bounding plane separating the *thermal blocks;* and

c) the equivalent heat transfer coefficient, which is restricted to a value between 0.0 and 0.35 W/m$^2$·°K (2.0 btuh/ft$^2$·°F) and has a default of 0.35.

This refers to open plan layouts in which a perimeter and interior are arbitrarily defined but there is no actual wall.

**7)** If input is provided for interzone heat transfer, then the compliance shell shall transfer the data to the energy analysis module and shall include a message in the output report to alert the building official.

# 4.4. Modeling Energy Systems – General

## 4.4.1 General

### 4.4.1.1. Scope

**1)** This Section contains general requirements for modeling mechanical systems of the *proposed design*. It is to be used in conjunction with Sections 4.5., 4.6., and 4.7.

**2)** Input processing for *terminal characteristics* shall comply with the provisions of Section 4.5.

*Terminal characteristics* are defined as those features and parameters that pertain only to the *thermal block* served, and are not included in the definition of the *secondary system*.

**3)** Input processing for *secondary systems* shall comply with the provisions of Section 4.6.

*Secondary system* is defined as the system that provides air for ventilation (as well as distribution of heating and cooling) to the *thermal block* (i.e. fan system). *Secondary systems* may include equipment, dedicated to the system, that converts electricity or fuel to heating or cooling. *Secondary system*s may be “single zone” (serving only a single *thermal block*), or multiple zone (serving one or more *thermal blocks*).

**4)** Input processing for *primary systems* shall comply with the provisions of Section 4.7.

*Primary system* is defined as the system that consists of the equipment to convert electricity or fuel to heating or cooling and distribute it to one or more *secondary system*s, where such equipment is not already defined as part of the *secondary system* (i.e. *boilers* and chillers).

**5)** The compliance shell shall set up the required linkages between HVAC *terminal characteristics* (see Section 4.5.), *secondary systems* (see Section 4.6.), and *primary systems* (see Section 4.7.) so that the energy analysis module can properly simulate the *proposed design*.

#### 4.4.1.2. Required Capabilities

**1)** The compliance software shall be capable of modeling the HVAC systems listed in Table 4.4.1.A. It is not necessary that these systems be explicitly identified as such, but it must be possible, using the input features provided, to define a model that is a good (thermal energy) representation of the system.

**2)** Unless otherwise stated, all features described in Sections 4.5., 4.6., and 4.7. that are applicable to the HVAC system in the *proposed design* are required capabilities.

#### 4.4.1.3. Optional Capabilities

**1)** Features identified as being optional capabilities need not be included in the compliance software. Compliance software may incorporate these features provided that all of the relevant requirements of Sections 4.5., 4.6., and 4.7. are satisfied.

#### 4.4.1.4. Capabilities Not Permitted

**1)** Features and systems that are not defined in this document, or in an addendum or interpretation issued by the CCBFC, as either required or optional capabilities are not permitted in compliance software.

Some systems and features have been identified as capabilities that are not to be simulated for performance analysis; a notable example is operating strategies that cannot be verified at the time of building permit. Other systems and features have not yet been defined.

### 4.4.2 Thermal Block Heating/Cooling Loads

**1)** The compliance shell shall, either directly or by utilizing the loads calculation capability of the energy analysis module, calculate design peak heating and cooling loads for each *thermal block* of the *proposed design*, in accordance with good engineering practice, as defined in Article 6.2.1.1. of the National Building Code of Canada 1995. These calculations and those in Subsection 5.4.2. of this document shall use the same procedures and climate data.

# Table 4.4.1.A. Systems Modeling Capability

| |
|---|
| **Heating Only** (1) |
| Ventilation + electric resistance heat (2) |
| Ventilation + hydronic heating (3) |
| Ventilation + fuel fired *furnace* (4) |
| **Single Zone** |
| Air conditioner + electric resistance heat (2) (5) |
| Air conditioner + hydronic heating (3) (5) |
| Air conditioner + fuel fired *furnace* (4) (5) |
| “Built-up” single zone (constant volume-variable temperature with hydronic cooling) (6) (7) |
| **Multiple Zone** |
| VAV with or without reheat (8) (9) (10) |
| Constant volume reheat (8) (9) (10) |
| Multizone or dual duct (constant volume) (8) (9) (10) |
| Multizone or dual duct (variable volume) (8) (9) (10) **Note: This is an optional software capability.** |
| 2-pipe fan coil or induction (6) (9) (10) |
| 4-pipe fan coil or induction (6) (9) (10) |
| **Heat Pump** |
| Single zone air-to-air heat pump |
| Water– loop (unitary) heat pump (11) |
| Ground source heat pump **Note: This is an optional software capability.** |

**Notes:**

(1) Any system may be “heating only” by setting cooling capacity to zero.

(2) Electric heater may be contained in the *secondary system* unit or be a terminal device in the supply air (e.g. duct heater) or located in space (e.g. baseboard heater, radiant panels).

(3) Hydronic heater may be contained in *secondary system* unit or be a terminal device in the supply air (e.g. reheat coil) or located in space (e.g. convector, *unit heater*, or radiant panels).

(4) *Furnace* may be part of *secondary system* package or separate unit.

(5) Air conditioner may be part of *secondary system* package or separate unit.

(6) Chilled water for cooling may be from reciprocating or centrifugal chiller.

(7) Heating may be electric or hydronic, and may be contained in the *secondary system* unit or be a terminal device in the supply air (e.g. duct heater) or located in space (e.g. baseboard heater, convector, etc.).

(8) Cooling may be DX package unit, or by chilled water from reciprocating or centrifugal chiller.

(9) Heating may be divided into preheat and heating coils and may be electric, hydronic or by a *furnace*.

(10) Reheat may be located in a duct or in a space, and may be electric, hydronic or by a *furnace*.

(11) Water loop includes equipment to reject heat from the loop (e.g. condenser or cooling tower) and to provide supplemental heat (e.g. *boiler*).

### 4.4.3. Air Flow Rates

**1)** The compliance shell shall determine the calculated design air flow rate for each *thermal block* of the *proposed design*, calculated as the larger of:

a) the minimum outdoor airflow requirement;
b) the design air flow rate for heating, calculated assuming a supply air temperature of 43°C (110°F);
c) if the *thermal block* is "cooled" (see Subsection 4.4.10.), then the design air flow rate for cooling, calculated assuming a supply air temperature of 13°C (55°F).

**2)** The compliance shell shall determine the calculated design air flow rate for each *secondary system*, equal to the sum of the calculated air flow rates for the *thermal blocks* served by the system, as determined from Sentence (1).

**3)** For each *secondary system*, the compliance shell shall determine the air flow sizing factor $R_F$ as follows, except that $R_F$ shall not be greater than 1.3:

$$R_F = (PDAF + 0.0745 \bullet TSC) / CDAF$$

Assumes 12°C temperature rise.

where

PDAF = the *proposed design* air flow rate (L/s) for the *secondary system* (see Subsection 4.6.4.);
TSC = the sum of secondary cooling capacities (W) for *thermal blocks* served by *secondary system* (see Subsection 4.5.3.);
CDAF = calculated design air flow rate for *secondary system* from Sentence (2).

**4)** The air flow sizing factor $R_F$ for each *thermal block* is equal to the value of $R_F$ for the *secondary system* by which it is served.

### 4.4.4. System and Equipment Heating/Cooling Loads

**1)** The compliance shell shall calculate the peak heating and cooling loads for each *secondary system* and for each *primary system* (heating and cooling equipment) of the *proposed design*, in accordance with good engineering practice using the system air flow rates determined in Subsection 4.4.3. and taking into account ventilation air, reheat requirements, and temperature rise from fans.

Must be the same as used for the *reference case* in Chapter 5.

### 4.4.5. Heading Sizing Factor

**1)** The compliance shell shall determine the heating sizing factor $R_H$ for each primary heating system from the ratio of the heating capacity of the *primary system* for the *proposed design* divided by the heating load for the *primary system* as calculated in Subsection 4.4.4.:

a) if ratio is greater than 1.3, then $R_H = 1.3$;
b) otherwise, $R_H$ = ratio.

$R_H$ can not be less than 1. If so, this is an error. See Subsection 4.4.9.

**2)** The compliance shell shall determine the heating sizing factor $R_H$ for each secondary heating system as the smaller of:

a) the heating sizing factor for the primary heating system serving the *secondary system*, or
b) the factor determined from the ratio of the heating capacity of the *secondary system* for the *proposed design* divided by the heating load for the *secondary system* as calculated in Subsection 4.4.4.:
    i) if ratio is greater than 1.3, then $R_H = 1.3$;
    ii) otherwise, $R_H$ = ratio.

$R_H$ can not be less than 1. If so, this is an error. See Subsection 4.4.9.

### 4.4.6. Cooling Sizing Factor

**1)** The compliance shell shall determine the cooling sizing factor $R_C$ for each primary cooling system from the ratio of the cooling capacity of the *primary system* for the *proposed design* divided by the cooling load for the *primary system* as calculated in Subsection 4.4.4.:

a) if ratio is greater than 1.3, then $R_C = 1.3$;
b) otherwise, $R_C$ = ratio.

Unlike for heating, the value of $R_C$ can be less that 1.

**2)** The compliance shell shall determine the cooling sizing factor $R_C$ for each secondary cooling system as the smaller of:

a) the cooling sizing factor for the primary cooling system serving the *secondary system*, or
b) the factor determined from the ratio of the cooling capacity of the *secondary system* for the *proposed design* divided by the cooling load for the *secondary system* as calculated in Subsection 4.4.4.:
    i) if ratio is greater than 1.3, then $R_H = 1.3$;
    ii) otherwise, $R_H$ = ratio.

The reason for doing this is because of a limitation in most of the energy programs, which model the *secondary system* with no feedback from the *primary system*. The room therefore does not know that the chiller can't supply the cooling. This gives "loads not met errors" with an incorrect answer. This can not be permitted. By undersizing the *secondary system* cooling capacity, the program is able to undercool the space and calculate the corresponding deviation in space temperature. Note that it is a requirement that the energy analysis module have this capability.

### 4.4.7. Makeup Air Check

**1)** The compliance shell shall check whether the sum of all exhaust air flows specified for *thermal blocks* of the *proposed design* (see Subsection 4.5.6.) exceeds the sum of minimum outdoor air flow rates for all *secondary systems* of the *proposed design* (see Articles 4.3.2.1., 4.3.2.2., and 4.3.3.4.). If it does, then the compliance shell shall issue an error message and shall not perform the compliance analysis.

The message will inform the user that either the exhaust needs to be decreased, or exceptional conditions for outdoor air requirement (see Subsection 4.3.4.) be defined to increase the outdoor air requirement in appropriate *thermal blocks*.

### 4.4.8. Indirectly Conditioned Thermal Blocks

**1)** The compliance shell shall ensure that when a *thermal block* is specified as “indirectly conditioned” (see Article 4.3.1.3.), input is not permitted for terminal heating or cooling (see Subsections 4.5.2. and 4.5.3.), and the *thermal block* is not served by a *secondary system*. In this circumstance, the compliance shell shall issue an error message and shall not perform the compliance analysis.

### 4.4.9. Heating Capacity Check

**1)** The compliance shell shall check the heating capacity of primary and *secondary systems* for the *proposed design* against the peak loads calculated in Subsection 4.4.4. The performance analysis shall not proceed if any of the heating systems or equipment are undersized. The compliance shell shall either automatically resize the undersized equipment to meet the load and issue a warning message that this has occurred, or shall treat as an error condition and not perform the analysis.

**2)** The compliance shell shall check the results of the simulation by the energy analysis module to ensure that the heating temperature for each *thermal block* was maintained as defined in the heating schedule for the *thermal block*. If the temperature was not maintained, then the compliance shell shall issue an error message and shall not issue a compliance analysis report.

This check is performed by examining the results from the energy analysis module. This is necessary to be sure that there was not, for example, an outdoor reset schedule that would not heat the space.

### 4.4.10. Cooling Capacity Check

**1)** The compliance shell shall check input of the *proposed design* to determine whether each *thermal block* is "cooled" or "not cooled":

a) if a *thermal block* is served by a *secondary system* that has the capacity to provide mechanical cooling, or contains terminal cooling/recooling devices (see Subsection 4.5.3.), then the *thermal block* is "cooled";

b) otherwise, the *thermal block* is "not cooled."

Used in calculating sizing factors.

**2)** The compliance shell shall check the results of the simulation by the energy analysis module to determine if the cooling temperature for each *thermal block* was maintained as defined in the cooling schedule for the *thermal block*. If the temperature was not maintained, then the compliance shell shall issue an warning message in the output report to inform the building official that the *building* is not fully cooled.

This check is performed by examining the results from the energy analysis module. It is permissible to have partial cooling, but this is just to be sure that it is intended. (Does the owner know?)

### 4.4.11. Heating Energy Sources

**1)** The compliance shell shall determine, from the input for terminal heating/reheating in *thermal blocks* (see Subsection 4.5.2.), *secondary systems*, and *primary systems*, which of the heating energy sources listed in Appendix D of the *Code* are used in the *proposed design*, and the total heating capacity of each source.

**2)** For each *secondary system*, the compliance shell shall determine which heating energy sources are used in either the *secondary system* heating or in the terminal heating/reheating for the *thermal blocks* served by the system.

Used to determine the energy source for the *reference case*.

# 4.5. HVAC Terminal Characteristics

## 4.5.1. Scope

**1)** This Section deals with input for those parts of secondary (HVAC) systems that serve only the *thermal block* with which they are associated, and are not accounted for in the *secondary system* description (see Section 4.6.).

**2)** All devices that supply heating or cooling, or control the distribution of air from the central air handler to each *thermal block,* must be accounted for.

If the *thermal block* is served by a single zone system e.g. unitary air-conditioning) it may not be necessary to specify any *terminal characteristics* here; the system description (see Section 4.6.) must then completely define the heating/cooling controlled by the room thermostat.

Normally this Section would not apply to single zone systems. Even single zone systems serving only a single *thermal block* would normally be described in Section 4.6.

## 4.5.2. Terminal Heating/Reheating Devices

### 4.5.2.1. Electric Resistance Heating

**1)** The compliance shell shall provide a means of indicating the presence of electric resistance heating for each *thermal block*. The default is no electric resistance (heating or capacity equals zero).

**2)** If there is electric resistance heat, then the compliance shell shall accept input for heating capacity.

May be either single zone, or multiple zone system.

### 4.5.2.2. Hydronic Heating

**1)** The compliance shell shall provide a means of indicating the presence of hydronic heating for each *thermal block*. The default is no hydronic heating (or capacity equals zero).

May be either single zone, or multiple zone system.

**2)** If there is hydronic heating, then the compliance shell shall accept input to describe the heating, including:

a) total heating capacity;
b) identification of the primary heating system (*boiler*) that serves this heating.

**3)** The compliance shell shall not permit control of terminal heating as a reset schedule that varies the heating output at any hour as a function of outdoor temperature for that hour (rather than controlled by space thermostat) to be used for compliance analysis.

Control of space heating by outdoor reset is not permitted by the mandatory provisions of the *Code*.

**4)** The compliance shell shall ensure that the hydronic heating is assigned to the designated primary heating system.

## 4.5.3. Terminal Cooling/Recooling Devices

**1)** The compliance shell shall provide a means of indicating the presence of terminal cooling for each *thermal block*. The default is no terminal cooling (or capacity equals zero).

Applicable to multiple zone systems only.

Note: not intended for packaged air-conditioning, which would be considered single zone A/H system and described under *secondary system*s, Section 4.6.

**2)** If there is input for terminal cooling, then the compliance shell shall accept input to describe the cooling, including:

a) total cooling capacity;
b) identification of the primary cooling system (chilled water) that serves the elements.

**3)** The compliance shell shall ensure that the terminal cooling is assigned to the designated primary cooling system.

## 4.5.4. Terminal Air Delivery

**1)** If a *thermal block* is served by a single zone *secondary system*, then the compliance shell shall not provide for any input for terminal air delivery rate.

Applicable to multiple zone systems only; air delivery rate for single zone system is given in Subsection 4.6.5.

**2)** If a *thermal block* is served by a multiple zone *secondary system* and air from a central air handler is supplied to the *thermal block* by a variable air volume terminal device (VAV box), then the compliance shell shall accept input for:

a) maximum airflow rate, l/s;
b) minimum airflow rate, l/s;
c) identification of the *secondary system* serving the *thermal block*.

**3)** If a *thermal block* is served by a multiple zone *secondary system* and the total air flow rate supplied to the *thermal block* from a central air handler remains constant, then the compliance shell shall accept input for:

a) total airflow rate to *thermal block*;
b) identification of *secondary system* that serves the *thermal block*.

This applies to all constant volume multiple zone systems (i.e.both single duct and dual duct).

**This is an optional software capability:**

**4)** If a *thermal block* is served by a multiple zone *secondary system* and hot and cold air from a central air handler are mixed and supplied to the *thermal block* and the total air flow rate varies (i.e. variable volume - dual duct mixing box), then the compliance shell shall accept input for:

a) maximum hot deck airflow rate;
b) minimum airflow rate when 100% hot deck air;
c) maximum cold deck airflow rate
d) minimum airflow rate when 100% cold deck air;
e) identification of *secondary system* that serves the *thermal block*.

**5)** The compliance shell shall permit input for dual duct-variable volume terminal unit only if the energy analysis module has the optional capability of modeling dual duct variable air volume systems.

**6)** If there is input for a variable air volume terminal unit as described in Sentences (2) or (4), then the compliance shell shall calculate total air flow rate under minimum flow conditions. If this rate is less than 2 L/s per $m^2$ of floor area (0.4 cfm/$ft^2$), then the compliance shell shall generate a warning notice to this effect in the output report.

The *reference case* assumes a minimum of 2 L/s/$m^2$ (0.4 cfm/$ft^2$). The *proposed design* can be lower if, for example, fan powered boxes are used. However, the designer may have to justify that the design is good practice, and that they are not simply specifying a low flow rate to try to decrease the simulated energy consumption.

## 4.5.5. Terminal Fan Systems

**1)** The compliance shell shall provide a means of indicating the presence of terminal fans for each *thermal block*. The default is no terminal fans.

Units that deliver outdoor air (e.g. unit ventilator) must be defined as *secondary systems*.

**2)** If there is input for terminal fans, then the compliance shell shall accept input to describe the fans, consistent with the capabilities of the energy analysis module, including:

a) rated fan power, w;
b) method of fan control, selected from
    i) always on,
    ii) according to the operation schedule determined by *space use classification*,
    iii) cycle with demand for heating or cooling,
    iv) controlled to maintain minimum flow in a VAV (parallel) box, subject to either (i) or (ii).

### 4.5.6. Thermal Block Exhaust

**1)** The compliance shell shall provide a means of indicating the presence of exhaust system associated with each *thermal block*. The default is no exhaust fan.

**2)** If there is input for *thermal block* exhaust, then the compliance shell shall accept input to describe the exhaust, consistent with the capabilities of the energy analysis module, including:

a) exhaust air flow, L/s;
b) rated exhaust fan power, kw.

The operation of the exhaust fan shall be according to the fan operation schedule for the *secondary system* that serves the *thermal block*.

### 4.5.7. Space Temperature Control

**1)** The compliance shell shall ensure that the space temperature schedule determined in Article 4.3.3.5. is used for thermostatically controlled terminal devices.

**2)** The compliance shell shall set the room throttling range to no greater than 1°C. This shall be the same for modeling both the *proposed design* and the *reference case*.

## 4.6. Secondary (Air Handling) Systems

### 4.6.1. Scope

**1)** This Section deals with those parts of the HVAC system that provide conditioned air to one or more *thermal blocks*. The outdoor air required by all *thermal blocks* supplied by each *secondary system* will be included in the conditioned air flow.

**2)** This Section is to be used with Sections 4.5. (HVAC *Terminal Characteristics*) and 4.7. (*Primary System*s and Equipment) to completely describe the HVAC system for the *proposed design*.

### 4.6.2. System Identification and Type

**1)** The compliance shell shall accept input of an identifier for the *secondary system* and shall ensure that this identifier is unique.

**2)** The compliance shell shall accept input for either "single zone" or "multiple zone." If input is "single zone," then the compliance shell shall ensure that the *secondary system* serves only one *thermal block*. If input is "multiple zone," then the compliance shell shall ensure that the *secondary system* serves one or more *thermal blocks*. Failure of these tests shall result in an error message and the performance analysis will not be run.

**3)** The compliance shell shall accept input of appropriate generic systems types (e.g. dual duct) to facilitate input of system parameters consistent with the capabilities of the *energy analysis module*.

**This is an optional software capability:**

4) The compliance shell shall accept optional input to identify the *secondary system* as "existing."

## 4.6.3. Provision of Outdoor Air

### 4.6.3.1. Minimum Outdoor Air

**1)** The compliance shell shall not provide for a *secondary system* input for minimum outdoor air flow rate, but shall calculate minimum outdoor air flow rate in accordance with Sentences (3) to (6).

**2)** The compliance shell shall determine whether the *secondary system* is variable air volume.

**3)** If the *secondary system* is "single zone," then the compliance shell shall set the minimum outdoor air flow rate to be equal to the minimum outdoor air requirement for the *thermal block* served, as determined from Subsection 4.3.2. or Article 4.3.3.4.

**4)** If the *secondary system* is "multiple zone," then the compliance shell shall perform the following calculation:

a) calculate TOA as the sum of minimum outdoor air requirements for the *thermal blocks* served;

b) calculate X, equal to TOA divided by the system design air flow rate from Subsection 4.6.4.;

c) for each *thermal block* j, served by the system, calculate $Z_J$ as follows:

  i) if the *secondary system* is not variable air volume, then

  $Z_J$ = the minimum outdoor air requirement for the *thermal block* divided by the design air flow rate for the *thermal block*;

This is derived from the critical zone method of ASHRAE 62-1989 and ensures that each *thermal block* receives adequate ventilation.

For VAV systems this is maximum air flow.

- ii) if the *secondary system* is variable air volume, then

  $Z_J$ = the minimum outdoor air requirement for the *thermal block* divided by the minimum air flow rate for the *thermal block* from Subsection 4.5.4.;

d) determine $Z_{CRIT}$, the maximum value of $Z_J$;

e) calculate Y,

$$Y = X / (1 + X - Z_{CRIT});$$

f) minimum outdoor air flow rate for system equals Y times system air flow rate from Subsection 4.4.3.

**5)** If the *secondary system* is multiple zone and not variable air volume, then the compliance shell shall set the minimum fraction outdoor air to be equal to the value of Y obtained from Sentence (4).

**6)** If the *secondary system* is multiple zone and variable air volume, then the compliance shell shall accept input of either “minimum percent” or “minimum airflow,” and:

a) if input is “minimum percent,” then:
  i) set the type of minimum outdoor air control to be minimum percent;and
  ii) set the minimum fraction outdoor air to be equal to the value of Y obtained from Sentence (4);
b) if input is “minimum airflow,” then:
  i) set the type of minimum outdoor air control to be minimum flow rate;
  ii) set the minimum outdoor air flow rate to be equal to Y times the sum of the minimum (supply) air flow rates for the *thermal blocks* served, from Subsection 4.5.4.; and
  iii) generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

If the *proposed design* is VAV and control is minimum %, then set the minimum percentage to give minimum outdoor air when VAV supply is at minimum flow.

The *reference case* for VAV will use minimum outdoor air as a flow rate (i.e. no matter what supply air flow).

### 4.6.3.2. Cooling With Outdoor Air

**1)** The compliance shell shall accept input for the provision for outdoor air for the *secondary system* as one of:

a) varied in order to cool with outdoor air (economizer);
b) constant at the minimum outdoor air flow rate; or
c) constant a 100% of total air delivery (e.g. for makeup air service).

**2)** If the input from Sentence (1) is (a), then the compliance shell shall accept input to specify the manner of control, including:

- a) maximum outdoor air flow rate;
- b) control of mixed air temperature;
- c) type of “economizer” control dry bulb, enthalpy, etc.);
- d) operation of cooling equipment in conjunction with the economizer control (e.g. either economizer and cooling can both function together, or system reverts to minimum outdoor air whenever cooling is activated).

**3)** The compliance shell shall ensure the input from Articles 4.6.3.1. and 4.6.3.2. is accurately converted to the appropriate form and used by the *energy analysis module* to simulate the intended manner of control of outdoor air in the performance analysis.

## 4.6.4. Supply Fans

**1)** If a *secondary system* is single zone, then the compliance shell shall accept input for the design air flow rate for the system.

**2)** If a *secondary system* is multiple zone, then the compliance shell shall calculate the design air flow rate by summing the design (maximum) terminal air delivery rates (see Subsection 4.5.4.) for the *thermal blocks* served by the *secondary system*.

**3)** If a *secondary system* includes one or more of *furnace* unit, direct expansion cooling, or heat pump, then the compliance shell shall accept input for:

- a) whether or not fan power is included in the overall performance rating of the heating or cooling equipment contained in the *secondary system*; default is “included”;
- b) fan power at design airflow; no default;
- c) method of fan control, selected from the following options, the default is (ii):
  - i) always on;
  - ii) according to the operation schedule determined by *space use classification*; or
  - iii) cycle with heating to maintain setback temperature during shutoff/setback period.

**4)** If a *secondary system* does not includes any of *furnace* unit, direct expansion cooling, or heat pump, then the compliance shell shall accept input for:

- a) the design static pressure,
- b) either the combined fan, drive, and motor efficiency; or a combination of parameters from which the combined efficiency can be determined;

c) the position of the fan with respect to the heating and cooling coils (i.e. drawthrough or blowthrough);

Determines where fan temperature rise occurs.

d) whether or not the motor is located in the airstream.

Along with the above, determines amount of temperature rise.

e) operation of fan (off, or cycled with heating to maintain setback temperature) during shutoff/setback period.

**5)** If a *secondary system* is variable air volume, then the compliance shell shall accept input to define fan power versus flow characteristics either:

a) as generic type of fan and flow control, selected from those given in Table 5.4.9.A.; or

**This is an optional software capability:**

b) as a power versus flow profile.

**6)** If input from Sentence (5) is a generic type, then the compliance shell shall generate the flow versus fan power profile for that type based on Table 5.4.9.A.

**This is an optional software capability:**

**7)** If input from Sentence (5) is a power versus flow profile, then the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

**8)** The compliance shell shall ensure the input from Subsection 4.6.4. is accurately converted to the appropriate form and used by the energy analysis module to simulate the fan power and fan temperature rise.

## 4.6.5. Return/Relief Fans

**1)** The compliance shell shall provide a means to indicate the presence of a return/relief fan in a *secondary system*.

**2)** If there is a return relief fan, then the compliance shell shall accept input for:

a) the design static pressure; and

b) the combined fan, drive; and motor efficiency.

**3)** The compliance shell shall ensure the input from Subsection 4.6.5. is accurately converted to the appropriate form and used by the energy analysis module to simulate the fan power and fan temperature rise.

## 4.6.6. Heating Coils

### 4.6.6.1. Electric Resistance Heating

**1)** The compliance shell shall provide a means to indicate the presence of electric heating in a *secondary system*.

**2)** If there is electric heating, then the compliance shell shall accept input of heating capacity.

### 4.6.6.2. Hydronic Heating

**1)** The compliance shell shall provide a means to indicate the presence of hydronic heating in a *secondary system*.

**2)** If there is hydronic heating, then the compliance shell shall accept input of:

a) heating capacity; and
b) identification of the primary heating system (*boiler*) that serves the coils.

## 4.6.7. Cooling Coils

**1)** The compliance shell shall provide a means to indicate the presence of hydronic cooling in a *secondary system*.

**2)** If there is hydronic cooling, then, the compliance shell shall accept input to describe cooling coils, including:

a) cooling capacity; and
b) identification of the primary cooling system (chiller) that serves the coils.

## 4.6.8. Furnace Unit

**1)** The compliance shell shall provide a means to indicate the presence of a *furnace* unit in a *secondary system*.

**2)** If there is a *furnace* unit, then compliance shell shall accept input for *furnace*, including:

a) the fuel used, selected from the list in Appendix D of the *Code* (except electric or heat pump);
b) design heating capacity;
c) either AFUE or *combustion efficiency*.

**This is an optional software capability:**

**3)** The compliance shell shall accept optional input of part load efficiency characteristics. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

The program will default to the same part load performance as is assumed for the *reference case*.

**4)** Except when input of part load efficiency characteristics are provided for a *furnace* unit, as permitted in Sentence (3), the compliance shell shall apply part load efficiency characteristics the same as those given for fuel fired heater in Article 5.4.7.3.

Same as for the *reference case*.

**5)** If input from Sentence (3) for *furnace* efficiency is AFUE, then the compliance shell shall determine the corresponding full load efficiency $E_t$ as follows:

If AFUE ≤ 83.5, then

$$E_t = 0.002907 \bullet AFUE + 0.5787$$

If AFUE > 83.5, then

$$E_t = 0.011116 \bullet AFUE - 0.098185$$

**6)** If fan power is included in the performance rating of the unit [see Clause 4.6.4.(3)(a)], then the compliance shell shall decrease the heating capacity from Sentence (2) by the amount of the rated fan power [see Clause 4.6.4.(3)(b)].

## 4.6.9. Direct Expansion Cooling

**1)** The compliance shell shall provide a means to indicate the presence of direct expansion cooling (condensing unit) in a *secondary system*.

**2)** If there is direct expansion cooling, then compliance shell shall accept input to describe the cooling unit, including:

a) design cooling capacity; and
b) one of EER, COP, or SEER.

**This is an optional software capability:**

3) The compliance shell shall accept optional input of part load efficiency characteristics. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

The program will default to the same part load performance as is assumed for the *reference case*.

**4)** Except when input of part load efficiency characteristics are provided for a direct expansion unit, as permitted in Sentence (3), the compliance shell shall apply part load efficiency characteristic the same as those given for a direct expansion unit in 5.4.8.2.(3)

**5)** If input from Sentence (3) for direct expansion unit efficiency is SEER, then the compliance shell shall determine the corresponding *EER* as follows:

$$EER = 1.006 \cdot \text{SEER}$$

**6)** If fan power is included in the performance rating of the unit [see Clause 4.6.4.(3)(a)], then the compliance shell shall increase the cooling capacity from Sentence (2) by the amount of the rated fan power
[see Clause 4.6.4.(3)(b)].

## 4.6.10. Heat Pump

### 4.6.10.1. Air to Air Heat Pump

**1)** If a *secondary system* is an air to air heat pump, then the compliance shell shall accept input to describe the heat pump, including:

a) heating capacity;
b) heating efficiency as COP or EER;
c) cooling capacity; and
d) cooling efficiency as one of one of EER, COP, or SEER.

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**This is an optional software capability:**

**2)** The compliance shell shall accept optional input of part load efficiency characteristics for heating and cooling. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

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**3)** Except when input of part load efficiency characteristics are provided as permitted in Sentence (2), the compliance shell shall apply the part load efficiency characteristics for heating and cooling as given in Appendix A.

4) If input from Sentence (1) for cooling efficiency is SEER, then the compliance shell shall determine the corresponding full load efficiency as follows:

$$EER = 1.006 \cdot \text{SEER}$$

**5)** If fan power is included in the performance rating of the unit [see Clause 4.6.4.(3)(a)], then the compliance shell shall increase the cooling capacity from Sentence (1) by the amount of the rated fan power [see Clause 4.6.4.(3)(b)].

**This is an optional software capability:**

### 4.6.10.2. Ground Source Heat Pump

**1)** If a *secondary system* is a ground source heat pump, then the compliance shell shall accept input to describe the heat pump, including:

a) heating capacity;
b) heating COP;
c) cooling capacity; and
d) cooling COP.

**This is an optional software capability:**

### 4.6.10.3. Water Loop Heat Pump

**1)** If a *secondary system* is a water loop heat pump, then the compliance shell shall accept input to describe the heat pump, including:

a) heating capacity;
b) heating COP;
c) cooling capacity;
d) cooling COP; and
e) identification of the (primary heat pump) water loop system to which it is connected.

## 4.6.11. Supply Air Temperature Control

**1)** The compliance shell shall accept optional input to define the control of supply air temperature of a *secondary system* as one of the following:

a) a constant setpoint temperature;
b) scheduled reset of supply temperature from outdoor air temperature; or
c) reset of supply temperature from zone requiring maximum heating or cooling (discriminator control).

The default is constant setpoint temperature control at a temperature of 13°C (55°F).

**2)** The compliance shell shall ensure the input from Sentence (1) is converted to the appropriate form and used by the energy analysis module to simulate the intended manner of supply air temperature control in the performance analysis.

### 4.6.12. Heat Recovery

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**This is an optional software capability:**

**1)** The compliance shell shall provide a means to indicate the presence of exhaust air heat recovery in a *secondary system*.

**2)** If there is exhaust air heat recovery, then the compliance shell shall accept input to describe the effectiveness of heat recovery.

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### 4.6.13. Operation Schedules

**1)** If a *secondary system* serves *thermal blocks* with different *space use classifications*, and if there are different operation schedules associated with the different *space use classifications*, then equipment in the system must be in operation whenever the schedule of any of the *thermal blocks* served calls for the system to be on.

**2)** If the *secondary system* for the *reference case* serves the same *thermal blocks* as that of the *proposed design*, the same fan operation schedule shall be used for both the *reference case* and the *proposed design.*

**3)** If the *secondary system* for the *reference case* does not serve the same *thermal blocks* as that of the *proposed design,* then

i) systems serving *thermal blocks* not included in the multi-zone system shall use fan operation schedules corresponding to their *space use classifications;*

ii) the multi-zone system serving the remaining *thermal blocks* shall be in operation whenever the schedule of any of the *thermal blocks* served calls for the system to be on.

That is if the conditions of Sentence 5.4.1.(3) are met.

# 4.7 Primary Systems and Equipment

## 4.7.1. Scope

**1)** This Section deals with equipment that converts fuel or electricity to heating and cooling.

**2)** This Section is to be used with Sections 4.5. (HVAC *Terminal Characteristics*) and 4.6. (*Secondary Systems*) to completely describe the HVAC system.

## 4.7.2. Primary Heating Systems

### 4.7.2.1. Identification

**1)** The compliance shell shall accept input of an identifier for the primary heating system and shall ensure that this identifier is unique.

### 4.7.2.2. Purchased Heating

**1)** The compliance shell shall provide a means of indicating that a primary heating system is "purchased heating."

Purchased heating is steam or hot water supplied from a central plant or distribution system. This could include steam or hot water from process waste heat.

**2)** If a primary heating system is "purchased heating," then the compliance shell shall accept input for the energy source that is used to generate the purchased heat, restricted to a selection from the list in Appendix D of the *Code* as appropriate for the administrative region.

**3)** If a primary heating system is "purchased heating," then the compliance shell shall generate data for a *boiler*:

a) sized for the peak heating load on the primary heating system;
b) using the energy source obtained from Sentence (2);
c) having efficiency at full load of 80%; and
d) part load characteristics the same as those given for a *boiler* in 5.4.7.4.(4).

Sets up a primary heating system having the same characteristics as the reference system.

### 4.7.2.3. Boilers

**1)** The compliance shell shall provide a means of indicating that a primary heating system contains one or more *boilers*.

**2)** If a primary heating system contains one or more *boilers*, then the compliance shell shall accept the following input for each *boiler*:

a) the fuel used, restricted to a selection from the list in Appendix D of the *Code*;
b) design capacity;
c) either AFUE or full load efficiency.

**3)** If a primary heating system contains more than one *boiler*, then the compliance shell shall accept input to define the sequencing of *boilers*.

---

**This is an optional software capability:**

**4)** The compliance shell shall accept optional input of part load efficiency characteristics for a *boiler*. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

The program will default to the same part load performance as is assumed for the *reference case*.

---

**5)** Except when input of part load efficiency characteristics are provided for a *boiler*, as permitted in Sentence (4), the compliance shell shall apply part load efficiency characteristic part load characteristics the same as those given for a *boiler* in Sentence 5.4.7.4.(4).

**6)** If input from Sentence (2) for *boiler* efficiency is AFUE, then the compliance shell shall determine the corresponding full load efficiency as follows:

if AFUE < 80, then

$$Et = 0.1 \bullet AFUE + 72.5$$

if AFUE ≥ 80, then

$$Et = 0.875 \bullet AFUE + 10.5$$

Converts to full load efficiency.

### 4.7.2.4. Pumps and Auxiliaries

**1)** The compliance shell shall accept input to describe heating circulation pumping sufficient to determine at least:

a) effective pump head;
b) water flow rate; and
c) pumping power.

For a single pump distribution system, the effective pump head is simply the pump head. For compound pumping systems, the effective pump head is the head that would make the power for a single pump equal to the sum of the system pump powers, where the single pump is assumed to have:

a) a design flow rate equal to the design flow through the *boiler*; and

b) a combined motor/impeller efficiency of 60%.

**This is an optional software capability:**

#### 4.7.2.5. Heat Recovery from Chiller

**1)** The compliance shell shall provide a means of indicating that a primary heating system includes heat recovery from a chiller.

**2)** If a primary heating system includes heat recovery from a chiller, then the compliance shell shall accept input to define the characteristics of the heat recovery system in a form suitable for use by the energy analysis module.

**This is an optional software capability:**

#### 4.7.2.6. Heat Storage

**1)** The compliance shell shall provide a means of indicating that a primary heating system includes heat storage.

**2)** If a primary heating system includes heat storage, then the compliance shell shall accept input to define the characteristics of the heat storage system in a form suitable for use by the energy analysis module.

### 4.7.3. Primary Cooling Systems

#### 4.7.3.1. Identification

**1)** The compliance shell shall accept input of an identifier for the primary cooling system and shall ensure that this identifier is unique.

#### 4.7.3.2. Purchased Cooling

**1)** The compliance shell shall provide a means of indicating that a primary cooling system is “purchased cooling.”

Purchased cooling is chilled water from a central plant or distribution system.

**2)** If a primary cooling system is “purchased cooling,” then the compliance shell shall generate data for an electric chiller plant, of the type and characteristics described in Sentences 5.4.8.3.(2) to (12).

Sets up a primary cooling system having the same characteristics as the reference system.

### 4.7.3.3. Vapour Compression Chillers

**1)** The compliance shell shall provide a means of indicating whether a primary cooling system contains one or more vapour compression chillers.

**2)** If a primary cooling system contains one or more chillers, then the compliance shell shall accept the following input for each chiller:
a) design capacity;
b) type of chiller, either centrifugal or reciprocating;
c) one of COP or EER.

**3)** If a primary cooling system contains more than one chiller, then the compliance shell shall accept input to define the sequencing of chillers.

---

**This is an optional software capability:**

**4)** The compliance shell shall accept optional input of performance characteristics as a function of part load and condenser temperature. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

---

**5)** Except when input of performance characteristics are provided for a chiller, as permitted in Sentence (4), the compliance shell shall apply performance characteristics as follows:
a) if the chiller is reciprocating, then the same as those given in Sentence 5.4.8.3.(6);
b) if the chiller is centrifugal, then the same as those given in Sentence 5.4.8.3.(7).

The program will default to the same part load performance as is assumed for the *reference case*.

### 4.7.3.4. Absorption Chillers

**1)** The compliance shell shall provide a means of indicating whether a primary cooling system contains one or more absorption chillers.

**2)** If a primary cooling system contains one or more absorption chillers, then the compliance shell shall accept the following input for each chiller:
a) design capacity;
b) the fuel used, selected from the list in Appendix D of the *Code*;
c) COP.

**3)** If a primary cooling system contains more than one chiller, then the compliance shell shall accept input to define the sequencing of chillers.

**This is an optional software capability:**

**4)** The compliance shell shall accept optional input of performance characteristics as a function of part load and condenser temperature. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

**5)** Except when input of performance characteristics are provided for a chiller, as permitted in Sentence (4), the compliance shell shall apply performance characteristics as given for absorption chiller in Appendix A.

### 4.7.3.5. Cooling Towers and Condensers

**1)** The compliance shell shall provide a means of indicating that a primary cooling system contains a cooling tower.

**2)** If a primary cooling system contains a cooling tower, then the compliance shell shall accept the input to describe the cooling tower installation including:

a) design capacity;
b) number of cells;
c) design fan power;
d) design pump power;
e) design entering and leaving water temperature;
f) method of temperature control.

**This is an optional software capability:**

**3)** The compliance shell shall accept optional input of performance characteristics as a function of part load and operating conditions. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

**4)** Except when input of performance characteristics are provided for a cooling tower, as permitted in Sentence (3), the compliance shell shall apply performance characteristics as given in Sentence 5.4.8.3.(12).

The program will default to the same part load performance as is assumed for the *reference case*.

### 4.7.3.6. Pumps and Auxiliaries

**1)** The compliance shell shall accept input to describe cooling circulation pumping sufficient to determine at least:

a) effective pump head;
b) water flow rate; and
c) pumping power.

For a single pump distribution system, the effective pump head is simply the pump head. For compound pumping systems, the effective pump head is the head that would make the power for a single pump equal to the sum of the system pump powers, where the single pump is assumed to have:

a) a design flow rate equal to the design flow through the chiller; and

b) a combined motor/impeller efficiency of 60%.

**This is an optional software capability:**

### 4.7.3.7. Water Side Economizer

**1)** The compliance shell shall provide a means of indicating that a primary cooling system includes water side economizer.

**2)** If a primary cooling system includes water side economizer, then the compliance shell shall accept input to define the characteristics of the water side economizer system.

**This is an optional software capability:**

### 4.7.3.8. Cool Storage

**1)** The compliance shell shall provide a means of indicating that a primary cooling system includes cool storage.

**2)** If a primary cooling system includes cool storage, then the compliance shell shall accept input to define the characteristics of the cool storage system.

## 4.7.4. Primary Water Loop System

### 4.7.4.1. Identification

**1)** The compliance shell shall accept input of an identifier for the primary water loop system and shall ensure that this identifier is unique.

### 4.7.4.2. Heat Rejector

**1)** The compliance shell shall provide a means of indicating that a primary water loop system contains a cooling tower or condensor.

**2)** If a primary cooling system contains a cooling tower or condensor, then the compliance shell process input as described in Article 4.7.3.5.

### 4.7.4.3. Supplemental Heater

**1)** The compliance shell shall provide a means of indicating that supplemental heating for a primary water loop system is either:

a) by connection to a primary heating system; or
b) by a dedicated supplemental heater.

**2)** If supplemental heating is by connection to a primary heating system, then the compliance shell shall attach the water loop heating load to that primary heating system.

**3)** If supplemental heating is by one or more dedicated *boilers*, then the compliance shell shall process input as described in Article 4.7.2.3.

### 4.7.4.4. Pumps and Auxiliaries

**1)** The compliance shell shall accept input to describe primary water loop circulation pumping sufficient to determine at least:

a) effective pump head;
b) water flow rate; and
c) pumping power.

For a single pump distribution system, the effective pump head is simply the pump head.

For compound pumping systems, the effective pump head is the head that would make the power for a single pump equal to the sum of the system pump powers, where the single pump is assumed to have:

a) a design flow rate equal to the design flow through the chiller; and

b) a combined motor/impeller efficiency of 60%.

**This is an optional software capability:**

#### 4.7.4.5. Thermal Storage

**1)** The compliance shell shall provide a means of indicating that a primary water loop system includes thermal storage.

**2)** If a primary water loop system includes thermal storage, then the compliance shell shall accept input to define the characteristics of the thermal storage system.

### 4.7.5. Service Water Heating

#### 4.7.5.1. Identification

**1)** The compliance shell shall provide a means for the user to indicate that *service water* heating is not included in the analysis.

If *service water* systems meet the prescriptive requirements of the *Code* (Section 6.3.), then it is not necessary to simulate them.

**2)** The compliance shell shall accept input of an identifier for the *service water* heating system and shall ensure that this identifier is unique.

#### 4.7.5.2. Storage Tank

**1)** The compliance shell shall accept input to indicate the presence of a storage tank.

**This is an optional software capability:**

**2)** If there is *service water* storage, then the compliance shell shall accept input of heat loss characteristic of the storage tank.

#### 4.7.5.3. Electric Water Heater

**1)** If *service water* heating is electric resistance, then the compliance shell shall accept input of heater capacity.

#### 4.7.5.4. Service Water Boiler

**1)** If *service water* heating is by a dedicated *boiler*, then the compliance shell shall accept input of:

a) the fuel used, restricted to a selection from the list in Appendix D of the *Code* as appropriate for the administrative region;
b) design capacity;
c) full load efficiency.

**This is an optional software capability:**

**2)** The compliance shell shall accept optional input of part load efficiency characteristics for a *boiler*. If this input is provided, the compliance shell shall generate a notice in the output report to alert the building official that this option was chosen and that supporting documentation may be required.

The program will default to the same part load performance as is assumed for the *reference case*.

**3)** Except when input of part load efficiency characteristics are provided for a *boiler*, as permitted in Sentence (2), the compliance shell shall apply part load efficiency characteristics the same as those given in Sentence 5.4.13.(5).

### 4.7.5.5. Combined Space/Service Water Heating

**1)** If *service water* heating is by connection to a primary heating system, then the compliance shell shall attach the *service water* heating load to that primary heating system.

# CHAPTER 5
# COMPLIANCE SHELL: GENERATION OF REFERENCE CASE

## 5.1. General

### 5.1.1. Scope

**1)** This chapter specifies requirements for the compliance shell to generate data, from the input for the *proposed design,* that defines the *reference case,* which is then used by the energy analysis module to perform the analysis that calculates the *building energy target*.

### 5.1.2. Compliance

(Blank for numbering consistency.)

### 5.1.3. Project Identification

(Blank for numbering consistency.)

### 5.1.4. Geographic Region and Climate Data

**1)** The compliance shell shall ensure that the analysis for the *reference case* is performed with the same climate data as that for the *proposed design* (see Subsection 4.1.4.).

## 5.2. Division into Thermal Blocks

**1)** The compliance shell shall create for the *reference case* the same *thermal blocks* as defined for the *proposed design*.

## 5.3. Modeling Thermal Loads for Reference Case

**1)** The compliance shell shall generate data for each *thermal block* of the *reference case* as detailed in Subsections 5.3.1. through 5.3.7. In every case, the data shall relate to the corresponding *thermal block* of the *proposed design*.

## 5.3.1. General

### 5.3.1.1. Thermal Block Identification

(Blank for numbering consistency.)

### 5.3.1.2. Heating Source Classification

(Blank for numbering consistency.)

### 5.3.1.3. Directly/Indirectly Conditioned Thermal Block

**1)** The compliance shell shall set the *thermal block* to be directly conditioned or indirectly conditioned according to the input for the corresponding *thermal block* of the *proposed design*.

### 5.3.1.4. Floor Area

**1)** The compliance shell shall set the floor area of each *thermal block* for the *reference case* to be the same as that defined for the *proposed design* and shall transfer this data to the energy analysis module.

## 5.3.2. Space Use Classification

**1)** The compliance shell shall set the following space use characteristics for the *thermal block* to be the same as those determined for the *proposed design* in Subsection 4.3.2. (and, if exceptional conditions were specified, Subsection 4.3.3.):
- a) number of occupants;
- b) receptacle power;
- c) *service water* heating;
- d) minimum outdoor air requirement;
- e) space temperature schedule;
- f) *occupancy*, lighting, and operation schedules; and
- g) process loads.

## 5.3.3. Exceptional Conditions

**1)** The compliance shell shall set the lighting area factor for the *thermal block* to the value determined by the input from Article 4.3.3.6.

This is used to calculate *reference case* lighting in Subsection 5.3.4.

## 5.3.4. Lighting

**1)** For each thermal *block*, the compliance shell shall calculate the reference lighting power according to *space use classification* as follows:
- a) if *space use classification* is according to *building type* then the product of floor area and lighting power density for that *building type* from Table 4.3.2.A.;

b) if *space use classification* is according to *space function* then the product of floor area, lighting area factor, and lighting power density for that *space function* from Table 4.3.2.B.; or

Single *space function* is only case in which user can specify lighting area factor.

c) if *space use classification* is “combined” then the product of the floor area and the area weighted average of the lighting power densities from Table 4.3.2.B. for the *space functions* that are combined.

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**This is an optional software capability:**

d) If the lighting is identified as “existing” [see Sentence 4.3.4.(1)] then the reference lighting power is equal to the connected lighting power for the *proposed design* from the input of Article 4.3.4.1.

---

**2)** The *compliance shell* shall calculate:

a) the sum of reference lighting power for all *thermal blocks*;

b) the sum of the connected lighting power for all *thermal blocks* of the *proposed design*.

Single *space function* is only case in which user can specify lighting area factor.

**3)** The compliance shell shall set the connected lighting power for the *reference case*, based on the values from Sentence (2) above, as follows:

a) if the sum of the connected lighting power for the *proposed design* is greater than the sum of reference lighting power, then the connected lighting for each *thermal block* of the *reference case* is equal to the reference lighting power determined in Sentence (1);

b) otherwise, connected lighting power for each *thermal block* of the *reference case* is equal to that of the *proposed design*.

**4)** The compliance shell shall generate data so that the energy analysis module will assign the same proportions of radiant and convective heat as used in the *proposed design*.

i.e. incandescent or non-incandescent

**5)** The compliance shell shall set the fraction of heat from lights that goes to the space for each *thermal block* of the *reference case* according to location of lighting fixtures input for the *proposed design*:

a) for fixtures recessed into a ceiling used as a return air *plenum* or when return air is ducted directly through the fixture, 85 % to space (and rest to return air);

b) for all others, 100% to space.

**6)** The compliance shell shall transfer the lighting data to the energy analysis module to calculate the *building energy target*.

## 5.3.5. Envelope Components

**1)** The compliance shell shall calculate the *fenestration-to-wall ratio* (FWR) for the *proposed design* as follows:

$$FWR = (TA_{WIND} + TA_{SKY}) / (TA_{WALL} + TA_{DOOR} + TA_{ROOF} + TA_{WIND} + TA_{SKY})$$

where:

$TA_{WIND}$ = sum of areas of all windows and other *fenestration* other than *skylights* in the *proposed design* (see Article 4.3.5.5.);

$TA_{SKY}$ = sum of areas of all *skylights* in the *proposed design* (see Article 4.3.5.6.);

$TA_{ROOF}$ = sum of the products of opaque roof area times sine of the tilt angle (from horizontal) for all roofs in the *proposed design* (see Article 4.3.5.2.);

For horizontal roofs this is zero.

$TA_{WALL}$ = sum of the products of opaque wall area times sine of the tilt angle (from horizontal) for all walls in the *proposed design* (see Article 4.3.5.1.);

For vertical walls this is just the opaque wall area

$TA_{DOOR}$ = sum of the areas all doors in the *proposed design* (see Article 4.3.5.4.).

### 5.3.5.1. Exterior Walls

**1)** The compliance shell shall set the orientation and absorptance for each exterior wall of the *reference case* to be the same as that for the *proposed design*.

**2)** Except when a wall is "existing," the compliance shell shall set the area of the opaque portion of each exterior wall, $A_R$, for the *reference case* as follows:

a) if FWR is no greater than 0.4, then $A_R$ is the same as the *proposed design*;

b) if FWR is greater than 0.4, then

$$A_R = A_P + (1 - (0.4 / FWR)) \bullet A_{WIND}$$

Note that this means input must relate the window to the wall in which it is located.

where:

$A_P$ = area of opaque wall for *proposed design*;

$A_{WIND}$ = area of windows contained in the wall for *proposed design*;

FWR = *fenestration-to-wall ratio* [see Sentence 5.3.5.(1)].

**This is an optional software capability:**

**3)** When a wall is "existing," the compliance shell shall set the area of the opaque portion for the *reference case* to be the same as that for the *proposed design.*

**4)** Except when a wall is "existing," the compliance shell shall set each wall for the *reference case* to be of the construction given in Table 5.3.5.A., and shall adjust the insulation to give the following *overall thermal transmittance* for the wall:

a) if the wall is "solid masonry" [see Sentence 4.3.5.1.(2)] or "existing" [see Sentence 4.3.5.1(4)], then equal to that for the *proposed design*;

b) if the wall is "above ground portion of *foundation* wall," then to the reciprocal of the *RSI-value* required by Table 3.2.3.1. of the *Code* for the applicable combination of *principal heating source* and administrative region;

c) otherwise, to that required by Table 3.3.1.1.A. of the *Code* for the applicable combination of *principal heating source* and administrative region.

## Table 5.3.5.A. Reference Case Wall Construction

| Wall Type | Layer material | Thickness (mm) |
|---|---|---|
| All types | Outside air film | |
| | Brick, face | 100 |
| | Air space | 25 |
| | Insulation, polystyrene | (1) |
| | Gypsum board | 15 |
| | Inside air film | |

**Notes:**

(1) Insulation thickness as required to make wall *U-value* equal to prescriptive requirement given in Table 3.3.1.1.A. of the *Code*.

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**This is an optional software capability:**

**5)** When a wall is "existing," the compliance shell shall set the *U-value* and wall construction for the *reference case* to be the same as the *proposed design*.

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**6)** The compliance shell shall transfer all of the wall data to the energy analysis module for calculating the *building energy target*.

### 5.3.5.2. Roofs

**1)** The compliance shell shall set the orientation and absorptance for each roof of the *reference case* to be the same as the *proposed design*.

**2)** Except when a roof is "existing," the compliance shell shall set the area of the opaque portion of each roof, $A_R$, for the *reference case* as follows:

a) if total *skylight* area, $TA_{SKY}$, is no greater than 2% of total roof area, $TA_{ROOF}$, or if FWR is no greater than 0.4 [see Sentence 5.3.5.(1)], then $A_R$ is the same as the *proposed design*;

b) if total *skylight* area, $TA_{SKY}$, is greater than 2% of total roof area, $TA_{ROOF}$, and FWR is greater than 0.4 [see Sentence 5.3.5.(1)], then

$$A_R = A_P + (1 - (0.4 / FWR)) \bullet A_{SKY}$$

where:

$A_P$ = area of opaque roof for the *proposed design*;

$A_{SKY}$ = area of *skylights* contained in the roof for the *proposed design*;

FWR = *fenestration-to-wall ratio* (see Sentence 5.3.5.(1))

Note that this means input must relate the *skylight* to the roof in which it is located.

**This is an optional software capability:**

**3)** When a roof is "existing," the compliance shell shall set the area, *U-value*, and roof construction of the opaque portion of the roof for the *reference case* to be the same as the *proposed design*.

**4)** Except when a roof is "existing," the compliance shell shall set each roof for the *reference case* to be of the construction given in Table 5.3.5.B. according to the corresponding roof type for the *proposed design*, and shall adjust the insulation to give an *U-value* for the roof equal to that required by Table 3.3.1.1.A. of the *Code* for that roof type and for the applicable combination of *principal heating source* and administrative region.

Table 5.3.5.B. has construction for roofs:

- *attic*
- roof-joist
- built up (representing all other)

## Table 5.3.5.B. Reference Case Roof Construction

| Roof Type | Layer material | Thickness (mm) |
|---|---|---|
| Type 1: *attic* | Outside air film (in *attic*) | |
| | Insulation, mineral fibre | (1) |
| | Gypsum board | 15 |
| | Inside air film | |
| Type 2: roof-joist | Outside air film | |
| | Plywood | 12 |
| | Insulation, mineral fibre | (1) |
| | Gypsum board | 15 |
| | Inside air film | |
| Type 3: all other | Outside air film | |
| | Gravel | 50 |
| | Roofing, built-up | 10 |
| | Insulation, polystyrene | (1) |
| | Metal deck | 1.5 |
| | Inside air film | |

**Notes:**

(1) Insulation thickness as required to make roof *U-value* equal to prescriptive requirement given in Table 3.3.1.1.A. of the *Code*

**5)** The compliance shell shall transfer all of the roof data to the energy analysis module for calculating the *building energy target*.

### 5.3.5.3. Exposed Floors

**1)** The compliance shell shall set the area for each floor of the *reference case* to be the same as the *proposed design*.

**2)** Except when a floor is "existing," the compliance shell shall set each floor for the *reference case* to be of the construction given in Table 5.3.5.C. according to the corresponding floor type for the *proposed design*, and shall adjust the insulation to give the overall *U-value* for the floor that is required by Table 3.3.1.1.A. of the *Code* for that floor type and for the applicable combination of *principal heating source* and administrative region.

Table 5.3.5.C. has construction for floors:
- truss
- floor-joist
- under slab (representing all other)

## Table 5.3.5.C. Reference Case Floor Construction

| Floor Type | Layer material | Thickness (mm) |
|---|---|---|
| Type 1: parallel-chord trusses and joist-type floors | Outside air film | |
| | Gypsum board | 12 |
| | Insulation, mineral fibre | (1) |
| | Air space | 50 |
| | Plywood | 19 |
| | Inside air film | |
| Type 2: all other floors | Outside air film | |
| | Gypsum board | 12 |
| | Insulation, polystyrene | (1) |
| | Concrete | 50 |
| | Inside air film | |

**Notes:**

(1) Insulation thickness as required to make floor *U-value* equal to prescriptive requirement given in Table 3.3.1.1.A. of the *Code*.

**This is an optional software capability:**

**3)** When a floor is "existing," the compliance shell shall set the area, *U-value*, and floor construction of the floor for the *reference case* to be the same as the *proposed design*.

**4)** The compliance shell shall transfer all of the floor data to the energy analysis module for calculating the *building energy target*.

### 5.3.5.4. Doors

**1)** The compliance shell shall set the area and *overall thermal transmittance* of each door to be the same as the corresponding door in the *proposed design*.

The *reference case* is defined with same dimensions and *U-value* as the *proposed design*.

**2)** The compliance shell shall transfer all of the door data to the energy analysis module for calculating the *building energy target*.

### 5.3.5.5. Windows

**1)** For each window of the *reference case*, the compliance shell shall set the following:

a) orientation to the same as that for the *proposed design*;
b) solar heat gain coefficient (SHGC) to the same as that for the *proposed design*.

**2)** Except when a window is "existing," the compliance shell shall, for each window of the *reference case*, set the following:

a) *overall thermal transmittance* to:
  - i) if the window is "exempted," then equal to that for the *proposed design*;
  - ii) if the window is "glass block," then equal to 1.25 times the value corresponding to the entry for a FWR of 0.4 from Table 3.3.1.2. of the *Code,* for "operable window" and for the applicable combination of *principal heating source* and administrative region;
  - iii) otherwise, equal to the value corresponding to the entry for a FWR of 0.4 from Table 3.3.1.2. of the *Code,* for the applicable combination of window type, *principal heating source* and administrative region.

b) area as follows:
  - i) if FWR is no greater than 0.4, then the same as the *proposed design*;
  - ii) if FWR is greater than 0.4, then equal to the *proposed design* multiplied by the ratio 0.4/FWR.

**This is an optional software capability:**

**3)** For each window that is "existing," the compliance shell shall set the *reference case* to the following:

a) *overall thermal transmittance* equal to that for the *proposed design*; and

b) area the same as the *proposed design*.

**4)** The compliance shell shall set all windows of the *reference case* to have no shading by exterior shading devices, regardless of whether or not these were input for the *proposed design* in accordance with Sentence 4.3.5.5.(3).

**5)** The compliance shell shall transfer the data for windows of the *reference case* to the energy analysis module for calculating the *building energy target,* with the following adjustments:

a) if the energy analysis module uses SHGC in calculations, then transfer an adjusted value as follows:

$$SHGC_{ADJUSTED} = 0.8 \bullet SHGC;$$

Factor of 0.8 is to account for incidental shading.

b) if the energy analysis module uses shading coefficient (SC) in calculations, then transfer an adjusted value as follows:

$$SC = 0.8 \bullet 1.15 \bullet SHGC.$$

Factor of 1.15 is to convert SHGC to SC.

**This is an optional software capability:**

**6)** If input was entered for shading of a window by *buildings* or structures as provided in Sentence 4.3.5.5.(5), then the compliance shell shall set the *reference case* to have the same shading as the *proposed design*.

### 5.3.5.6. Skylights

**1)** For each *skylight* of the *reference case*, the compliance shell shall set the following:

a) orientation to the same as that for the *proposed design*;

b) solar heat gain coefficient (SHGC) to the same as that for the *proposed design*.

**2)** Except when a *skylight* is “existing,” the compliance shell shall, for each *skylight* of the *reference case*, set the following:

a) *overall thermal transmittance* as follows:

  i) if total *skylight* area, $TA_{SKY}$, is no greater than 2% of total roof area, $TA_{ROOF}$, [see Sentence 5.3.5.(1)], then as required in Sentence 3.3.1.2.(2) of the *Code*;

  ii) if total *skylight* area, $TA_{SKY}$, is greater than 2% of total roof area, $TA_{ROOF}$, then equal to the value corresponding to the entry for a FWR of 0.4 from Table 3.3.1.1.C. of the *Code* for “operable windows,” for the applicable combination of *principal heating source* and administrative region; and

b) area as follows:

  i) if total *skylight* area, $TA_{SKY}$, is no greater than 2% of total roof area, $TA_{ROOF}$, or if FWR is no greater than 0.4 [see Sentence 5.3.5.(1)], then the same as the *proposed design*;

  ii) if total *skylight* area, $TA_{SKY}$, is greater than 2% of total roof area, $TA_{ROOF}$, and FWR is greater than 0.4 [see Sentence 5.3.5.(1)], then equal to the *proposed design* multiplied by the ratio 0.4/FWR.

**This is an optional software capability:**

**3)** For each *skylight* that is “existing,” the compliance shell shall set the *reference case* to the following:

a) *overall thermal transmittance* equal to that for the *proposed design*;

b) area the same as the *proposed design*.

**4)** The compliance shell shall set all *skylights* of the *reference case* to have no shading by exterior shading devices, regardless of whether or not these were input for the *proposed design* in accordance with Sentence 4.3.5.6.(2).

**5)** The compliance shell shall transfer the data for *skylights* of the *reference case* to the energy analysis module for calculating the *building energy target,* with the following adjustments:

a) if the energy analysis module uses SHGC in calculations, then transfer an adjusted value as follows:

$SHGC_{ADJUSTED} = 0.8 \cdot SHGC$;

Factor of 0.8 is to account for incidental shading.

b) if the energy analysis module uses shading coefficient (SC) in calculations, then transfer an adjusted value as follows:

$SC = 0.8 \cdot 1.15 \cdot SHGC$.

Factor of 1.15 is to convert SHGC to SC.

---

**This is an optional software capability:**

**6)** If input was entered for shading of a *skylight* by *buildings* or structures as provided in Sentence 4.3.5.6.(4), then the compliance shell shall set the *reference case* to have the same shading as the *proposed design*. The compliance shell shall transfer this shading data to the energy analysis module for calculating the *building energy target*.

---

### 5.3.5.7. Walls in Contact with the Ground

**1)** For each wall in contact with the ground, the compliance shell shall:

a) set the area and dimensional data the same as the *proposed design*;

b) assign to each wall the thermal insulation required by Table 3.2.3.1. of the *Code* for the applicable combination of *principal heating source* and administrative region; and

c) transfer the data to the energy analysis module for calculating the *building energy target*.

Note that this is the same as for the *proposed design*.

### 5.3.5.8. Floors in Contact with the Ground

**1)** For each floor in contact with the ground, the compliance shell shall:

a) set the area and dimensional data the same as that for the *proposed design*;

b) assign the thermal insulation required by Table 3.2.3.1. of the *Code* for the applicable combination of *principal heating source* and administrative region; and

c) transfer the data to the energy analysis module for calculating the *building energy target*.

Note that this is the same as for the *proposed design*.

#### 5.3.5.9. Air Leakage (Infiltration)

**1)** The compliance shell shall transfer data to the energy analysis module so that the analysis for each *thermal block* of the *reference case* that contains exterior walls is performed with air leakage (infiltration) set to a constant value of 0.25 L/S per $m^2$ (0.05 $cfm/ft^2$) of gross wall area.

### 5.3.6. Thermal Mass

**1)** For each *thermal block* of the *reference case,* the compliance shell shall transfer to the energy analysis module input that defines the thermal response characteristics of the *thermal block* as the equivalent of “medium weight” construction (see Tables 25 and 26 of the ASHRAE 1993 Handbook – Fundamentals) for calculating the *building energy target*.

### 5.3.7. Heat Transfer Between Thermal Blocks

**1)** The compliance shell shall set all interzone heat transfer data for the *reference case* to the same as that for the *proposed design* and shall transfer this data to the energy analysis module for calculating the *building energy target*.

## 5.4. Modeling Energy Systems for Reference Case

### 5.4.1. Reference System Type

**1)** Except as provided in Sentence (5) the compliance shell shall define a system for the *reference case* corresponding to each *secondary system* of the *proposed design*, in accordance with Sentences 5.4.1.(2) to (4) and Subsections 5.4.2. through 5.4.13.

**2)** Except as provided in Sentence (4), if the *proposed design* for a *thermal block* is a single-zone system, then the *reference case* system for the *thermal block* will be a single-zone system as summarized in Table 5.4.1.A.

**3)** Except as provided in Sentence (4), if the *proposed design* serves *thermal blocks* from a multiple-zone system, then:

a) the *reference case* system will be as summarized in Table 5.4.1.B.; and

b) the *reference case* system will serve the same *thermal blocks* as the system for the *proposed design*, except that if the multiple-zone system for the *proposed design* serves *thermal blocks* having a space use listed in Sentence (4), then those *thermal blocks* will not be included in the multiple-zone reference system but will be served by a reference system as provided in Sentence (4).

**4)** If the *space use classification* of a *thermal block* is one of:

a) *Building Type* - Multifamily Residential; or
b) *Space Function* Type
    i) Hotel/Motel - guestroom;
    ii) Dormitory - bedroom;
    iii) Dormitory - bedroom/study;
    iv) Fire/Police - fire engine room; or
    v) Fire/Police - jail cell;

then the *reference case* system for the *thermal block* will be as summarized in Table 5.4.1.C.

**This is an optional software capability:**

**5)** If a *secondary system* is identified as “existing,” then the *reference case* will be the same as the “existing” system.

## TABLE 5.4.1.A. Reference Case: System AH1 – Single Zone

| | |
|---|---|
| **Description** | This system supplies a constant flow of air and varies the temperature (or may supply the heat by an independent heating system e.g. baseboards) to maintain space temperature. The system is controlled by one zone thermostat.<br>Physically might be either air-conditioning/heater package such as rooftop, or built up system served by chiller/*boiler*. |
| **Supply airflow rate** | Determined from load calculation (see Subsection 5.4.3.). |
| **Fans** | If the *proposed design* is dx cooling, then supply fan with 325 Pa (1.3 inches) static and 40% combined efficiency; no return fan.<br>If the *proposed design* is hydronic cooling, then supply fan with 500 Pa (2 inches) static and 50% combined efficiency; return fan with 0.6 inches static and 25% (see Subsection 5.4.9.). |
| **Outdoor air** | 100% outdoor air “free cooling” using enthalpy economizer control (see Subsection 5.4.11.). |
| **Operating schedule** | (See Subsection 5.4.12.) |
| **Heating capacity** | (See Subsection 5.4.5.) |
| **Heating equipment** | If the *proposed design* is electric heat, then electric resistance heat (see Article 5.4.7.1.).<br>If the *proposed design* is heat pump, then see Article 5.4.7.2.<br>If the *proposed design* is fuel fired and not hydronic, then fuel fired *furnace* (see Article 5.4.7.3.).<br>If the *proposed design* is hydronic, then hot water *boiler* (see Article 5.4.7.4.). |
| **Cooling capacity** | (See Subsection 5.4.6.) |
| **Cooling equipment** | If the *proposed design* has no cooling, then no cooling (see Article 5.4.8.1.).<br>If the *proposed design* has dx cooling, then dx package air-conditioning (see Article 5.4.8.2.).<br>If the *proposed design* is hydronic, then chiller (see Article 5.4.8.3.). |

## Table 5.4.1.B. Reference Case: System AH2 – Multiple Zone

| | |
|---|---|
| **Description** | This system supplies a varying flow of air at a constant temperature. The airflow rate is determined by the VAV terminals in the zones.<br>Physically might be either air-conditioning/heater package such as rooftop, or built up system served by chiller/*boiler.* |
| **Zone Terminal Units** | Zone VAV terminal units with maximum airflow sized to meet load (see Subsection 5.4.2.), and minimum airflow rate of 2 L/s/m$^2$ of floor area (0.4 cfm/ft$^2$).<br>Zone reheat sized to meet load (see Subsection 5.4.2.). |
| **Supply airflow rate** | Determined from load calculation (see Subsection 5.4.3.). |
| **Supply air temperature** | Supply air tmperature from *secondary system* to terminal units is constant at 13°C (55°F). |
| **Fans** | If the *proposed design* is dx cooling, then supply fan with 750 Pa (3.0 inches) static and 45% combined efficiency plus return fan with 150 Pa (0.6 inches) static and 25% efficiency.<br>If the *proposed design* is hydronic cooling, then supply fan with 1000 Pa (4.0 inches) static and 55% combined efficiency plus return fan with 250 Pa (1.0 inches) static and 30% efficiency.<br>Fan flow vs power characteristic as shown in Figure 5.4.9.A.:<br>-if less than 7.5 kw, then as shown in curve (a);<br>-if less than 25 kw but greater than 7.5 kw, then as shown in curve (b);<br>-if fan is greater than 25 kw, then as shown in curve (c).<br>(See Subsection 5.4.9.). |
| **Outdoor air** | 100% outdoor air “free cooling” using enthalpy economizer control (see Subsection 5.4.11.). |
| **Operating schedule** | (See Subsection 5.4.12.). |
| **Heating capacity** | (See Subsection 5.4.5.). |
| **Heating equipment** | If the *proposed design* is electric heat, then electric resistance heat (see Article 5.4.7.1.).<br>If the *proposed design* is heat pump, then see Article 5.4.7.2.<br>If the *proposed design* is fuel fired and not hydronic, then fuel fired *furnace* (see Article 5.4.7.3.).<br>If the *proposed design* is hydronic, then hot water *boiler* (see Article 5.4.7.4.). |
| **Cooling capacity** | (See Subsection 5.4.6.) |
| **Cooling equipment** | If the *proposed design* has no cooling, then no cooling (see Article 5.4.8.1.).<br>If the *proposed design* has dx cooling, then dx package air-conditioning (see Article 5.4.8.2.).<br>If the *proposed design* is hydronic, then chiller (see Article 5.4.8.3.). |

## TABLE 5.4.1.C. Reference Case: System AH3 – Residential/Hotel/Motel

| | |
|---|---|
| **Description** | Physically might be either unitary package air-conditioning/heater, or fan coil unit. This is a single zone system serving only one *thermal block*. |
| **Supply airflow rate** | Determined from load calculation (see Subsection 5.4.3.). |
| **Fans** | Fan with static pressure of 125 Pa (0.5 inch) and combined fan-motor-drive efficiency of 25%, configuration as described in Subsection 5.4.9. Fan runs continuously when system scheduled on. |
| **Outdoor air** | Constant outdoor air at ventilation rate given in Table 4.3.2.B. for *space function* (i.e. no economizer) (see Subsection 5.4.11.). |
| **Operating schedule** | (See Subsection 5.4.12.). |
| **Heating capacity** | (See Subsection 5.4.5.). |
| **Heating equipment** | If the *proposed design* is electric heat, then electric resistance heat (see Article 5.4.7.1.);<br>If the *proposed design* is heat pump, then see Article 5.4.7.2.<br>If the *proposed design* is fuel fired and not hydronic, then fuel fired *furnace* (see Article 5.4.7.3.).<br>If the *proposed design* is hydronic, then hot water *boiler* (see Article 5.4.7.4.). |
| **Cooling capacity** | (See Subsection 5.4.6.) |
| **Cooling equipment** | If the *proposed design* has no cooling, then no cooling (see Article 5.4.8.1.);<br>If the *proposed design* has dx cooling, then dx package air-conditioning (see Article 5.4.8.2.);<br>If the *proposed design* is hydronic, then chiller (see Article 5.4.8.3.). |

## 5.4.2. Thermal Block Heating/Cooling Loads

**1)** The compliance shell shall, either directly or by utilizing the loads calculation capability of the energy analysis module, calculate design peak heating and cooling loads for each *thermal block* of the *reference case*, in accordance with good engineering practice. These calculations and those in Subsection 4.4.2. shall use the same procedures and climate data.

**2)** If a reference system is of Type AH2 as described in Table 5.4.1.B., then the peak reheat required for each *thermal block* served by the system shall be calculated assuming a minimum airflow rate of 2 L/s per $m^2$ of floor area.

## 5.4.3. Air Flow Rates

**1)** The compliance shell shall determine the design air flow rate for each *thermal block* of the *reference case*, calculated as the larger of:

a) the minimum outdoor airflow requirement as specified in Table 4.3.2.A. or Table 4.3.2.B. for the *space use classification* of the *thermal block*;

b) the design air flow rate for heating, calculated assuming a supply air temperature of 43°C (110°F), multiplied by the fan sizing factor $R_F$, as determined in Subsection 4.4.3;

c) if the *thermal block* is “cooled” (see Subsection 4.4.10.), then the larger of:

  i) the design air flow rate for cooling, calculated assuming a supply air temperature of 13°C (55°F), multiplied by the fan sizing factor $R_F$, as determined in Subsection 4.4.3., or

  ii) 2 L/s per $m^2$ of floor area.

**2)** The compliance shell shall determine the design air flow rate for each *secondary system* of the *reference case* by calculating the sum of the design air flow rates for the *thermal blocks* served by the system, as determined in Sentence (1).

## 5.4.4. System Peak Heating/Cooling Load

**1)** The compliance shell shall calculate the peak heating load and peak cooling load for each *secondary system* of the *reference case*, in accordance with good engineering practice as defined in Article 6.2.1.1. of the National Building Code of Canada, using the system design air flow rate determined in Subsection 5.4.3. and taking into account ventilation air and temperature rise from fans. These calculations shall use the same procedures and climate data as the calculations of Subsection 4.4.4.

## 5.4.5. System Heating Capacity

**1)** The compliance shell shall set the heating capacity of each *secondary system* of the *reference case* to be equal to peak heating load, as determined in Subsection 5.4.4., multiplied by the heating sizing factor Rh of the corresponding system for the *proposed design*, as determined in Subsection 4.4.5.

Heating coil, or capacity of packaged unit.

The *proposed design* heating system cannot be undersized. It may be oversized, but if it is oversized, then the reference is correspondingly oversized.

**2)** If the reference system is of Type AH2 as described in Table 5.4.1.B., then the compliance shell shall set the capacity of the heating (reheat) terminal unit in each *thermal block* served by the system to be equal to the peak reheat required by the *thermal block*, as calculated in Subsection 5.4.2., multiplied by the heating sizing factor Rh for the corresponding system of the *proposed design*, as determined in Subsection 4.4.5.

## 5.4.6. System Cooling Capacity

**1)** The compliance shell shall set the cooling capacity of each *secondary system* for the *reference case* to be equal to the peak cooling load, as determined in Subsection 5.4.4., multiplied by the cooling sizing factor $R_C$ of the corresponding system for the *proposed design*, as determined in Subsection 4.4.6.

Cooling coil, or capacity of packaged unit.

The *proposed design* cooling system can be either oversized or undersized. If it is, then the reference is correspondingly oversized or undersized.

## 5.4.7. Heating Equipment

**1)** Except as provided in Sentence (2), the compliance shell shall determine the heating equipment for the *reference case* depending on the type of heating equipment and the heating energy source specified for the *proposed design*, in accordance with Articles 5.4.7.1. to 5.4.7.6.

---

**This is an optional software capability:**

**2)** If heating equipment is identified as "existing," then the *reference case* shall be the same as the "existing" equipment.

---

### 5.4.7.1. Electric Resistance Heating

**1)** If, for the *proposed design,* the *secondary system* and the terminal heating in *thermal blocks* served by the *secondary system* does not contain heating capacity from a source other than electric resistance heating, then the heating energy source for the corresponding *secondary system* for the *reference case* shall be electric resistance.

### 5.4.7.2. Heat Pumps

**1)** If, for the *proposed design,* the *secondary system* is an electric heat pump and none of the heating capacity for auxiliary heating or terminal heating in *thermal blocks* served by the *secondary system* is from a source having an *energy source adjustment factor* (from Appendix D of the *Code*) less than that for "heat pump," then the corresponding *secondary system* for the *reference case* shall be an electric heat pump having a constant COP equal to the reciprocal of the *energy source adjustment factor* for "heat pump."

**2)** If, for the *proposed design,* the *secondary system* is an electric heat pump and some of the heating capacity for auxiliary heating or terminal heating in *thermal blocks* served by the *secondary system* is from a source having an *energy source adjustment factor* (from Appendix D of the *Code*) less than that for "heat pump," then the energy source for the reference system heating shall be that fuel used in the *proposed design* that has the lowest *energy source adjustment factor*, and

a) if the *proposed design* is air-to-air heat pump, then the reference system heating will be a *furnace* as given in Article 5.4.7.3.;

b) if the *proposed design* is ground source or water loop heat pump, then the reference system heating will be hydronic with a *boiler* as given in Article 5.4.7.4.

### 5.4.7.3. Fuel Fired Heater

**1)** If, for the *proposed design,* the *secondary system* is a fuel fired heater (e.g. *furnace*) and none of the heating capacity for the *secondary system* or terminal heating in *thermal blocks* served by the *secondary system* is either hydronic or from a source having an *energy source adjustment factor* (from Appendix D of the *Code*) less than that for the energy source for the fuel fired heater, then the corresponding *secondary system* for the *reference case* shall be heated by a fuel fired *furnace* having the same fuel as specified for the *proposed design*.

**2)** The heating capacity of the *furnace* shall be the system heating capacity as determined in Subsection 5.4.5.

3) The *furnace* is defined as follows:

a) efficiency at full load of 80%;

b) part load characteristics as given in Appendix A.

### 5.4.7.4. Hydronic Heating

**1)** If, for the *proposed design*, the *secondary system* heating or terminal heating in *thermal blocks* served by the *secondary system* includes capacity that is hydronic, except in the case of an air-to-air heat pump, then the corresponding *secondary system* for the *reference case* shall be hydronic with a fuel fired heating plant.

**2)** The fuel for the reference system heating plant shall be the same as for the *proposed design*.

**3)** The heating capacity of the heating plant shall be calculated in accordance with good engineering practice, as defined in Article 6.2.1.1. of the National Building Code of Canada, from the heating capacities for the systems served by the plant, as determined in Subsection 5.4.5. of this document. The calculation method shall be the same as that in Subsection 4.4.4.

Calculation based on coincident loads is acceptable.

**4)** The reference system heating plant shall consist of one *boiler* defined as follows:

a) efficiency at full load of 80%;

b) part load characteristics as given in Appendix A.

#### 5.4.7.5. Purchased Heating

**1)** If, for the *proposed design,* the primary heating system is purchased hot water or steam, then the *reference case* shall be a fuel fired *boiler* fired by the fuel identified as the energy source for the purchased heating (see Article 4.7.2.2.).

#### 5.4.7.6. Pumps for Hydronic Heating

**1)** If the *reference case* contains a heating plant (see Articles 5.4.7.4. and 5.4.7.5.), then the power for heating circulation pumps for the heating plant shall be calculated for a constant speed pump having:

a) combined motor/impeller efficiency of 60%;

b) design water flow rate based on *boiler* capacity from Article 5.4.7.4 and 16°C (29°F) temperature drop; and

c) design pump head equal to the effective pump head from Article 4.7.2.4.

### 5.4.8. Cooling Equipment

**1)** Except as provided in Sentence (2), the compliance shell shall determine the cooling equipment for the *reference case* depending on the type of cooling equipment specified for the *proposed design*, in accordance with Articles 5.4.8.1. to 5.4.8.4.

**This is an optional software capability:**

**2)** If cooling equipment is identified as “existing,” then the *reference case* will be the same as the “existing” equipment.

#### 5.4.8.1. No Cooling

**1)** If, for the *proposed design,* the *secondary system* and the terminal cooling in *thermal blocks* served by the *secondary system* does not contain cooling capacity, then the corresponding *secondary system* for the *reference case* shall have no cooling capacity.

#### 5.4.8.2. Direct Expansion Cooling

**1)** If, for the *proposed design*, the *secondary system* cooling is direct expansion, then the cooling equipment for the corresponding *secondary system* for the *reference case* shall be (electric) direct expansion.

**2)** The cooling capacity of the direct expansion unit shall be the system cooling capacity as determined in Subsection 5.4.6.

**3)** The unit shall be defined as follows:

a) COP at full load conditions of Section 2.5; and

b) performance characteristics (as function of part load) as given in Appendix A.

### 5.4.8.3. Hydronic Cooling

**1)** If, for the *proposed design,* the cooling for the *secondary system* or for terminal cooling in *thermal blocks* served by the *secondary system* is hydronic, then the cooling for the corresponding *secondary system* for the *reference case* shall be hydronic with an electric chiller plant.

**2)** The cooling capacity of the chiller plant shall be the sum of the cooling capacities for the systems served by the plant, as determined in Subsection 5.4.6.

**3)** If the chiller plant capacity is no greater than 700 kw (200 tons), then the plant shall consist of one reciprocating chiller having characteristics as given in Sentence (6).

**4)** If the chiller plant capacity is greater than 700 kw (200 tons) but not greater than 2100 kw (600 tons), then the plant shall consist of one centrifugal chiller having characteristics as given in Sentence (7).

**5)** If the chiller plant capacity is greater than 2100 kw (600 tons), then the plant shall consist of 2 centrifugal chillers, each with a capacity of 50% of the plant capacity, having characteristics as given in Sentence (7).

**6)** Each reciprocating chiller shall be defined as follows:

a) COP at design conditions of Section 3.8;

b) performance characteristics (as function of part load and condenser water temperature) as given in Appendix A.

**7)** Each centrifugal chiller shall be defined as follows:

a) COP at design conditions of 5.2;

b) performance characteristics (as function of part load and condenser water temperature) as given in Appendix A;

**8)** The program shall calculate the cooling tower capacity required based on water temperature rise from 29°C to 35°C (85°F to 95°F).

**9)** If the cooling tower capacity is greater than 1750 kw (500 tons), then the cooling tower for the *reference case* shall consist of multiple cells, the size of each cell being the capacity in kw divided by 1750.

**10)** Cooling tower fan power shall be calculated based on:

a) a constant speed fan with cycling control (i.e. proportional to load);
b) design fan power in watts equal to 0.015 multiplied by the tower capacity in kw (5.9 hp/1000MBH).

**11)** Cooling tower pump power shall be calculated based on:

a) a constant speed pump with a water flow rate determined from tower capacity and water temperature rise of 6°C (10°F);
b) pump head equal to:
   i) if the *proposed design* contains a cooling tower pump, then the cooling tower pump head for the *proposed design*; or
   ii) if the *proposed design* does not contain a cooling tower pump, then equal to 180 kPa (60 ft); and
c) combined motor/impeller efficiency of 70%.

**12)** Cooling tower performance characteristics (as function of part load and ambient conditions) shall be as given in Appendix A.

#### 5.4.8.4. Pumps for Hydronic Cooling

**1)** If the *reference case* contains a chiller plant (see Article 5.4.8.3.), then the design power for cooling circulation pumps for the chiller plant shall be calculated for a constant speed pump having:

a) combined motor/impeller efficiency of 60%;
b) design water flow rate based on chiller capacity from Article 5.4.8.3. and 6°C (11°F) temperature drop; and
c) design pump head equal to the effective pump head from Article 4.7.3.6.

### 5.4.9. Supply and Return Fans

**1)** Except when a fan is “existing” the compliance shell shall define the supply and return fans of each *secondary system* for the *reference case* as follows:

a) For modeling of fan temperature rise, the supply fan motor shall be assumed to be located in the air stream and located after heating/cooling coils (i.e. drawthrough configuration).
b) Fans static pressure (sp) and efficiency (eff) shall be as given in Tables 5.4.1.A. through 5.4.1.C.

c) If the reference system is of Type AH2, as described in Table 5.4.1.B., then the fan power versus flow rate characteristic shall be as given in Figure 5.4.9.A., depending on the design fan power determined from equation:

$$W_F = (0.001 \bullet F \bullet sp) / eff$$

$W_F$ = (cfm•746•sp)/(6350•eff)

where

F is the system design air flow rate in L/s from Subsection 5.4.3.:

i) if $W_F$ is ≤ 7.5 kw, then as shown in curve a;
ii) if $W_F$ is > 7.5 kw but ≤ 25 kw, then as shown in curve b;
iii) if $W_F$ is > 25 kw, then as shown in curve c.

**Fans**

If P < D, then F = E, otherwise F = A + B • P + C • P • P

| Fan Type\Coefficient | A | B | C | D | E |
|---|---|---|---|---|---|
| (a) | 0.227143 | 1.178929 | -0.41071 | 0.47 | 0.68 |
| (b) | 0.584345 | -0.57917 | 0.970238 | 0.35 | 0.5 |
| (c) | 0.339619 | -0.84814 | 1.495671 | 0.25 | 0.22 |
| (d) | 0.00153028 | 0.00520806 | 1.0086242 | 0.20 | 0.04 |

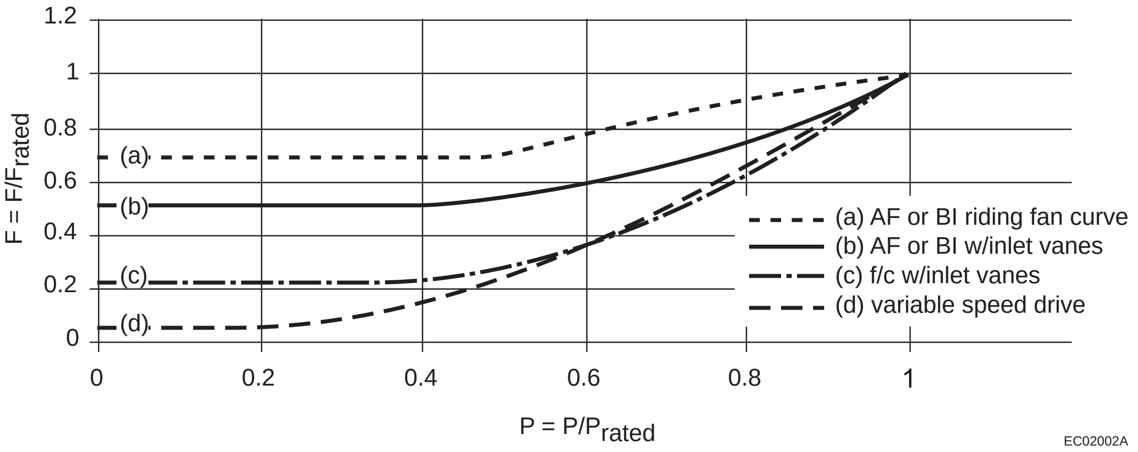

Figure 5.4.9.A. Fan Part-Load Curves

**This is an optional software capability:**

**2)** If a fan is identified as “existing,” then the *reference case* shall be the same as the “existing” fan.

## 5.4.10. Exhaust Fans

**1)** The compliance shell shall define the exhaust fans for the *reference case* to be the same as those for the *proposed design*.

## 5.4.11. Outdoor Air

**1)** The compliance shell shall define the control of outdoor air for each *secondary system* of the *reference case* in accordance with Sentences (2) to (5).

**2)** If the reference system is of Type AH3, as described in Table 5.4.1.C., then the outdoor air shall be constant when the system is scheduled on and equal to the outdoor air requirements for the *thermal block* served by the system (see Subsection 5.3.2.).

**3)** If the reference system is of Type AH1, as described in Table 5.4.1.A., or AH2, as described in Table 5.4.1.B., then the control of outdoor air when the system is scheduled on shall be as follows:

- a) Outdoor air flow rate shall be no lower than the minimum, as calculated in Sentence (4) or (5) as applicable;
- b) When outdoor air temperature is lower than system supply air temperature, then system supply air temperature shall be achieved by mixing return air and outdoor air, where outdoor air can be up to 100% of supply air and may be no lower than the minimum outdoor air flow rate for the system as calculated in Sentences (4) and (5); at low outdoor air temperatures the mixed air may have to be heated to achieve system supply air temperature;
- c) When outdoor air temperature is higher than the system supply air temperature:
  - i) if the enthalpy of outdoor air is no greater than the enthalpy of return air, then the outdoor air shall be 100% of the supply air;
  - ii) if the enthalpy of outdoor air is greater than the enthalpy of the return air, then the outdoor air shall be equal to the minimum outdoor air flow rate for the system as calculated in Sentences (4) and (5).

**4)** If the reference system is of Type AH1, as described in Table 5.4.1.A., or AH3, as described in Table 5.4.1.C., then the minimum outdoor air flow rate for the system shall be equal to the minimum outdoor air requirement for the *thermal block* that it serves.

**5)** If the reference system is of Type AH2, as described in Table 5.4.1.B., then the minimum outdoor air flow rate for the system shall be calculated as follows:

This is derived from the critical zone method of ASHRAE 62-1989 and ensures that each *thermal block* receives adequate ventilation.

a) calculate TOA as the sum of minimum outdoor air requirements for the *thermal blocks* served;
b) calculate X, equal to TOA divided by the system design air flow rate from Subsection 5.4.3.;
c) for each *thermal block* j, served by the system, calculate $Z_J$ equal to the minimum outdoor air requirement for the *thermal block* divided by (2 L/s • floor area of *thermal block* in $m^2$);
d) determine $Z_{CRIT}$, the maximum value of $Z_J$;
e) calculate Y,
   $Y = X / (1 + X - Z_{CRIT})$;
f) minimum outdoor air flow rate (L/s) for system = Y • 2 • the sum of the floor areas of the *thermal blocks* served by the system.

This is minimum VAV flow rate.

## 5.4.12. Operating Schedules

**1)** The *compliance shell* shall set room temperature and system operating schedules for the *reference case* to be the same as determined for the *proposed design* in Subsection 4.3.2. (and, if exceptional conditions were specified, Article 4.3.3.5.).

**2)** If the *proposed design* supplies heating during setback periods without the use of a fan (e.g. baseboards), then the *reference case* heating during setback periods shall be baseboard heating.

**3)** If the *proposed design* supplies heating during setback periods by operating the fan system, then the *reference case* shall cycle the fan system on demand for heating during setback periods but operate with no cooling and zero outdoor air during this operation.

## 5.4.13. Service Water Heating

**1)** Except as provided in Sentence (6), the *compliance shell* shall define a *service water* heating system for the *reference case* in accordance with Sentences (2) to (5).

**2)** The *service water* heating load for the *reference case* shall be the same as that determined for the *proposed design*.

**3)** The *service water* standby loss for the *reference case* shall be the same as that determined for the *proposed design*.

Requirements for *standby losses* are in the mandatory section of the *Code*.

**4)** If the *service water* for the *proposed design* is heated electrically, then the *reference case service water* heating system shall be electric.

**5)** If the *service water* heating for the *proposed design* is not electric, then the *reference case service water* heating system has the same fuel source as the *proposed design* and consists of one *boiler* defined as follows:

a) efficiency at full load of 80%;
b) part load characteristics as given in Appendix A.

**This is an optional software capability:**

**6)** If *service water* heating is identified as “existing,” then the *reference case* shall be the same as the “existing” *service water* heating system.

# CHAPTER 6
# COMPLIANCE SOFTWARE:  OUTPUT REPORTS

## 6.1. General

### 6.1.1. Page Identification

**1)** Each page of every report produced by the compliance shell shall contain a header including the following information:

a) project name;
b) date of analysis;
c) unique run number to identify all report pages as being the result of that analysis run;
d) report title; and
e) page number (consecutive within each report).

This is to prevent pages from different analysis runs, or getting mixed up.

**2)** If the *proposed design* fails to show compliance (see Section 3.9), then the header of every report produced by that run shall contain a clear indication that it is “not for Code compliance.”

**3)** If the compliance software has the capability of performing non-compliance analysis, then the header of every report produced by a non-compliance run shall contain a clear indication that it is “not for Code compliance.”

### 6.1.2. Required Reporting Capability

**1)** The compliance shell shall be capable of producing compliance reports and non-compliance messages as described in Sections 6.2. and 6.3.

# 6.2. Compliance Reports

## 6.2.1. Basic Compliance Report

**1)** The following information shall be included in the basic compliance report produced by the compliance shell.

### 6.2.1.1. Project Information

**1)** The project information section of the report shall contain:

a) project name or identifier;
b) project description;
c) project address;
d) name of designer responsible for certifying compliance with the *Code*;
e) geographic region in which *proposed design* is to be built;
f) identifier for climate data set used for analysis;
g) *principal heating source*; and
h) conditioned floor area of the *proposed design*.

### 6.2.1.2. Envelope Summary Data

**1)** This section of the report shall contain the following data for both the *proposed design* and the *reference case*:

a) gross wall area;
b) total window area;
c) gross roof area;
d) total *skylight* area;
e) *fenestration-to-wall ratio*;
f) *overall thermal transmittance* for opaque *walls*;
g) *overall thermal transmittance* for *fenestration*;
h) *overall thermal transmittance* for opaque *roofs*;
i) *overall thermal transmittance* for *skylights*;
j) heat loss coefficient for the *building*, determined as the sum of the product of area and *overall thermal transmittance* for all above-ground envelope components; and
k) heat loss coefficient for the *building*, normalized by dividing by total floor area.

This includes values that can be used as a reality check in reviewing the report.

**2)** The report shall identify which *building* characteristics fall short of the prescriptive requirements of the *Code* and which *building* characteristics exceed them.

### 6.2.1.3. Lighting Summary Data

**1)** This section of the report shall contain the following data for the *proposed design*:

a) total connected lighting power in *conditioned spaces*, kw;
b) average *lighting power density*, obtained by dividing the total connected lighting power by the total floor area, w/m$^2$;

c) total lighting power allowance, kw; and
d) average *lighting power density*, obtained by dividing the total lighting power allowance by the total floor area, w/m$^2$.

**2)** The report shall identify which *building* characteristics fall short of the prescriptive requirements of the *Code* and which *building* characteristics exceed them.

### 6.2.1.4. HVAC Summary Data

**1)** This section of the report shall contain the following data for the *proposed design*:
a) total heating capacity, by heating energy source used;
b) total cooling capacity, by energy source used for cooling;
c) total supply air flow; l/s;
d) total supply fan power at design, kw;
e) total return fan power at design, kw;
f) sum of supply fan power plus return fan power divided by total supply air flow, w per l/s.

**2)** This section of the report shall contain the following data for the *reference case* systems:
a) total heating capacity, by heating energy source used;
b) total cooling capacity, by energy source used for cooling;
c) total supply air flow; l/s;
d) total supply fan power at design, kw;
e) total return fan power at design, kw; and
f) sum of supply fan power plus return fan power divided by total supply air flow, w per l/s.

**3)** The report shall identify which *building* characteristics fall short of the prescriptive requirements of the *Code* and which *building* characteristics exceed them.

### 6.2.1.4.A. *Service Water* Heating Summary Data

**1)** The report shall identify whether or not *service water* heating systems of the *proposed design* have been taken into account in the simulation.

**2)** If *service water* heating systems are part of the simulation, this section of the report shall contain the total heating capacity for both the *proposed design* and the *reference case*.

**3)** The report shall identify which *building* characteristics fall short of the prescriptive requirements of the *Code* and which *building* characteristics exceed them.

**1)** This section of the report shall contain an advisory or warning message for every instance in which such a message is called for in the present document.

#### 6.2.1.5. Advisory Messages

**1)** This section of the report shall contain an advisory or warning message for every instance in which such a message is called for in this supplement.

#### 6.2.1.6. Energy Performance Summary

**1)** This section of the report shall contain the following results from the performance analysis:

a) the portion of energy use of the *proposed design* for each energy source, MJ;
b) the portion of the energy budget corresponding to each energy source, MJ;
c) the energy use of the *proposed design* (sum of all energy sources), MJ; and
d) the energy budget for the *proposed design* (sum of all energy sources), MJ.

#### 6.2.1.7. Statement of Compliance

**1)** If the energy use is no greater than the energy budget, then the report shall contain a statement that the design corresponding to this analysis satisfies the energy budget requirement and complies with the *Code*.

**2)** If the energy use is greater than the energy budget, then the report shall contain a statement that the design corresponding to this analysis fails the energy budget requirement and does not comply with the *Code*.

#### 6.2.1.8. Certification

**1)** This section of the report shall contain a statement of certification, to be signed by the designer, that:

a) this analysis was performed in accordance with Part 8 of the *Code*;
b) input for this analysis is a true representation of the *proposed design* submitted for approval; and
c) all other requirements of Part 8 of the *Code* are satisfied.

### 6.2.2. Input Data for Proposed Design

**1)** This report shall provide, in a clearly readable form, a complete list of all inputs on which the compliance analysis is based.

## 6.3. Messages of Non-Compliance

**1)** When the compliance shell determines non-compliance because of errors found in input consistency or heating capacity checks, it shall produce a report describing the reason for non-compliance.

# CHAPTER 7
# ENERGY ANALYSIS MODULE: CALCULATION CAPABILITIES

## 7.1. General

### 7.1.1. Scope

**1)** The energy analysis module used in the compliance software must satisfy the requirements contained in this chapter.

**2)** The energy analysis module shall be capable of modeling all of the features and characteristics that are required capabilities of the compliance shell as provided in Article 4.1.2.5.

**3)** The energy analysis module shall be capable of modeling those optional capabilities that are included in the compliance shell, as provided in Article 4.1.2.6.

**4)** The energy analysis module shall be capable of modeling at least 15 *thermal blocks*.

**5)** The energy analysis module shall be capable of modeling at least 15 separate *secondary systems*.

### 7.1.2. Calculation Methods

**1)** The energy analysis module shall calculate the annual consumption of fuel and electricity for:
- a) heating;
- b) cooling;
- c) fans, pumps, and auxiliaries;
- d) lights;
- e) receptacles and miscellaneous electric; and
- f) *service water* heating.

**2)** The energy analysis module shall perform a simulation on a time interval no greater than 1 hour over a one year period (8760 hours).

**3)** The calculation methods employed in the simulation shall be scientifically justified (ASHRAE accepted or equivalent).

The DOE-2.1E program will be considered a standard against which other software can be compared.

### 7.1.3. Climate Data

**1)** The energy analysis module shall perform simulation using hourly values of climate data, such as temperature, humidity and insolation derived from measured climate data and shown to be a good representation of climate, compared to the average of at least 10 years of measured data, for the weather station representative of the administrative region (see Appendix B).

CWEC files are examples of data that could satisfy this requirement.

**2)** The energy analysis module shall calculate solar radiation on exterior surfaces on an hourly basis from the values of direct normal irradiance and diffuse horizontal irradiance contained in the climate data, assuming a ground reflectance (albedo) of 0.6 for hours when there is snow cover and 0.2 when there is no snow cover.

### 7.1.4. Thermal Mass

**1)** The calculation procedures used in the energy analysis module shall account for the effect of thermal mass on:

a) loads due to occupants, lights, solar radiation, and transmission through *building envelope*;
b) amount of heating and cooling required to maintain the specified space temperature schedules; and
c) variation in space temperature.

### 7.1.5. Modeling Space Temperature

**1)** The energy analysis module shall contain a dynamic simulation of space temperature that accounts for:

a) deadband between heating and cooling thermostat settings;
b) temperature drift in transition to setback or setup thermostat schedules;
c) temperature drift in periods when heating or cooling capability are scheduled off;
d) temperature drift when heating or cooling capability of the system is limited by heating or cooling capacity, air flow rate, or scheduled supply air temperature; and
e) indirectly conditioned *thermal blocks*, where the temperature is determined by internal loads, heat transfer through *building envelope*, and heat transfer between *thermal blocks* (see Subsection 7.1.6.).

### 7.1.6. Heat Transfer Between Thermal Blocks

**1)** The energy analysis module shall be capable of modeling heat transfer between a *thermal block* and adjacent *thermal blocks*.

**2)** The energy analysis module shall account for the effect of this heat transfer on the space temperature, space conditioning loads, and resulting energy use in the *thermal block* and in the adjacent *thermal blocks*.

## 7.2. Loads Calculation

### 7.2.1. Internal Loads

**1)** The energy analysis module shall be capable of calculating the hourly cooling loads due to occupants, lights, receptacles, and process loads.

**2)** The energy analysis module shall be capable of simulating schedules for internal loads in the form given in Table 4.3.2.C.

**3)** The simulation of cooling load due to lights shall account for:

a) the effect of the proportion radiant and convective heat, which depends on the type of light, on the dynamic response characteristic; and
b) a portion of heat from lights going directly to return air, the amount depending on the type and location of fixture.

### 7.2.2. *Building Envelope* Loads

**1)** The energy analysis module shall calculate heat transfer through walls, roofs and floors for each *thermal block*, accounting for the dynamic response due to thermal characteristics of the particular construction, as defined in Articles 4.3.5.1. through 4.3.5.3.

**2)** The calculation of heat transfer through walls and roofs shall account for the effect of solar radiation absorbed on the exterior surface, which depends on orientation and absorptance of the surface.

**3)** The energy analysis module shall calculate heat transfer through *fenestration*, including *skylights*, accounting for both temperature difference and transmission of solar radiation through the glazing.

**4)** Calculation of cooling load due to transmission of solar radiation through *fenestration* shall account for:

- a) orientation (azimuth and tilt of surface);
- b) thermal and solar properties (*U-value* and *solar heat gain coefficient* or shading coefficient); and
- c) dynamic response due to effect of thermal mass characteristics of the space.

### 7.2.3. Air Leakage (Infiltration)

**1)** The energy analysis module shall be capable of simulating a constant rate of air leakage (infiltration).

## 7.3. Systems Simulation

### 7.3.1. General

**1)** The energy analysis module shall be capable of modeling:

- a) the reference systems defined in Section 5.4.;
- b) the systems listed in Table 4.4.1.A. (see Article 4.4.1.2.); and
- c) all required features as provided in Article 4.4.1.2.

**2)** The capability to model multiple zone systems shall allow at least 15 *thermal blocks* to be served by one multiple zone system.

### 7.3.2. Terminal Characteristics

**1)** The energy analysis module shall be capable of simulating the effect on space temperature and energy use of:

- a) limited capacity of terminal heating devices;
- b) limited capacity of terminal cooling devices; and
- c) limited rate of air flow to the *thermal block*.

### 7.3.3. Secondary Systems

**1)** The energy analysis module shall be capable of simulating the effect on energy use and space temperature in *thermal blocks* served by the *secondary system* of:

- a) limited heating capacity of *secondary system*; and
- b) limited cooling capacity of *secondary system*.

**2)** The simulation of *secondary systems* shall account for:

a) temperature rise of supply air due to heat from supply fan, depending on the location of the fan;
b) temperature rise of return air due to heat from return fan;
c) temperature rise of return air due to heat from lights to return air stream; and
d) fan power as a function of supply air flow in variable air volume systems.

## 7.3.4. Primary Systems

**1)** The energy analysis module shall be capable of simulating the effect on energy use of limited heating or cooling capacity of the *primary system*.

**2)** If the energy analysis module is not capable of simulating the effect of limited heating or cooling capacity of the *primary system* on space temperature in *thermal blocks* dependent on the *primary system* for heating and cooling, then it shall issue a warning message when loads on the *primary system* are not met.

## 7.3.5. Equipment Efficiency

**1)** The energy analysis module shall be capable of modeling the efficiency of *furnaces* and *boilers* as a function of part load.

**2)** The energy analysis module shall be capable of modeling the efficiency of heat pumps and direct expansion cooling as a function of part load and climatic conditions.

**3)** The energy analysis module shall be capable of modeling the efficiency of chillers as a function of part load and condensing fluid temperature.

# APPENDIX A
# EQUIPMENT PERFORMANCE CHARACTERISTICS

This Appendix contains the performance characteristics that are required for *reference case* equipment, and those that are to be defaults for the *proposed design*.

These performance characteristics are specified as the curve-fit equations and coefficients that are the defaults in the DOE-2 program. If a program other than DOE-2 is used for the energy analysis module then other representations of performance characteristics are acceptable, provided they give equivalent performance for the equipment described.

## A.1 Service Water Heater

The following shall be applied for *reference case service water* heating *boilers* that are not electric (see Subsection 5.4.13.), and shall be the default characteristics for *proposed design service water* heating *boilers* that are not electric (see Article 4.7.5.4.).

### Fuel Service Water Heater Part Load Efficiency Curve

An adjustment factor that represents the percentage full load fuel consumption as a function of the percentage full load capacity.

$$Fuel_{partload} = Fuel_{design} \times FHeatPLC\left(Q_{partload}, Q_{rated}\right)$$

$$FHeatPLC = \left( a + b \times \frac{Q_{partload}}{Q_{rated}} + c \times \left( \frac{Q_{partload}}{Q_{rated}} \right)^2 \right)$$

where:

| | | |
|---|---|---|
| FHeatPLC | = | The Fuel Heating Part Load Efficiency Curve |
| $Fuel_{partload}$ | = | The fuel consumption at part load conditions |
| $Fuel_{design}$ | = | The fuel consumption at design conditions |
| $Q_{partload}$ | = | The water heater capacity at part load conditions |
| $Q_{rated}$ | = | The water heater capacity at design conditions |
| a | = | Constant, 0.021826 |
| b | = | Constant, 0.977630 |
| c | = | Constant, 0.000543 |

## A.2 Furnace

The following shall be applied when the *reference case* heating is a *furnace* (see Article 5.4.7.3.), and shall be the default characteristics for *proposed design* heating that is a *furnace* (see Subsection 4.6.8.).

### Furnace Fuel Heating Part Load Efficiency Curve

An adjustment factor that represents the percentage full load fuel consumption as a function of the percentage full load capacity.

$$Fuel_{partload} = Fuel_{rated} \times FHeatPLC\left(Q_{partload}, Q_{rated}\right)$$

$$FHeatPLC = \left(a + b \times \frac{Q_{partload}}{Q_{rated}} + c \times \left(\frac{Q_{partload}}{Q_{rated}}\right)^2\right)$$

where:

FHeatPLC = The Fuel Heating Part Load Efficiency Curve

$Fuel_{partload}$ = The fuel consumption at part load conditions (Btuh)

$Fuel_{rated}$ = The fuel consumption at rated conditions (Btuh)

$Q_{partload}$ = The capacity at part load conditions (Btuh)

$Q_{rated}$ = The capacity at rated conditions (Btuh)

$Q_{available}$ = The available capacity at present conditions (Btuh)

a = Constant, 0.0186100

b = Constant, 1.0942090

c = Constant, -0.1128190

# A.3 Boiler

The following shall be applied when the *reference case* heating is a *boiler* (see Article 5.4.7.4.), and shall be the default characteristics for *proposed design* heating that is a *boiler* (see Article 4.7.2.3.).

## Fuel Heating Boiler Efficiency Adjustment Curve

An adjustment factor that represents the percentage full load fuel consumption as a function of the percentage full load capacity.

$$Fuel_{partload} = Fuel_{design} \times FHeatPLC\left(Q_{partload}, Q_{rated}\right)$$

$$FHeatPLC = \left( a + b \times \frac{Q_{partload}}{Q_{rated}} + c \times \left( \frac{Q_{partload}}{Q_{rated}} \right)^2 \right)$$

where:

FHeatPLC = The Fuel Heating Part Load Efficiency Curve

$Fuel_{partload}$ = The fuel consumption at part load conditions (Btuh)

$Fuel_{design}$ = The fuel consumption at design conditions (Btuh)

$Q_{partload}$ = The *boiler* capacity at part load conditions (Btuh)

$Q_{rated}$ = The *boiler* capacity at design conditions (Btuh)

a = Constant, 0.082597

b = Constant, 0.996764

c = Constant, -0.079361

## A.4 Direct Expansion Cooling

The following shall be applied when the *reference case* cooling is direct expansion (see Article 5.4.8.2.), and shall be the default characteristics for *proposed design* cooling that is direct expansion (see Subsection 4.6.9.).

### Electric DX Cooling Capacity Adjustment Curves

A curve or group of curves that represent the available total cooling capacity as a function of cooling coil and condenser conditions

$$Q_{available}\left(t_{wb}, t_{odb}\right) = CAP\_FT \times Q_{rated}$$

$$CAP\_FT = a + b \times t_{wb} + c \times t_{wb}{}^{2} + d \times t_{odb} + e \times t_{odb}{}^{2} + f \times t_{wb} \times t_{odb}$$

where:

$Q_{available}$ = Available cooling capacity at present evaporator and condenser conditions (MBH)

$t_{wb}$ = The entering coil wet-bulb temperature (°F)

$t_{odb}$ = The outside-air dry-bulb temperature (°F)

$Q_{rated}$ = Rated capacity at ARI conditions (MBH)

a = Constant, 0.8740302

b = Constant, -0.0011416

c = Constant, 0.0001711

d = Constant, -0.0029570

e = Constant, 0.0000102

f = Constant, -0.0000592

Note: if an air-cooled unit employs an evaporative condenser, $t_{odb}$ is the effective dry-bulb temperature of the air leaving the evaporative cooling unit.

## Electric DX Cooling Efficiency Adjustment Curve

A curve or group of curves that varies the cooling efficiency of a direct expansion (DX) coil as a function of evaporator conditions, condenser conditions and part-load ratio.

$$P_{operating} = P_{rated} \times EIR\_FPLR \times EIR\_FT \times CAP\_FT$$

where:

$P_{operating}$ = Power draw at specified operating conditions (kW)
$P_{rated}$ = Rated power draw at ARI conditions (kW)
$EIR\_FPLR$ = Adjustment to rated efficiency due to changes in coil load
$EIR\_FT$ = Adjustment to rated efficiency due to environmental variables

$$EIR\_FPLR = a + b \times PLR + c \times PLR^2 + d \times PLR^3$$

where:

$PLR$ = Part load ratio based on available capacity (not rated capacity)
a = Constant, 0.2012301
b = Constant, -0.0312175
c = Constant, 1.9504979
d = Constant, -1.1205105

$$PLR = \frac{Q_{operating}}{Q_{available}\left(t_{wb}, t_{odb}\right)}$$

where:

$Q_{operating}$ = Present load (Btuh)
$Q_{available}$ = Available capacity at present evaporator and condenser conditions (Btuh).
$t_{wb}$ = The entering coil wet-bulb temperature (°F)
$t_{odb}$ = The outside-air dry-bulb temperature (°F)

Note: if an air-cooled unit employs an evaporative condenser, $t_{odb}$ is the effective dry-bulb temperature of the air leaving the evaporative cooling unit.

$$EIR\_FT = a + b \times t_{wb} + c \times t_{wb}{}^{2} + d \times t_{odb} + e \times t_{odb}{}^{2} + f \times t_{wb} \times t_{odb}$$

where:

$t_{wb}$ = The entering coil wet-bulb temperature (°F)

$t_{odb}$ = The outside-air dry-bulb temperature (°F)

a = Constant, -1.0639310

b = Constant, 0.0306584

c = Constant, -0.0001269

d = Constant, 0.0154213

e = Constant, 0.0000497

f = Constant, -0.0002096

## A.5 Electric Chiller

The following shall be applied when the *reference case* cooling is an electric chiller (see Article 5.4.8.3.), and shall be the default characteristics for *proposed design* cooling that is an electric chiller (see Article 4.7.3.3.).

### Electric Chiller Cooling Capacity Adjustment Curve

A curve or group of curves that represent the available total cooling capacity as a function of evaporator and condenser conditions.

$$Q_{available}\left(t_{chws}, t_{cws}\right) = CAP\_FT \times Q_{rated}$$

$$CAP\_FT = a + b \times t_{chws} + c \times t_{chws}{}^{2} + d \times t_{cws} + e \times t_{cws}{}^{2} + f \times t_{chws} \times t_{cws}$$

where:

$Q_{available}$ = Available cooling capacity at present evaporator and condenser conditions (MBH)

$t_{chws}$ = The chilled water supply temperature (°F)

$t_{cws}$ = The condenser water supply temperature (°F)

$Q_{rated}$ = Rated capacity at ARI conditions (MBH)

and coefficients are as follows:

| Coefficient | Reciprocating | Centrifugal |
|---|---|---|
| a | 0.58531422 | -0.29861976 |
| b | 0.01539593 | 0.02996076 |
| c | 0.00007296 | -0.00080125 |
| d | -0.00212462 | 0.01736268 |
| e | -0.00000715 | -0.00032606 |
| f | -0.00004597 | 0.00063139 |

## Electric Chiller Cooling Efficiency Adjustment Curves

A curve or group of curves that varies the cooling efficiency of an electric chiller as a function of evaporator conditions, condenser conditions and part-load ratio.

$$P_{operating} = P_{rated} \times EIR\_FPLR \times EIR\_FT \times CAP\_FT$$

where:

$P_{operating}$ = Power draw at specified operating conditions (kW)

$P_{rated}$ = Rated power draw at ARI conditions (kW)

$EIR\_FPLR$ = Adjustment to rated efficiency due to changes in load

$EIR\_FT$ = Adjustment to rated efficiency due to environmental variables

$$EIR\_FPLR = a + b \times PLR + c \times PLR^2$$

where:

$PLR$ = Part load ratio based on available capacity (not rated capacity)

and coefficients are as follows:

| Coefficient | Reciprocating | Centrifugal |
|---|---|---|
| a | 0.08144133 | 0.17149273 |
| b | 0.41927141 | 0.58820208 |
| c | 0.49939604 | 0.23737257 |

$$PLR = \frac{Q_{operating}}{Q_{available}\left(t_{chws}, t_{cws}\right)}$$

where:

$Q_{operating}$ = Present load on chiller (Btuh)

$Q_{available}$ = Chiller available capacity at present evaporator and condenser conditions (Btuh).

$t_{chws}$ = The chilled water supply temperature (°F)

$t_{cws}$ = The condenser water supply temperature (°F)

$$EIR\_FT = a + b \times t_{chws} + c \times t_{chws}^{2} + d \times t_{cws} + e \times t_{cws}^{2} + f \times t_{chws} \times t_{cws}$$

where:

$t_{chws}$ = The chilled water supply temperature (°F)

$t_{cws}$ = The condenser water supply temperature (°F)

and coefficients are as follows:

| **Coefficient** | **Reciprocating** | **Centrifugal** |
|---|---|---|
| a | 0.46140041 | 0.51777196 |
| b | -0.00882156 | -0.00400363 |
| c | 0.00008223 | 0.00002028 |
| d | 0.00926607 | 0.00698793 |
| e | 0.00005722 | 0.00008290 |
| f | -0.00011594 | -0.00015467 |

## A.6 Cooling Tower

The following shall be applied when the *reference case* cooling has a cooling tower (see Article 5.4.8.3.), and shall be the default characteristics for *proposed design* cooling towers (see Article 4.7.3.5.).

### Cooling Tower Capacity Adjustment Curve(s)

A curve or group of curves that represent the available total cooling capacity as a function of outdoor air wet-bulb, condenser water supply and condenser water return temperatures.

$$Q_{available} = Q_{rated} \times FWB \times \left( \frac{t_R}{10} \right)$$

where:

$Q_{available}$ = Available cooling capacity at present outside air and condenser water conditions (MBH)

$Q_{rated}$ = Rated cooling capacity at CTI test conditions (MBH)

FWB = The ratio of available capacity to rated capacity (gpm/gpm).

$$FWB = a + b \times FRA + c \times FRA^2 + d \times t_{owb} + e \times t_{owb}{}^2 + f \times FRA \times t_{owb}$$

where:

FRA = An intermediate capacity curve based on range and approach

$t_{owb}$ = The outside-air wet-bulb temperature (°F)

a = Constant, 0.60531402

b = Constant, -0.03554536

c = Constant, 0.00804083

d = Constant, -0.02860259

e = Constant, 0.00024972

f = Constant, 0.00490857

$$FRA = \frac{-d - f \times t_R + \sqrt{\left(d + f \times t_R\right)^2 - 4 \times e \times \left(a + b \times t_R + c \times t_R{}^2 - t_A\right)}}{2 \times e}$$

where:

$t_R$ = The tower range (°F)

$t_A$ = The tower approach (°F)

a = Constant, -2.22888899

b = Constant, 0.16679543

c = Constant, -0.01410247

d = Constant, 0.03222333

e = Constant, 0.18560214

f = Constant, 0.24251871

$$t_R = t_{cwr} - t_{cws}$$

and

$$t_A = t_{cws} - t_{owb}$$

where:

$t_{cw}$ = The condenser water return temperature (°F)

$t_{cws}$ = The condenser water supply temperature (°F)

$t_{owb}$ = The outside-air wet-bulb temperature (°F)

## A.7 Electric Air-Source Heat Pump

The following default characteristics for *proposed design* that is electric air-source heat pump (see Subsection 4.6.10.).

### Heat Pump Heating Capacity Adjustment Curve(s)

**Description:**

A curve or group of curves that represent the available heat-pump heating capacity as a function of evaporator and condenser conditions.

$$Q_{available}\left(t_{db}, t_{odb}\right) = CAP\_FT \times Q_{rated}$$

where:

$Q_{available}$ = Available heating capacity at present evaporator and condenser conditions (MBH)

$Q_{rated}$ = Rated capacity at ARI conditions (in MBH)

and

$$CAP\_FT = a + b \times t_{odb} + c \times t_{odb}{}^2 + d \times t_{odb}{}^3$$

where:

$t_{db}$ = The entering coil dry-bulb temperature (°F)

$t_{odb}$ = The outside-air dry-bulb temperature (°F)

a = Constant, 0.2536714

b = Constant, 0.0104351

c = Constant, 0.0001861

d = Constant, -0.0000015

## Heat Pump Heating Efficiency Adjustment Curve(s)

A curve or group of curves that varies the heat-pump heating efficiency as a function of evaporator conditions, condenser conditions and part-load ratio.

$$P_{operating} = P_{rated} \times EIR\_FPLR \times EIR\_FT \times CAP\_FT$$

where:

$P_{operating}$ = Power draw at specified operating conditions (kW)

$P_{rated}$ = Rated power draw at ARI conditions (kW)

$$EIR\_FPLR = a + b \times PLR + c \times PLR^2 + d \times PLR^3$$

where:

a = Constant, 0.0856522

b = Constant, 0.9388137

c = Constant, -0.1834361

d = Constant, 0.1589702

$PLR$ = Part load ratio based on available capacity (not rated capacity)

$$PLR = \frac{Q_{operating}}{Q_{available}\left(t_{db}, t_{odb}\right)}$$

where:

$Q_{operating}$ = Present load on heat pump (Btuh)

$Q_{available}$ = Heat pump available capacity at present evaporator and condenser conditions (Btuh).

$t_{db}$ = The entering coil dry-bulb temperature (°F)

$t_{odb}$ = The outside-air dry-bulb temperature (°F)

$$EIR\_FT = a + b \times t_{odb} + c \times {t_{odb}}^2 + d \times {t_{odb}}^3$$

where:

$t_{odb}$ = The outside-air dry-bulb temperature (°F)

a = Constant, 2.4600298

b = Constant, -0.0622539

c = Constant, 0.0008800

d = Constant, -0.0000046

## A.8 Absorption Chiller

The following default characteristics for *proposed design* that is absorption chiller (see Article 4.7.3.4.).

### Absorption Chiller Cooling Capacity Adjustment Curve

A curve or group of curves that represent the available total cooling capacity as a function of evaporator and condenser conditions.

$$Q_{available}\left(t_{chws}, t_{cws}\right) = CAP\_FT \times Q_{rated}$$

$$CAP\_FT = a + b \times t_{chws} + c \times t_{chws}^{\ 2} + d \times t_{cws} + e \times t_{cws}^{\ 2} + f \times t_{chws} \times t_{cws}$$

where:

$Q_{available}$ = Available cooling capacity at present evaporator and condenser conditions (MBH)

$t_{chws}$ = The chilled water supply temperature (°F)

$t_{cws}$ = The condenser water supply temperature (°F)

$Q_{rated}$ = Rated capacity at ARI conditions (MBH)

and coefficients are as follows:

| Coefficient | Single Stage Absorption | Double Stage Absorption | Direct-Fired Absorption |
|---|---|---|---|
| a | 0.723412 | -0.816039 | 1.000000 |
| b | 0.079006 | -0.038707 | 0.000000 |
| c | -0.000897 | 0.000450 | 0.000000 |
| d | -0.025285 | 0.071491 | 0.000000 |
| e | -0.000048 | -0.000636 | 0.000000 |
| f | 0.000276 | 0.000312 | 0.000000 |

## Steam-Driven Single and Double Effect Chiller Efficiency Adjustment Curves

A curve or group of curves that varies the cooling efficiency of a steam-driven single and double effect absorption chiller as a function of evaporator conditions, condenser conditions and part-load ratio.

$$Fuel_{partload} = Fuel_{rated} \times FIR\_FPLR \times FIR\_FT \times CAP\_FT$$

where:

| | | |
|---|---|---|
| $Fuel_{partload}$ | = | Fuel consumption at specified operating conditions (Btuh) |
| $Fuel_{rated}$ | = | Rated fuel consumption at ARI conditions (Btuh) |

$$FIR\_FT = a + b \times t_{chws} + c \times t_{chws}^{\;2} + d \times t_{cws} + e \times t_{cws}^{\;2} + f \times t_{chws} \times t_{cws}$$

where:

| | | |
|---|---|---|
| $t_{chws}$ | = | The chilled water supply temperature (°F) |
| $t_{cws}$ | = | The condenser water supply temperature (°F) |

and coefficients are as follows:

| Coefficient | Single Stage Absorption | Double Stage Absorption |
|---|---|---|
| a | 0.652273 | 1.658750 |
| b | 0.000000 | 0.000000 |
| c | 0.000000 | 0.000000 |
| d | -0.000545 | -0.290000 |
| e | 0.000055 | 0.000250 |
| f | 0.000000 | 0.000000 |

$$FIR\_FPLR = a + b \times PLR + c \times PLR^2$$

where:

*PLR* = Part load ratio based on available capacity (not rated capacity)

and coefficients are as follows:

| **Coefficient** | **Single Stage Absorption** | **Double Stage Absorption** |
|---|---|---|
| a | 0.098585 | 0.013994 |
| b | 0.583850 | 1.240449 |
| c | 0.560658 | -0.914883 |

$$PLR = \frac{Q_{operating}}{Q_{available}\left(t_{chws}, t_{cws}\right)}$$

where:

$Q_{operating}$ = Present load on chiller (Btuh)

$Q_{available}$ = Chiller available capacity at present evaporator and condenser conditions.

## Direct-Fired Double Effect Chiller Efficiency Adjustment Curves

A curve or group of curves that varies the cooling efficiency of direct-fired double effect absorption chiller as a function of evaporator conditions, condenser conditions and part-load ratio.

$$Fuel_{partload} = Fuel_{rated} \times FIR\_FPLR \times FIR\_FT1 \times FIR\_FT2 \times CAP\_FT$$

where:

$Fuel_{partload}$ = Fuel consumption at specified operating conditions (Btuh)
$Fuel_{rated}$ = Rated fuel consumption at ARI conditions (Btuh)

$$FIR\_FT1 = a + b \times t_{chws} + c \times t_{chws}{}^{2}$$

and

$$FIR\_FT2 = d + e \times t_{cws} + f \times t_{cws}{}^{2}$$

where:

$t_{chws}$ = The chilled water supply temperature (°F)
$t_{cws}$ = The condenser water supply temperature (°F)
a = Constant, 4.42871284
b = Constant, -0.13298607
c = Constant, 0.00125331
d = Constant, 0.86173749
e = Constant, -0.00708917
f = Constant, 0.0010251

$$FIR\_FPLR = a + b \times PLR + c \times PLR^{2}$$

where:

$PLR$ = Part load ratio based on available capacity (not rated capacity)
a = Constant, 0.13551150
b = Constant, 0.61798084
c = Constant, 0.24651277

$$PLR = \frac{Q_{operating}}{Q_{available}\left(t_{chws}, t_{cws}\right)}$$

where:

$Q_{operating}$ = Present load on chiller (Btuh)
$Q_{available}$ = Chiller available capacity at present evaporator and condenser conditions.

# APPENDIX B ADMINISTRATIVE REGIONS

| Province/ Territory | Administrative Region | Identification | Representative Weather Station |
|---|---|---|---|
| Newfoundland | A<br>B<br>C<br>D | Island, except Northern Peninsula<br>Northern Peninsula & Labrador Coast<br>Goose Bay/Happy Valley<br>Western Labrador | A & B: St John's<br>C & D: Goose Bay |
| Prince Edward Island | A | Prince Edward Island | Charlottetown |
| Nova Scotia | A | Nova Scotia | Halifax |
| New Brunswick | A | New Brunswick | Fredericton |
| Quebec | A<br>B<br>C | Existing Zone A*<br>Existing Zones B*, C* and D*<br>Existing Zone E* and F* | A: Montréal (Dorval)<br>B: Bagotville<br>C: Schefferville |
| Ontario | A<br>B | < 5000 Degree-days<br>≥ 5000 Degree-days | A: Toronto<br>B: Thunder Bay |
| Manitoba | A<br>B | South of the 53rd Parallel (< 6500 Degree-days approximately)<br>At or North of the 53rd Parallel | A: Winnipeg<br>B: Thompson |
| Saskatchewan | A | Saskatchewan | Saskatoon |
| Alberta | A<br>B<br>C | Calgary, Lethbridge<br>Red Deer, Edmonton, Grand Prairie<br>Fort McMurray | A: Calgary<br>B: Edmonton Int'l<br>C: Fort McMurray |

* (As defined in the existing Québec Regulation Respecting Energy Conservation in New Buildings)

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| Province/ Territory | Administrative Region | Identification | Representative Weather Station |
|---|---|---|---|
| British Columbia | A | ≤ 3500 Degree-days. Excluding:<br>• Vancouver Island<br>• the District of Squamish<br>• the Communities of Woodfibre, Port Mellon, Gibsons, Sechelt and Powel River<br>• Texada Island | A: Vancouver |
| | B | > 4500 Degree-days | B: Prince George |
| | C | Vancouver Island Gas Pipeline Service Area, Including<br>• Vancouver Island<br>• the District of Squamish<br>• the Communities of Woodfibre, Port Mellon, Gibsons, Sechelt and Powel River<br>• Texada Island | C: Victoria |
| | D | 3501 to 4500 Degree-days, B.C. Hydro Service Area | D & E: Kamloops |
| | E | 3501 to 4500 Degree-days,<br>West Kootenay Power Service Area | |
| Yukon | A | Southern Yukon | A: Whitehorse |
| | B | Central Yukon | B: Dawson (Norman Wells) |
| | C | Northern Yukon | C: Old Crow (Inuvik) |
| NWT | A | Southwest NWT | A: Fort Smith |
| | B | Great Slave Lake | B: Yellowknife |
| | C | Mackenzie Valley | C: Norman Wells |
| | D | Western Arctic | D: Inuvik |
| | E | Keewatin | E: Baker Lake |
| | F | Baffin | F: Iqualuit/Coral H. |
| | G | Eastern Arctic | G: Iqualuit/Coral H. |
| | H | Arctic Islands | H: Resolute |