Oregon
Kate Brown, Governor

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Construction Industry Energy Board and
Residential and Manufactured Structures Board
Combined meeting agenda
Tuesday, March 16, 2021, 9:30 a.m.
Live virtual-conference board meeting
Audio-streamed via the Internet

I. Board business

A. Call to order
B. Roll call for the Construction Industry Energy Board (CIEB)
C. Roll call for the Residential and Manufactured Structures Board (RMSB)
D. Approval of agenda and order of business
E. Approval of board meeting draft minutes:
   - CIEB meeting of Feb. 9, 2021
   - RMSB meeting of Jan. 6, 2021
F. Date of next regularly scheduled board meetings:
   - CIEB – June 8, 2021
   - RMSB – July 7, 2021

II. Public comment

The division is taking extra precautions for public meetings given concerns regarding the Coronavirus/COVID-19. Board members and staff will be connected by "GoToMeeting." Because of these unusual circumstances, the division is taking steps to ensure an opportunity for written testimony and remote oral testimony for the public. Send your written testimony or request to provide oral public testimony to the boards coordinator 24 hours in advance of this meeting date. Requesting oral testimony for this meeting has a cutoff date of March 15, 2021, at noon. (Additional instructions are at the end of the agenda).

III. Reports

A. Program update for CIEB
B. Program update for RMSB

IV. Communications - None

V. New business

Boards make a recommendation to the Administrator on the adoption of the 2021 Oregon Residential Reach Code with an anticipated effective date of April 1, 2021

VI. Announcements - None

VII. Adjournment

Please read carefully

Temporary instructions for submitting public testimony for board meetings:

- **Please submit written testimony for consideration by noon the day before the scheduled meeting by email to debra.j.woods@oregon.gov.**
- **Include your name and the organization you represent (if any).**
- **List the board and agenda item to which your comments are related.**
- **Please include all related material.**
- **Expect an email from the boards coordinator, the chief, or the chair of the board acknowledging that your testimony has been received and will be presented to the board.**
- ***If you would like to be connected by the GoToMeeting for oral testimony, please send an email to debra.j.woods@oregon.gov and the boards coordinator will send you specific instruction on the process by email. Please include your name, organization, and the agenda item to which your testimony relates. The board Chair will manage public testimony during the meeting. Testimony will be limited to 5 minutes.***
- **If you do not receive confirmation of your testimony within one business day or by 8:30 a.m. on the date of the board meeting, please resubmit your testimony.**

Thank you for working with us to ensure the health and safety of all participants.

Note: **For information regarding re-appointments or board vacancies, please visit the Governor's website.**

State of Oregon

Agenda Item I.D.

Construction Industry Energy Board (CIEB)
Virtual meeting minutes
Feb. 9, 2021

CIEB members present: Thomas Kyle, Vice-chair, acting chair, Electrical and Elevator Board
Travis Argue, State Plumbing Board
Walter Caudle, Mechanical Board
John Chmelir, Residential and Manufactured Structures Board
Gary Heikkinen, Building Codes Structures Board
Heather Miller, Electrical and Elevator Board
Blake Shelide, Oregon Department of Energy
Matthew Rozzell, State Plumbing Board
Eli Volem, Residential and Manufactured Structures Board
Kail Zuschlag, Building Codes Structures Board

CIEB members absent: Jay Hansen, Chair, Mechanical Board

Staff: Alana Cox, interim administrator, Building Codes Division
Mark Heizer, mechanical and energy systems engineer
Kelly Thomas, energy policy analyst
Julia Hier, senior policy advisor
Tyler Glaze, policy analyst
Andy Skinner, plumbing chief
Keith Anderson, electrical chief
Melissa Stiles, policy development coordinator
Debi Barnes-Woods, boards administrator/coordinator

Guests: Kevin Duell, NW Natural
Aaron Gunzner, Air Movement and Control Association
Christian Taber, committee member ASHRAE Standards 90.1
Cindy Strecker, Clearesult
Dave Young, RDH
David Heslam, Earth Advantage Institute
Don MacOdrum, TRC Companies
Eric Lacey, RECA-Codes
Eric Sandoval, Building Codes Structures Board chair
Harold Friberg, Pacific Northwest Building Resilience Coalition
Jeff Mang, JC Mang Consulting
John Frankel, NW Natural
Mark Lyles, New Buildings Institute
Michael Ivanovich, Pacific Northwest National Laboratory
Michael Rosenberg, Pacific Northwest National Laboratory

Mike Manzi, BORA
Mike Moore, Stator LLC
Scott Criswell, SACSS
Shilpa Surana, NEEA
Terry Whitehill, Portland building official
Tom Young, NWCMA

I. Board business

A. Call to order

Thomas Kyle, Vice-chair, acting chair, called the CIEB virtual meeting, to order at 9:30 a.m.

B. Roll call

All members were present but Jay Hansen, chair, who was excused.

C. Approval of agenda and order of business

Acting Chair Kyle ruled the agenda and order of business approved.

D. Approval of the CIEB meeting draft minutes

Acting Chair Kyle ruled final the draft meeting minutes of October 20, 2020.

E. Date of the next regularly scheduled meeting

March 16, 2021

F. 2021 board meeting calendar dates

March 16, June 8, and October 19, 2021

II. Public comment

No general public comments were received.

III. Reports

Update on the 2021 Oregon Residential Reach Code

Mark Heizer, P.E., mechanical and energy systems engineer, gave an update on the Oregon residential reach code, an optional code builders could choose to use. The draft document came out of public comments, public meetings hosted by Buildings Codes Division and stakeholder outreach by Oregon Department of Energy. It is posted to the division website: https://www.oregon.gov/bcd/codes-stand/Pages/reach.aspx

Here are highlights:

* Changing wall construction requirements from R21 to R23 advanced framing.
* Modified additional measures table requiring three options instead of one.
* Updated performance path to the energy rating index.

* Solar ready and electric vehicle portions are still being worked out with members of the Electrical and Elevator board, contractors and Energy Trust of Oregon, to align with energy savings incentives.
Mr. Heizer said homes built to this program, the equivalent of zero energy ready homes, will probably exceed what is needed for Executive Order 17-20. The division will bring the 2021 Oregon Residential Reach Code to the combined CIEB and RMSB meeting March 16.

There was one request for public testimony for this agenda item and Acting Chair Kyle called on Kevin Duell, NW Natural. Mr. Duell said NW Natural supports several aspects of the reach code, including the requirement of three options from the additional measures table, specifying the vertical drain water heat recovery unit and heat performance measures, air and duct leakage testing, measures for plumbing and hot water savings, and the additional energy rating index. He asked if footnote C in the additional measures table should read, "measures 3 and 4 and 6 could not be combined" instead of "measures 3 and 4 could not be combined," because 3 and 4 are mutually exclusive. He recommends Measure 1 or 2 be required choices; high efficiency water heating is important because it is independent of the building envelope and would lock in occupant-driven savings.

IV. Communications - None

V. New business

Board review, make recommendations about energy provision updates to the Oregon Structural Specialty Code to ASHRAE 90.1-2019.
Mark Heizer, P.E., mechanical and energy systems engineer, provided an overview of the mid-cycle update of the commercial code energy provisions to ASHRAE 90.1-2019, which replaces ASHRAE 90.1-2016.

ASHRAE has built in cost effectiveness, subcommittees on lighting, mechanical, modeling, continuous review of updates, and a substantive public feedback process. It aligns with the latest Executive Order 20-04, which requires a 60 percent reduction of regulated energy use relative to the code in place in 2006, which was the 2004 energy code. The goal is to exceed the 60 percent target through the 2028 code. ASHRAE 90.1-2019 complies with the Senate Bill 79 request to align with the Architecture 2030 program, and raises awareness of renewables. US Department of Energy provides compliance tools.

The division is moving to ASHRAE 90.1, with the promise to adopt the next version as quickly as possible. Just like the residential code, there will be a longer grace period, six months, to give people time for training and give BCD time to provide building official training. The new version of the COMcheck compliance tool is available for building officials. The division will create a supplemental sheet for Oregon updates. Mr. Heizer thanked Mike Rosenberg and staff from

Pacific Northwest National Laboratory, which contracts with US Department of Energy to track ASHRAE changes and process. This is a 40 percent improvement over 2004 for whole building energy use, weighted for climate zones. Across Oregon's climate zone 4c, there is a 6.4 percent improvement on energy savings, better than the national average of 5 percent. Climate zone 5b east of the Cascade Mountains showed a 5.5 percent improvement. Mr. Heizer reviewed the matrix, posted online here: https://www.oregon.gov/bcd/codes-stand/code-adoption/Documents/21oeesc-summary-matrix.pdf

Aaron Gunzer pointed out FEI replaces FEG in the new matrix in ASHRAE 90.1-2019. Board Member Eli Volem thanked the division for the presentation and said he is glad the reach code is following the time frame plan and sticking with the trajectory. He asked about training and paperwork efficiency, which was noted in the written testimony submitted by Jeff Burns. Mr. Heizer said the division's remote training will be available to everyone; USDOE also provides training. Mr. Heizer estimates it will take five minutes to complete the extra paperwork and anticipates a time savings with the new COMcheck program. Tom Young asked about SAM 19-01 and Mr. Heizer said the new energy code will replace it.

Tyler Glaze, policy analyst, said written testimony was received for this agenda item from Jeff Burns, architect with Burns Organic Modern, posted online: https://www.oregon.gov/bcd/boards/Documents/20210208-jeff-burns-pc.pdf

Mr. Glaze addressed special voting requirements; all four members of the Residential Manufactured Structures Board and Building Codes Structures Board must vote yes to move a motion forward. Acting Chair Kyle asked for a motion. Blake Shelide, Oregon Department of Energy, said the transition to ASHRAE 90.1 has been set up very well by Building Codes Division over the last couple of years. This energy code gets Oregon 45 percent of the 60 percent way toward meeting Executive Order 20-04. Oregon is making really good progress with this code and it represents a good trajectory for the state.

Motion by Blake Shelide to approve the proposed adoption of ASHRAE 90.1-2019, with the finding that the added cost, if any, is necessary to the health and safety of the occupants or the public or necessary to conserve scarce resources.

Roll call vote taken:
Yea: Travis Argue, Walter Caudle, John Chmelir, Gary Heikkinen, Heather Miller, Matthew Rozzell, Blake Shelide, Eli Volem, Kail Zuschlag, and Vice-chair Acting Chair Thomas Kyle
Nay: none
Motion carried unanimously.

VI. Announcements - None

VII. Adjournment

Acting Chair Kyle adjourned the Construction Industry Energy Board meeting of February 9, 2021, at 10:37 a.m.

Respectfully submitted by Melissa Stiles, policy development coordinator.

State of Oregon

Agenda Item I.D.

Residential and Manufactured Structures Board (RMSB)
Virtual Meeting Minutes
January 6, 2021

RMSB members: Rebai Tamerhoulet, Vice-chair, building official
Gordon Anslow, home designer
James Austin, manufacturer of manufactured dwellings
John Chmelir, multi-family contractor
Rich Fry, residential structural contractor
Emily Kemper, public member
Douglas Lethin, remodeler residential structural contractor
Rich Tovar, residential building trade sub-contractor
Eli Volem, utility of energy supplier
Forrest Barnes, distributor of new manufactured dwellings

Staff: Alana Cox, interim administrator, Building Codes Division
Dawn Bass, interim deputy administrator, BCD
Richard Rogers, manager, chief building official, PTS
Mark Heizer, P.E., mechanical & energy systems engineer, PTS
Julia Hier, senior policy advisor, PTS
Tony Rocco, structural program chief, PTS
Andy Boulton, policy analyst, PTS
Warren Jackson, manager, Field Services and Statewide Services
Eric McMullen, senior building codes specialist, PTS
Debi Barnes-Woods, boards administrator/coordinator, PTS
Melissa Stiles, policy development coordinator, PTS

Guests: Shilpa Surana, Northwest Energy Efficiency Alliance
Eric Lacey, Responsible Energy Code Alliance
David Heslam, Zero Coalition
Mike Goodrich, Oregon Home Builders Association
Don MacOdrum, senior project manager, Energy Trust of Oregon
Kevin Duell, engineering consultant, NW Natural
Mike Moore, energy analyst, Oregon Department of Energy
Gary Heikkinen, energy consultant
Alyssa Baz, plans examiner, Lane County Building
Blake Shelide, Oregon Department of Energy
Angela Crowley-Koch, Solar Education Fund
Warren Cook, Oregon Department of Energy

I. Board business

A. Call to order

Rebai Tamerhoulet, vice-chair, acting chair, called the virtual board meeting to order at 9:35 a.m.

B. Roll call

All members were present. Member Forrest Barnes connected to the virtual board meeting at 10:24 a.m.

C. Approval of agenda and order of business

The chair ruled the agenda and order of business approved.

D. Approval of the draft minutes

The chair ruled the RMSB draft meeting minutes of October 7, 2020, final, with the correction of the word “ducted homes” replacing “ductless homes,” on Page 4.

E. Date of the next regularly scheduled meeting

April 7, 2021

II. Public comment

No general comments or testimony were received.

III. Reports

Residential structures program update

Chief Tony Rocco said staff is finalizing the 2021 ORSC adoption through rule making and publishing. The division is developing training. A new technical bulletin is posted here: https://www.oregon.gov/bcd/codes-stand/Documents/uacs-techb.pdf

Chief Rocco said the division has been working with building officials on their Chapter 1 requested amendments. He summarized the draft, which can be found here: https://www.oregon.gov/bcd/boards/Documents/rmsb-20210106-agenda.pdf. Chair Tamerhoulet asked if the amendments would appear in the next code. Chief Rocco said the anticipated timeline is to have ORSC Chapter 1 adopted and printed as a portion of the 2021 ORSC, effective April 1.

Mark Heizer, mechanical and energy code engineer, said the division received eight proposals about the 2021 Oregon Residential Reach Code and have posted them here: https://www.oregon.gov/bcd/codes-stand/Pages/reach.aspx The proposals will be reviewed during the public meeting on January 13 and combined into a consensus document. The division hopes to bring a 2021 Oregon Residential Reach Code final version to the Construction Industry Energy Board (CIEB) and Residential and Manufactured Structures Board (RMSB) boards soon.

Board Member Rich Fry asked if local municipalities can adopt this as their standard code. Mr. Heizer said ORS 455.040 allows jurisdictions to approach the division to go through the process of local adoption. No one did it during the last reach code, but there is a possibility of that happening in this current version. Board Member Emily Kemper asked if the division is still accepting proposals. Mr. Heizer said people can bring proposals to the public meeting January 13.

IV. Communications - None

V. Appeals - None

VI. Unfinished business - None

VII. New business

Board review and make a recommendation to the Administrator regarding the requested changes to the additional measures table, Table N1101.1(2) in Chapter 11 of the 2021 Oregon Residential Specialty Code (ORSC)

Andy Boulton, policy analyst, said the code committee held meetings in August and took testimony about the additional measures table, including Zero Coalition's suggested changes to the table. Zero Coalition is here today to request removal of Measure 7 from Table N1101.1(2). The chair invited testimony.

Eric Lacey, chair of the Responsible Energy Codes Alliance, supports Zero Coalition's request to remove the Measure 7 credit for low glazing area because he said it would be a free ridership credit. Builders reduce glazing area on homes to cut costs, not save energy, he said. This Measure 7 credit could take the place of other options that provide more energy savings. Shilpa Surana of Northwest Energy Efficiency Alliance, said she supports removing Measure 7 because the energy savings associated with this measure are substantially less than with other measures in the table. Mike Goodrich of Oregon Homebuilders Association and co-chair of the code committee, said he supports providing options for builders and creative ways to save energy but does not object to the removal of Measure 7.

Chair Tamerhoulet invited board discussion. Member Gordon Anslow said, as someone building affordable houses while meeting the desires of homeowners, he supports retaining Measure 7 in the table because it gives flexibility. Juggling the window area is part of the Chapter 11 measures spreadsheet calculations. Builders are careful and quasi-scientific about putting windows in places that give the most natural light. While they work with the occasional couple with an expensive view lot wanting a lot of windows in their home, most homebuyers are struggling to have enough money to build at all. Mr. Anslow actively engages them in a discussion of how to allocate money to pay for various energy conservation measures. The limiting of window area is one of the more significant things to

adjust. He doesn't see a lot of people wanting 20 percent windows, knowing they will have large utility bills as a result.

Board Member Eli Volem asked about energy savings based on home size and life span. Board Member Gordon Anslow said the standard is the same for a 5,000-square-foot home as it is for a 1,500-square-foot-home. He supports a sliding scale for energy requirements based on home size to make things more equitable and ensure the right to build a basic, affordable house. Board Member John Chmelir suggested adding a side standard to Measure 7 based on an 1800-square-foot home. Member Volem agreed, especially since zero energy standards will eventually have size adjustment standards. Member Anslow said the wording needs to be studied carefully using current data to avoid unintended consequences. Board Member Rich Fry said he supports a sliding scale after a careful study with relevant data.

David Heslam of Zero Coalition, who re-joined the meeting, also provided testimony. He said Zero Coalition's suggested changes to Measure 7, including a size adjustment, which was rejected by the code committee. Later, when Zero Coalition understood the ramifications of adding the measure to the table without adding a size element, the group decided it was best to propose retracting Measure 7. Zero Coalition hopes the board will factor in home size in future codes.

Mr. Heizer said there is an ability to trade off window and wall area using the online, code-based tool, as Mr. Anslow noted. Energy Trust data shows about 30 percent of homes are built with 12 percent glazing or less. Member Volem said he continues to support removing the measure until more data is obtained. He said there is a lifetime benefit of having fewer windows. Member Anslow said there is a societal benefit to having more efficient houses but currently all the expense falls on the individual who is building the house.

Motion by Gordon Anslow to decline to make any changes in Table 1101.1(2) with the finding that the added cost, if any, is necessary to the health and safety of the occupants or the public or necessary to conserve scarce resources.

Roll call vote taken:
Yea: Gordon Anslow, James Austin, Forrest Barnes, John Chmelir, Rich Fry, Douglas Lethin, Rich Tovar.
Nay: Emily Kemper, Eli Volem, and Chair Rebai Tamerhoulet
Motion carried.

Mike Moore of Strator LLC, on behalf of Boran-NuTone, requested clarification on item 8 in the additional measures table, how to interpret code requirements for HVAC and minimum fan ratings. Shilpa Surana requested clarification about system designs on supply fans. Mr. Heizer said the division will discuss this in

code training and provide a clarification guide. Board Member John Chmelir said technical problems prevented him from speaking during the Chapter 1 update about permits for landscape retaining walls. He said the wording, “when measured from the bottom of the footing” is not practical. In order to get a permit, a homeowner would have to hire an engineer. He thinks the language should end at “4 feet in height.” Chair Tamerhoulet said cities receive complaints from landscapers about retaining walls and that is why the state is letting local jurisdictions design their own approach. Member Chmelir said cities don’t get involved when paint fails, a heating system fails or when a tree dies that a landscaper planted because these are issues between homeowners and contractors, not building code issues. Chief Rocco confirmed the landscape retaining walls would be regulated only when a local municipality chooses to adopt a local ordinance. Member Anslow said the language of measuring from the bottom of the footing strikes him as excessively restrictive. He recommends talking with soil engineers about the wording.

VIII. Announcements - None

IX. Adjournment

Chair Tamerhoulet adjourned the meeting of January 6, 2021, at 11:35 a.m.

Respectfully submitted by Melissa Stiles, policy development coordinator.

Agenda Item V.

State of Oregon **Board memo**

Building Codes Division **March 16, 2021**

To: Construction Industry Energy Board (CIEB) and Residential & Manufactured Structures Board (RMSB)

From: Andy Boulton, policy advisor, Policy and Technical Services

Subject: 2021 Oregon Residential Reach Code

Action requested:
Recommend approval of the 2021 Oregon Residential Reach Code (ORRC).

Background:
The 2021 ORRC is an optional set of standards designed to increase energy efficiency. All municipalities must accept the reach code, and it provides an additional efficiency compliance path for builders, consumers, contractors, and others. The reach code must be technically feasible and must be more efficient than the building code. The division's goal is to have the 2021 ORRC in place by April 1, 2021.

The division solicited public input and proposals for what should be included in the 2021 ORRC. Interested parties were invited to propose provisions to include in the reach code, comment on the format, propose methodologies, and provide general comments. Proposals were based on the anticipated 2021 Oregon Residential Specialty Code, as approved by the Residential and Manufactured Structures Board at its October 7, 2020, meeting.

The solicitation for reach code proposals opened on November 2, 2020, and closed on December 16, 2020. The division received several proposals, which were refined through outreach and dialogue between division staff and stakeholders. Additionally, outreach specific to electric vehicle readiness language and solar readiness language was done to align those sections with model code, incentive programs, installer experience, and the electrical code.

On January 25, 2021, the division held a public meeting to hear comments and questions regarding the 2021 ORRC. Public input was also taken at the January 26, 2021, meeting of the Department of Energy's Energy Code Stakeholder Panel. All the comments and questions from the January meetings as well as

any additional written public comments were taken into consideration when the division drafted the proposed 2021 ORRC.

The division invites discussion from the boards regarding the adoption of the 2021 ORRC and seeks their recommendation about its content and timing.

Options:

- Recommend approval of the proposed 2021 ORRC, to go into effect April 1, 2021, with the finding that the added cost, if any, is necessary to the health and safety of the occupants or the public or necessary to conserve scarce resources.

- Recommend amending and approving the proposed 2021 ORRC and include a recommended effective date in the motion, with the finding that the added cost, if any, is necessary to the health and safety of the occupants or the public or necessary to conserve scarce resources.

- Recommend disapproval of the proposed 2021 ORRC and include the reason for the disapproval in the motion.

2021 OREGON RESIDENTIAL REACH CODE
DRAFT PROVISIONS – Changes to 21 ORSC

The following is the draft 2021 Oregon Residential Reach Code provisions amending the 2021 Oregon Residential Specialty Code (ORSC) provisions in Chapter 11. This draft includes all public comment and stakeholder considerations up to Feb. 26, 2021.

The changes are denoted as follows:

Blue = language added to the approved 2021 ORSC provisions.

Red/~~Strikethrough~~ = language deleted from the approved 2021 ORSC provisions.

Green/Underline = Electric Vehicle Ready and Photovoltaic Ready language added to the approved 2021 ORSC provisions

PART I—ENERGY CONSERVATION

SECTION N1101
SCOPE

N1101.1 General. The provisions of this reach code replace Chapter 11 of the 2021 Oregon Residential Specialty Code and regulate the exterior envelope, as well as the design, construction and selection of heating, ventilating and air-conditioning systems, lighting and piping insulation required for the purpose of effective conservation of energy within a building or structure governed by this code.

All conditioned spaces within new residential buildings shall comply with Table N1101.1(1) and three additional measures from Table N1101.1(2).

Exceptions:

1. ~~Application to existing buildings shall comply with Section N1101.2.~~
2. ~~Application to additions shall comply with Section N1101.3.~~
3. ~~Heated or cooled detached *accessory structures* that are not habitable shall meet the following envelope requirements without any additional measures: Walls: R-21/U-0.064; Roofs: R-38/U-0.027 (attic) or R-20 continuous insulation/U-0.048 (above deck); Windows: U-0.35; Opaque doors: U-0.70; Roll-up doors: U-0.50.~~

N1101.2 Application to existing buildings. Not applicable.

N1101.3 Additions. Additions to existing buildings or structures may be made without making the entire building or structure comply if the new additions comply with the requirements of this chapter.

N1101.3.1 Large additions. Additions that are equal to or more than 600 square feet (55 m^2) in area shall be required to comply with Table N1101.1(1) and two additional measures from Table N1101.1(2).

~~**N1101.3.2 Small additions.** Additions that are less than 600 square feet (55 m^2) in area shall be required to select one measure from Table N1101.1(2) or comply with Table N1101.3.~~

~~**Exception:** Additions that are less than 225 square feet (20.9 m^2) in area shall not be required to comply with Table N1101.1(2) or Table N1101.3.~~

N1101.4 Information on plans and specifications. Plans and specifications shall show in sufficient detail all pertinent data and features of the building and the equipment and systems as herein governed, including, but not limited to: exterior envelope component materials; *R*-values of insulating materials; *fenestration U-factors* and SHGC value; HVAC equipment efficiency performance and system controls; lighting; an additional measures selected from Table N1101.1(2); and the other pertinent data to indicate compliance with the requirements of the chapter.

~~**TABLE N1101.3**~~
~~**SMALL ADDITION ADDITIONAL MEASURES (select one)**~~

~~1~~	~~Increase the ceiling insulation of the existing portion of the home as specified in Table N1101.2.~~
~~2~~	~~Replace all existing single-pane wood or aluminum windows to the U-factor as specified in Table N1101.2~~
~~3~~	~~Insulate the existing floor, crawl space or basement wall systems as specified in Table N1101.2 and install 100 percent of permanently installed lighting fixtures as CFL, LED or linear fluorescent, or a minimum efficacy of 40 lumens per watt as specified in Section N1107.2.~~
~~4~~	~~Test the entire dwelling with a blower door and exhibit no more than 4.5 air changes per hour @ 50 Pascals.~~
~~5~~	~~Seal and performance test the duct system.~~
~~6~~	~~Replace existing 80 percent AFUE or less gas furnace with a 92 percent AFUE or greater system.~~
~~7~~	~~Replace existing electric radiant space heaters with a ductless mini split system with a minimum HSPF of 10.0.~~
~~8~~	~~Replace existing electric forced air furnace with an air source heat pump with a minimum HSPF of 9.5.~~
~~9~~	~~Replace existing water heater with a water heater meeting:~~ ~~Natural gas/propane water heater with minimum UEF 0.90, or~~ ~~Electric heat pump water heater with minimum 2.0 COP.~~

TABLE N1101.1(1)
PRESCRIPTIVE ENVELOPE REQUIREMENTS [a]

BUILDING COMPONENT	STANDARD BASE CASE		LOG HOMES ONLY	
	Required Performance	Equiv. Value[b]	Required Performance	Equiv. Value[b]
Wall insulation—above grade	~~U-0.059~~ U-0.057[c]	R-23 Advanced[c] or R-13+6 c.i. ~~R-21~~ Intermediate[c]	Note d	Note d
Wall insulation—below-grade[e]	C-0.063	R-15 c.i./R-21 or 13+5 c.i.	C-0.063	R-15/R-21
Flat ceilings[f]	U-0.021	R-49	U-0.020	R-49 A[h]
Vaulted ceilings[g]	U-0.033	R-30 Rafter or R-30A[g, h] Scissor Truss	U-0.027	R-38A[h]
Underfloors	U-0.033	R-30	U-0.033	R-30
Slab-edge perimeter[m]	F-0.520	R-15	F-0.520	R-15
Heated slab interior[i]	n/a	R-10	n/a	R-10
Windows[j]	U-0.27	U-0.27	U-0.27	U-0.27
Windows SHGC[j]	≤ 0.40	≤ 0.40	≤ 0.40	≤ 0.40
Skylights	U-0.50	U-0.50	U-0.50	U-0.50
Exterior doors[k]	U-0.20	U-0.20	U-0.54	U-0.54
Exterior doors with > 2.5 ft^2 glazing[l]	U-0.40	U-0.40	U-0.40	U-0.40

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m^2, 1 degree = 0.0175 rad, n/a = not applicable.

a. As allowed in Section N1104.1, thermal performance of a component may be adjusted provided that overall heat loss does not exceed the total resulting from conformance to the required U-factor standards. Calculations to document equivalent heat loss shall be performed using the procedure and approved U-factors contained in Table N1104.1(1).

b. *R*-values used in this table are nominal for the insulation only in standard wood-framed construction and not for the entire assembly.

c. Wall insulation requirements apply to all exterior wood-framed, concrete or masonry walls that are above grade. This includes cripple walls and rim joist areas. Nominal compliance with ~~R-21~~ R-23 insulation and Advanced Framing (N1104.5.1) ~~Intermediate Framing (N1104.5.2)~~ with insulated headers. Buildings greater than two stories above grade may utilize R-23 Intermediate Framing (N1104.5.2) on the first floor above grade if a registered design professional determines necessary.

d. The wall component shall be a minimum solid log or timber wall thickness of 3.5 inches.

e. Below-grade wood, concrete or masonry walls include all walls that are below grade and do not include those portions of such wall that extend more than 24 inches above grade. R-21 for insulation in framed cavity; R-15 continuous insulation; or R-13 framed cavity and R-5 continuous insulation.

f. Insulation levels for ceilings that have limited attic/rafter depth such as dormers, bay windows or similar architectural features totaling not more than 150 square feet in area may be reduced to not less than R-21. When reduced, the cavity shall be filled (except for required ventilation spaces). R-49 insulation installed to minimum 6-inches depth at top plate at exterior of structure to achieve U-factor.

g. Vaulted ceiling surface area exceeding 50 percent of the total heated space floor area shall have a U-factor no greater than U-0.026 (equivalent to R-38 rafter or scissor truss with R-38 advanced framing).

h. A = Advanced frame construction. See Section N1104.6.

i. Heated slab interior applies to concrete slab floors (both on and below grade) that incorporate a radiant heating system within the slab. Insulation shall be installed underneath the entire slab.

j. Sliding glass doors shall comply with window performance requirements. Windows exempt from testing in accordance with Section NF1111.2, Item 3 shall comply with window performance requirements if constructed with thermal break aluminum or wood, or vinyl, or fiberglass frames and double-pane glazing with low-emissivity coatings of 0.10 or less. Buildings designed to incorporate passive solar elements may include glazing with a *U*-factor greater than 0.35 by using Table N1104.1(1) to demonstrate equivalence to building envelope requirements.

k. A maximum of 28 square feet of exterior door area per dwelling unit can have a *U*-factor of 0.54 or less.

l. Glazing that is either double pane with low-e coating on one surface, or triple pane shall be deemed to comply with this requirement.

m. Minimum 24-inch horizontal or vertical below-grade.

TABLE N1101.1(2)
ADDITIONAL MEASURES

1	**HIGH EFFICIENCY HVAC SYSTEM[a]** a. Gas-fired furnace or boiler AFUE 94 percent, or b. Air source heat pump HSPF 10.0/14.0 SEER cooling, or c. Ground source heat pump COP 3.5 or Energy Star rated
2	**HIGH EFFICIENCY WATER HEATING SYSTEM[b]** a. Natural gas/propane water heater with minimum UEF 0.90, or b. Electric heat pump water heater with minimum ~~2.0 COP, or~~ UEF 2.9, or c. Natural gas/propane tankless/instantaneous heater with minimum 0.80 UEF and vertical Drain Water Heat Recovery Unit installed on minimum of one shower/tub-shower
3	**WALL INSULATION UPGRADE** Exterior walls—U-0.045/R-21 conventional framing with R-5.0 continuous insulation
4	**ADVANCED ENVELOPE** Windows—U-0.21 (Area weighted average), and Flat ceiling[e]—U-0.017/R-60, and Framed floors—U-0.026/R-38 or slab edge insulation to F-0.48 or less (R-10 for 48”; R-15 for 36” or R-5 for fully insulated slab)
5	**DUCTLESS HEAT PUMP** For dwelling units with all-electric heat provide: Ductless heat pump of minimum HSPF 10 in primary zone replaces zonal electric heat sources, and Programmable thermostat for all heaters in bedrooms
6	**HIGH EFFICIENCY THERMAL ENVELOPE UA[c]** Proposed UA is 8 percent lower than the Code UA
~~7~~	~~**GLAZING AREA**~~ ~~Glazing area, measured as the total of framed openings is less than 12 percent of conditioned floor area~~
7	**SUPER HIGH EFFICIENCY THERMAL ENVELOPE UA[c]** Proposed UA is 18 percent lower than the Code UA Equates to two selections from this table. When selecting this measure either Additional Measure 1 or 2 must be selected.
8	**3 ACH AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION** Achieve a maximum of 3.0 ACH50 (0.24 cfm/sf at 50 pascals) whole-house air leakage when third-party tested and provide a whole-house ventilation system including heat recovery complying of the following: a. A fan performance of not less than 1.2 cfm/watt and an ASRE of not less than 66 percent, or b. A fan performance of not less than 1.6 cfm/watt and an ASRE of not less than 63 percent. ~~with a minimum sensible heat recovery efficiency of not less than 66 percent.~~

For SI: 1 square foot = 0.093 m^2, 1 watt per square foot = 10.8 W/m^2.

a. Appliances located within the building thermal envelope shall have sealed combustion air installed. Combustion air shall be ducted directly from the outdoors. Measures 1 and 5 may not be combined for compliance with Section N1101.1.

b. The maximum vaulted ceiling surface area shall not be greater than 50 percent of the total heated space floor area unless vaulted area has a *U*-factor no greater than U-0.026.

c. In accordance with Table N1104.1(1), the Proposed UA total of the Proposed Alternative Design shall be a minimum of 8 percent less than the Code UA total of the Standard Base Case for Additional Measure 6 or 18 percent less than the Code UA total of the Standard Base Case for Additional Measure 7. Measures 3 or 4 may not be combined for compliance with Section N1101.1 when selecting Measure 6 or 7.

d. The fan performance and Adjusted Sensible Recovery Efficiency (ASRE) shall be determined at or above the design airflow rate from values listed in accordance with the Home Ventilating Institute (HVI) Publication 920-2020 at zero degrees Celsius or shall be interpolated from such values.

SECTION N1102
DEFINITIONS

AFUE (ANNUAL FUEL UTILIZATION EFFICIENCY). The energy output divided by the energy input, calculated on an annual basis and including part load and cycling effects. AFUE ratings shall be determined using the US Department of Energy test procedures (10 CFR Part 430).

AUTOMATIC. Self-acting, operating by its own mechanism when actuated by some impersonal influence, such as a change in current strength, pressure, temperature or mechanical configuration. (See also "Manual.")

BASEMENT WALL. The opaque portion of any wall which encloses a basement and is partially or totally below grade.

BELOW-GRADE WALLS. The walls or the portion of walls entirely below the finished grade or which extend 2 feet (610 mm) or less above the finished grade.

BTU (British Thermal Unit). The amount of heat required to raise the temperature of 1 pound (0.454 kg) of water (about 1 pint) from 59ºF to 60ºF (15ºC to 16ºC).

BUILDING THERMAL ENVELOPE. That element of a building which encloses conditioned spaces through which thermal energy may be transmitted to or from the exterior or to or from unconditioned spaces.

C (Thermal Conductance). See "Thermal conductance."

CONDITIONED SPACE. A space within the building, separated from unconditioned space by the building thermal envelope, which by introduction of conditioned air, by heated and/or cooled surfaces, or by air or heat transfer from directly conditioned spaces is maintained at temperatures of 55ºF (13ºC) or higher for heating and/or 85ºF (29.4ºC) or below for cooling. (Enclosed corridors between conditioned spaces shall be considered as conditioned space. Spaces where temperatures fall between this range by virtue of ambient conditions shall not be considered as conditioned space.)

COOLED SPACE. A space within a building provided with a mechanical cooling supply.

ERI REFERENCE DESIGN. A version of the rated design that meets the minimum requirements of the 2006 International Energy Conservation Code.

EXTERIOR DOOR. A permanently installed operable barrier by which an entry is closed and opened. Exterior doors include doors between conditioned and unconditioned spaces, such as a door between a kitchen and garage.

EXTERIOR ENVELOPE. See "Building envelope."

EXTERIOR WALL. Any member, or group of members, which defines the exterior boundaries of the conditioned space and which has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

EXTERIOR WINDOW. An opening, especially in the wall of a building, for admission of light or air that is usually closed by casement or sashes containing transparent material (such as glass) and in some cases capable of being opened and shut. All areas, including frames, in the shell of a conditioned space that let in natural light, including skylights, sliding glass doors, glass block walls and the glazed portions of the doors.

When calculating the energy performance of the exterior envelope, the area of the window shall be the total area of glazing measured using the rough opening dimensions, and including the glass, sash and frame.

FENESTRATION. Windows and doors in the exterior envelope. See the definitions for "Exterior door" and "Exterior window."

FLOOR AREA. The area included within the surrounding exterior walls of a building or portion thereof, exclusive of courts. The floor area of a building or portion thereof not provided with surrounding exterior walls shall be the usable area under the horizontal projection of the roof or floor above.

GLAZING. All areas including frames in the shell of a conditioned space that let in natural light, including windows, clerestories, skylights, sliding glass doors, glass block walls and the glazed portion of doors.

GROSS AREA OF EXTERIOR WALLS. Wall areas, as measured on the exterior, including foundation walls above grade; peripheral edges of floors; window areas, including sash; and door areas, where such surfaces are exposed to outdoor air and enclose a heated or mechanically cooled space.

HEATED SPACE. A space within a building served by a mechanical, electrical or combustion source of heat. Spaces within a basement shall be defined as heated when any of the following apply: the space is finished, or has heating registers or contains heating devices.

HIGH-EFFICIENCY LIGHT SOURCE. Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, LED lamps, fixture-integrated illumination devices, or lamps with an efficacy not less than 65 lumens per watt for each lamp or luminaires with an efficacy not less than 45 lumens per watt per each luminaire.

HSPF (HEATING SEASONAL PERFORMANCE FACTOR). The total heating output of a heat pump during its normal annual usage period for heating divided by the total electric power input in watt-hours during the same period.

HUMIDISTAT. An instrument which measures changes in humidity and controls a device or devices to maintain a desired humidity.

HVAC (HEATING, VENTILATING AND AIR-CONDITIONING) SYSTEM. Refers to the equipment, distribution network and terminals that provide either collectively or individually the processes of heating, ventilating and/or air-conditioning processes to a building.

K (THERMAL CONDUCTIVITY). See "Thermal conductivity."

MANUAL (nonautomatic). Action requires human intervention as the basis for control (see "Automatic").

OTHER BUILDINGS. All buildings and structures, or portions thereof, that are not defined as residential buildings (see "Residential buildings").

PERM RATING (DRY CUP). The measure of the ability of a material of specific thickness to transmit moisture in terms of the amount of moisture transmitted per unit time for a specified area and differential pressure. Dry cup perm rating is expressed in grains/hr/ft^2, inches of Hg. Permeance may be measured by using

ASTM E96-72 or other approved dry cup method. The closer the dry cup perm rating approaches zero, the better the vapor retarder. Permeability is defined as the permeance of a material for specified unit length (perm/in).

***R* (THERMAL RESISTANCE).** See "Thermal resistance."

***Rt* (THERMAL RESISTANCE TOTAL).** See "Thermal resistance total."

RATED DESIGN. A description of the proposed building used to determine the energy rating index.

SOLAR READY ZONE. A section or section(s) of the roof designated and reserved for the future installation of a solar photovoltaic or related technology. The zone shall be exclusive of access, pathways, or setback areas.

THERMAL CONDUCTANCE (*C*). The constant time rate of heat flow through a unit area of a body induced by a unit temperature difference between the surfaces [Btu/(h · ft^2 · °F)].

It is the reciprocal of thermal resistance (see "Thermal resistance").

THERMAL CONDUCTIVITY (*K*). The rate of heat flow through 1 square foot (0.0929 m^2) of a homogeneous material 1 inch (25.4 mm) in thickness when there is a temperature difference of 1°F (-17.2°C) between the opposite faces of the material, expressed as Btu/h per square foot per °F temperature difference. Thermal conductivity is similar to thermal conductance (*C*), except thermal conductance applies to the actual thickness of the material.

THERMAL RESISTANCE (*R*). The measure of the resistance of a material or building component to the passage of heat, has the value of (hr · ft^2 · °F)/Btu, and is the reciprocal of thermal conductance.

THERMAL RESISTANCE TOTAL (*Rt*). The sum of the resistance for all of the individual components of the assembly, including framing members, multiple layer connections, insulation and air films expressed in (°F · ft^2 · Btu/h).

THERMAL TRANSMITTANCE (*U*). The coefficient of heat transfer. It is the time rate of heat flow per unit area under steady state conditions from the fluid on the warm side of the barrier to the fluid on the cold side, per unit temperature difference between the two fluids, Btu/ (hr · ft^2 · °F).

THERMOSTAT. An instrument that measures changes in temperature and controls a device or devices to maintain a desired temperature.

TOTAL SOLAR RESOURCE FRACTION. The fraction of usable solar energy that is received by the solar panel/collector throughout the year. This accounts for the impacts due to external shading, collector tilt and collector orientation.

***U* (THERMAL TRANSMITTANCE).** See "Thermal transmittance."

VAULTED CEILING. A residential building is a ceiling with a minimum slope of 2 in 12.

WINDOW. See "Exterior window."

ZONE. A space or group of spaces within a building with heating or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

SECTION N1103
ALTERNATIVE SYSTEMS

Alternative designs may be approved by the *building official* when it can be demonstrated that the proposed annual energy consumption will not exceed that of a similar building with similar forms of energy requirements designed in accordance with the provisions of this chapter. The only allowed trade-offs in this analysis are between building envelope components.

Proposed alternative designs submitted as requests for exception to the standard design criteria shall be accompanied by an energy analysis prepared in accordance with criteria specified in Part II, Alternative Systems Analysis.

N1103.1 Design parameters. For calculations under this section, the following design parameters shall apply:

The outside temperature shall be taken from the 99-percent winter temperature values and the 1-percent summer temperature values listed in ASHRAE *Handbook of Fundamentals*. For areas not listed, the designer should obtain the most reliable design temperatures available. Selected values are subject to approval of the *building official*.

SECTION N1104
EXTERIOR ENVELOPE REQUIREMENTS

N1104.1 General. This section provides, minimum requirements for exterior envelope construction.

The exterior building envelope shall comply with Table N1101.1(1) or shall be demonstrated using Table N1104.1(1). The requirements specified in Table N1101.1(2) shall apply to both Tables N1101.1(1) and N1104.1(1).

Buildings designed to incorporate passive solar elements may use Table N1104.1(1) to demonstrate building envelope requirements in this code, in addition to requirements specified in Table N1101.1(2).

N1104.2 Insulation materials. Insulation materials shall be installed in accordance with manufacturer's listing and installation instructions and this code. Insulation *R*-values shall be specified as required in 16 CFR Ch. I (1-1-91 Edition) Part 460—Labeling and Advertising of Home Insulation. Cellulose insulation shall conform to Interim Safety Standard for Cellulose Insulation (16 CFR Part 1209) issued by the Consumer Product Safety Commission July 6, 1979 (44FR 39938). Foam plastic shall be as specified in Section R316.

N1104.2.1 Insulation clearance restriction. Blown, poured, batt and spray-on type insulation applied from above the ceiling level shall be limited to vented attic spaces where the roof slope is 4 units vertical in 12 units horizontal (33.3-percent slope) or greater and there is at least 44 inches (1118 mm) of headroom at the roof ridge. (Clear headroom is defined as the distance from the top of the bottom chord of the truss or ceiling joists to the underside of the roof sheathing.) Netted or other applications that allow for verification of insulation application shall be allowed for low-slope roofs.

N1104.2.2 Batt-type insulation. Batt-type insulation shall be installed flush against the warm side of the cavity insofar as practicable.

N1104.2.3 Insulation protection. Insulation exposed to the exterior shall be protected from physical and solar damage.

N1104.2.4 Clearances. Recessed light fixtures shall be IC-labeled for direct insulation contact.

Thermal insulation shall not be installed within 3 inches (76 mm) of any metal chimney or gas vent that is not listed for insulation clearances.

A permanent sleeve of fine wire mesh screen, sheet metal or other noncombustible material shall be installed to maintain the required clearances.

N1104.2.5 Baffles. Baffles of a durable rigid material shall be provided to prevent obstruction of vent openings and to deflect incoming air above the surface of porous insulation so as to prevent wind-washing and blowing of loose material. Thermal insulation shall not be installed in a manner that would obstruct openings required for attic ventilation.

N1104.2.6 Below-grade exterior insulation. Below-grade exterior insulation shall meet the following conditions:

1. The insulation shall be a material that is approved for below-grade applications in wet environments.
2. Insulation shall be installed from the top of the footing to the top of the concrete basement wall.
3. Insulation shall be adequately protected from the elements (ultraviolet and mechanical) in accordance with manufacturer's specifications.
4. The top of the insulation shall be installed in a manner to allow water runoff and prevent pooling.

N1104.2.7 Recessed lighting fixtures. Recessed lighting fixtures installed within the building envelope shall meet one of the following requirements.

1. Type IC-rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity, and the annular space between the ceiling cutout and lighting fixture shall be sealed.
2. Type IC-rated in accordance with ASTM E283 with no more than 2.0 cubic feet per minute (cfm) (0.944 L/s) air movement from the conditioned space to the ceiling cavity at 1.57 psi pressure (75 Pa) difference shall be labeled and the annular space between the ceiling cutout and lighting fixture shall be sealed.
3. Type IC-rated installed inside a sealed box constructed from a minimum 0.5-inch-thick (12.7 mm) gypsum wallboard or constructed from a preformed polymeric vapor retarder or other air-tight assembly manufactured for this purpose.

N1104.2.8 Doors and pull-down stairs to unconditioned spaces. Service doors between unconditioned and conditioned spaces shall meet the thermal requirements of Sections N1104.2.9.1 and N1104.2.9.2.

N1104.2.8.1 Vertical doors. *U*-factors for vertical doors providing access from conditioned to unconditioned spaces shall comply with the exterior door provisions of Table N1101.1(1).

N1104.2.8.2 Pull-down stairs. Horizontal pull-down stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces shall have a maximum average *U*-factor of U-0.10 or an *R*-value of not less than R-10, have a net area of the framed opening not exceeding 13.5 square feet, and have the perimeter of the hatch weatherstripped.

N1104.3 Exterior doors. Doors shall be tested according to the requirements of Section N1104.4. When calculating the energy performance of the exterior envelope, the area of doors shall be the actual unit size.

Exceptions:

1. Unglazed doors that are not tested according to the requirements of Section N1104.4 shall be assigned a default *U*-value of 0.54.
2. Sliding glass doors and swinging glass doors shall meet the specifications for windows and shall be treated as such.
3. Doors that incorporate glazed areas more than 2.5 square feet (0.23 m^2) in area shall be considered exterior doors with greater than or equal to 2.5 square feet (0.23 m^2) glazing. Doors shall meet the air leakage requirements of Section N1104.8.

N1104.4 Windows. All windows installed in Oregon shall meet the requirements of Part III, Fenestration Standard.

1. Decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area is exempt from thermal performance requirements and does not need to be included in Table N1104.1(1) calculations.
2. Glass block assemblies may use a *U*-factor of 0.51.
3. The *U*-factor for windows may be a weighted average of total window area when all other building envelope measures are in compliance with the performance requirements specified in this code. This calculation shall be provided to the building official and the windows that are less than required for prescriptive compliance shall be identified on the plans.

N1104.4.1 Thermal performance labeling. All fenestrations shall have labels. The labels shall be a National Fenestration Rating Council (NFRC) certified product or a state-approved label for windows produced in low volume. All labeling shall conform to the following requirements:

1. Be imprinted and not handwritten.
2. Face the interior of the room.
3. List the *U*-factor.
4. Be attached to the window until the building inspector inspects and verifies the labeling.

Exceptions:

1. Labeling is not required for decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area.
2. Portions of labels for windows produced in low volume may be handwritten.

TABLE N1104.1(1)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS [b]	STANDARD BASE CASE [a]			PROPOSED A		ALTERNATIVE	
	Areas [c]	*U*-factor	Areas × *U*	*R*-value[d]	Areas [c]	*U*-factor [e]	Areas x *U*
Flat ceilings		0.021					
Vaulted ceilings [f]		0.033					
Conventional wood-framed walls		~~0.059~~0.057					
Underfloor		0.033					
Slab edge		F = 0.52[g]					
Below-grade walls		C = 0.063[g]					
Windows		0.27					
Skylights		0.50					
Exterior doors [h]		0.2					
Doors with > 2.5 ft^2 glazing		0.4					
CODE UA =				Proposed UA[i] =			

a. Base path 1 represents Standard Base Case from Table N1101.1(1). *U*-factors shall be adjusted to match selected Envelope Measure [Table N1101.1(2)].

b. Performance trade-offs are limited to those listed in Column 1. Heat plant efficiency, duct insulation levels, passive and active solar heating, air infiltration and similar measures including those not regulated by code must not be considered in this method of calculation.

c. Areas from plan take-offs. All areas must be the same for both Standard Base Case and Proposed Alternate. The vaulted ceiling surface area for Standard Base Case must be the actual surface area from the plan take-off not to exceed 50 percent of the total heated space floor area. Any roof areas in excess of 50 percent for Base Case must be entered at U-0.021 (R-49) with "Flat ceilings" area.

d. Minimum component requirements insofar as practicable: Walls R-15/U-0.080; Floors R-21/U-0.047; Flat Ceilings R-38/U-0.031; Vaults R-21/U-0.055; Below-Grade Wood, Concrete or Masonry Walls R-15/C-0.069; Slab Edge R-10/F-0.52; Duct Insulation R-8. *R*-values used in this table are nominal, for the insulation only and not for the entire assembly. Window and skylight *U*-values shall not exceed 0.65 (CL65). A single door not to exceed 28 square feet (2.6 m^2) per dwelling unit is permitted to be excluded from the thermal performance calculations. All other Door-values shall not exceed 0.54 (Nominal R-2).

e. *U*-factors for wood-framed ceilings, walls and floor assemblies shall be as specified in Table N1104.1(2). *U*-factors for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using ASHRAE *Handbook of Fundamentals* procedures.

f. Vaulted area, unless insulated to R-38, 0.027, shall not exceed 50 percent of the total heated space floor area.

g. F = The heat loss coefficient, Btu/hr*ft^2*°F per foot of perimeter. C = the heat loss coefficient Btu/hr*ft^2*°F per square foot of underground wall.

h. A maximum of 28 square feet of exterior door area per dwelling unit can have a *U*-factor of 0.54 or less. Default *U*-factor for an unglazed wood door is 0.54.

i. Proposed UA must be less than or equal to CODE UA. For compliance with Envelope Measure 6, the Proposed UA must be a minimum of 8 percent less than the CODE UA.

TABLE N1104.1(2)
APPROVED DEFAULT *U*-FACTORS

FLAT CEILINGS [a]		
Insulation	**Type**	***U*-Factor**
R-38	Conventional framing	0.027
R-38	Advanced framing[c]	0.026
R-49	Conventional framing	0.021
R-49	Advanced framing[c]	0.020
R-60	Conventional framing	0.017
VAULTED CEILINGS [a]		
Insulation	**Type**	***U*-Factor**
R-21	Rafter framing	0.050
R-30	Rafter framing	0.032
R-38	Rafter framing	0.026
R-21	Scissors truss	0.052
R-30	Scissors truss	0.034
R-38	Scissors truss	0.027
R-49	Scissors truss	0.021
R-30	Advanced scissors truss[c]	0.032
R-38	Advanced scissors truss[c]	0.026
R-49	Advanced scissors truss[c]	0.020
EPS FOAM CORE PANEL VAULTED CEILINGS		
Insulation	**Type**	***U*-Factor**
R-29	$8^1/_4$″ EPS foam core panel	0.034
R-37	$10^1/_4$″ EPS foam core panel	0.027
R-44	$12^1/_4$″ EPS foam core panel	0.023
FLOORS [a]		
Insulation	**Type**	***U*-Factor**
R-21	Underfloor	0.046
R-25	Underfloor	0.039
R-30	Underfloor	0.033
R-38	Underfloor	0.026
SLAB-ON-GRADE		
Insulation	**Type**	***F*-Factor[f]**
R-10	Slab edge 24”	0.54
R-15	Slab edge 24”	0.52
EPS FOAM CORE PANEL EXTERIOR WALLS		
Insulation	**Type**	***U*-Factor**
R-14.88	$4^1/_2$″ EPS foam core panel	0.059
R-22.58	$6^1/_4$″ EPS foam core panel	0.040
R-29.31	$8^1/_4$″ EPS foam core panel	0.031
BELOW GRADE WALLS		
Insulation	**Type**	***C*-Factor**
R-10 c.i.	R-10 continuous insulation	0.085
R-15 c.i.	R-15 continuous insulation	0.063
R-13	R-13 cavity and air space	0.080
R-21	R-21 cavity and air space	0.063

EXTERIOR WALLS[a]			
Insulation	**Insulation Sheathing**	**Framing**	***U*-Factor**
R-15	0	Conventional framing	0.083
R-15	0	Intermediate framing[b]	0.078
R-19	0	Conventional framing	0.067
R-19	0	Intermediate framing[b]	0.063
R-19	0	Advanced framing[d]	0.062
R-21	0	Conventional framing	0.063
R-21	0	Intermediate framing[b]	0.059
R-21	0	Advanced framing[d]	0.057
R-13	3.5[e]	Conventional framing	0.065
R-13	5[e]	Conventional framing	0.059
R-13	7[e]	Conventional framing	0.053
R-13	3.5[e]	Advanced framing[d]	0.062
R-13	5[e]	Advanced framing[d]	0.056
R-13	7[e]	Advanced framing[d]	0.050
R-15	3.5[e]	Conventional framing	0.062
R-15	5[e]	Conventional framing	0.056
R-15	7[e]	Conventional framing	0.050
R-15	3.5[e]	Advanced framing[d]	0.057
R-15	5[e]	Advanced framing[d]	0.052
R-15	7[e]	Advanced framing[d]	0.047
R-19	3.5[e]	Conventional framing	0.052
R-19	5[e]	Conventional framing	0.048
R-19	7[e]	Conventional framing	0.044
R-19	3.5[e]	Advanced framing[d]	0.049
R-19	5[e]	Advanced framing[d]	0.046
R-19	7[e]	Advanced framing[d]	0.042
R-21	3.5[e]	Conventional framing	0.049
R-21	5[e]	Conventional framing	0.045
R-21	7[e]	Conventional framing	0.041
R-21	3.5[e]	Advanced framing[d]	0.046
R-21	5[e]	Advanced framing[d]	0.043
R-21	7[e]	Advanced framing[d]	0.039

For SI: 1 inch = 25.4 mm.

a. *U*-factors are for wood-framed construction. *U*-factors for other assemblies which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE *Handbook of Fundamentals* procedures.

b. Intermediate framing consists of wall studs placed at a minimum 16 inches on center with insulated headers. Voids in headers shall be insulated with rigid insulation having a minimum *R*-value of 4 per 1-inch (25.4 mm) (W/m^3-k) thickness.

c. Advanced framing construction for ceilings as defined in Section N1104.6.

d. Advanced framing construction for walls as defined in Section N1104.5.1

e. Insulation sheathing shall be rigid insulation material, installed continuously over entire exterior or interior of wall (excluding partition walls).

f. *F*-factor is heat loss coefficient in Btu/hr*ft^2*°F per lineal foot of concrete slab perimeter for 24 inches below-grade.

N1104.4.2 Combined products. When different window types are combined, mulled together by the manufacturer or manufactured to fit a framed rough opening, a single label may be used.

Exception: A solarium shall have one label providing a description of each of the glazed surfaces, such as the front, overhead and each side.

N1104.4.3 Air leakage requirements. Air infiltration rates for all exterior windows, swinging doors and sliding glass doors shall be certified in accordance with ASTM E283, *Standard Test Methods for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen*. Tests shall be conducted at a differential pressure of 1.57 pounds per square foot (75 Pa) [equivalent to 25 mph (40 km/h) wind condition].

1. Windows—0.37 cubic feet per minute (cfm) per foot (0.17 L/s per m) of sash crack.
2. Swinging doors—0.37 cfm per square foot (0.17 L/s per m^2) of door area.
3. Sliding doors—0.37 cfm per square foot (0.17 L/s per m^2) of door area.

Exception: Site-built windows.

N1104.4.4 Alterations. New windows shall have a maximum *U*-factor as required by Table N1101.1(1).

Exceptions:

1. Decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area may be exempt from thermal performance requirements and Table N1104.1(1) calculations.
2. Where necessary to retain architectural consistency with remaining windows in the building, new windows shall have a maximum *U*-value of 0.65.

N1104.5 Walls.

N1104.5.1 Advanced framing for walls. Advanced framing for walls shall be the prescriptive ~~is an optional~~ construction method as listed in Table N1101.1(1) and ~~. Advanced framing, when used to qualify a design under the requirements of Table N1104.1(1),~~ shall meet the following requirements:

1. Walls. Walls shall be framed with 2 × studs at 24 inches (406 mm) on center and shall include the following, as detailed in Items 2 and 3.
2. Corners and intersections. Exterior wall and ceiling corners shall be fully insulated through the use of three-stud corners configured to allow full insulation into the corner, or two-stud corners and drywall backup clips or other *approved* technique. Intersections of interior partition walls with exterior walls shall be fully insulated through the use of single backer boards, mid-height blocking with drywall clips or other approved technique.
3. Headers. Voids in headers 1 inch (25.4 mm) to 2 inches (51 mm) in thickness shall be insulated with insulation that has a value of R-4 or greater per 1-inch (25.4 mm) thickness. Voids in headers greater than 2 inches (51 mm) in depth shall be insulated to a minimum level of R-10. Nonstructural headers (such as in gable-end walls) shall be eliminated and replaced with insulation to achieve thermal performance levels equivalent to the surrounding area

N1104.5.2 Intermediate framing for walls. Intermediate framing for walls is an optional construction method. Intermediate framing, when used to achieve improved wall performance under the requirements of Table 1101.1(1) or Table N1104.1(2), shall meet the following requirements:

1. Walls. Walls shall be framed with 2 × studs at 16 inches (610 mm) on center and shall include the following, as detailed in Items 2 and 3.
2. Corners and intersections. Exterior wall and ceiling corners shall be fully insulated through the use of three-stud corners configured to allow full insulation into the corner, or two-stud corners and drywall backup clips or other approved technique. Intersections of interior partition walls with exterior walls shall be fully insulated through the use of single backer boards, mid-height blocking with drywall clips or other approved technique.
3. Headers. Voids in headers 1 inch (25.4 mm) to 2 inches (51 mm) in thickness shall be insulated with insulation that has a value of R-4 or greater per 1 inch (25.4 mm) thickness. Voids in headers greater than 2 inches (51 mm) in depth shall be insulated to a minimum level of R-10. Nonstructural headers (such as in gable-end walls) shall be eliminated and replaced with insulation to achieve thermal performance levels equivalent to the surrounding area.

N1104.5.3 Below-grade walls. Walls enclosing heated spaces below grade shall be insulated from the bottom of the above-grade subfloor downward to the top of the below-grade finished floor.

N1104.6 Roof/ceiling: advanced framing for ceilings. Advanced framing for ceilings is an optional construction method. Advanced framing, when used to qualify a design under the requirements of Section N1104.1, shall meet the following requirements.

Framing techniques shall be used in attics and ceilings to provide full insulating value to the outside of exterior walls. This shall be accomplished through the use of extra-depth or oversized trusses, double rafters, special insulation components installed at the edge of the wall, or other approved combinations of framing and insulation. The entire surface of the exterior ceiling shall be insulated to the required value including attic hatches, structural members, electrical fixtures (where allowed by the code) and plumbing penetrations.

N1104.7 Slab-on-grade floors. For slab-on-grade floors, the perimeter of the floor shall be insulated.

The insulation shall extend downward from the top of the slab for a minimum of 24 inches (610 mm) or downward to the bottom of the slab, then horizontally beneath the slab for a minimum total distance of 24 inches (610 mm).

Exception: For monolithic slabs, the insulation shall extend downward from the top of the slab to the bottom of the thickened edge.

N1104.7.1 Slab-on-grade floors with hydronic heat. For slab-on-grade floors that incorporate hydronic heating, in addition to

perimeter insulation, the entire underside of slab shall be insulated to R-10.

N1104.8 Air leakage. The building thermal envelope shall be constructed to limit air leakage in accordance with this section.

N1104.8.1 Air barriers. A continuous air barrier shall be installed and fully aligned with the building thermal envelope on every vertical portion of air-permeable insulation and on the warm side of horizontal, air-permeable insulation. Air-permeable insulation shall not be used as a sealing material.

Exception: Unvented attics, continuous insulation walls and similar conditions where an impermeable insulation layer forms an air barrier.

N1104.8.2 Sealing required. Exterior joints around window and door frames, between wall cavities and window or door frames, between walls and foundation, between walls and roof, between wall panels, at penetrations or utility services through walls, floors and roofs and all other openings in the exterior envelope shall be sealed in a manner approved by the *building official*. Sealing for the purpose of creating a continuous air barrier shall be in accordance with the applicable requirements of Table N1104.8, ~~or~~ and the *dwelling* shall be tested to demonstrate a blower door result not greater than 4.0 ACH50.

N1104.8.2.1 Top plate sealing. At all walls in contact with vented attics, the wall covering (gypsum board or other) shall be sealed to the top plate with caulk, sealant, gasket or other *approved* material.

N1104.9 Moisture control. To ensure the effectiveness of insulation materials and reduce the hazard of decay and other degradation due to condensation within the structure, moisture-control measures shall be included in all buildings and structures or portions thereof regulated by this chapter.

N1104.9.1 Vapor retarders. Vapor retarders shall be installed in accordance with Section R318.

N1104.9.2 Ground cover. A ground cover shall be installed in the crawl space for both new and existing buildings when insulation is installed. Ground cover shall be installed in accordance with Chapter 4.

TABLE N1104.8
AIR BARRIER INSTALLATION AND AIR SEALING REQUIREMENTS

COMPONENT	AIR BARRIER CRITERIA
General requirements	A continuous air barrier shall be installed in alignment with the building thermal envelope.
	Breaks or joints in the air barrier shall be sealed.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed.
	Access openings, drop-down stairs, or knee wall doors to unconditioned attic spaces shall be gasketed and sealed.
Walls	The junction of the foundation and sill plate shall be sealed.
	The junction of the top plate and the top of interior walls shall be sealed between wall cavities and windows or door frames.
	All penetrations or utility services through the top and bottom plates shall be sealed.
	Knee walls shall be sealed.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors shall be sealed.
Rim/band joists	Rim/band joists shall be a part of the thermal envelope and have a continuous air barrier.
Floors Including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.
Shafts, penetrations	Duct shafts, utility penetrations and flue shafts opening to exterior or unconditioned space shall be sealed.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.
Shower/tub on exterior walls	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.

N1104.10 Air Leakage Testing. The *building* or dwelling unit shall be tested and verified as having an air leakage rate in accordance with Section N1104.8.2. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM 779, or ASTM E1827 and reported at a pressure of 0.2-inch w.g. (50 Pa). Where required by the *building official*, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *building official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope.*

N1104.10.1 During testing. The *building* or *dwelling unit* shall meet all of the following conditions during testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weather-stripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

SECTION N1105
HEATING, VENTILATING AND AIR-CONDITIONING SYSTEMS

N1105.1 General. This section provides minimum requirements for heating, ventilating and air-conditioning systems.

N1105.2 Insulation of ducts. All new duct systems or new portions of duct systems exposed to unconditioned spaces, and buried ductwork within insulation that meets the exception to Section N1105.3, shall be insulated to minimum R-8.

Exceptions:

1. The replacement or addition of a furnace, air conditioner or heat pump shall not require existing ducts to be insulated to current code.
2. Exhaust and intake ductwork.

N1105.3 Installation of ducts. All new duct systems and air handling equipment and appliances shall be located fully within the building thermal envelope.

Exceptions:

1. Ventilation intake ductwork and exhaust ductwork.
2. Up to 5 percent of the length of an HVAC system ductwork shall be permitted to be located outside of the thermal envelope.
3. Ducts deeply buried in insulation in accordance all of the following:
   - 3.1. Insulation shall be installed to fill gaps and voids between the duct and the ceiling, and a minimum of R-19 insulation shall be installed above the duct between the duct and unconditioned attic.
   - 3.2. Insulation depth marker flags shall be installed on the ducts every 10 feet (3048 mm) or as *approved* by the *building official*.
   - 3.3 Duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with duct testing requirements below, is less than or equal to 4.0 cubic feet per minute (42.5L/min) per 100 square feet (9.29 m^2) of conditioned floor area by the duct system.

N1105.4 Duct Leakage Testing. Ducts shall be pressure tested to determine air leakage by one of the following methods:

1. **Rough-in test:** Total leakage shall be measured with a pressure differential of 0.1-inch w.g. (25 Pa) across the system including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.
2. **Postconstruction test:** Total leakage shall be measured with a pressure differential of 0.1-inch w.g. (25 Pa) across the system including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.

Exceptions:

1. A duct leakage test shall not be required when the ducts and air handlers are located entirely within the building thermal envelope.
2. A duct air leakage test shall not be required for ducts serving heat or energy recovery ventilators that are not integrated with ducts.

N1105.5 HVAC controls. All heating, ventilating and air-conditioning systems shall be provided controls as specified herein.

N1105.5.1 Temperature. Each heating, ventilating and air-conditioning system shall be provided with at least one thermostat for the regulation of temperature. Each thermostat shall be capable of being set from 55ºF to 75ºF (13ºC to 24ºC) where used to control heating only and from 70ºF to 85ºF (21ºC to 29ºC) where used to control cooling only. Where used to control both heating and cooling, it shall be capable of being set from 55ºF to 85ºF (13ºC to 29ºC) and shall be capable of operating the system heating and cooling in sequence. It shall be capable of providing a temperature range of at least 5ºF (-15ºC) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

N1105.5.2 Humidity. If a heating, ventilating and air-conditioning system is equipped with a means for adding moisture to maintain specific selected relative humidity in spaces or zones, a humidistat shall be provided. This device shall be capable of being set to prevent new energy from being used to produce space relative humidity above 30 percent. Where a humidistat is used in a heating, ventilating and air-conditioning system for controlling moisture removal to maintain specific selected relative humidity in spaces or zones, it shall be capable of being set to prevent new energy from being used to produce a space-relative humidity below 60 percent.

N1105.5.3 Temperature zoning. Each separate heating, ventilating and air-conditioning system shall be provided at least one thermostat for regulation of space temperature. In addition, a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating or cooling input to each zone or floor, excluding unheated or noncooled basements and garages.

N1105.5.4 Setback and shutoff. The thermostat, or an alternative means such as switch or clock, shall provide a readily accessible manual or automatic means for reducing the energy required for heating and cooling during periods of nonuse or reduced need.

Exceptions:

1. Where it can be shown that setback or shutdown will not result in a decrease in overall building energy.
2. Equipment with full-load demand of 2 kilowatts (6.826 Btu/h) or less may be controlled by readily accessible off-hour controls.

Lowering thermostat setpoints to reduce energy consumption of heating system shall not cause energy to be expended to reach the reduced setting.

N1105.5.4.1 Heat pump controls. All heat pump system thermostats shall be capable of manual setback and limiting the use of supplemental heat during warm-up periods.

N1105.5.4.1.1 Outdoor thermostat required. An outdoor thermostat or factory installed temperature sensor with electronic controls shall be used to lock out supplemental heat based on outdoor air temperature. The lock-out temperature shall be set at 4ºF (40ºC). There shall be no compressor lock-out temperature.

N1105.6 Outside combustion air. See Section R1006 for required outside combustion air for masonry fireplaces, factory-built fireplace and factory-built stoves.

N1105.7 Ventilation fan efficiency. Bathroom exhaust fans and outdoor ventilation air supply fans shall be Energy Star certified.

N1105.8 Furnace fan efficiency. New central furnaces shall have electronically commutated fan motors with a fan efficiency rating meeting 10 CFR 430.32(y).

SECTION N1106
PIPING INSULATION

N1106.1 Mechanical system piping insulation. Mechanical system piping capable of carrying fluids above 105ºF (40.5ºC) or below 55ºF (13ºC) shall be insulated to a minimum of R-3.

N1106.2 Domestic and service hot water systems. Domestic hot water piping shall be insulated to a minimum of R-3 at the following locations:

1. Pipe located outside the building thermal envelope.
2. The first 8 feet (2438 mm) of pipe into and out of a water heater.
3. Recirculating water piping.

SECTION N1107
LIGHTING AND POWER

N1107.1 General. The provisions of this section apply to lighting equipment, solar and electric vehicle ready technology, related controls and electric circuits serving all conditioned and unconditioned interior floor space and exterior building facades of all dwelling units and guest rooms within residential buildings and structures, or portions thereof.

N1107.2 High-efficiency interior lighting. All permanently installed lighting fixtures shall be *high-efficiency light sources*.

The building official shall be notified in writing at the final inspection that the permanently installed lighting fixtures have met this requirement.

Exception: Two permanently installed lighting fixtures are not required to be *high-efficiency light sources* when controlled by a dimmer or automatic control.

N1107.3 High-efficiency exterior lighting. All exterior lighting fixtures affixed to the exterior of the building shall be *high-efficiency light sources*.

Exception: Two permanently installed lighting fixtures are not required to be *high-efficiency light sources* when controlled by automatic control.

N1107.4 Solar ready construction. New detached one- and two-family *dwellings* and *townhouses* classified as Group R-3, shall comply with Sections N1107.4.1 through N1107.4.4.

Exceptions:

1. New detached one- and two-family *dwellings* and *townhouses* with a permanently installed on-site renewable energy system, or an active permit application for an on-site permanently installed renewable energy system, as determined by the *building official*.
2. A building where there is less than 600 square feet (55.74 m^2) of roof area oriented between 90 degrees and 270 degrees of true north.
3. A building where all areas of the roof that would otherwise meet the requirements of Section N1107.4 have a Total Solar Resource Fraction (TSRF) less than 80 percent.

N1107.4.1 Construction documents. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in sufficient detail that the work will conform with Section N1107.4. Information on construction documents shall include but are not limited to: location and size of the *solar ready zone*, junction boxes terminating the interconnection pathway, and other pertinent data to indicate conformance.

N1107.4.2 Solar ready zone. New detached one- and two-family *dwellings* with not less than 600 square feet (55.74 m^2), and townhouses with not less than 300 square feet (27.87 m^2) of contiguous roof area, located on a single roof plane, oriented in a single direction other than north, shall indicate a *solar ready zone* on the construction documents.

The total *solar ready zone* area shall be not less than 300 square feet (27.87 m^2). Where composed of more than one *solar ready zone*, individual zones shall be composed of areas not less

than 5 feet (1.524 m) in width and not less than 80 square feet (7.44 m^2) in area. The *solar ready zone* shall be exclusive of access, pathways, or setback areas in accordance with Section 3111 of the *Building Code.*

Exception: A townhouse dwelling unit with a total floor area less than or equal to 2,000 square feet (185.8 m^2) shall have a *solar ready zone* area of not less than 150 square feet (13.94 m^2) per dwelling unit.

N1107.4.2.1 Obstructions. *Solar ready zones* shall be free from obstructions, including but not limited to: mechanical exhaust vents, chimneys, and roof-mounted equipment.

Exception: Plumbing vents may be located in the *solar ready zone*.

N1107.4.2.2 Shading. The *solar ready zone* shall be set back from any existing or new, permanently affixed object on the building or site that is located south, east or west of the solar zone a distance not less than two times the objects height above the nearest point on the roof surface. Such objects include, but are not limited to: taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees and roof plantings.

N1107.4.3 Solar interconnection pathway and termination. A square metal junction box not less than 4 inches by 4 inches (102 mm by 102 mm) with a metal box cover shall be provided within 24 inches (610 mm) horizontally or vertically of the main electrical panel. A minimum ¾-inch (19 mm) nonflexible metal raceway with a pull string shall extend from the junction box to a capped roof termination or to an accessible location in the *attic* with a vertical clearance of not less than 36 inches (914 mm).

Where the raceway terminates in the *attic*, the termination shall be in a metal junction box not less than 4 inches by 4 inches (102 mm by 102 mm) with a box cover located not less than 6 inches (152 mm) above the insulation. The ~~end of the raceway~~ junction box shall be marked as "RESERVED FOR SOLAR."

Exception: In lieu of ¾-inch (19 mm) nonflexible metal raceway, a minimum of two No. 10 copper 3-wire with ground Metal Clad (MC) cable shall be installed ~~from~~ between the junction boxes with ~~to the termination point including~~ 6 inches (152 mm) of free conductor in each junction box. ~~additional wire is permitted.~~

N1107.4.4 Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a double-pole circuit breaker for future solar electric installation and shall be labeled "RESERVED FOR FUTURE SOLAR."

N1107.5 Electric vehicle ready construction. Detached one- and two-family *dwellings* and *townhouses* classified as Group R-3, with attached private garages or off-street parking spots adjacent to the dwelling shall comply with Sections N1107.5.1 through N1107.5.3.

Exception: Where an interior or exterior Level II Charging Station is installed at time of construction

N1107.5.1 Construction documents. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in sufficient detail that the work will conform with Sections N1107.5.1 through N1107.5.3. Information on construction documents shall include, but are not limited to: an electric vehicle interconnection pathway and the location of future electric vehicle space(s) and electric vehicle charger(s).

N1107.5.2 Electric vehicle interconnection pathway and termination. A listed raceway, for each dwelling unit, to accommodate a dedicated branch circuit shall be provided. The raceway shall not be less than ¾ inch (19 mm). The raceway shall be securely fastened at the main service or subpanel and shall terminate in close proximity to the proposed location of the charging system into a *listed* cabinet, box or enclosure. Raceways shall be continuous at enclosed or concealed areas and spaces and provided with a pull string. A raceway may terminate in another location, approved by the local *building official*, when it can be demonstrated that the area is accessible and no removal of materials is necessary to complete the final installation.

N1107.5.3 Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a double-pole circuit breaker for future electric installation of at least one 50-Amp breaker labeled "RESERVED FOR FUTURE EV CHARGER".

SECTION N1108
PLUMBING FIXTURE EFFICIENCY

N1108.1 General. This section shall apply to plumbing fixture efficiency.

N1108.1.1 Fixture efficiency. Fixture efficiency shall be per the *Plumbing Code*.

N1108.2 Application of WEStand. Those portions of the 2017 WEStand, *Water Efficiency and Sanitation Standard for the Built Environment*, as published by International Association of Plumbing and Mechanical Officials (IAPMO) shall apply, where applicable to the building or *dwelling unit.*

PART II—ALTERNATIVE SYSTEMS ANALYSIS

SECTION NA1109
ALTERNATIVE SYSTEMS ANALYSIS

This section provides an alternative method of demonstrating code compliance with this chapter by demonstrating a minimum Energy Rating Index (ERI) score ~~that such deviation will result in an annual energy consumption equal to or less than a building that is in compliance with this chapter~~.

~~NA1109.1 Annual energy consumption.~~ ~~The baseline design, conforming to requirements specified in this Chapter and the proposed design shall be analyzed using the same procedures. The analyses shall use equal floor area and equal environmental requirements. The comparison shall be expressed in Btu input per gross building square foot of conditioned space per year (MJ/m^2 per year). The annual energy use of the proposed building shall be 8 percent less than the code baseline prescriptive requirements without the application of additional measures in accordance with Table N1101.1(2).~~

NA1109.1 Energy Rating Index (ERI) Path. Compliance with this section requires that the thermal envelope of the project meet or exceed the efficiency requirements of Section N1104 and the *rated design* shall be shown to have a score less than or equal to the values in Table NA1109.1 when compared to the *ERI reference design* determined in accordance with RESNET/ICC 301, excluding renewable power.

TABLE NA1109.1
MAXIMUM ENERGY RATING INDEX (ERI)

Climate Zone	ERI not including OPP
4C	53
5B	52

~~NA1109.2 Basis for comparison.~~ ~~Both baseline and proposed alternative designs shall include parameters as specified in Table NA1109.2.~~

~~NA1109.2.1 Internal heat gain.~~ ~~The total internal heat gain shall be calculated by Equation NA1109.2.1(1). For single zone calculations, the daily total sensible internal gains (Btu/day) shall be determined by Equation NA1109.2.1(2). For multiple-zone HVAC systems, the daily total sensible internal gains (Btu/day) shall be determined by Equation NA1109.2.1(2) for the living zone and Equation NA1109.2.1(3) for the sleeping zone. The daily total latent load for each zone shall be determined using Equation NA1109.2.1(4).~~

~~Internal heat gains shall be distributed over the day according to the profile in Table NA1109.2.~~

~~Where multiple zone space conditioning is modeled, the profile shown for Zone 2 shall be used for bedrooms and bathrooms; the profile shown for Zone 1 shall be used for all other conditioned rooms. Where single zone space conditioning is modeled, the hourly profile for single-zone designs shall be used.~~

~~Equation NA1109.2.1(1)~~

~~Total Heat Gains = Sensible Heat Gains + Latent Heat Gains~~

~~Equation NA1109.2.1(2)~~

~~Single Zone or Living Zone: Sensible Heat Gains = (Floor Area of Zone 15 Btu/day ft^2) + (Number of living units 20,000 Btu/day)~~

~~Equation NA1109.2.1(3)~~

~~Sleeping Zone: Sensible Heat Gains = Floor Area of Zone 15 Btu/day ft^2~~

~~Equation NA1109.2.1(4)~~

~~Latent Heat Gains = 0.2 Sensible Heat Gains~~

~~TABLE NA1109.2~~
~~BASIS FOR COMPARISON~~

~~INPUT PARAMETERS FOR ANALYSIS~~		
~~Parameter~~	~~Proposed Building~~	~~Code Baseline~~
~~Building Envelope~~		
~~Opaque construction materials~~	~~As designed~~	~~Code minimum~~
~~Fenestration performance~~	~~As designed~~	~~Code minimum~~
~~Shading devices~~	~~As designed~~	~~Same as proposed~~
~~Window area~~	~~As designed~~	~~Same as proposed~~
~~Skylight area~~	~~As designed~~	~~Same as proposed[a]~~
~~Building orientation~~	~~As designed~~	~~Same as proposed~~
~~Solar gain~~	~~As designed~~	~~Same as proposed~~
~~Building infiltration~~	~~0.3 ACH Natural~~	~~Same as proposed~~
~~HVAC Systems~~		
~~HVAC system type(s)~~	~~As designed~~	~~Same as proposed~~
~~HVAC efficiency~~	~~Code efficiencies[b]~~	~~Same as proposed[b]~~
~~Heating fuel~~	~~As designed~~	~~Same as proposed~~
~~Cooling fuel~~	~~As designed~~	~~Same as proposed~~
~~Temperature setpoints~~	~~As designed~~	~~Same as proposed~~
~~Equipment capacity~~	~~As designed~~	~~Same as proposed~~
~~Mechanical ventilation~~	~~As designed~~	~~Same as proposed~~
~~Lighting~~		
~~Artificial lighting~~	~~As designed~~	~~Code required~~
~~Daylighting~~	~~As designed~~	~~Same as proposed~~
~~Design Conditions~~		
~~Building occupancy~~	~~As designed~~	~~Same as proposed~~
~~Building operational schedules~~	~~As designed~~	~~Same as proposed~~
~~Climatic data~~	~~As designed~~	~~Same as proposed~~
~~Internal loads~~	~~As designed~~	~~Same as proposed~~
~~Cooking fuel~~	~~As designed~~	~~Same as proposed~~

~~a. Code baseline skylight area shall be same as proposed up to a maximum of two percent of the heated space floor area.~~

~~b. Systems not regulated by code, such as electric heat, shall comply with standard equipment efficiency for such equipment.~~

~~NA1109.2.2 Thermostat setpoints.~~ ~~In the analysis for both the baseline and proposed designs, all conditioned spaces shall be maintained at the specified thermostat setpoints at all times except for minor deviations at thermostat setback and setup and when outdoor conditions exceed normal design conditions.~~

~~If the specified equipment in the proposed design is too small to meet the load, its capacity shall be increased in the calculations. If equipment to meet a load is not included in the design, such equipment shall be assumed in the calculations and its energy use included. In no case shall the energy use of proposed design be reduced by not conditioning its spaces.~~

~~For central space conditioning systems without zonal control, the entire conditioned floor area shall be on thermostatically~~

controlled zone. The thermostat settings shall be those listed for a single zone in Table NA1109.2.2. For multiple zone designs, the multiple zone thermostat settings in Table NA1109.2.2 shall be used. Zone 1 represents all conditioned spaces other than Zone 2 (bedrooms and bathrooms). The effect of heat transfer between zones, including nonclosable openings shall be included in the calculation

N**A1109.3 Analysis procedure.** The analysis of the annual energy usage of the standard and the proposed alternative building and system designs shall meet the following criteria:

TABLE NA1109.2.2
THERMOSTAT SETTINGS (°F)

TIME OF DAY	SINGLE ZONE		MULTIPLE ZONE			
	Heat	Cool	Zone 1 Living		Zone 2 Sleeping	
			Heat	Cool	Heat	Cool
6 – 9 a.m.	68	78	68	78	68	78
9 a.m. – 5 p.m.	68	78	68	78	60	85
5 – 11 p.m.	68	78	68	78	68	78
11 p.m. – 6 a.m.	60	78	60	85	60	78

NA1109.3.1 The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be of sufficient detail to permit the evaluation of effect of building data (such as orientation, size and shape, and transfer characteristics of mass, air, moisture and heat) and hourly climatic data.

NA1109.3.2 The calculation procedure used to simulate the operation of the building and its service systems through a full-year operating period shall be of sufficient detail to permit the evaluation of the effect of system design, climatic factors, operational characteristics and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of all systems and equipment. The calculation procedure shall be based on 8,760 hours of operation of the building and its service systems and shall utilize techniques recommended in the appropriate ASHRAE publications or produce results consistent with such recommended procedures.

NA1109.3.2.1 The calculation procedure shall explicitly cover the following items:

1. Climatic data: coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.
2. Building data: orientation, size, shape, mass, air, moisture and heat transfer characteristics.
3. Operational characteristics: temperature, humidity, ventilation, illumination, control mode for occupied and nonoccupied hours.
4. Mechanical equipment: design capacity, part load profile.
5. Internal heat generation: lighting, equipment, number of people during occupied and nonoccupied periods.

NA1109.4 Documentation. Proposed alternative designs, submitted as requests for exceptions to the standard design criteria, shall be accompanied by an energy analysis comparison report prepared by a registered engineer. The report shall provide sufficient technical detail describing the differences between the two building and systems designs and on the data used in and resulting from the comparative analysis.

NA1109.4.1 The documentation shall demonstrate that the analysis used is consistent with the techniques and procedures specified in this section and the following ASHRAE documents:

1. 2001 ASHRAE *Handbook of Fundamentals*.
2. 2000 ASHRAE *Handbook of HVAC Systems and Equipment*.
3. ASHRAE *Principles of Heating, Ventilating and Air Conditioning*.

PART III—MECHANICAL VENTILATION

SECTION NM1101
MECHANICAL VENTILATION

NM1101.1 System design. The whole-house ventilation system shall consist of one or more supply or exhaust fans, or a combination of such, and associated ducts and controls. The whole house ventilation system shall provide balanced ventilation. Local exhaust or supply fans are permitted to serve as part of such a system. Outdoor air ducts connected ventilation provided by a supply fan ducted to the return side of an air handler shall be considered as providing supply ventilation for the balanced system and shall not be interlocked with the furnace fan (if present).